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HERA-1A, HEAT TRANSFER IN ROD ASSEMBLIES

A computer programme
for steady state thermo-hydraulic analysis of multirod fuel bundles
cooled by liquid metal under non-boiling conditions

by

R. NIJSING and W. EIFLER

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Joint Nuclear Research Centre
Ispra Establishment - Italy

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ABSTRACT

The present report provides a description of HERA-1A, a computer programme for steady state thermo-hydraulic analysis of multirod fuel bundles with liquid metal cooling. A description is given of the physical model and mathematical procedures underlying the programme. A complete listing of the programme with sample output is given as appendix.

KEYWORDS

H CODES
FUEL ELEMENT CLUSTERS
HEAT TRANSFER
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SODIUM
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1. INTRODUCTION

This report presents the HERA computer programme for steady state thermohydraulic analysis of multirod fuel bundles cooled by an incompressible fluid under non-boiling conditions. The present version 1 A of HERA considers a hexagonal fuel rod assembly cooled by sodium. It essentially applies to bundles of bare rods and to bundles with grid type spacers. It may also be used for bundles with helical spacers, but it is recognized that for these geometries intersubchannel transport phenomena at the edge of the bundle are not described in an entirely satisfactory way.

The HERA computer programme is based on a "lumped parameter" approach involving subdivision of the bundle flow area into a number of parallel subchannels and characterization of the hydrodynamic and thermal conditions of the coolant in each of these subchannels by bulk average values. Hydrodynamic and thermal interactions between adjacent subchannels are described in terms of mixing coefficients. The present version of HERA is chiefly aimed at evaluating how intersubchannel mixing attenuates differences in subchannel coolant temperature that arise from a lateral power gradient along the diagonal of the hexagonon and/or from differences in the subchannel geometry.

For arrays of bare rods both turbulent diffusion and conduction contribute to intersubchannel mixing. In the presence of helical spacers the dominating mechanism (unless for small pitch to diameter ratios, say beneath 1.08) is the periodic transverse flow induced by the spacer. Grids cause enhanced turbulent mixing and in the edge region of the bundle, where both coolant velocities and grid flow resistance coefficients are likely to vary among subchannels, they may give rise to lateral pressure gradients causing cross flow. In the present version of HERA cross flow effects are ignored and for the case of helical spacers intersubchannel heat transport is described in terms of a continuous mixing model and not in terms of a doubtless more realistic periodic mixing model.

The computer programme HERA-1A computes subchannel coolant mass flow rates, subchannel coolant enthalpies and various derived parameters of engineering interest. Axially averaged coolant mass flow rates result from subchannel momentum balances over the fuel rod bundle length. In these balances account is taken of pressure drop across the fuel element, friction at the subchannel walls, pressure drop across the grids and intersubchannel mixing between adjacent subchannels. The axial distribution of subchannel coolant enthalpies is found from subchannel heat balances that lead to a system of linear first order differential equations, each made up of an axial enthalpy gradient term and of terms accounting for transport of heat between adjacent subchannels and for subchannel heat input. The latter is determined from the lateral and axial power distributions which can be matched by analytical expressions.

An outstanding feature of the HERA computer programme is that the mathematical solution of the coolant enthalpy differential equation system is obtained analytically via the solution of an algebraic eigenvalue problem. This provides the homogeneous part of the solution for the subchannel coolant enthalpy distribution, that depends exclusively on the geometrical configuration, the subchannel mass flow distribution and the mixing characteristics. The power distribution characteristics have an effect only on the "particular" solution. The chief part of the computation time is bound up with the solution of the eigenvalue problem, whereas the formulation of the "particular" solution requires very little time. As a consequence it becomes possible to obtain results for a number of additional different power distributions, other conditions remaining unvaried, with only a slight increase of computation time.

The HERA computer programme further is characterized by the simplicity of the procedure for specifying input data. E.g. subchannel data (subchannel sections, wetted perimeters, heated perimeters, hydraulic diameters, characterization of subchannel interactions etc.) are not specified as input information, but they are evaluated in the programme. This approach makes it necessary to focus the attention on a specific rod bundle geometry. The present version of the HERA programme considers rod assemblies with a triangular lattice in hexagonal boxes as employed in reactors of the fast breeder type.

The following chapters present an outline of the physical models and of the mathematical procedures underlying the programme and furnish a description of this programme. A somewhat more detailed account of the physical and mathematical aspects underlying the HERA rod bundle analysis will be published in a separate paper[1].

2. OUTLINE OF PHYSICAL MODELS AND BASIC EQUATIONS

2.1 Hydrodynamic and thermal subchannel interactions

2.1.1 Assemblies of bare rods

The present considerations regard intersubchannel transport of momentum and heat in assemblies of bare parallel rods. It is assumed that molecular diffusion (i.e. conduction, applying to heat transport only) and turbulent diffusion represent the sole mechanisms contributing to this transport process. Subchannel mass flow rates are assumed to be invariant with axial position. Coolant density variations are ignored. Momentum and heat mixing coefficients $\alpha(I, J)$ and $\beta(I, J)$ characterizing transport between subchannels I and J (see Fig. 1) are defined by:

$$\alpha(I, J) = \frac{Q_m}{dz\,[\rho U(I) - \rho U(J)]} \tag{1}$$

$$\beta(I, J) = \frac{Q_h}{dz\,[H(I) - H(J)]} \tag{2}$$

Here Q_m/dz and Q_h/dz represent intersubchannel flows of momentum and heat per unit of length whereas U(I) and H(I) denote bulk average values of axial velocity and coolant enthalpy (the latter at a given axial position z) in a subchannel I. Assuming Q_m and Q_h to be invariant with φ in the interval $-\varphi_c(J) \leq \varphi \leq \varphi_c(I)$ at any φ value in this interval holds:

$$\frac{Q_m}{dz} = - 2\, Y_\varphi \varepsilon_\varphi\, \rho\, \frac{d u_{1.m.\varphi}}{r_{eff.}\, d\varphi} \tag{3}$$

$$\frac{Q_h}{dz} = - 2\, Y_\varphi (\psi\, \varepsilon_\varphi + a)\, \rho\, \frac{d H_{1.m.\varphi}}{r_{eff.}\, d\varphi} \tag{4}$$

Here Y_φ is a radial distance parameter given for the example of Fig. 1 by:

$$Y_\varphi = \frac{p(I, J).\, R}{\cos\varphi} - R \tag{5}$$

where p(I, J) is the pitch to diameter ratio of the rods separating subchannels I and J. The parameter r_{eff} denotes an effective radial position approximated by:

$$r_{eff.} = p(I, J)\, R \tag{6}$$

An assumption must be made with regard to the circumferential position inside a subchannel I at which the radially averaged velocity $u_{1.m.\varphi}$ and enthalpy $H_{1.m.}$ equal the subchannel bulk values U(I) and H(I). The pessimistic option made in the HERA programme is that this occurs at the position $\varphi_c(I)$ corresponding to the centroid of I. The (radially averaged) turbulent diffusivity ε_φ is expressed by:

$$\varepsilon_\varphi = CEF.\, Y_\varphi \left[\frac{\tau_w(I)}{\rho}\right]^{1/2} \tag{7}$$

with CEF = 0.154[2]. The following expression is employed for the ratio of turbulent diffusivities for heat and momentum transfer:

$$\psi = 1.38\, [\, 1\text{-}\exp(-12.4\; 10^{-5}\; ANF.YF\; Re.Pr^{1/3})\,] \tag{8}$$

which is a modification of the relation due to Bobkov et al.[3]. Here ANF denotes the ratio of turbulent diffusivities in circumferential and radial direction and YF the ratio of circumferentially averaged profile length Y_φ to the hydraulic diameter. Integrating eqs. (3) and (4) circumferentially in the interval $-\varphi_c(J)$ and $+\varphi_c(I)$ yields:

$$[\alpha\, (I, J)\,]^{-1} = \int_{-\varphi_c(J)}^{+\varphi_c(I)} \frac{p(I, J)R}{2Y_\varphi\, \varepsilon_\varphi}\, d\varphi \tag{9}$$

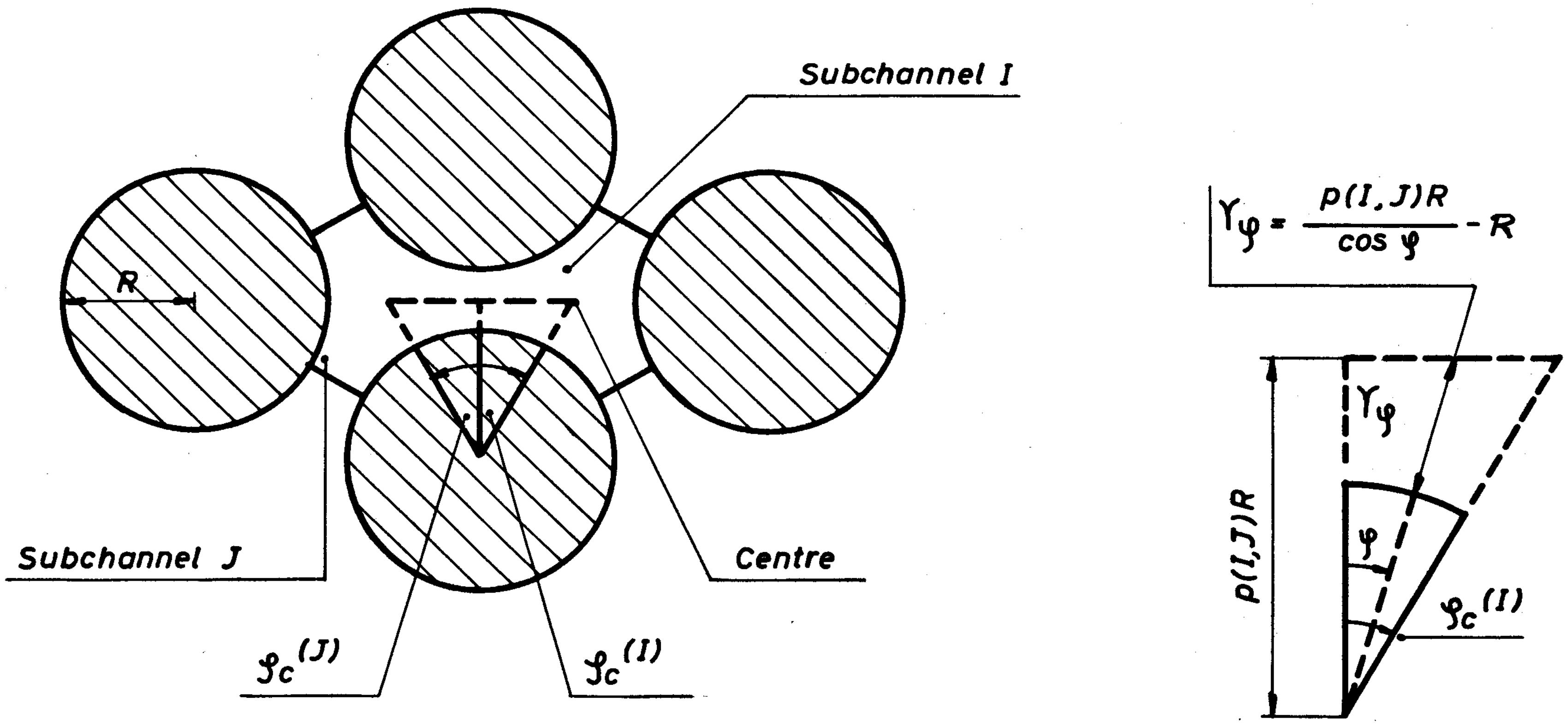


Fig. 1 TURBULENT DIFFUSIVE TRANSPORT BETWEEN CENTRAL SUBCHANNELS I AND J

$$[\beta(I, J)]^{-1} = \int_{-\varphi_c(J)}^{\varphi_c(I)} \frac{p(I, J)\ R}{2Y_\varphi(\psi\,\varepsilon_\varphi + a)\,\rho}\, d\varphi \tag{10}$$

It is worth pointing out that the physical properties underlying the computation of $\alpha(I, J)$ and $\beta(I, J)$ are taken at the spatially averaged coolant temperature in the fuel element.

2.1.2 Grid effects

The presence of grids will cause an augmentation of intensity and scale of turbulence in the downstream region, entailing an increase of turbulent diffusivity compared to that in assemblies of bare rods. In the vicinity of the channel wall, where coolant velocities and grid flow resistance coefficients are likely to vary from one subchannel to the other, lateral pressure differences will develop leading to intersubchannel cross flow at positions both upstream and downstream of a grid. The model in the present computer programme considers the enhancement of turbulent diffusion to be constant over the axial distance interval between two grids. The effect of cross flow on intersubchannel heat transport is taken into consideration in an approximate manner by introducing a grid mixing coefficient $\gamma(I, J)$ for macroscopic interactions between a subchannel I and a neighbouring subchannel J is defined by a heat balance across the grid for the subchannel I:

$$H(I)_d = H(I)_u + \sum^{N(I)} \frac{\gamma(I, J)}{G(I)} \left[H(J)_u - H(I)_u \right] \tag{11}$$

Here the subscripts d and u denote downstream and upstream positions. The summation in the second right hand term of eq. (11) is carried out over the number of bounding subchannels N(I).

2.1.3 Assemblies of rods provided with helical spacers

The configuration considered (see Fig. 2) is one in which the rods are spaced by helical wires, all turning in the same direction. The dominating physical mechanism underlying mixing is here a periodic transverse mass flow between adjacent subchannels, induced by the axially varying circumferential position of the spacer. The transverse mass flow between two central subchannels and between a central subchannel and a peripheral subchannel undergoes a periodic variation over characteristic axial distance intervals h, changing direction at distance intervals h/2. Here h is the axial spacer pitch. The transverse mass flow between peripheral subchannels is of the single direction type, varying only in magnitude over the characteristic axial length h. The above behaviour is illustrated in Fig. 3. At axial locations where the spacer traverses the gap between rods in the direction from subchannel I towards subchannel J the transverse mass flow reaches maximum values. The fluid, obliged to follow the spacer bodily into J, transports enthalpy at a rate given by:

$$\frac{Q_h}{dz} = \beta(I)\, H_g(I, J) \qquad (12)$$

where $\beta(I)$ is a single direction convective transport coefficient given by:

$$\beta(I) = d_s \pi \, \frac{d+d_s}{h} \, \rho \, U_g(I, J) \qquad (13)$$

In the above equations $U_g(I, J)$ and $H_g(I, J)$ represent the axial coolant velocity and the coolant enthalpy respectively in the gap (I, J). For a correct description of the mixing behaviour in multirod systems with helical spacers it is necessary to have information on the axial variation of transverse mass flow (related to β (I)) and on the mixing behaviour within a single subchannel. The latter providing the possibility to establish the difference $H(I) - H_g(I, J)$ and $U(I) - U_g(I, J)$.

The model adopted in the present computer programme is a continuous

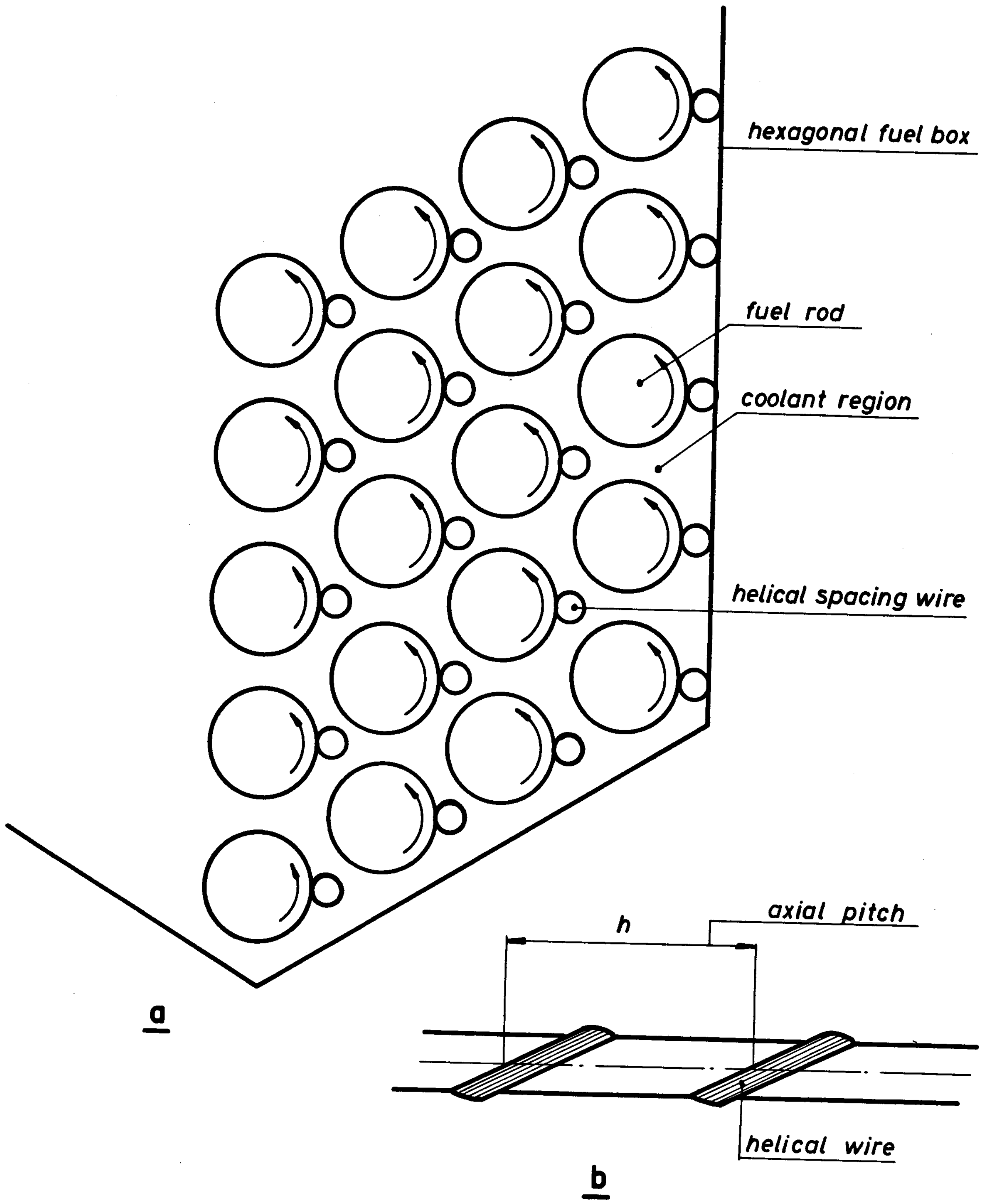
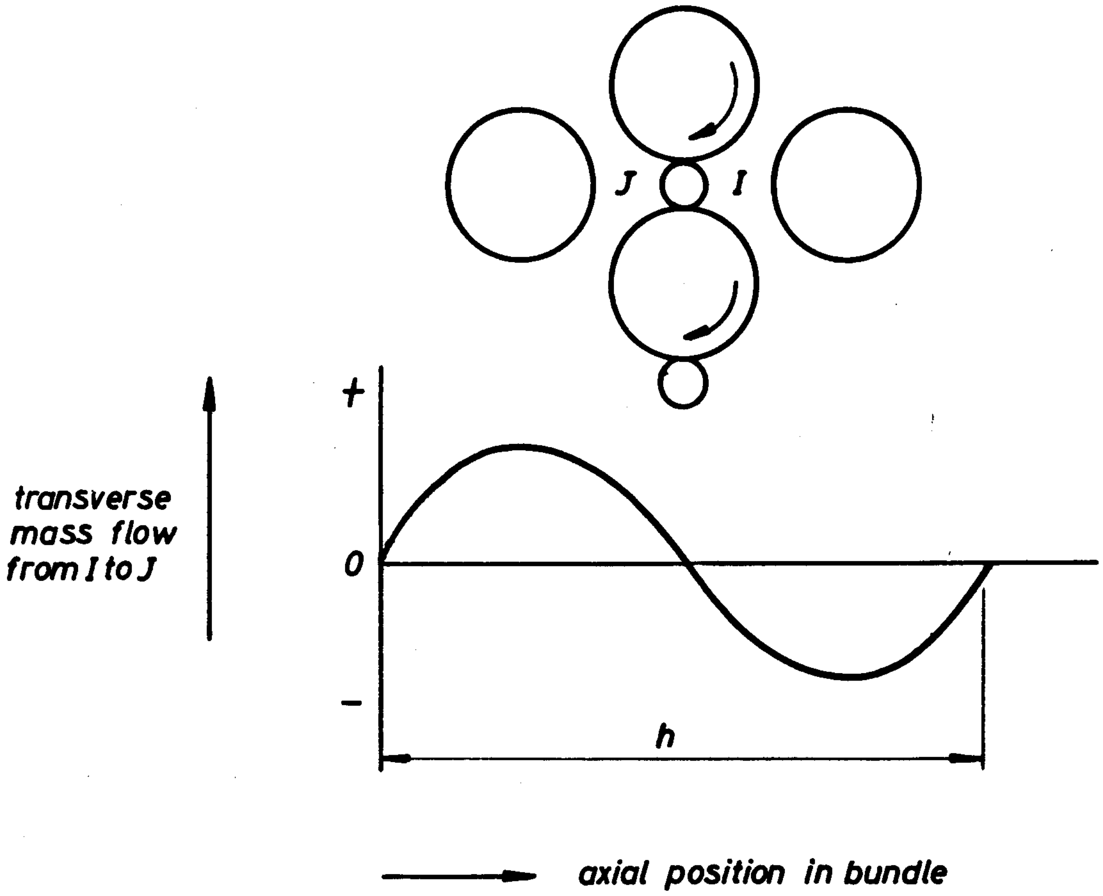
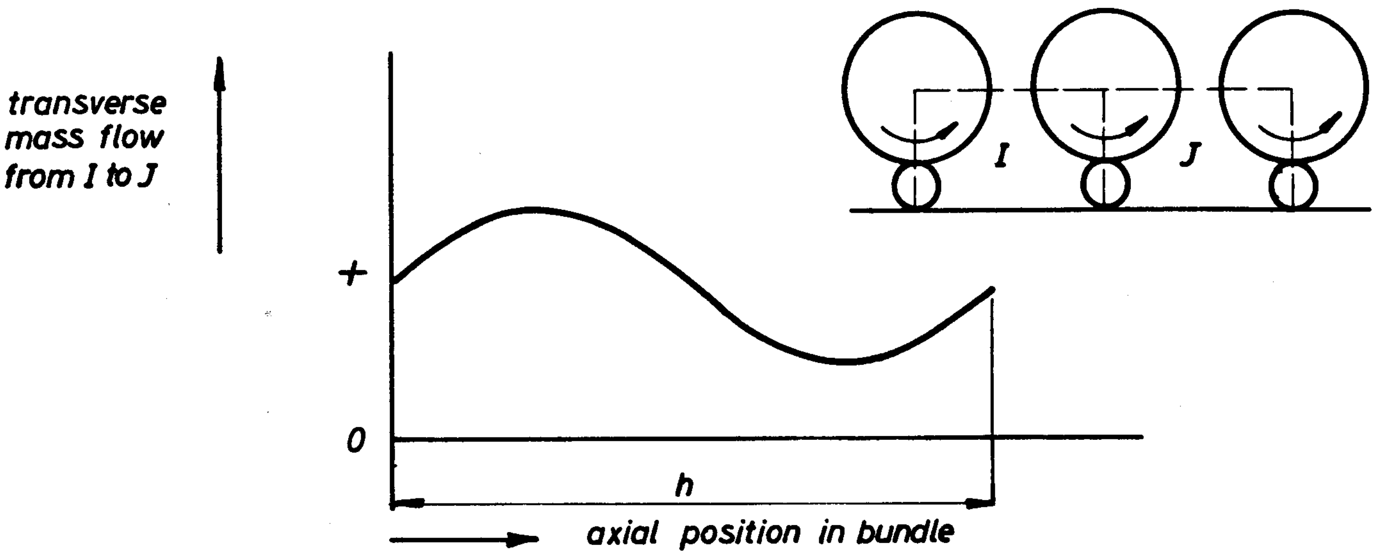


Fig. 2 HEXAGONAL FUEL ROD BUNDLE WITH HELICAL SPACING WIRES



a periodic variation of transverse mass flow between 2 central subchannels



b periodic variation of transverse mass flow between 2 peripheral subchannels

Fig. 3 MIXING BEHAVIOUR IN BUNDLE WITH HELICAL SPACERS

mixing model, i. e. the intersubchannel transport effects are averaged axially. For interactions between central subchannels or between a central subchannel and a peripheral subchannel where transport is of the two-direction type, the following procedure is adopted:

(a) $H_g(I, J)$ and $U_g(I, J)$ are assumed to equal the bulk average values H(I) and U(I) in the subchannel I from which the flow is being deflected;

(b) intersubchannel heat flows, alternating direction at axial distance intervals h/2, are assumed to be constant in each of these intervals and equal to the predictions of the maximum rate expressions (12) and (13). This results into the following expression for the mixing coefficient $\beta(I, J)$ as defined by eq. (2):

$$\beta(I, J) = \frac{1}{4} d_s \pi \frac{d+d_s}{h} \rho \left[U(I) + U(J) \right] \tag{14}$$

One has to be careful in applying the continuous mixing model to interactions between peripheral subchannels where a single direction transport mechanism is operative. It follows from continuity considerations that the axially averaged lateral mass flow between peripheral subchannels must be the same for each subchannel. The value of $U_g(I, J)$ in the "axially averaged version" of eq. (13) thus ought to be a constant e. g. an averaged peripheral subchannel velocity U_p. Employing a procedure similar to that outlined above, leads to the following rate expressions:

$$\frac{Q_h}{dz} = \beta(I)\, H(I) \tag{15}$$

$$\beta(I) = d_s\, \pi \frac{d+d_s}{h} \rho\, U_p \tag{16}$$

Applying the above two equations in the matrix differential equation for the subchannel coolant enthalpy distribution gives rise to an asymmetric matrix with complex eigenvalues. This would give rise to additional complexity in the present computer programme which was not considered justified. For the peripheral subchannels therefore also a two-directional transport model*)

*) providing optimistic results

was adopted with $\beta(I, J)$ given by:

$$\beta(I, J) = \frac{1}{2} d_s \pi \frac{d+d_s}{h} \rho \left[U(I) + U(J) \right] \tag{17}$$

Since intersubchannel mixing of momentum and heat are governed here by the same mechanism, one has in view of eqs. (1) and (2) for the momentum mixing coefficient $\alpha(I, J)$:

$$\alpha(I, J) = \beta(I, J)/\rho \tag{18}$$

It is worth pointing out that expressions for the mixing coefficients also may be specified as input data, instead of calculating the latter with eqs. (16) and (17).

2.2 Subchannel coolant mass flow distribution

The chief aim is to compute the distribution of axially averaged subchannel coolant mass flow rates. Axial changes in coolant density, leading to acceleration pressure drop, are ignored and no consideration is given to axial variations in subchannel mass flow due to the presence of spacing devices. The computation procedure is illustrated for the case of a rod bundle with grid type spacing.

A momentum balance set up for a subchannel I over the entire fuel element length Z_t yields:

$$\underbrace{\tau_w(I) W_p(I)}_{\text{friction}} + \underbrace{\sum_J N(I)\, \alpha(I, J) \left[\rho U(I) - \rho U(J) \right]}_{\text{diffusional interchange with neighbouring subchannels}}$$

$$+ \underbrace{\frac{1}{2} n_g c_g(I) \rho U(I)^2 S(I)/Z_t}_{\text{grid pressure drop}} = \underbrace{(P_i - P_o) S(I)/Z_t}_{\text{total pressure drop}} \tag{19}$$

Here $W_p(I)$ and $S(I)$ are the wetted perimeter and flow area of subchannel I, whereas n_g and $c_g(I)$ denote the total number of grids and the grid flow resistance respectively. Eq. (19) implies the usual assumption of uniform coolant pressure distribution at fuel bundle inlet and outlet. The average subchannel wall shear stress $\tau_w(I)$ is related to the subchannel coolant flow properties by:

$$\tau_w(I) = 1/2\ f(I)\ \rho(I)\ U(I)^2 \tag{20}$$

with the friction factor f(I) expressed by:

$$f(I) = CFR\left(\frac{d_h(I)\ \rho\, U(I)}{\mu}\right)^{-EXF} \tag{21}$$

Here μ is the dynamic coolant viscosity (evaluated at the bulk average coolant temperature in the fuel element), CFR and EXF are constants (input data) and $d_h(I)$ is the equivalent hydraulic diameter defined by:

$$d_h(I) = 4\frac{S(I)}{W_p(I)} \tag{22}$$

The attention is now focussed on the symmetry section. For the present configuration this is one twelfth of the fuel bundle section, as is illustrated in Fig. 4. Application of the mass conservation principle to this section yields:

$$\sum_{1}^{NM} \frac{G(I)}{G_t} = \sum_{1}^{NM} GR(I) = 1 \tag{23}$$

with

$$G(I) = \rho\ U(I)\ S(I) \tag{24}$$

$$GR(I) = G(I)/G_t \tag{25}$$

NM being the total number of subchannels and G_t being the total mass flow rate.

The procedure adopted for solving the equation system (19) and (23) is to neglect first subchannel interactions. Making use of the "zero mixing" values GR(I) thus obtained, it is possible to linearize eq. (19) by introducing:

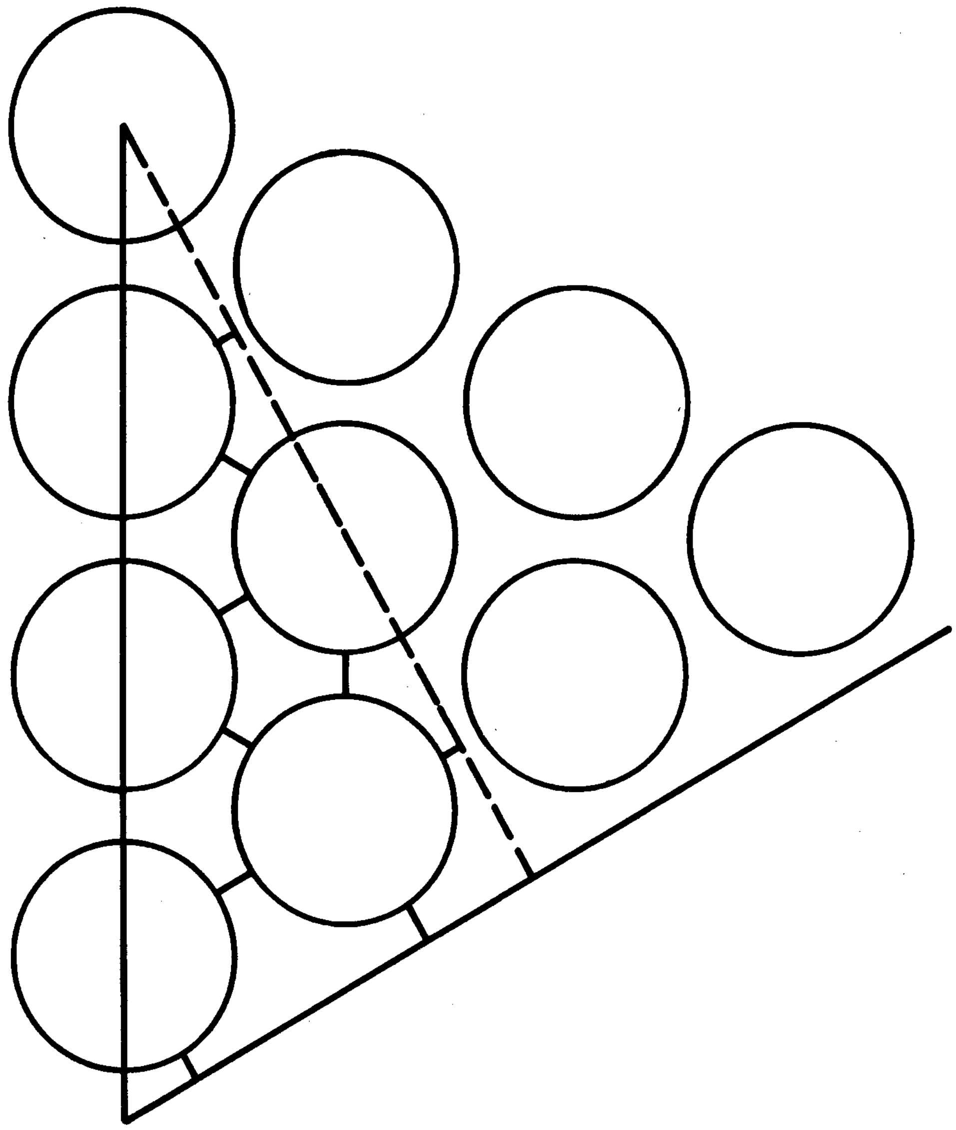


Fig. 4 ONE TWELFTH OF BUNDLE SECTION CONSIDERED IN FLOW ANALYSIS

$$FUF(I) = \frac{1}{2} f(I)\, GR(I) \frac{G_t^2 W_p(I)}{\rho S(I)^3} + \frac{1}{2} n_g c_g(I) GR(I) \frac{G_t^2}{\rho S(I)^2 Z_t} \qquad (26)$$

This leads to:

$$\left[FUF(I) + \frac{G_t}{S(I)^2} \sum^{N(I)} \alpha(I,J) \right] GR(I) - G_t \sum^{N(I)} \frac{\alpha(I,J)}{S(I).S(J)} GR(J) - \frac{(P_i - P_o)}{Z_t} = 0 \qquad (27)$$

for I = 1 - NM.

Eqs. (23) and (27) represent a system of NM + 1 linear equations with NM unknowns GR(I) and the unknown value $(P_i - P_o)/Z_t$. This system is solved by matrix inversion. The computed values of GR(I) are then substituted in eq. (26) to obtain a more accurate approximation of FUF(I). This computation procedure is repeated until GR(I) and $(P_i - P_o)/Z_t$ differ by less than a prescribed small amount from values determined in a preceding calculation.

2.3 Subchannel coolant enthalpy distribution

A heat balance applied to a subchannel I over an axial increment dz yields the following differential equation:

$$G(I) \frac{dH(I)}{dz} = QS(I)Hp(I) - \sum^{N(I)} \beta(I,J) \left[H(I) - H(J) \right] \qquad (28)$$

where QS(I) is the average heat flux associated with subchannel I and Hp(I) is the heated perimeter of subchannel I. The summation in the second right hand term is again carried out over N(I) bounding subchannels. The above equation may be made dimensionless as follows:

$$GR(I) \frac{dHR(I)}{dZR} = \frac{CQS(I).Hp(I)}{QFRAT.PERS} CZ - \sum^{N(I)} \frac{L}{G_t} \beta(I,J) \left[HR(I) - HR(J) \right] \qquad (29)$$

Here G_t is the total mass flow rate in the fuel bundle section considered*), L is the total heated length, whereas ZR and HR(I) are dimensionless variables defined by:

*) Note that this section generally differs from that previously considered in connection with the coolant mass flow distribution.

$$ZR = \frac{z}{zTOT} \tag{30}$$

$$HR(I) = \frac{H(I) - H_{in}}{\Delta H} \tag{31}$$

H_{in} being the inlet enthalpy and ΔH being the axial bulk coolant enthalpy rise over the fuel rod bundle. In the first right hand term of eq. (29) only CZ depends on axial position, it is given by:

$$CZ = \frac{QFZ}{QFO} \tag{32}$$

where QFZ and QFO are cross sectionally averaged heat fluxes at position ZR and at the channel centre respectively. PERS is the heated perimeter of the section considered and QFRAT is given by:

$$QFRAT = \frac{QFAV}{QFO} \tag{33}$$

where QFAV is the spatially averaged fuel bundle heat flux. The parameter CQS(I) is defined by:

$$CQS(I) = \frac{QS(I)}{QFZ} \tag{34}$$

The fact that CQS(I) is invariant with axial position implies the assumption that the axial power distribution is the same for all fuel rods.

Eq. (29) can be brought in the slightly modified form:

$$GR(I) \frac{dHR(I)}{dZR} = D(I, I) \; HR(I) + \sum N(I) \; D(I, J) \; HR(J) + GR(I) \; QR_z(I) \tag{35}$$

where

$$D(I, J) = \frac{ZTOT}{G_t} \beta(I, J) \tag{36}$$

$$D(I, I) = - \sum N(I) \; D(I, J) \tag{37}$$

$$QR_z(I) = \frac{CQS(I). \, Hp(I) \;\; CZ}{QFRAT. \, PERS \;\; GR(I)} \tag{38}$$

The ensemble of equations for all subchannels is expressed in compact form as:

$$\left\{\frac{dHR}{dZR}\right\} = \left[GR\right]^{-1}\left[A\right]\left\{HR\right\} + \left\{QR_z\right\} \tag{39}$$

Here $\left[GR\right]$ is a diagonal matrix of dimensionless subchannel mass flow rates and $\left[A\right]$ is a symmetric matrix of dimensionless intersubchannel mixing coefficients D(I, J)*), whereas

$\left\{\frac{dHR}{dZR}\right\}$, $\left\{HR\right\}$ and $\left\{QR_z\right\}$ represent column vectors of dimensionless enthalpy gradients, dimensionless enthalpies and dimensionless heat input terms respectively.

The linear first order matrix differential equation (39) is solved by applying an eigenvector expansion. The linear transformation carried out for this purpose is:

$$\left\{HR\right\} = \left[VE\right]\left\{HT\right\} \tag{40}$$

where $\left[VE\right]$ is the eigenvector matrix of $\left[E\right]$, the latter being given by:

$$\left[E\right] = \left[GR\right]^{-1}\left[A\right] \tag{41}$$

Substituting eq. (40) into eq. (39) and premultiplying by $\left[VE\right]^{-1}$ yields:

$$\left\{\frac{dHT}{dZR}\right\} = \left[VE\right]^{-1}\left[E\right]\left[VE\right]\left\{HT\right\} + \left[VE\right]^{-1}\left\{QR_z\right\} \tag{42}$$

where $\left[VE\right]^{-1}\left[E\right]\left[VE\right]$ represents a diagonal matrix with the eigenvalues $\gamma(I)$ of $\left[E\right]$ on the diagonal. Hence

$$\left\{\frac{dHT}{dZR}\right\} = \left[\diagdown \gamma(I) \diagdown\right]\left\{HT\right\} + \left\{R_z\right\} \tag{43}$$

In the above expression $\left\{R_z\right\}$ is the column vector of transformed subchannel heat input terms resulting by carrying out the indicated matrix multiplications on the second right hand term of eq. (42). Eq. (43) represents an

---

*) Note that D(I, J) is zero for all subchannels J not interacting with subchannel I.

uncoupled system of first order differential equations in terms of the transformed enthalpies HT(I) which can be written in an alternate way as:

$$\frac{dHT(I)}{dZR} = \gamma(I).HT(I) + R_z(I), \; I = 1, 2, \ldots NM \tag{44}$$

The problem now has been reduced to the solution of the algebraic eigenvalue problem:

$$\left[E\right]\left\{V\right\} = \gamma\left\{V\right\} \tag{45}$$

where $\left\{V\right\}$ is the eigenvector corresponding to a given eigenvalue γ.
For obtaining the solution of eq. (45) advantage is taken of the fact that $\left[GR\right]$ and $\left[A\right]$ represent real symmetric matrices, the former being in addition positive-definite and diagonal. Once the full set of eigenvalues $\gamma(I)$ for $I = 1, NM$ and the matrix VE of associated eigenvectors $\left[V_1, V_2, V_3, \ldots V_{NM}\right]$ has been evaluated, the differential equation system (44) can be solved in a straightforward manner. One directly obtains:

$$HT(I) = B(I) \exp\left[\gamma(I)\, ZR\right] + P_z(I) \tag{46}$$

where $P_z(I)$ is the particular solution due to the heat input term $R_z(I)$. Account now still has to be taken of the initial conditions for HR(I) at Z = 0, which can be specified as an initial condition for HT(I) using the transformation:

$$\left\{HT\right\} = \left[VE\right]^{-1}\left\{HR\right\} \tag{47}$$

The solution in terms of HR(I) is obtained by carrying out the back transformation indicated by eq. (40).

2.4 Aspects related to the spatial variation of fuel heat generation

2.4.1 Variation of heat generation in the axial direction

The assumption is made that for all rods the axial variation of heat generation is the same. Axial variation of heat generation is arbitrary and is expressed in terms of the following Fourier series expression:

$$CZ = \frac{QFZ}{QFO} = \sum_{1}^{NAT} AFL(N) \sin\left(\frac{N\pi Y}{ZEX}\right) + CONS \tag{48}$$

Fig. 5 provides explanations with regard to the parameters used in the above expression. The heat generation region extends from Z = 0 to Z = ZTOT. Beyond this region the heat generation curve may be extrapolated. At Y = 0 the normalized heat generation term CZ has a prescribed value CONS, where $0 \leqslant CONS \leqslant CZ_{min}$, CZ_{min} representing the minimum value of CZ at either Z = 0 or at Z = ZTOT. From Fig. 5 it now appears that the extrapolated length ZEX is given by

$$ZEX = YO1 + YO2 + ZTOT \tag{49}$$

The coefficients AFL(N) in eq. (48) are determined by matching eq. (48) with a specified axial distribution of heat generation at a prescribed number NAT axial positions.

The spatially averaged value of CZ is given by:

$$CZ_{av} = \frac{QFAV}{QFO} = \frac{1}{ZT\emptyset T} \int_{0}^{ZTOT} CZ \, dZ \tag{50}$$

In view of eq. (48) we have

$$CZ_{av} = \frac{ZEX}{\pi ZTOT} \sum_{1}^{NAT} AFL(N) . DIFCO(N) + CONS \tag{51}$$

where

$$DIFCO(N) = \frac{1}{N}\left[\cos\left(\frac{N\pi Y01}{ZEX}\right) - \cos\left(\frac{N\pi(ZTOT+Y01)}{ZEX}\right)\right] \tag{52}$$

It is worth pointing out that when the axial heat generation distribution is not the same for each rod, the computer programme has to be modified in the sense that eq. (48) is applied to all rods having different axial distribu-

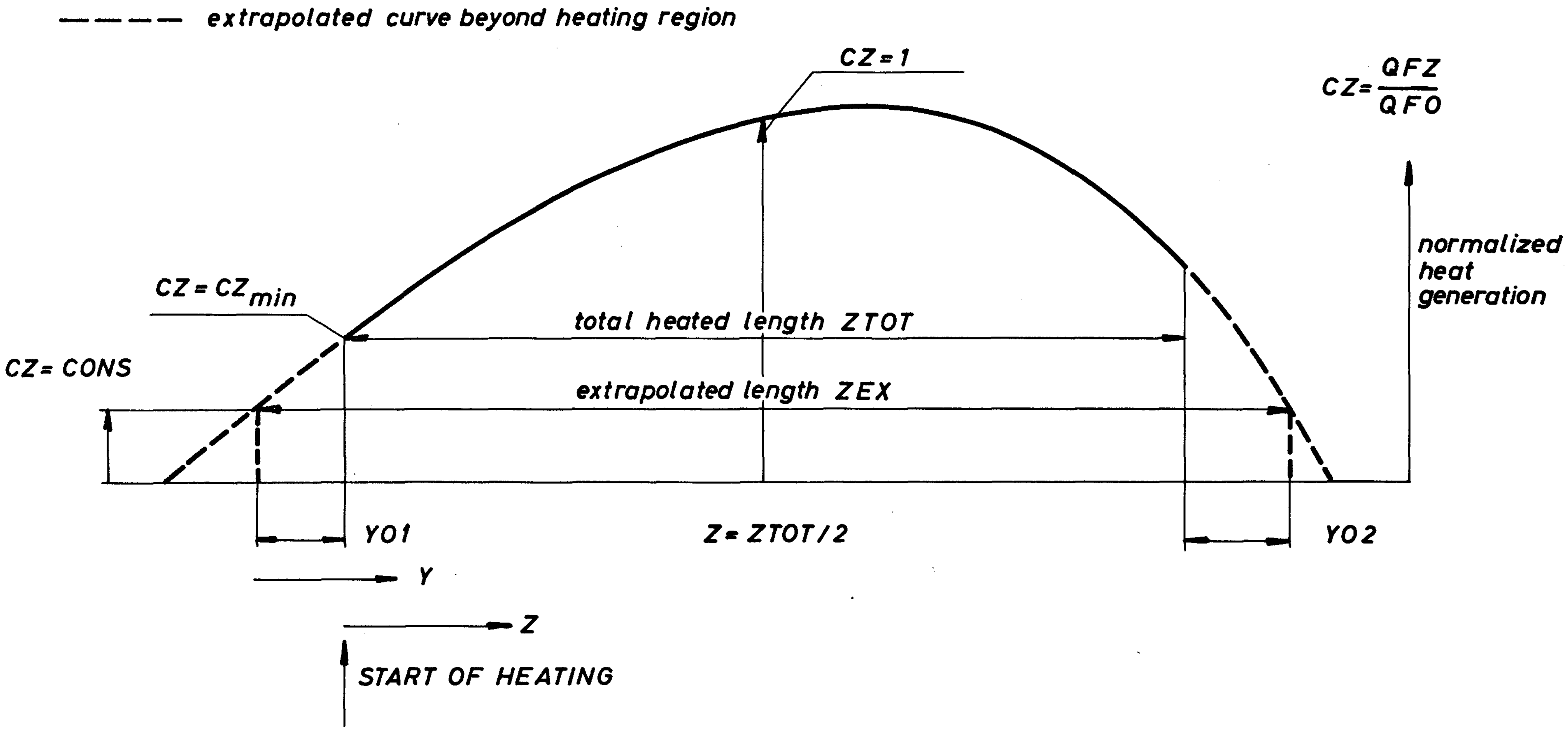


Fig. 5 AXIAL VARIATION OF HEAT GENERATION

tions.

2.4.2 Variation of heat generation in the lateral direction

The following assumptions are made: (a) the value of fuel heat generation in a rod bundle cross section depends on the radial distance from the core centre only, (b) the radial distribution of fuel heat generation has the same shape for all axial positions. The position of the hexagonal fuel box with regard to the reactor core centre is that shown in Fig. 6. For this configuration the lateral variation of heat generation attains a maximum along the diagonal of the hexagonon.

The radial variation of fuel heat generation is represented by the polynome expression:

$$QLR = B_o - B_1 . RD - B_2 \, RD^2 \tag{53}$$

where QLR is the linear power at a radial distance RR normalized with respect to that of the fuel rod with maximum rating in the fuel box. RD is a dimensionless distance parameter given by:

$$RD = \frac{RR}{RO + ZL} \tag{54}$$

where RO is the radial distance from the core centre of the rod (centre) with highest rating and ZL is the distance between the centres of the most distant rods in the hexagonon. Defining VX as the variation of heat generation along the hexagonon diagonal (between the centres of the most distant rods), normalized with respect to the heat generation of the rod with maximum rating and introducing

$$RATA = B_2/B_1 \tag{55}$$

we have, since by definition QLR = 1 at RR = RO,

$$B_1 = \frac{VX}{ZLD + RATA(ZLD^2 + 2RDO.\,ZLD)} \tag{56}$$

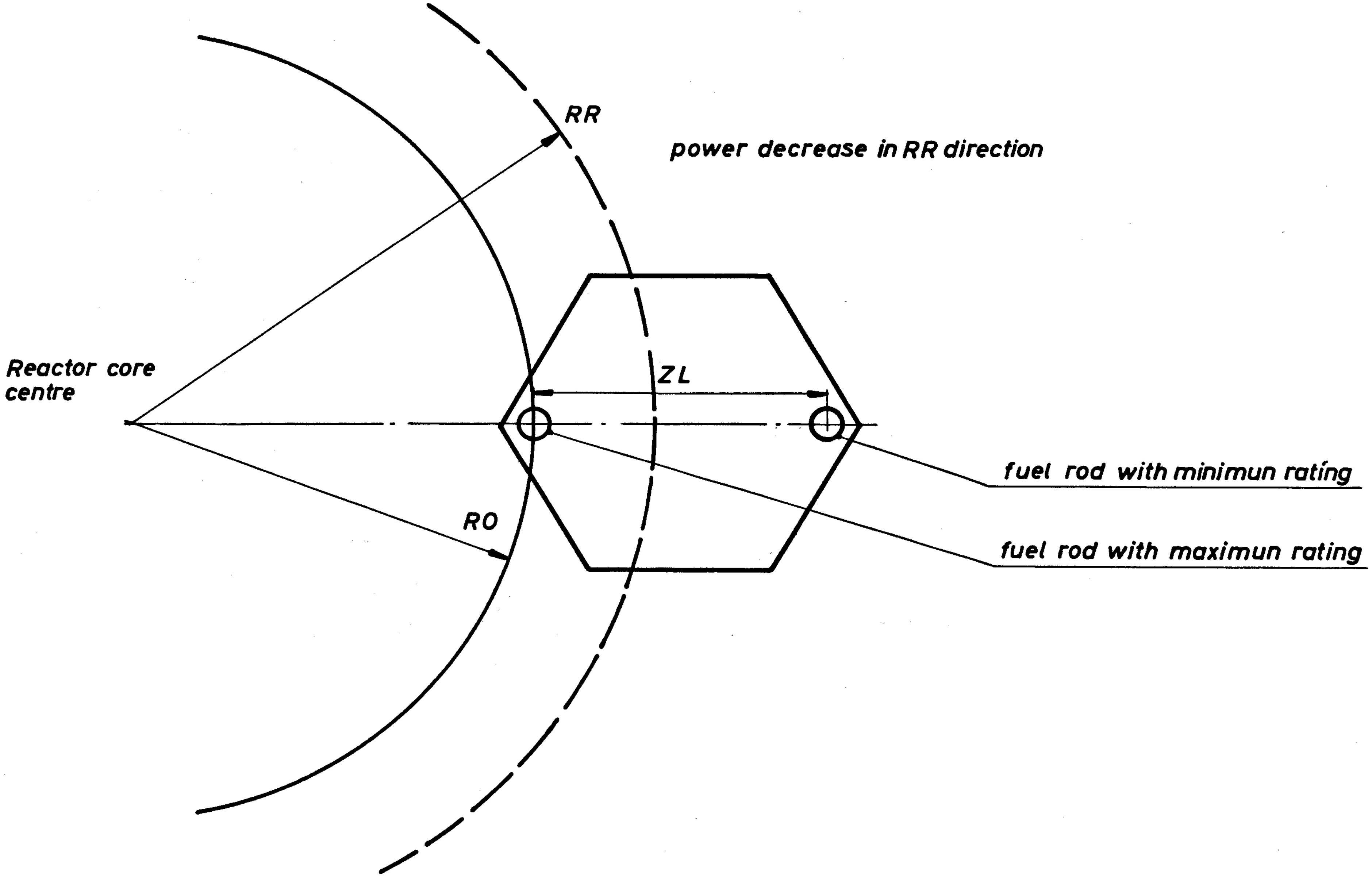


Fig. 6 POSITION OF HEXAGONAL FUEL BOX WITH RESPECT TO REACTOR CORE CENTRE

$$B_2 = RATA . B_1 \tag{57}$$

$$B_o = 1 + B_1 . RDO + B_2 . RDO^2 \tag{58}$$

where $$ZLD = \frac{ZL}{RO + ZL} \tag{59}$$

$$RDO = \frac{RO}{RO + ZL} \tag{60}$$

The parameters VX and RATA are specified as input information.

3. DESCRIPTION OF THE HERA-1A COMPUTER PROGRAMME

3.1 Topographical considerations

As outlined previously the specific rod bundle geometry considered in HERA-1A is the hexagonal fuel rod bundle of which a cross section is shown in Fig. 7. A regular array with equal rod spacing is considered. The geometry therefore is fully defined when the following data are specified:

- the number of rod rows NROMA
- the outer cladding radius RC
- the pitch to diameter ratio P
- the dimensionless rod-wall distance PW

According to their position in the bundle one may distinguish central subchannels and peripheral subchannels and according to shape triangular subchannels (NTYP = 1), rectangular subchannels (NTYP = 2) and angular subchannels (NTYP = 3).

For the calculation of the subchannel coolant mass flow distribution it is sufficient to consider the symmetry section presented in Fig. 8 a*) i.e. one twelfth of the bundle section. The heat transfer analysis is aimed at evalua-

*) Strictly this is not true for the case of a bundle with helical spacers, where owing to single direction momentum transport in the peripheral subchannels one sixth of the bundle should be considered.

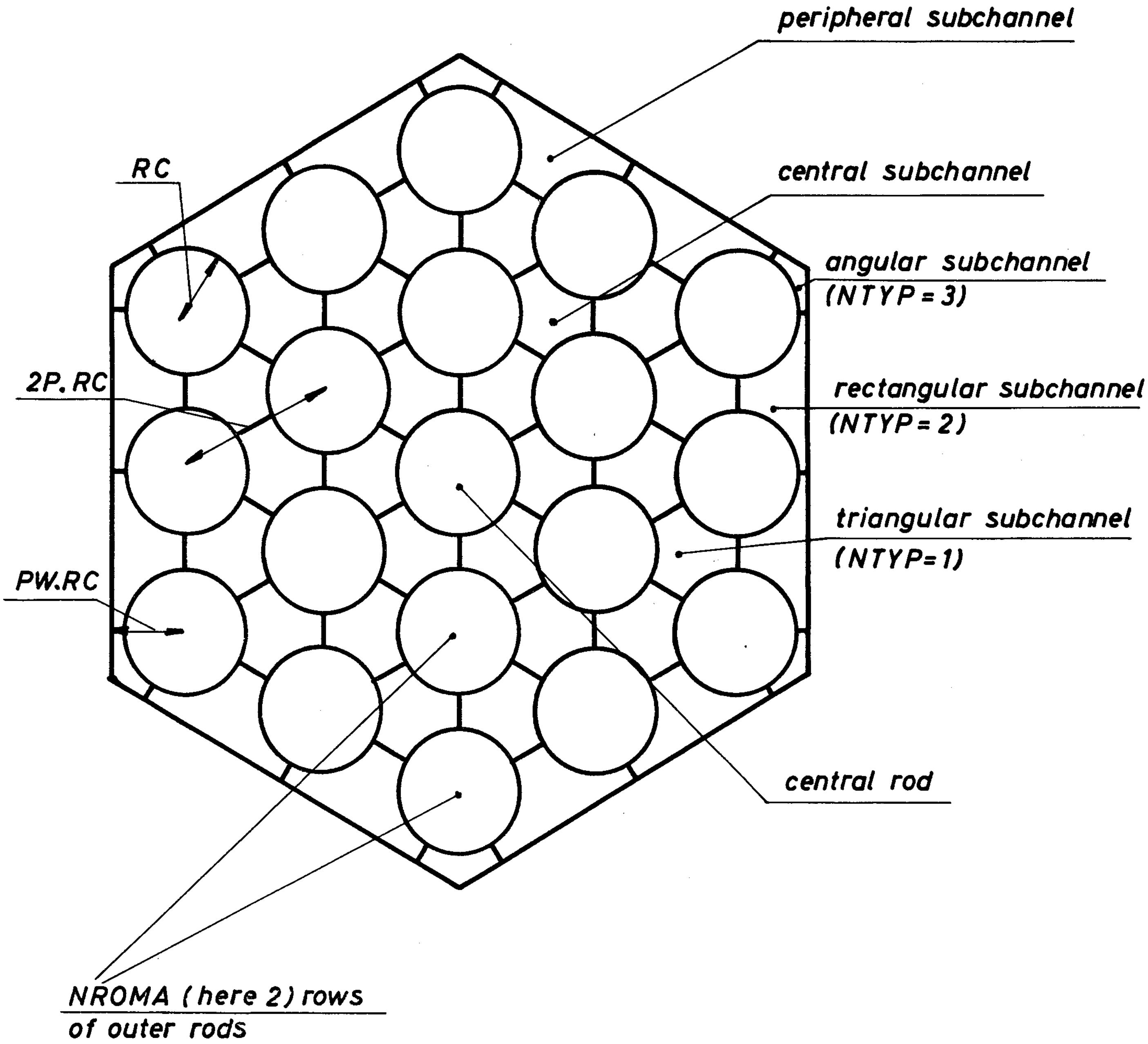
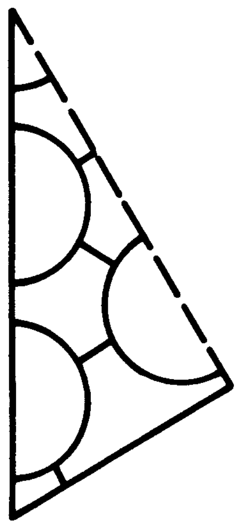
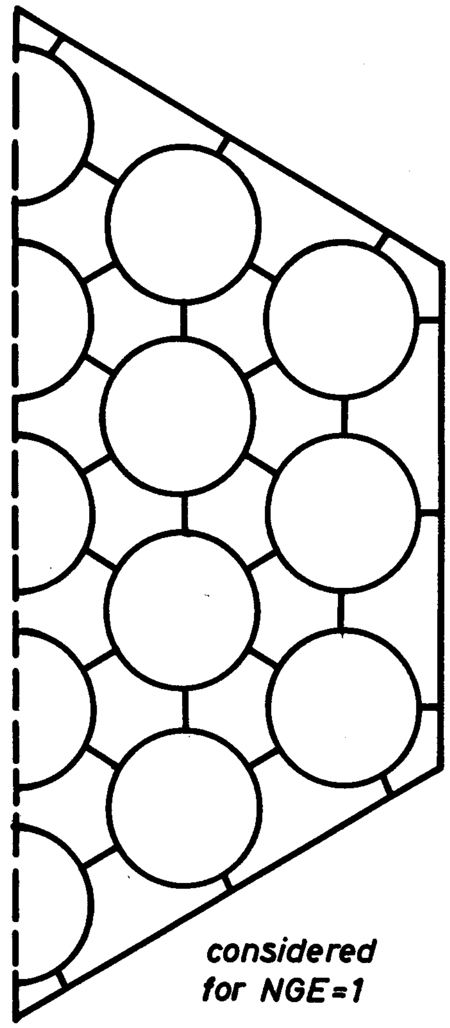


Fig. 7 HEXAGONAL FUEL ROD BUNDLE



a Symmetry section for flow analysis



b Symmetry section for heat transfer analysis

Fig. 8 SYMMETRY SECTIONS

ting the effect of a lateral power gradient along the hexagonon diagonal. For this case it is sufficient to consider half a hexagonon*) as indicated in Fig. 8 b.

To establish in a straightforward manner which subchannels interact with each other it is important to number the subchannels in a suitable manner. Two methods have been adopted simultaneously here. In the first method two indices are assigned to a given subchannel, one denoting the subchannel row NRO and one denoting the number NUM in a given row. In the other method subchannels receive each a single identification number ranging from 1 till NM. Fig. 9 illustrates this for the half hexagonon. The two ways of indexing are connected by the expressions:

$$I = NOT\ (NRO,\ NUM) \qquad (61)$$

$$NRO = NROW\ (I) \qquad (62)$$

$$NUM = NUMS(I) \qquad (63)$$

For the heat transfer situation considered i.e. power variation along the diagonal usually intersubchannel heat transport in the direction normally to the diagonal is of negligible importance. For this situation it mostly is sufficiently accurate to consider one or two rows of subchannels along the diagonal. Fig. 10a and b illustrate these alternatives. Another possibility provided by HERA-1A is to consider NRY rows of outer subchannels in half a hexagonon, as is illustrated in Fig. 10 c. Selection of the above rod bundle sections has the obvious advantage of reducing the number of subchannels and hence the computation time involved in the solution of the eigenvalue problem.

3.2 Specification of input data

This paragraph deals with a description of the input data.

Card number 1 specifies selection numbers affecting the type of calcula-

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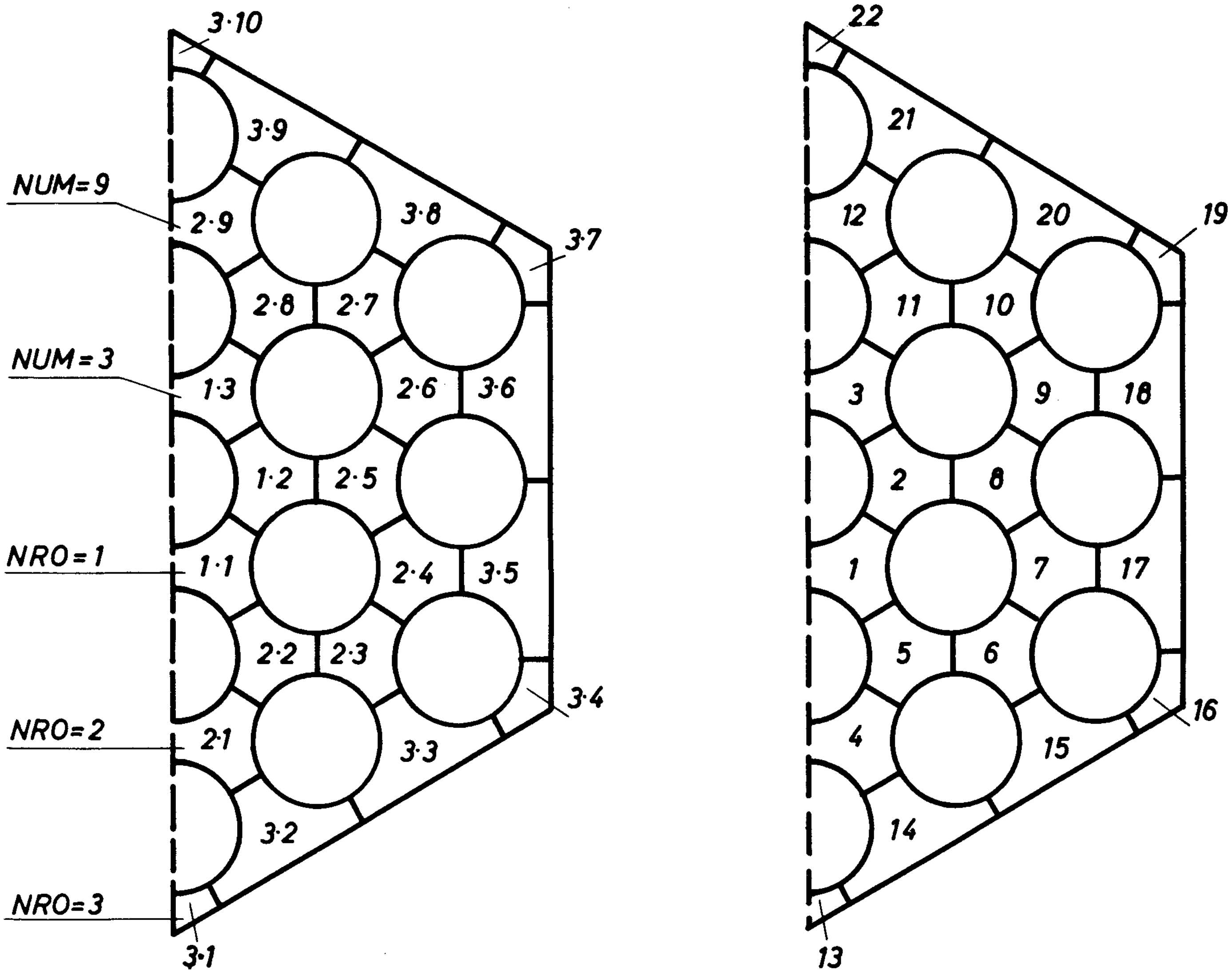
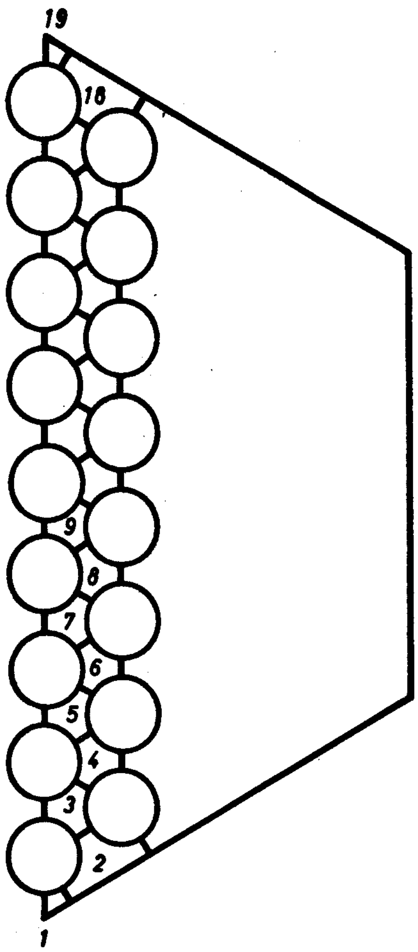
*) The same observation applies here as under the preceding footmark on page 22. For helical spacers it would be strictly necessary to consider an entire hexagonon.



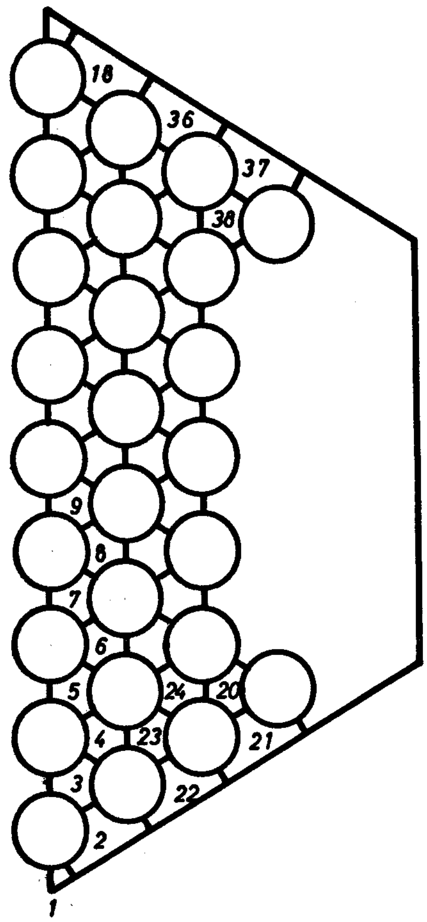
a subchannels with indices NRO, NUM

b subchannels with a single index I

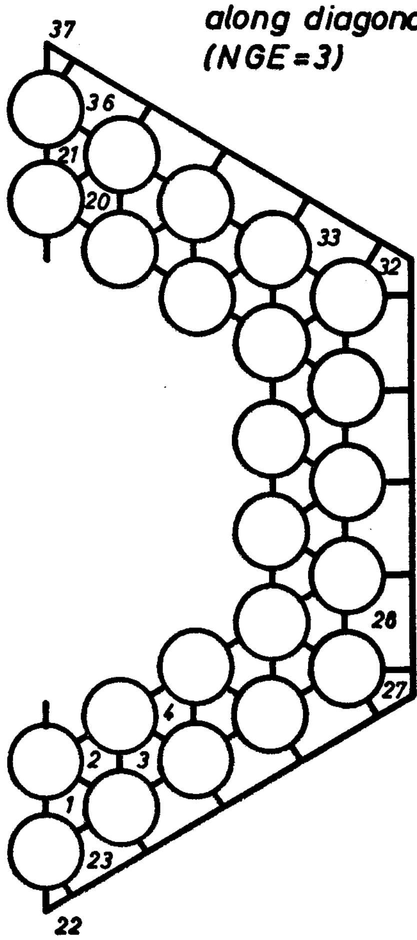
Fig. 9 INDEXING OF SUBCHANNELS



a single row of subchannels along diagonal (NGE = 2)



b two rows of subchannels along diagonal (NGE = 3)



c NRY (here 2) rows of outer subchannels (NGE = 4)

Fig. 10 CHARACTERISTIC SECTIONS FOR VARIOUS VALUES OF NGE tions to be carried out. NGE determines the geometry for which calculations are carried out. NGE = 1 corresponds to half a hexagonon; NGE = 2 to a single row of subchannels along the diagonal and NGE = 4 to NRY rows of outer subchannels in half a hexagonon. NSP determines the type of spacer, NSP = 1 corresponding to grid spacers and NSP = 2 corresponding to helical spacers. NFLOW denotes the type of input related to the rod bundle mass flow rate. For NFLOW = 1 the mass flow rate is computed from a prescribed axial coolant temperature rise DELTC, for NFLOW = 2 the mass flow rate is specified. NMIMO regards intersubchannel momentum transport, for NMIMO = 1 it is disregarded. for NMIMO = 2 it is taken into consideration. NMIH has a similar effect on intersubchannel heat transport. NCON determines whether conduction contributes to intersubchannel heat transport (only for grid type spacers). For NCON=1 there is no contribution, for NCON = 2 conduction is taken into account. NKG (only for grid type spacers) regards intersubchannel mixing by grids. For NKG = 1, no mixing at grids, for NKG = 2, account is taken of mixing at grids. NMIX regards intersubchannel mixing for helical spacers. For NMIX = 1 mixing input data are employed, for NMIX = 2 the maximum mixing rate expressions (14) and (17) are used.

Card number 2 specifies options. For NOP having values above 1 control data are printed. NCA is the number of additional computation cases with different spatial heat generation distributions (for the same fuel element power as the first case).

Card number 3 specifies the total number of rod rows NROMA in the bundle and the number of outer subchannel rows NRY (to be taken into consideration for NGE = 4).

Card number 4 specifies the pitch to diameter ratio P, the dimensionless rod-wall distance PW, the fuel radius RF and the outer cladding radius RC.

Card number 5 specifies for grid type spacers (NSP = 1) the total rod bundle length (unheated part included) ZUN, the heated rod bundle length ZTOT, the axial length increments YO1 and YO2 related to the axial heat generation distribution (see Fig. 5), the axial distance ZIC of the first grid from the fuel bundle inlet, the axial distance between grids ZC.

Card number 5 specifies for helical spacers (NSP = 2) ZTOT, YO1, YO2 and the axial spacer pitch ZG.

Card number 6 specifies for NFLOW = 2 the total fuel bundle mass flow rate.

Card number 6 specifies for NFLOW = 1 the axial coolant temperature rise DELTC in the fuel element.

Card number 7 specifies for grid type spacers (NSP = 1) the coefficient CFR and the exponent EXF in friction factor expression (21), grid flow resistance coefficients CG1, CG2 and CG3 for a triangular subchannel, rectangular subchannel and angular subchannel (see Fig. 7), the coefficient CEF in the turbulent diffusivity expression (7) and the grid mixing coefficient GAMMA ($\gamma(I, J)$ in eq. (11)) .

Card number 7 specifies for helical spacers (NSP = 2) CFR, EXF and intersubchannel mixing coefficient parameters CMIX1 and CMIX2 which correspond to $\beta(I, J)/\left[\rho U(I) + \rho U(J)\right]$ in eqs. (17) and (14) respectively.

Card number 8 specifies fuel conductivity VLF, the cladding conductivity VLCL and the fuel-cladding contact resistance BETA.

Card number 9 specifies the coolant temperature TIN and the coolant pressure PIN at the inlet of the fuel region.

Card number 10 specifies the maximum linear power QLMAX(W/m) of the rod with the highest rating.

Card number 11 specifies the fractional variation of heat generation VX along the diagonal (see 2.4.2), the radial distance RO of the rod with the highest rating from the reactor core centre and the coefficient ratio RATA defined by eq. (55).

Card number 12 specifies the number of axial positions NAX (i.e. for grid spacers between two grids, for helical spacers along the entire fuel rod bundle), at which computation results are furnished, and the number of axial positions NAT at which eq. (48) is matched to the prescribed axial power distribution.

Card number 13 specifies the axial positions ZI(NA) at which the heat generation is specified.

Card number 14 specifies the parameter CONS (see eq. (48) and Fig. 4) the heat generation term QFRO at Z = ZTOT/2, the maximum heat generation QFRMA and the heat generation terms QFRZ(NA) corresponding to ZI(NA). Note that the latter three parameters can be specified in arbitrary (but the same) units.

It is worth pointing out that, unless otherwise specified, all data figuring in the input are in kg/m/sec units.

3.3 Outline of programme structure

An approximate idea of the HERA programme structure can be obtained from the simplified flow diagramme shown in Fig. 11.

After reading of the input data, the geometry parameters of the hexagonal rod bundle are computed (channel dimensions and sections, wetted perimeters, heated perimeters, hydraulic diameters, thermal diameters of subchannels). It is worth pointing out that for the case of helical spacers (wires) axially averaged values of geometry parameters are determined.

Subsequently consideration is given to the spatial heat generation distribution. The Fourier series coefficients AFL(NA) (see eq. (51)) are deter-

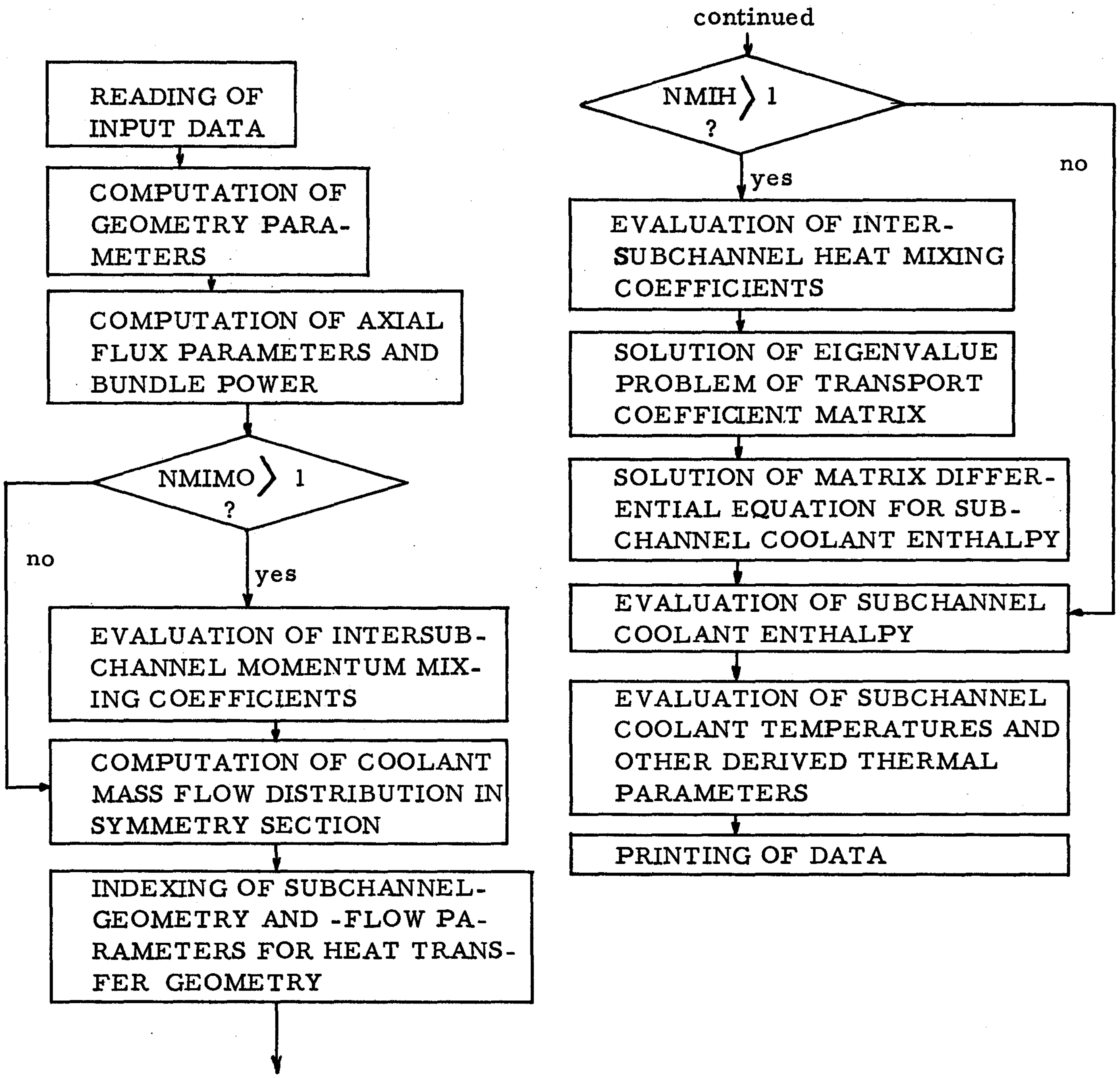


Fig. 11 - Simplified Flow Diagramme of HERA-1A

mined using a matrix inversion technique (subroutine INMAT). The subroutine RODFLU is employed to calculate QFRAT2, the ratio of cross sectionally averaged heat flux to that of the rod with highest rating, and the linear powers associated with each rod in half the hexagonon. Finally the fuel bundle power POW is calculated.

In treating the coolant flow aspects attention is first given to physical properties and bulk flow characteristics. Depending on whether NFLOW has the value 1 or 2, the total coolant mass flow rate FMTOT is determined from the axial coolant temperature rise DELTC, or DELTC is determined from FMTOT. The enthalpy-temperature relationships for the coolant (sodium), employed in this calculation are given by the functions FUNH(T) and FUNT(H). Physical properties VRHO, VMUF and VA are taken at the bulk average coolant temperature TCAV. The bulk coolant velocity UB and the fuel element Reynolds number REFU now are calculated. For determining the subchannel mass flow rates the attention is focussed on the smallest symmetry section (see Fig. 7 a). The subroutines INDEX and SECDIA are employed to number subchannels and to furnish indices to subchannel geometry parameters in this section. First the subchannel coolant mass flow rates (FMR(I), normalized with respect to the section coolant mass flow rate FMCS, are determined for "zero" intersubchannel mixing. Provided NMIMO has a value exceeding 1, account is taken of intersubchannel mixing. The subroutine INAC establishes which subchannels interact with each other. For the case of turbulent diffusion (for NSP = 1 only) the subroutine FIFU establishes turbulent interaction terms FSF1, FSF2, FSF3, FSF4, corresponding to integrated values of the geometry dependent part of eq. (9). For grid spacers (NSP = 1) the intersubchannel momentum mixing coefficients VM(I, J) are evaluated by the subroutine MIFU, for helical spacers (NSP = 2) this is done by the subroutine HELMIX. The values of FMR(I) (equivalent to GR(I) in eq. (25)) are now determined by solving eq. (27) iteratively.

To establish the distribution of the subchannel coolant enthalpies it is first necessary to index subchannels and subchannel parameters for the new rod bundle section under consideration. This is done by calling the subroutines INDEX and SECDIA. The subchannel coolant mass flow rates evaluated for one twelfth of the bundle section, are associated with the subchannels in half a hexagonon making use of the subroutine TRANS. The subroutine RODSUB is used for evaluating the average subchannel heat fluxes CQS(I) normalized with respect to the cross section averaged heat flux QFZ (see eq. (34)). The essential input information for RODSUB regards the fuel rod ratings already established by the subroutine RODFLU. Provided NMIH is larger than one, account is taken of intersubchannel interactions. Depending on the rod bundle section considered, it is established which subchannels interact with each other by calling the subroutines INAC (NGE = 1, NGE = 4) or INAC2 (NGE = 2, NGE = 3). Intersubchannel heat mixing coefficients VM(I, J) are established by subroutines FIFU and MIFU for grid spacers (NSP = 1) and by subroutine HELMIX for helical spacers (NSP = 2). The attention is now turned to the solution of the eigenvalue problem. The coefficient matrix $\left[A \right]$ in eq. (39) is constituted by the elements VM(I, J) as computed by loops 210 and 211 of the main programme. The eigenvalues EIVR(I) (Υ(I) in eq. (44)) and the eigenvector elements VM(I, J)*) of the matrix $\left[E \right]$ as defined by eq. (41) are determined by the subroutine EIVA. The basic information underlying the solution of the matrix differential equation for the subchannel coolant enthalpy is now available. In the loop 225 the normalized subchannel coolant enthalpies HR(I), defined by eq. (31), are computed at specified axial positions. In addition a number of derived thermal parameters are evaluated. Among others the subchannel coolant temperature TCO(I) and the average subchannel cladding temperature TCL(I). In evaluating the latter, use is made of a conventional heat transfer coefficient expression. In the presence of grid spacers and for values of NKG exceeding 1 account is taken of subchannel coolant mixing at grids according to eq. (11). In addition to the above parameters, the fuel centre temperature of the rod with the highest rating is also determined at the various axial positions.

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*) Note that VM(I, J) is used to denote a number of different parameters.

It is worth pointing out that for NCA larger than 1 additional heat generation patterns can be examined without repeating the solution of the eigenvalue problem. After having computed the first case, additional sets of cards (from card number 11 onwards) are read. After having newly calculated the heat generation parameters, it is immediately proceeded with the computation of subchannel coolant enthalpies and derived thermal parameters.

4. CONCLUDING REMARKS

The computation procedures underlying the HERA computer programme provide the possibility of a rapid and efficient thermal analysis based on application of the subchannel concept, of fuel rod bundles with single phase cooling. The present version of HERA considers a liquid metal coolant (sodium) and a hexagonal bundle geometry. The same programme can be easily modified for application to other coolants and other bundle configurations. For a different coolant one only has to change the 5 "physical property functions" at the beginning of the main programme. Other bundle configurations require a number of minor modifications in the "geometry chapter" of the main programme and changes in a few subroutines (essentially, INDEX, INAC and RODSUB),

Owing to the fact that an analytic mathematical solution procedure is being used, computations are very precise and rapid. A particular advantage of this method of approach is that results for additional different spatial heat generation distributions can be obtained almost instantaneously. The advantage of this method also becomes apparent when it is required to investigate the effect of uncertainties in intersubchannel heat mixing coefficients. Heat transfer results for additional cases where mixing coefficients differ by a factor FACT1, FACT2, etc. from those of the reference case can be immediately obtained by multiplying the already known algebraic eigenvalues γ(I) for the nominal reference case by these factors (the eigenvectors remaining unchanged).

Although the HERA programme can be used for thermal analysis of very large rod bundles, it has been used by the authors only for bundles with a maximum of 100 subchannels. This in order to avoid waste of computation time, which on the IBM370/165 computer for the 100 subchannel case is about 1.5 min. *). Much larger fuel rod bundles can be considered by focussing on certain characteristic regions in the bundle (e.g. in the present HERA version for NGE = 2, 3 and 4) where most important temperature variations may be expected. Work will however still be undertaken by us to develop methods, resting on the same basic principles for analysis of systems with a very large number of subchannels (say 500) without necessitating significantly more computertime and -storage than presently required.

ACKNOWLEDGEMENT

Stimulating discussions with Messrs. I. GALLIGANI and G. DI COLA on problems related to solution of algebraic eigenvalue problems, are gratefully acknowledged.

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*) Note that the time required for the solution of the eigenvalue problem with EIVA increases with the third power of the matrix order.

NOMENCLATURE

(Symbols of text and most important symbols of listing)

Symbol	Definition	Observations
a	thermal diffusivity (m^2/sec)	text
[A]	matrix of dimensionless intersubchannel mixing coefficients	text, eq. (39)
BETA	fuel-cladding contact resistance (m^2 $^oC/W$)	input
CEF	coefficient in turbulent diffusivity expression	input, eq. (7)
CFR	coefficient in friction factor expression	input, eq. (21)
$C_g(I)$ } CG(I)	flow resistance coefficients of grid in subchannel (I)	eq. (19)
CG1, CG2, CG3	flow resistance coefficients of grid in triangular, rectangular, and angular subchannel	input
CMIX1, CMIX2	parameters related to mixing in bundles with helical spacers	input
CONS	prescribed value of heat generation parameter CZ at Y=0	input
CQS(I)	average subchannel heat flux normalized with respect to the cross section averaged heat flux	eq. (34)
CZ	normalized heat generation term	eq. (48)
d	outer diameter of rod (m)	text
d_s	diameter of spacing wire (m)	text
DELTC	axial bulk coolant temperature rise (^oC)	input (if NFLOW = 1)

Symbol	Definition	Observations
$d_h(I)$ } DH(I) }	hydraulic diameter of subchannel (m)	
EXF	exponent in friction factor expression	input, eq. (21)
EIVR(I)	eigenvalue	(= γ(I))
f(I)	subchannel friction factor	text, eq. (21)
FMCS	mass flow rate in symmetry section (kg/sec)	
FMTOT	bundle mass flow rate (kg/sec)	
FMR(I)	normalized subchannel mass flow rate	
G(I)	subchannel mass flow rate	
G_t	mass flow rate in symmetry section (kg/sec)	text, (=FMCS)
GR(I)	normalized subchannel mass flow rate	text, (= FMR(I))
GAMMA	grid mixing coefficient	input, (= γ(I, J))
h	axial pitch of helical spacer	text, (= ZG)
$H_{l.m.\varphi}$	radially averaged coolant enthalpy (J/kg)	text, eq. (4)
H(I)	subchannel coolant enthalpy (J/kg)	
HIN	inlet coolant enthalpy (J/kg)	
HOUT	outlet " " "	
HR(I)	normalized subchannel coolant enthalpy	eq. (31)
ΔH	axial bulk coolant enthalpy rise (J/kg)	

Symbol	Definition	Observations
Hp(I) HPER(I)	subchannel heated perimeter (m)	
HT(I)	transformed normalized subchannel coolant enthalpy	eq. (47)
n_g	total number of grids in bundle	text
N(I)	number of bounding subchannels of a subchannel I	text
NAT	number of axial positions used in matching of heat generation distribution	input
NAX	number of axial positions at which output is specified	input (see 3.2)
NCON	selection number related to heat conduction in mixing	input
NFLOW	selection number related to bundle mass flow rate	input
NGE	selection number related to geometry	input
NKG	selection number related to grid mixing	input
NM	total number of subchannels	
NMIH	selection number related to intersubchannel heat mixing	input
NMIMO	selection number related to intersubchannel momentum mixing	input
NMIX	selection number related to mixing with helical spacers	input
NOP	selection number related to printing of control data	input
NSP	selection number related to type of spacer	input
NROMA	number of rod rows (around central rod)	input
NRY	number of outer subchannel rows	input (for NGE = 4)

Symbol	Definition	Observations
P	pitch to diameter ratio	input
p(I, J)	" " "	text
P_i	inlet pressure (N/m^2)	text
P_o	outlet " "	text
PERS	heated perimeter of half hexagon (m)	
PIN	inlet pressure at start of heating (N/m^2)	input
POW	fuel bundle power (W)	
PR, Pr	Prandtl number	
PW	dimensionless rod-wall distance	input
Q_h	intersubchannel heat flow (J/sec)	text
Q_m	" momentum flow $(kg\ m/sec^2)$	text
QFAV	spatially averaged fuel bundle heat flux (W/m^2)	
QFRAT	ratio QFAV to QFO	eq. (33)
QFRAT2	parameter relating fuel bundle heat flux to that of rod with maximum rating	
QFRMA	heat generation at axial position of maximum rating (arbitrary units)	same units (QFRMA, QFRO, QFRZ(NA))
QFRO	heat generation at Z = ZTOT/2 (arbitrary units)	same units (QFRMA, QFRO, QFRZ(NA))
QFRZ(NA)	heat generation terms at ZI(NA) (arbitrary units)	same units (QFRMA, QFRO, QFRZ(NA))

Symbol	Definition	Observations
QFO	cross section averaged fuel bundle heat flux at Z = ZTOT/2 (W/m^2)	
QFZ	cross section averaged fuel bundle heat flux at axial position Z (W/m^2)	
QLR	linear power normalized with respect to that of rod with maximum rating	eq. (53)
QLFRAV	axially averaged linear power of rod with maximum rating (W/m)	
QLMAX	maximum linear power of rod with maximum rating (W/m)	input
$QR_Z(I)$	dimensionless subchannel heat input term	eq. (38)
R	rod radius (m)	text
r	radial distance from rod centre (m)	text
RR	radial distance from reactor core centre (m)	
r_{eff}	effective radial distance	text, eq. (6)
RATA	coefficient ratio	input, eq. (55)
RC	outer cladding radius (m)	input
RD	normalized value of RR	eq. (54)
RF	outer radius of fuel (m)	input
RE Re	Reynolds number	
REFU	fuel bundle Reynolds number	

Symbol	Definition	Observations
RO	distance from reactor core of rod with maximum rating (m)	input
S(I)	subchannel flow area (m^2)	
TCAV	averaged coolant temperature in fuel bundle (°C)	
TCL(I)	average subchannel cladding temperature (°C)	
TCO(I)	subchannel coolant temperature (°C)	
TFC	centre temperature of fuel rod with maximum rating(°C)	
TIN	coolant inlet temperature (°C)	input
U(I)	subchannel coolant velocity (m/sec)	
UB	bulk coolant velocity in fuel element (m/sec)	
U_g(I, J)	coolant velocity in gap between subchannels I, J	text
$U_{l.m.\varphi}$	radially averaged coolant velocity at position φ (m/sec)	eq. (3)
UR(I)	subchannel coolant velocity normalized with respect to UB	
VA	thermal diffusivity (m^2/sec)	= a
VLCL	thermal conductivity of cladding (W/m°C)	input
VLF	thermal conductivity of fuel (W/m°C)	input
VMUF	dynamic viscosity of coolant (kg/m sec)	= μ
VRHO	coolant density (kg/m^3)	= ρ
VX	fractional decrease of power along diagonal of hexagon	input
Wp(I), WPER(I)	wetted perimeter of subchannel (m)	

Symbol	Definition	Observations
Y_φ	radial distance parameter (m)	text, eq. (5)
Y01, Y02	axial distance parameters associated with axial heat generation distribution	input, see Fig. 5
z, Z	axial distance (m)	
Z_t, ZUN	entire bundle length (unheated part included) (m)	input
ZEX	extrapolated length	see Fig. 5
ZG	axial distance between grids or axial pitch of helical spacer	input
Z1G	distance from heating inlet of first grid	input
ZI(NA)	axial positions where QFRZ(NA) is specified	input
ZL	distance (along diagonal) between rods of maximum and minimum rating (m)	
ZR	axial distance normalized with respect to ZTOT	
ZTOT	heated length of fuel bundle (m)	input
Greek Symbols		
α (I, J)	intersubchannel momentum mixing coefficient (m^2/sec)	text, eq. (1)
β (I, J)	intersubchannel heat mixing coefficient (kg/m sec)	text, eq. (2)
γ_i	algebraic eigenvalue	text, = EIVR(I)
γ (I, J)	grid mixing coefficient	text, eq. (1) = GAMMA
ε_φ	momentum turbulent diffusivity for circumferential transport (m^2/sec)	text, eq. (3)

Symbol	Definition	Observations
φ	circumferential position	text
μ	dynamic coolant viscosity (kg/m sec)	text = VMUF
ν	kinematic coolant viscosity (m^2/sec)	text
ρ	coolant density (kg/m^3)	text = VRHO
ψ	ratio diffusivities for heat and momentum transfer	text
τ_w(I)	subchannel wall shear stress (N/m^2)	text

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(2) R. NIJSING; "Heat Exchange and Heat Exchangers with Liquid Metals"; AGARD Lecture Series, No. 57 on Heat Exchangers, (1972).

(3) V. P. BOBKOV and M. Kh. IBRAGIMOV; "Application of the Uniform Diffusion Model to the Calculation of the Tangential Stresses and Velocity Field in a Turbulent Fluid Flow"; High Temp. 8 (1970) 305-310.

SAMPLE PROBLEM OUTPUT

INPUT DATA

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NGE=     1NSP=     1NFLOW=     1NMIMO=     2NMIH=     2NCON=     2NKG=     1NMIX=     2

NOP=     2NCA=     1

NROMA=     4NRY=     2P= 0.13000000D 01PW= 0.16000000D 01RF= 0.26000000D-02RC= 0.30000000D-02

ZUN= C.20000000D 01ZTOT= 0.10000000D 01Y01= 0.25000000D 00Y02= 0.25000000D 00Z1G= 0.10000000D 00ZG= 0.20000000D 00

DELTC= 0.20000000D 03

CFR= C.88000000D-01EXF= 0.25000000D 00CG1= 0.12000000D 01CG2= 0.12000000D 01CG3= 0.12000000D 01CEF= 0.15420000D 00
GAMMA= 0.50000000D-01

VLF= C.22000000D 01VLCL= 0.21000000D 02BETA= 0.10000000D-03

TIN= C.40000000D 03PIN= 0.60000000D 06QLMAX= 0.42000000D 05

NAX=          3NAT=          1

VALUES OF ZI(NA)
C.50CC0D 00

VX= C.50000D 00RO= 0.70000D 00RATA= 0.10000D-16

CONS= C.10000C00D-16QFRO= 0.10000000D 01      QFRMA= 0.10000000D 01
QFRZ VALUES ARE
 0.1CC00D 01
```

H E R A - 1A

SITUATION CONSIDERED

*** GRID SPACERS

*** INTERSUBCHANNEL MIXING OF COOLANT MOMENTUM

*** INTERSUBCHANNEL MIXING OF COOLANT ENTHALPY

*** CONDUCTION CONTRIBUTES TO INTERSUBCHANNEL HEATTRANSPORT

*** NO COOLANT ENTHALPY MIXING AT GRIDS

GEOMETRY PARAMETERS

NUMBER OF ROD ROWS=	4
NUMBER OF SUBCHANNELS=	64
FUEL RADIUS=	0.00260D 00 M
OUTER CLADDING RADIUS=	0.00300D 00M
LENGTH HEXAGONON DIAGONAL=	0.07349D 00M
WIDTH OF HEXAGONON IS	0.06364D 00M
TOTAL HEATED LENGTH=	1.00000D 00 M
DIMENSIONLESS ROD SPACING=	1.30000D 00
DIMENSIONLESS ROD-WALL SPACING=	1.60000D 00
TOTAL NUMBER OF RODS IN HEXAGONON=	61
TOTAL SECTION OF HEXAGONON=	0.00351D 00SQ.M
TOTAL COOLANT SECTION OF HEXAGONON=	0.00178D 00SQ.M
AXIAL DISTANCE BETWEEN BEGINNING OF FUEL AND FIRST GRID=	0.10000D 00M
AXIAL DISTANCE INTERVAL BETWEEN 2 GRIDS=	0.20000D 00 M
AXIAL DISTANCE BETWEEN LAST GRID AND END OF FUEL=	0.10000D 00 M
NUMBER OF GRIDS IN HEATED PART OF FUEL ELEMENT=	5
HYDRAULIC DIAMETER OF FUEL ELEMENT=	0.05204D-01 M
HYDR.DIAMETERS OF TRIANGULAR,RECTANGULAR AND ANGULAR SUBCHANNELS ARE	0.05181D-01 0.05411D-01AND 0.03957D-01RESPECTIVELY
THERMAL DIAMETERS OF TRIANGULAR, RECTANGULAR AND ANGULAR SUBCHANNELS ARE	0.05181D-01 0.09890D-01AND 0.01094D 00RESPECTIVELY

HYDRODYNAMIC AND THERMAL PARAMETERS

MAX. LINEAL POWER OF ROD WITH MAX. RATING=	420.000D 02W/M
COOLANT MASS FLOW RATE IN FUEL ELEMENT=	62.94107D-01KG/SEC
COOLANT INLET TEMPERATURE=	400.00000D 00DEGR.C
COOLANT INLET PRESSURE =	600.0000D-02BAR
BULK COOLANT OUTLET TEMPERATURE=	600.00000D 00DEGR.C
FUEL ELEMENT POWER=	1.58611D 00MEGAWATT
LINEAR POWER OF ROD MAX.RATING=	3.47337D 04W/M
AMPLITUDE OF LATERAL HEATGENERATION=	0.50000D 00
CONDUCTIVITIES OF FUEL AND CLADDING ARE	2.20000D 0021.00000D 00W/M DEG.C
FUEL-CLADDING CONTACT RESISTANCE=	1.00000D-04SQ.M*DEG.C/W
RATIO EXTRAPOLATION LENGTH TO HEATED LENGTH=	1.50000D 00
BULK ENTHALPY RISE OF COOLANT=	2.52000D 05J/KG
BULK COOLANT VELOCITY IN FUEL ELEMENT =	4.24356D 00 M/SEC
FRACTION OF FLOW IN OUTER SUBCHANNELS=	0.34340D 00
AXIAL FLUX SHAPE FACTOR=	0.82699D 00
FUEL ELEMENT REYNOLDS NUMBER=	76555.1D 00
PRANDTL NUMBER=	0.004511D 00
FUEL ELEMENT PECLET NUMBER=	34537.2D-02
RATIO TURBULENT DIFFUSIVITY FOR HEAT TO THAT FOR MOMENTUM =	0.66903D 00
COEFFICIENT FOR MIXING BETWEEN 2 TRIANG. SUBCHANNELS=	0.24187D-01
COEFFICIENT FOR MIXING BETWEEN ANGULAR AND RECT. SUBCHANNEL=	0.17758D-01
COEFFICIENT FOR MIXING BETWEEN RECT. AND TRIANG. SUBCHANNEL=	0.23414D-01
COEFFICIENT FOR MIXING BETWEEN 2 RECTANGULAR SUBCHANNELS=	0.14503D-01

SUBCHANNEL QUANTITIES

	1	2	3	4	5	6	7	8
REDUCED AV. HEAT FLUXES	0.10435D 01	0.10016D 01	0.96001D 00	0.11270D 01	0.10851D 01	0.10847D 01	0.10426D 01	0.10012D 01
	0.95912D 00	0.91771D 00	0.91815D 00	0.87652D 00	0.12105D 01	0.11686D 01	0.11682D 01	0.11261D 01
	0.11252D 01	0.10829D 01	0.10417D 01	0.99941D 00	0.95824D 00	0.91595D 00	0.87477D 00	0.87564D 00
	0.83423D 00	0.83467D 00	0.79303D 00	0.12940D 01	0.12521D 01	0.12516D 01	0.12096D 01	0.12086D 01
	0.11663D 01	0.11650D 01	0.11225D 01	0.10815D 01	0.10390D 01	0.99808D 00	0.95558D 00	0.91463D 00
	0.87214D 00	0.83118D 00	0.83249D 00	0.79130D 00	0.79216D 00	0.75075D 00	0.75118D 00	0.70954D 00
	0.13358D 01	0.13148D 01	0.12723D 01	0.12292D 01	0.11854D 01	0.11634D 01	0.11217D 01	0.10382D 01
	0.95480D 00	0.87137D 00	0.82965D 00	0.80993D 00	0.77016D 00	0.72972D 00	0.68862D 00	0.66791D 00
REDUCED MASS FLOWRATES	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01
	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01
	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01	0.13678D-01
	0.13678D-01	0.13678D-01	0.13678D-01	0.13682D-01	0.13678D-01	0.13683D-01	0.13678D-01	0.13683D-01
	0.13673D-01	0.13682D-01	0.13682D-01	0.13678D-01	0.13683D-01	0.13678D-01	0.13683D-01	0.13678D-01
	0.13682D-01	0.13682D-01	0.13678D-01	0.13683D-01	0.13678D-01	0.13683D-01	0.13678D-01	0.13682D-01
	0.44862D-02	0.26361D-01	0.26387D-01	0.26387D-01	0.26361D-01	0.89724D-02	0.26361D-01	0.26387D-01
	0.26387D-01	0.26361D-01	0.89724D-02	0.26361D-01	0.26387D-01	0.26387D-01	0.26361D-01	0.44862D-02
REDUCED BULK VELOCITIES	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00
	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00
	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00	0.99874D 00

	0.99874D 00	0.99874D 00	0.99874D 00	0.99905D 00	0.99876D 00	0.99907D 00	0.99876D 00	0.99907D 00
	0.99876D 00	0.99905D 00	0.99905D 00	0.99876D 00	0.99907D 00	0.99876D 00	0.99907D 00	0.99876D 00
	0.99905D 00	0.99905D 00	0.99876D 00	0.99907D 00	0.99876D 00	0.99907D 00	0.99876D 00	0.99905D 00
	0.93107D 00	0.10083D 01	0.10093D 01	0.10093D 01	0.10083D 01	0.93107D 00	0.10083D 01	0.10093D 01
	0.10093D 01	0.10083D 01	0.93107D 00	0.10083D 01	0.10093D 01	0.10093D 01	0.10083D 01	0.93107D 00
REDUCED SUBCH. HEATINPUT	0.12507D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13006D 01	0.13000D 01	0.12496D 01	0.12000D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14508D 01	0.14006D 01	0.14001D 01	0.13496D 01
	0.13485D 01	0.12979D 01	0.12485D 01	0.11978D 01	0.11485D 01	0.10978D 01	0.10484D 01	0.10495D 01
	0.99985D 00	0.10004D 01	0.95047D 00	0.15504D 01	0.15006D 01	0.14996D 01	0.14497D 01	0.14481D 01
	0.13979D 01	0.13958D 01	0.13449D 01	0.12962D 01	0.12449D 01	0.11962D 01	0.11449D 01	0.10962D 01
	0.10450D 01	0.99588D 00	0.99774D 00	0.94808D 00	0.94941D 00	0.89950D 00	0.90030D 00	0.85014D 00
	0.81355D 00	0.81764D 00	0.79047D 00	0.76368D 00	0.73721D 00	0.70853D 00	0.69755D 00	0.64503D 00
	0.59320D 00	0.54190D 00	0.50528D 00	0.50369D 00	0.47848D 00	0.45335D 00	0.42824D 00	0.40678D 00

N O M E N C L A T U R E

SIGNIFICANCE OF SYMBOLS DENOTING THERMAL QUANTITIES RELATED TO SUBCHANNELS

HR(I) DENOTES ENTHALPY RISE IN SUBCHANNEL I TO TOTAL ENTHALPY RISE OVER FUEL ELEMENT

H(I) DENOTES ENTHALPY IN SUBCHANNEL

RATHR(I) DENOTES RATIO ENTHALPY RISE IN SUBCHANNEL TO THAT IN HEXAGONON AT Z

QAV(I) DENOTES RATIO AV.SUBCHANNEL HEAT FLUX TO SPATIALLY AV. HEAT FLUX

TCO(I) DENOTES SUBCHANNEL COOLANT TEMPERATURE

REL(I) DENOTES SUBCHANNEL REYNOLDS NUMBER

TCL(I) DENOTES SUBCHANNEL AV. CLADDING TEMPERATURE

DIMENSIONLESS AXIAL DISTANCE ZR=0.0 AXIAL DISTANCE Z=0.0 M

```
RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT=    0.0
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=      0.60460D 00
AV. HEAT FLUX IN CROSS SECTION=                                    83.40108D 04W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING=                          131.8855D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING=                              210.000D 02W/M
PRESSURE=                                                          600.0000D-02BAR
COOLANT TEMPERATURE=                                               400.0000D 00 DEG.C
```

	1	2	3	4	5	6	7	8
HR(I)=	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RATHR(I)=	0.12507D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13006D 01	0.13000D 01	0.12496D 01	0.12000D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14508D 01	0.14006D 01	0.14001D 01	0.13496D 01
	0.13485D 01	0.12979D 01	0.12485D 01	0.11978D 01	0.11485D 01	0.10978D 01	0.10484D 01	0.10495D 01
	0.99985D 00	0.10004D 01	0.95047D 00	0.15504D 01	0.15006D 01	0.14996D 01	0.14497D 01	0.14481D 01
	0.13979D 01	0.13958D 01	0.13449D 01	0.12962D 01	0.12449D 01	0.11962D 01	0.11449D 01	0.10962D 01
	0.10450D 01	0.99588D 00	0.99774D 00	0.94808D 00	0.94941D 00	0.89950D 00	0.90030D 00	0.85014D 00
	0.81355D 00	0.81764D 00	0.79047D 00	0.76368D 00	0.73721D 00	0.70853D 00	0.69755D 00	0.64503D 00
	0.59320D 00	0.54190D 00	0.50528D 00	0.50369D 00	0.47848D 00	0.45335D 00	0.42824D 00	0.40678D 00
QAV(I)=	0.63090D 00	0.60559D 00	0.58042D 00	0.68137D 00	0.65607D 00	0.65579D 00	0.63035D 00	0.60532D 00
	0.57988D 00	0.55485D 00	0.55512D 00	0.52994D 00	0.73185D 00	0.70654D 00	0.70627D 00	0.68083D 00
	0.68028D 00	0.65471D 00	0.62981D 00	0.60424D 00	0.57935D 00	0.55378D 00	0.52888D 00	0.52941D 00
	0.50438D 00	0.50464D 00	0.47947D 00	0.78233D 00	0.75702D 00	0.75674D 00	0.73130D 00	0.73074D 00
	0.70517D 00	0.70434D 00	0.67864D 00	0.65389D 00	0.62819D 00	0.60344D 00	0.57774D 00	0.55298D 00
	0.52729D 00	0.50253D 00	0.50332D 00	0.47842D 00	0.47894D 00	0.45390D 00	0.45416D 00	0.42899D 00
	0.80763D 00	0.79491D 00	0.76925D 00	0.74319D 00	0.71672D 00	0.70338D 00	0.67816D 00	0.62772D 00
	0.57727D 00	0.52583D 00	0.50161D 00	0.48969D 00	0.46564D 00	0.44119D 00	0.41634D 00	0.40382D 00
TCD(I)=	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03	0.40000D 03
TCL(I)=	0.40663D 03	0.40637D 03	0.40610D 03	0.40717D 03	0.40690D 03	0.40690D 03	0.40663D 03	0.40637D 03
	0.40610D 03	0.40584D 03	0.40584D 03	0.40557D 03	0.40770D 03	0.40743D 03	0.40743D 03	0.40716D 03
	0.40715D 03	0.40689D 03	0.40662D 03	0.40635D 03	0.40609D 03	0.40582D 03	0.40556D 03	0.40557D 03
	0.40530D 03	0.40531D 03	0.40504D 03	0.40823D 03	0.40796D 03	0.40796D 03	0.40769D 03	0.40768D 03
	0.40742D 03	0.40741D 03	0.40714D 03	0.40688D 03	0.40661D 03	0.40635D 03	0.40608D 03	0.40582D 03
	0.40554D 03	0.40528D 03	0.40529D 03	0.40503D 03	0.40504D 03	0.40477D 03	0.40478D 03	0.40451D 03
	0.40693D 03	0.40863D 03	0.40835D 03	0.40807D 03	0.40778D 03	0.40603D 03	0.40736D 03	0.40681D 03
	0.40627D 03	0.40572D 03	0.40430D 03	0.40532D 03	0.40506D 03	0.40479D 03	0.40452D 03	0.40346D 03
REL(I)=	0.65246D 05	0.65246D 05	0.65246D 05	0.65246D 05	0.65246D 05	0.65246D 05	0.65246D 05	0.65246D 05

0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05
0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05	0.65246D	05
0.65246D	05	0.65246D	05	0.65246D	05	0.65267D	05	0.65248D	05	0.65268D	05	0.65248D	05	0.65268D	05
0.65248D	05	0.65267D	05	0.65267D	05	0.65248D	05	0.65268D	05	0.65248D	05	0.65268D	05	0.65248D	05
0.65267D	05	0.65257D	05	0.65248D	05	0.65268D	05	0.65248D	05	0.65268D	05	0.65248D	05	0.65267D	05
0.46450D	05	0.68803D	05	0.63371D	05	0.68871D	05	0.68803D	05	0.46450D	05	0.68803D	05	0.68871D	05
0.68871D	05	0.68803D	05	0.45450D	05	0.68803D	05	0.68871D	05	0.63871D	05	0.68803D	05	0.46450D	05

DIMENSIONLESS AXIAL DISTANCE ZR=0.500000D-01   AXIAL DISTANCE Z=0.500000D-01M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.32914D-01
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.71075D 00
AV. HEAT FLUX IN CROSS SECTION= 98.04385D 04W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 148.7179D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 246.870D 02W/M
PRESSURE= 598.4718D-02BAR
COOLANT TEMPERATURE= 406.5828D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.41164D-01	0.39513D-01	0.37870D-01	0.44457D-01	0.42806D-01	0.42788D-01	0.41128D-01	0.39495D-01
	0.37835D-01	0.36202D-01	0.35219D-01	0.34577D-01	0.47751D-01	0.46099D-01	0.46081D-01	0.44422D-01
	0.44386D-01	0.42717D-01	0.41093D-01	0.39425D-01	0.37801D-01	0.36132D-01	0.34508D-01	0.34542D-01
	0.32909D-01	0.32926D-01	0.31284D-01	0.50694D-01	0.49386D-01	0.49038D-01	0.47708D-01	0.47353D-01
	0.46003D-01	0.45640D-01	0.43990D-01	0.42658D-01	0.40722D-01	0.39367D-01	0.37452D-01	0.36075D-01
	0.34181D-01	0.32591D-01	0.32836D-01	0.31029D-01	0.31245D-01	0.29440D-01	0.29629D-01	0.27824D-01
	0.26784D-01	0.27070D-01	0.26175D-01	0.25288D-01	0.24410D-01	0.23332D-01	0.23098D-01	0.21364D-01
	0.19647D-01	0.17949D-01	0.16650D-01	0.16685D-01	0.15853D-01	0.15021D-01	0.14189D-01	0.13412D-01
RATHR(I)=	0.125(7D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13006D 01	0.13000D 01	0.12496D 01	0.12000D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14508D 01	0.14006D 01	0.14001D 01	0.13496D 01
	0.13485D 01	0.12979D 01	0.12485D 01	0.11978D 01	0.11485D 01	0.10978D 01	0.10484D 01	0.10495D 01
	0.99984D 00	0.10004D 01	0.95047D 00	0.15402D 01	0.15005D 01	0.14899D 01	0.14495D 01	0.14387D 01
	0.13977D 01	0.13866D 01	0.13365D 01	0.12961D 01	0.12372D 01	0.11961D 01	0.11379D 01	0.10961D 01
	0.10385D 01	0.99019D 00	0.99763D 00	0.94273D 00	0.94931D 00	0.89445D 00	0.90020D 00	0.84536D 00
	0.81377D 00	0.82245D 00	0.79527D 00	0.76832D 00	0.74162D 00	0.70889D 00	0.70176D 00	0.64909D 00
	0.59693D 00	0.54532D 00	0.50588D 00	0.50692D 00	0.48166D 00	0.45638D 00	0.43109D 00	0.40748D 00
QAV(I)=	0.74166D 00	0.71191D 00	0.68232D 00	0.80100D 00	0.77125D 00	0.77093D 00	0.74103D 00	0.71160D 00
	0.68169D 00	0.65226D 00	0.65258D 00	0.62299D 00	0.86034D 00	0.83059D 00	0.83027D 00	0.80036D 00
	0.79972D 00	0.76965D 00	0.74039D 00	0.71033D 00	0.68107D 00	0.65101D 00	0.62174D 00	0.62236D 00
	0.59293D 00	0.59324D 00	0.56365D 00	0.91968D 00	0.88993D 00	0.88960D 00	0.85969D 00	0.85904D 00
	0.82897D 00	0.82800D 00	0.79779D 00	0.76869D 00	0.73848D 00	0.70938D 00	0.67918D 00	0.65007D 00
	0.61987D 00	0.59076D 00	0.59169D 00	0.56241D 00	0.56303D 00	0.53359D 00	0.53390D 00	0.50431D 00
	0.94943D 00	0.93447D 00	0.90431D 00	0.87367D 00	0.84255D 00	0.82687D 00	0.79722D 00	0.73793D 00
	0.67863D 00	0.61933D 00	0.58968D 00	0.57566D 00	0.54739D 00	0.51865D 00	0.48944D 00	0.47472D 00
TCO(I)=	0.40823D 03	0.40790D 03	0.40757D 03	0.40889D 03	0.40856D 03	0.40856D 03	0.40823D 03	0.40790D 03
	0.40757D 03	0.40724D 03	0.40724D 03	0.40692D 03	0.40955D 03	0.40922D 03	0.40922D 03	0.40888D 03
	0.40888D 03	0.40854D 03	0.40822D 03	0.40788D 03	0.40756D 03	0.40723D 03	0.40690D 03	0.40691D 03
	0.40658D 03	0.40659D 03	0.40626D 03	0.41014D 03	0.40988D 03	0.40981D 03	0.40954D 03	0.40947D 03
	0.40920D 03	0.40913D 03	0.40880D 03	0.40853D 03	0.40814D 03	0.40787D 03	0.40749D 03	0.40722D 03
	0.40684D 03	0.40652D 03	0.40657D 03	0.40621D 03	0.40625D 03	0.40589D 03	0.40593D 03	0.40556D 03
	0.40536D 03	0.40541D 03	0.40524D 03	0.40506D 03	0.40488D 03	0.40467D 03	0.40462D 03	0.40427D 03
	0.40393D 03	0.40359D 03	0.40333D 03	0.40334D 03	0.40317D 03	0.40300D 03	0.40284D 03	0.40268D 03
TCL(I)=	0.41606D 03	0.41542D 03	0.41477D 03	0.41735D 03	0.41670D 03	0.41670D 03	0.41605D 03	0.41541D 03
	0.41476D 03	0.41412D 03	0.41413D 03	0.41349D 03	0.41864D 03	0.41799D 03	0.41799D 03	0.41734D 03
	0.41732D 03	0.41567D 03	0.41503D 03	0.41538D 03	0.41475D 03	0.41410D 03	0.41346D 03	0.41347D 03
	0.41284D 03	0.41284D 03	0.41220D 03	0.41986D 03	0.41928D 03	0.41920D 03	0.41862D 03	0.41854D 03
	0.41796D 03	0.41787D 03	0.41722D 03	0.41665D 03	0.41594D 03	0.41536D 03	0.41466D 03	0.41407D 03
	0.41338D 03	0.41275D 03	0.41281D 03	0.41214D 03	0.41219D 03	0.41151D 03	0.41156D 03	0.41088D 03
	0.41352D 03	0.41559D 03	0.41508D 03	0.41456D 03	0.41405D 03	0.41177D 03	0.41329D 03	0.41230D 03
	0.41131D 03	0.41033D 03	0.40839D 03	0.40960D 03	0.40912D 03	0.40864D 03	0.40816D 03	0.40676D 03
REL(I)=	0.66200D 05	0.66162D 05	0.66124D 05	0.66276D 05	0.66238D 05	0.66237D 05	0.66199D 05	0.66162D 05

```
0.66123D 05 0.66086D 05 0.66086D 05 0.66048D 05 0.66352D 05 0.66314D 05 0.66313D 05 0.66275D 05
0.66274D 05 0.66236D 05 0.66198D 05 0.66160D 05 0.66122D 05 0.66084D 05 0.66047D 05 0.66047D 05
0.66010D 05 0.66010D 05 0.65972D 05 0.66440D 05 0.66390D 05 0.66403D 05 0.66352D 05 0.66364D 05
0.66313D 05 0.66324D 05 0.66286D 05 0.66236D 05 0.66212D 05 0.66160D 05 0.66136D 05 0.66084D 05
0.66060D 05 0.66023D 05 0.66009D 05 0.65988D 05 0.65972D 05 0.65951D 05 0.65935D 05 0.65913D 05
0.46893D 05 0.69466D 05 0.69513D 05 0.69491D 05 0.69401D 05 0.46836D 05 0.69369D 05 0.69395D 05
0.69353D 05 0.69243D 05 0.46726D 05 0.69212D 05 0.69260D 05 0.69240D 05 0.69151D 05 0.46672D 05
            ENTHALPY CONTROL SUM= 0.10000000D 01
```

DIMENSIONLESS AXIAL DISTANCE ZR=0.100000D 00   AXIAL DISTANCE Z=0.100000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT=	0.70945D-01
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=	0.80911D 00
AV. HEAT FLUX IN CROSS SECTION=	11.16124D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING=	164.4745D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING=	281.035D 02W/M
PRESSURE=	596.9436D-02BAR
COOLANT TEMPERATURE=	414.1890D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.88728D-01	0.85169D-01	0.81529D-01	0.95826D-01	0.92267D-01	0.92229D-01	0.88651D-01	0.85131D-01
	0.81553D-01	0.78032D-01	0.73070D-01	0.74530D-01	0.10292D 00	0.99366D-01	0.99327D-01	0.95750D-01
	0.95672D-01	0.92076D-01	0.88575D-01	0.84979D-01	0.81478D-01	0.77882D-01	0.74380D-01	0.74455D-01
	0.70934D-01	0.70971D-01	0.67430D-01	0.10861D 00	0.10641D 00	0.10508D 00	0.10280D 00	0.10147D 00
	0.99125D-01	0.97782D-01	0.94277D-01	0.91920D-01	0.87287D-01	0.84828D-01	0.80277D-01	0.77735D-01
	0.73257D-01	0.69879D-01	0.70757D-01	0.66542D-01	0.67330D-01	0.63135D-01	0.63847D-01	0.59664D-01
	0.57760D-01	0.58664D-01	0.55737D-01	0.54814D-01	0.52903D-01	0.50327D-01	0.50062D-01	0.46319D-01
	0.42597D-01	0.38913D-01	0.35937D-01	0.36176D-01	0.34382D-01	0.32578D-01	0.30772D-01	0.28962D-01
RATHR(I)=	0.12507D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12496D 01	0.12000D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14508D 01	0.14006D 01	0.14001D 01	0.13496D 01
	0.13485D 01	0.12978D 01	0.12485D 01	0.11978D 01	0.11485D 01	0.10978D 01	0.10484D 01	0.10495D 01
	0.99984D 00	0.10004D 01	0.95046D 00	0.15309D 01	0.14999D 01	0.14811D 01	0.14490D 01	0.14302D 01
	0.13972D 01	0.13783D 01	0.13289D 01	0.12956D 01	0.12303D 01	0.11957D 01	0.11315D 01	0.10957D 01
	0.10326D 01	0.98498D 00	0.99735D 00	0.93794D 00	0.94904D 00	0.88992D 00	0.89994D 00	0.84099D 00
	0.81416D 00	0.82589D 00	0.79974D 00	0.77263D 00	0.74569D 00	0.70937D 00	0.70565D 00	0.65288D 00
	0.60042D 00	0.54350D 00	0.50655D 00	0.50991D 00	0.48463D 00	0.45920D 00	0.43374D 00	0.40823D 00
QAV(I)=	0.84430D 00	0.81044D 00	0.77575D 00	0.91185D 00	0.87799D 00	0.87762D 00	0.84358D 00	0.81008D 00
	0.77604D 00	0.74253D 00	0.74289D 00	0.70920D 00	0.97941D 00	0.94554D 00	0.94517D 00	0.91112D 00
	0.91039D 00	0.87617D 00	0.84286D 00	0.80864D 00	0.77532D 00	0.74111D 00	0.70778D 00	0.70849D 00
	0.67499D 00	0.67534D 00	0.64165D 00	0.10470D 01	0.10131D 01	0.10127D 01	0.97866D 00	0.97792D 00
	0.94370D 00	0.94259D 00	0.90819D 00	0.87508D 00	0.84068D 00	0.80756D 00	0.77317D 00	0.74004D 00
	0.70566D 00	0.67252D 00	0.67358D 00	0.64025D 00	0.64095D 00	0.60744D 00	0.60779D 00	0.57410D 00
	0.10808D 01	0.10638D 01	0.10295D 01	0.99458D 00	0.95915D 00	0.94131D 00	0.90755D 00	0.84005D 00
	0.77254D 00	0.70504D 00	0.67128D 00	0.65533D 00	0.62314D 00	0.59042D 00	0.55717D 00	0.54041D 00
TCO(I)=	0.41775D 03	0.41703D 03	0.41533D 03	0.41917D 03	0.41845D 03	0.41845D 03	0.41773D 03	0.41703D 03
	0.41631D 03	0.41561D 03	0.41561D 03	0.41491D 03	0.42058D 03	0.41987D 03	0.41987D 03	0.41915D 03
	0.41913D 03	0.41842D 03	0.41772D 03	0.41700D 03	0.41630D 03	0.41558D 03	0.41488D 03	0.41489D 03
	0.41419D 03	0.41419D 03	0.41349D 03	0.42172D 03	0.42128D 03	0.42102D 03	0.42056D 03	0.42029D 03
	0.41982D 03	0.41956D 03	0.41886D 03	0.41838D 03	0.41746D 03	0.41697D 03	0.41606D 03	0.41555D 03
	0.41465D 03	0.41398D 03	0.41415D 03	0.41331D 03	0.41347D 03	0.41263D 03	0.41277D 03	0.41193D 03
	0.41155D 03	0.41173D 03	0.41135D 03	0.41096D 03	0.41058D 03	0.41007D 03	0.41001D 03	0.40926D 03
	0.40852D 03	0.40778D 03	0.40719D 03	0.40724D 03	0.40688D 03	0.40652D 03	0.40615D 03	0.40579D 03
TCL(I)=	0.42670D 03	0.42562D 03	0.42456D 03	0.42884D 03	0.42777D 03	0.42775D 03	0.42667D 03	0.42561D 03
	0.42453D 03	0.42347D 03	0.42348D 03	0.42242D 03	0.43098D 03	0.42991D 03	0.42990D 03	0.42882D 03
	0.42879D 03	0.42771D 03	0.42665D 03	0.42557D 03	0.42451D 03	0.42343D 03	0.42237D 03	0.42239D 03
	0.42133D 03	0.42134D 03	0.42028D 03	0.43284D 03	0.43204D 03	0.43177D 03	0.43095D 03	0.43067D 03
	0.42984D 03	0.42956D 03	0.42849D 03	0.42767D 03	0.42637D 03	0.42553D 03	0.42425D 03	0.42339D 03
	0.42212D 03	0.42109D 03	0.42128D 03	0.42008D 03	0.42025D 03	0.41905D 03	0.41920D 03	0.41800D 03
	0.42087D 03	0.42335D 03	0.42258D 03	0.42181D 03	0.42105D 03	0.41818D 03	0.41991D 03	0.41842D 03
	0.41694D 03	0.41547D 03	0.41296D 03	0.41437D 03	0.41366D 03	0.41294D 03	0.41222D 03	0.41044D 03
REL(I)=	0.67288D 05	0.67207D 05	0.67127D 05	0.67449D 05	0.67368D 05	0.67368D 05	0.67286D 05	0.67206D 05

```
0.67125D 05 0.67045D 05 0.67046D 05 0.66965D 05 0.67610D 05 0.67529D 05 0.67529D 05 0.67447D 05
0.67446D 05 0.67364D 05 0.67285D 05 0.67203D 05 0.67123D 05 0.67041D 05 0.66961D 05 0.66963D 05
0.66883D 05 0.66884D 05 0.66303D 05 0.67760D 05 0.67690D 05 0.67681D 05 0.67608D 05 0.67599D 05
0.67525D 05 0.67515D 05 0.67435D 05 0.67362D 05 0.67278D 05 0.67201D 05 0.67118D 05 0.67039D 05
0.66957D 05 0.66380D 05 0.66380D 05 0.66805D 05 0.66802D 05 0.66727D 05 0.66722D 05 0.66646D 05
0.47401D 05 0.70233D 05 0.70256D 05 0.70209D 05 0.70094D 05 0.47279D 05 0.70025D 05 0.70003D 05
0.69913D 05 0.69754D 05 0.47043D 05 0.69688D 05 0.69713D 05 0.69669D 05 0.69556D 05 0.46929D 05
          ENTHALPY CONTROL SUM= 0.10000000D 01
```

DIMENSIONLESS AXIAL DISTANCE ZR=0.100000D 00   AXIAL DISTANCE Z=0.100000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT=	0.70945D-01
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=	0.80911D 00
AV. HEAT FLUX IN CROSS SECTION=	11.16124D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING=	164.4745D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING=	281.035D 02W/M
PRESSURE=	587.9768D-02BAR
COOLANT TEMPERATURE=	414.1890D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.88728D-01	0.85169D-01	0.81629D-01	0.95826D-01	0.92267D-01	0.92229D-01	0.88651D-01	0.85131D-01
	0.81553D-01	0.78032D-01	0.73070D-01	0.74530D-01	0.10292D 00	0.99366D-01	0.99327D-01	0.95750D-01
	0.95672D-01	0.92076D-01	0.83575D-01	0.84979D-01	0.81478D-01	0.77882D-01	0.74380D-01	0.74455D-01
	0.70934D-01	0.70971D-01	0.67430D-01	0.10861D 00	0.10641D 00	0.10508D 00	0.10280D 00	0.10147D 00
	0.99125D-01	0.97782D-01	0.94277D-01	0.91920D-01	0.87287D-01	0.84828D-01	0.80277D-01	0.77735D-01
	0.73257D-01	0.69879D-01	0.70757D-01	0.66542D-01	0.67330D-01	0.63135D-01	0.63847D-01	0.59664D-01
	0.57760D-01	0.58664D-01	0.56737D-01	0.54814D-01	0.52903D-01	0.50327D-01	0.50062D-01	0.46319D-01
	0.42597D-01	0.38013D-01	0.35937D-01	0.36176D-01	0.34382D-01	0.32578D-01	0.30772D-01	0.28962D-01
RATHR(I)=	0.12507D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12496D 01	0.12000D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14508D 01	0.14006D 01	0.14001D 01	0.13496D 01
	0.13485D 01	0.12978D 01	0.12485D 01	0.11978D 01	0.11485D 01	0.10978D 01	0.10484D 01	0.10495D 01
	0.99984D 00	0.10004D 01	0.95046D 00	0.15309D 01	0.14999D 01	0.14811D 01	0.14490D 01	0.14302D 01
	0.13972D 01	0.13783D 01	0.13289D 01	0.12956D 01	0.12303D 01	0.11957D 01	0.11315D 01	0.10957D 01
	0.10326D 01	0.98498D 00	0.99735D 00	0.93794D 00	0.94904D 00	0.88992D 00	0.89994D 00	0.84099D 00
	0.81416D 00	0.82589D 00	0.79974D 00	0.77263D 00	0.74569D 00	0.70937D 00	0.70565D 00	0.65288D 00
	0.60042D 00	0.54350D 00	0.50655D 00	0.50991D 00	0.48463D 00	0.45920D 00	0.43374D 00	0.40823D 00
QAV(I)=	0.84430D 00	0.81044D 00	0.77675D 00	0.91185D 00	0.87799D 00	0.87762D 00	0.84358D 00	0.81008D 00
	0.77604D 00	0.74253D 00	0.74289D 00	0.70920D 00	0.97941D 00	0.94554D 00	0.94517D 00	0.91112D 00
	0.91039D 00	0.87617D 00	0.84286D 00	0.80864D 00	0.77532D 00	0.74111D 00	0.70778D 00	0.70849D 00
	0.67499D 00	0.67534D 00	0.64165D 00	0.10470D 01	0.10131D 01	0.10127D 01	0.97866D 00	0.97792D 00
	0.94370D 00	0.94259D 00	0.90819D 00	0.87508D 00	0.84068D 00	0.80756D 00	0.77317D 00	0.74004D 00
	0.70566D 00	0.67252D 00	0.67358D 00	0.64025D 00	0.64095D 00	0.60744D 00	0.60779D 00	0.57410D 00
	0.10808D 01	0.10538D 01	0.10295D 01	0.99458D 00	0.95915D 00	0.94131D 00	0.90755D 00	0.84005D 00
	0.77254D 00	0.70504D 00	0.67128D 00	0.65533D 00	0.62314D 00	0.59042D 00	0.55717D 00	0.54041D 00
TCO(I)=	0.41775D 03	0.41703D 03	0.41533D 03	0.41917D 03	0.41845D 03	0.41845D 03	0.41773D 03	0.41703D 03
	0.41631D 03	0.41561D 03	0.41551D 03	0.41491D 03	0.42058D 03	0.41987D 03	0.41987D 03	0.41915D 03
	0.41913D 03	0.41842D 03	0.41772D 03	0.41700D 03	0.41630D 03	0.41558D 03	0.41488D 03	0.41489D 03
	0.41419D 03	0.41419D 03	0.41349D 03	0.42172D 03	0.42128D 03	0.42102D 03	0.42056D 03	0.42029D 03
	0.41982D 03	0.41956D 03	0.41886D 03	0.41838D 03	0.41746D 03	0.41697D 03	0.41606D 03	0.41555D 03
	0.41465D 03	0.41398D 03	0.41415D 03	0.41331D 03	0.41347D 03	0.41263D 03	0.41277D 03	0.41193D 03
	0.41155D 03	0.41173D 03	0.41135D 03	0.41096D 03	0.41058D 03	0.41007D 03	0.41001D 03	0.40926D 03
	0.40852D 03	0.40778D 03	0.40719D 03	0.40724D 03	0.40688D 03	0.40652D 03	0.40615D 03	0.40579D 03
TCL(I)=	0.42670D 03	0.42562D 03	0.42456D 03	0.42884D 03	0.42777D 03	0.42775D 03	0.42667D 03	0.42561D 03
	0.42453D 03	0.42347D 03	0.42348D 03	0.42242D 03	0.43098D 03	0.42991D 03	0.42990D 03	0.42882D 03
	0.42879D 03	0.42771D 03	0.42565D 03	0.42557D 03	0.42451D 03	0.42343D 03	0.42237D 03	0.42239D 03
	0.42133D 03	0.42134D 03	0.42028D 03	0.43284D 03	0.43204D 03	0.43177D 03	0.43095D 03	0.43067D 03
	0.42984D 03	0.42956D 03	0.42849D 03	0.42767D 03	0.42637D 03	0.42553D 03	0.42425D 03	0.42339D 03
	0.42212D 03	0.42109D 03	0.42128D 03	0.42008D 03	0.42025D 03	0.41905D 03	0.41920D 03	0.41800D 03
	0.42087D 03	0.42335D 03	0.42258D 03	0.42181D 03	0.42105D 03	0.41818D 03	0.41991D 03	0.41842D 03
	0.41694D 03	0.41547D 03	0.41296D 03	0.41437D 03	0.41366D 03	0.41294D 03	0.41222D 03	0.41044D 03
REL(I)=	0.67288D 05	0.67207D 05	0.67127D 05	0.67449D 05	0.67368D 05	0.67368D 05	0.67286D 05	0.67206D 05

```
0.67125D 05 0.67045D 05 0.67046D 05 0.66965D 05 0.67610D 05 0.67529D 05 0.67529D 05 0.67447D 05
0.67446D 05 0.67364D 05 0.67285D 05 0.67203D 05 0.67123D 05 0.67041D 05 0.66961D 05 0.66963D 05
0.66883D 05 0.66884D 05 0.66303D 05 0.67760D 05 0.67690D 05 0.67681D 05 0.67608D 05 0.67599D 05
0.67525D 05 0.67515D 05 0.67435D 05 0.67362D 05 0.67278D 05 0.67201D 05 0.67118D 05 0.67039D 05
0.66957D 05 0.66880D 05 0.66880D 05 0.66805D 05 0.66802D 05 0.66727D 05 0.66722D 05 0.66646D 05
0.47401D 05 0.70233D 05 0.70256D 05 0.70209D 05 0.70094D 05 0.47279D 05 0.70025D 05 0.70003D 05
0.69913D 05 0.69754D 05 0.47043D 05 0.69688D 05 0.69713D 05 0.69669D 05 0.69556D 05 0.46929D 05
           ENTHALPY CONTROL SUM= 0.10000000D 01
```

DIMENSIONLESS AXIAL DISTANCE ZR=0.200000D 00 AXIAL DISTANCE Z=0.200000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.16064D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.97826D 00
AV. HEAT FLUX IN CROSS SECTION= 13.49458D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 192.0836D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 339.787D 02W/M
PRESSURE= 584.9203D-02BAR
COOLANT TEMPERATURE= 432.1284D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.20091D 00	0.19285D 00	0.13483D 00	0.21698D 00	0.20892D 00	0.20883D 00	0.20073D 00	0.19276D 00
	0.18466D 00	0.17569D 00	0.17577D 00	0.16876D 00	0.23304D 00	0.22499D 00	0.22490D 00	0.21681D 00
	0.21662D 00	0.20848D 00	0.20056D 00	0.19241D 00	0.18449D 00	0.17634D 00	0.16841D 00	0.16859D 00
	0.16061D 00	0.16070D 00	0.15268D 00	0.24324D 00	0.24068D 00	0.23545D 00	0.23250D 00	0.22736D 00
	0.22419D 00	0.21899D 00	0.21125D 00	0.20791D 00	0.19570D 00	0.19187D 00	0.17999D 00	0.17583D 00
	0.16417D 00	0.15572D 00	0.15006D 00	0.14932D 00	0.15231D 00	0.14168D 00	0.14443D 00	0.13384D 00
	0.13097D 00	0.13414D 00	0.12979D 00	0.12539D 00	0.12099D 00	0.11416D 00	0.11450D 00	0.10600D 00
	0.97487D-01	0.89048D-01	0.81620D-01	0.82797D-01	0.78737D-01	0.74608D-01	0.70459D-01	0.65842D-01
RATHR(I)=	0.12506D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12496D 01	0.11999D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14507D 01	0.14006D 01	0.14000D 01	0.13496D 01
	0.13485D 01	0.12978D 01	0.12485D 01	0.11978D 01	0.11485D 01	0.10977D 01	0.10484D 01	0.10495D 01
	0.99980D 00	0.10004D 01	0.95043D 00	0.15142D 01	0.14982D 01	0.14657D 01	0.14473D 01	0.14153D 01
	0.13956D 01	0.13532D 01	0.13151D 01	0.12943D 01	0.12182D 01	0.11944D 01	0.11204D 01	0.10945D 01
	0.10220D 01	0.97557D 00	0.99639D 00	0.92952D 00	0.94815D 00	0.88197D 00	0.89909D 00	0.83314D 00
	0.81532D 00	0.83499D 00	0.80797D 00	0.78058D 00	0.75314D 00	0.71067D 00	0.71276D 00	0.65988D 00
	0.60686D 00	0.55432D 00	0.50809D 00	0.51541D 00	0.49014D 00	0.46443D 00	0.43861D 00	0.40987D 00
QAV(I)=	0.10208D 01	0.97987D 00	0.93914D 00	0.11025D 01	0.10615D 01	0.10611D 01	0.10199D 01	0.97943D 00
	0.93827D 00	0.89776D 00	0.89819D 00	0.85747D 00	0.11842D 01	0.11432D 01	0.11428D 01	0.11016D 01
	0.11007D 01	0.10593D 01	0.10191D 01	0.97769D 00	0.93741D 00	0.89604D 00	0.85575D 00	0.85661D 00
	0.81610D 00	0.81552D 00	0.77579D 00	0.12658D 01	0.12249D 01	0.12244D 01	0.11833D 01	0.11824D 01
	0.11410D 01	0.11396D 01	0.10981D 01	0.10580D 01	0.10164D 01	0.97638D 00	0.93481D 00	0.89475D 00
	0.85318D 00	0.81311D 00	0.81439D 00	0.77410D 00	0.77495D 00	0.73443D 00	0.73485D 00	0.69412D 00
	0.13068D 01	0.12862D 01	0.12447D 01	0.12025D 01	0.11597D 01	0.11381D 01	0.10973D 01	0.10157D 01
	0.93405D 00	0.85243D 00	0.81162D 00	0.79233D 00	0.75342D 00	0.71385D 00	0.67365D 00	0.65339D 00
TCO(I)=	0.44018D 03	0.43857D 03	0.43597D 03	0.44340D 03	0.44178D 03	0.44177D 03	0.44015D 03	0.43855D 03
	0.43693D 03	0.43534D 03	0.43535D 03	0.43375D 03	0.44661D 03	0.44500D 03	0.44498D 03	0.44336D 03
	0.44332D 03	0.44170D 03	0.44011D 03	0.43848D 03	0.43690D 03	0.43527D 03	0.43368D 03	0.43372D 03
	0.43212D 03	0.43214D 03	0.43054D 03	0.44865D 03	0.44814D 03	0.44709D 03	0.44650D 03	0.44547D 03
	0.44484D 03	0.44380D 03	0.44225D 03	0.44158D 03	0.43914D 03	0.43837D 03	0.43600D 03	0.43517D 03
	0.43283D 03	0.43134D 03	0.43201D 03	0.42986D 03	0.43046D 03	0.42834D 03	0.42889D 03	0.42677D 03
	0.42619D 03	0.42683D 03	0.42596D 03	0.42508D 03	0.42420D 03	0.42283D 03	0.42290D 03	0.42120D 03
	0.41950D 03	0.41781D 03	0.41632D 03	0.41656D 03	0.41575D 03	0.41492D 03	0.41409D 03	0.41317D 03
TCL(I)=	0.45112D 03	0.44906D 03	0.44701D 03	0.45523D 03	0.45317D 03	0.45315D 03	0.45108D 03	0.44904D 03
	0.44697D 03	0.44494D 03	0.44496D 03	0.44291D 03	0.45934D 03	0.45728D 03	0.45725D 03	0.45518D 03
	0.45514D 03	0.45305D 03	0.45103D 03	0.44895D 03	0.44693D 03	0.44485D 03	0.44282D 03	0.44287D 03
	0.44083D 03	0.44086D 03	0.43881D 03	0.46226D 03	0.46131D 03	0.46025D 03	0.45922D 03	0.45817D 03
	0.45709D 03	0.45503D 03	0.45403D 03	0.45293D 03	0.45003D 03	0.44883D 03	0.44599D 03	0.44473D 03
	0.44194D 03	0.44002D 03	0.44071D 03	0.43812D 03	0.43873D 03	0.43616D 03	0.43672D 03	0.43416D 03
	0.43754D 03	0.44097D 03	0.43963D 03	0.43829D 03	0.43693D 03	0.43270D 03	0.43494D 03	0.43234D 03
	0.42973D 03	0.42714D 03	0.42334D 03	0.42523D 03	0.42399D 03	0.42272D 03	0.42145D 03	0.41881D 03
REL(I)=	0.69797D 05	0.69620D 05	0.69443D 05	0.70151D 05	0.69974D 05	0.69972D 05	0.69794D 05	0.69618D 05

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0.69439D 05 0.69262D 05 0.69264D 05 0.69086D 05 0.70502D 05 0.70326D 05 0.70324D 05 0.70147D 05
0.70143D 05 0.69964D 05 0.69790D 05 0.69610D 05 0.69435D 05 0.69255D 05 0.69079D 05 0.69083D 05
0.68905D 05 0.68907D 05 0.68728D 05 0.70746D 05 0.70670D 05 0.70578D 05 0.70491D 05 0.70401D 05
0.70310D 05 0.70216D 05 0.70047D 05 0.69953D 05 0.69706D 05 0.69600D 05 0.69358D 05 0.69244D 05
0.69006D 05 0.68840D 05 0.68894D 05 0.68676D 05 0.68721D 05 0.68505D 05 0.68545D 05 0.68328D 05
0.48583D 05 0.72038D 05 0.72006D 05 0.71901D 05 0.71726D 05 0.48314D 05 0.71572D 05 0.71440D 05
0.71236D 05 0.70964D 05 0.47739D 05 0.70814D 05 0.70786D 05 0.70687D 05 0.70518D 05 0.47532D 05
                 ENTHALPY CONTROL SUM= 0.10000000D 01
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DIMENSIONLESS AXIAL DISTANCE ZR=0.300000D 00 AXIAL DISTANCE Z=0.300000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT=	0.26517D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=	0.11047D 01
AV. HEAT FLUX IN CROSS SECTION=	15.23814D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING=	213.5056D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING=	383.689D 02W/M
PRESSURE=	581.8639D-02BAR
COOLANT TEMPERATURE=	453.0341D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.33163D 00	0.31833D 00	0.30510D 00	0.35817D 00	0.34486D 00	0.34472D 00	0.33135D 00	0.31819D 00
	0.30482D 00	0.29166D 00	0.29180D 00	0.27857D 00	0.38465D 00	0.37139D 00	0.37120D 00	0.35787D 00
	0.35754D 00	0.34411D 00	0.33106D 00	0.31759D 00	0.30453D 00	0.29106D 00	0.27798D 00	0.27828D 00
	0.26510D 00	0.26526D 00	0.25201D 00	0.39751D 00	0.39663D 00	0.38508D 00	0.38318D 00	0.37183D 00
	0.36946D 00	0.35788D 00	0.34540D 00	0.34267D 00	0.32024D 00	0.31625D 00	0.29452D 00	0.28980D 00
	0.26848D 00	0.25644D 00	0.25385D 00	0.24453D 00	0.25109D 00	0.23203D 00	0.23809D 00	0.21905D 00
	0.21662D 00	0.22339D 00	0.21528D 00	0.20895D 00	0.20152D 00	0.18889D 00	0.19073D 00	0.17671D 00
	0.16251D 00	0.14842D 00	0.13520D 00	0.13802D 00	0.13133D 00	0.12445D 00	0.11750D 00	0.10917D 00
RATHR(I)=	0.12506D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12496D 01	0.11999D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14506D 01	0.14006D 01	0.13999D 01	0.13496D 01
	0.13483D 01	0.12977D 01	0.12485D 01	0.11977D 01	0.11484D 01	0.10976D 01	0.10483D 01	0.10495D 01
	0.99973D 00	0.10003D 01	0.95035D 00	0.14991D 01	0.14958D 01	0.14522D 01	0.14450D 01	0.14022D 01
	0.13933D 01	0.13496D 01	0.13026D 01	0.12923D 01	0.12077D 01	0.11926D 01	0.11107D 01	0.10929D 01
	0.10125D 01	0.96708D 00	0.99502D 00	0.92218D 00	0.94689D 00	0.87504D 00	0.89788D 00	0.82608D 00
	0.81692D 00	0.84242D 00	0.81563D 00	0.78797D 00	0.75998D 00	0.71235D 00	0.71929D 00	0.66639D 00
	0.61286D 00	0.55970D 00	0.50986D 00	0.52049D 00	0.49528D 00	0.46933D 00	0.44312D 00	0.41169D 00
QAV(I)=	0.11527D 01	0.11065D 01	0.10605D 01	0.12449D 01	0.11987D 01	0.11982D 01	0.11517D 01	0.11060D 01
	0.10595D 01	0.10138D 01	0.10142D 01	0.96825D 00	0.13372D 01	0.12909D 01	0.12904D 01	0.12439D 01
	0.12429D 01	0.11962D 01	0.11507D 01	0.11040D 01	0.10585D 01	0.10118D 01	0.96632D 00	0.96729D 00
	0.92154D 00	0.92202D 00	0.87603D 00	0.14294D 01	0.13831D 01	0.13826D 01	0.13361D 01	0.13351D 01
	0.12884D 01	0.12869D 01	0.12399D 01	0.11947D 01	0.11478D 01	0.11025D 01	0.10556D 01	0.10104D 01
	0.96341D 00	0.91817D 00	0.91951D 00	0.87411D 00	0.87507D 00	0.82932D 00	0.82980D 00	0.78380D 00
	0.14756D 01	0.14524D 01	0.14055D 01	0.13579D 01	0.13095D 01	0.12851D 01	0.12391D 01	0.11469D 01
	0.10547D 01	0.96257D 00	0.91649D 00	0.89470D 00	0.85076D 00	0.80609D 00	0.76069D 00	0.73781D 00
TCO(I)=	0.46633D 03	0.46367D 03	0.46102D 03	0.47163D 03	0.46897D 03	0.46894D 03	0.46627D 03	0.46364D 03
	0.46096D 03	0.45833D 03	0.45836D 03	0.45571D 03	0.47693D 03	0.47428D 03	0.47424D 03	0.47157D 03
	0.47151D 03	0.46882D 03	0.46621D 03	0.46352D 03	0.46091D 03	0.45821D 03	0.45560D 03	0.45566D 03
	0.45302D 03	0.45305D 03	0.45040D 03	0.47950D 03	0.47933D 03	0.47702D 03	0.47664D 03	0.47437D 03
	0.47389D 03	0.47158D 03	0.46908D 03	0.46853D 03	0.46405D 03	0.46325D 03	0.45890D 03	0.45796D 03
	0.45370D 03	0.45129D 03	0.45277D 03	0.44891D 03	0.45022D 03	0.44641D 03	0.44762D 03	0.44381D 03
	0.44332D 03	0.44463D 03	0.44326D 03	0.44179D 03	0.44030D 03	0.43778D 03	0.43815D 03	0.43534D 03
	0.43250D 03	0.42968D 03	0.42704D 03	0.42760D 03	0.42627D 03	0.42489D 03	0.42350D 03	0.42183D 03
TCL(I)=	0.47883D 03	0.47565D 03	0.47250D 03	0.48517D 03	0.48199D 03	0.48196D 03	0.47876D 03	0.47562D 03
	0.47243D 03	0.46929D 03	0.46932D 03	0.46616D 03	0.49151D 03	0.48834D 03	0.48829D 03	0.48510D 03
	0.48503D 03	0.48181D 03	0.47870D 03	0.47548D 03	0.47236D 03	0.46915D 03	0.46603D 03	0.46610D 03
	0.46295D 03	0.46299D 03	0.45983D 03	0.49511D 03	0.49442D 03	0.49209D 03	0.49120D 03	0.48890D 03
	0.48792D 03	0.48557D 03	0.48255D 03	0.48151D 03	0.47648D 03	0.47519D 03	0.47031D 03	0.46888D 03
	0.46408D 03	0.46118D 03	0.46268D 03	0.45831D 03	0.45964D 03	0.45532D 03	0.45654D 03	0.45222D 03
	0.45625D 03	0.46078D 03	0.45882D 03	0.45682D 03	0.45479D 03	0.44900D 03	0.45184D 03	0.44800D 03
	0.44413D 03	0.44028D 03	0.43500D 03	0.43744D 03	0.43562D 03	0.43374D 03	0.43185D 03	0.42823D 03
REL(I)=	0.72625D 05	0.72342D 05	0.72059D 05	0.73186D 05	0.72905D 05	0.72902D 05	0.72619D 05	0.72339D 05

0.72053D 05	0.71771D 05	0.71774D 05	0.71489D 05	0.73743D 05	0.73465D 05	0.73461D 05	0.73180D 05
0.73173D 05	0.72889D 05	0.72612D 05	0.72326D 05	0.72047D 05	0.71758D 05	0.71477D 05	0.71483D 05
0.71198D 05	0.71202D 05	0.70915D 05	0.74035D 05	0.73995D 05	0.73776D 05	0.73713D 05	0.73498D 05
0.73425D 05	0.73203D 05	0.72939D 05	0.72860D 05	0.72406D 05	0.72299D 05	0.71856D 05	0.71732D 05
0.71294D 05	0.71033D 05	0.71173D 05	0.70776D 05	0.70896D 05	0.70503D 05	0.70613D 05	0.70218D 05
0.49936D 05	0.74123D 05	0.74032D 05	0.73862D 05	0.73617D 05	0.49502D 05	0.73366D 05	0.73111D 05
0.72778D 05	0.72375D 05	0.48651D 05	0.72129D 05	0.72042D 05	0.71879D 05	0.71643D 05	0.48234D 05

ENTHALPY CONTROL SUM= 0.10000000D 01

DIMENSIONLESS AXIAL DISTANCE ZR=0.300000D 00 AXIAL DISTANCE Z=0.300000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.26517D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.11047D 01
AV. HEAT FLUX IN CROSS SECTION= 15.238140D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 213.5056D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 383.689D 02W/M
PRESSURE= 572.8971D-02BAR
COOLANT TEMPERATURE= 453.0341D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.33163D 00	0.31833D 00	0.30510D 00	0.35817D 00	0.34486D 00	0.34472D 00	0.33135D 00	0.31819D 00
	0.30482D 00	0.29166D 00	0.29180D 00	0.27857D 00	0.38465D 00	0.37139D 00	0.37120D 00	0.35787D 00
	0.35754D 00	0.34411D 00	0.33106D 00	0.31759D 00	0.30453D 00	0.29106D 00	0.27798D 00	0.27828D 00
	0.26510D 00	0.26526D 00	0.25201D 00	0.39751D 00	0.39663D 00	0.38508D 00	0.38318D 00	0.37183D 00
	0.36946D 00	0.35788D 00	0.34540D 00	0.34267D 00	0.32024D 00	0.31625D 00	0.29452D 00	0.28980D 00
	0.26848D 00	0.25544D 00	0.25385D 00	0.24453D 00	0.25109D 00	0.23203D 00	0.23809D 00	0.21905D 00
	0.21662D 00	0.22339D 00	0.21628D 00	0.20895D 00	0.20152D 00	0.18889D 00	0.19073D 00	0.17671D 00
	0.16251D 00	0.14842D 00	0.13520D 00	0.13802D 00	0.13133D 00	0.12445D 00	0.11750D 00	0.10917D 00
RATHR(I)=	0.12506D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12496D 01	0.11999D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14506D 01	0.14006D 01	0.13999D 01	0.13496D 01
	0.13483D 01	0.12977D 01	0.12485D 01	0.11977D 01	0.11484D 01	0.10976D 01	0.10483D 01	0.10495D 01
	0.99973D 00	0.10003D 01	0.95035D 00	0.14991D 01	0.14958D 01	0.14522D 01	0.14450D 01	0.14022D 01
	0.13933D 01	0.13496D 01	0.13026D 01	0.12923D 01	0.12077D 01	0.11926D 01	0.11107D 01	0.10929D 01
	0.10125D 01	0.96708D 00	0.99502D 00	0.92218D 00	0.94689D 00	0.87504D 00	0.89788D 00	0.82608D 00
	0.81692D 00	0.84242D 00	0.81563D 00	0.78797D 00	0.75998D 00	0.71235D 00	0.71929D 00	0.66639D 00
	0.61286D 00	0.55970D 00	0.50986D 00	0.52049D 00	0.49528D 00	0.46933D 00	0.44312D 00	0.41169D 00
QAV(I)=	0.11527D 01	0.11065D 01	0.10605D 01	0.12449D 01	0.11987D 01	0.11982D 01	0.11517D 01	0.11060D 01
	0.10595D 01	0.10138D 01	0.10142D 01	0.96825D 00	0.13372D 01	0.12909D 01	0.12904D 01	0.12439D 01
	0.12429D 01	0.11962D 01	0.11507D 01	0.11040D 01	0.10585D 01	0.10118D 01	0.96632D 00	0.96729D 00
	0.92154D 00	0.92202D 00	0.87503D 00	0.14294D 01	0.13831D 01	0.13826D 01	0.13361D 01	0.13351D 01
	0.12884D 01	0.12869D 01	0.12399D 01	0.11947D 01	0.11478D 01	0.11025D 01	0.10556D 01	0.10104D 01
	0.96341D 00	0.91817D 00	0.91961D 00	0.87411D 00	0.87507D 00	0.82932D 00	0.82980D 00	0.78380D 00
	0.14756D 01	0.14524D 01	0.14055D 01	0.13579D 01	0.13095D 01	0.12851D 01	0.12391D 01	0.11469D 01
	0.10547D 01	0.96257D 00	0.91549D 00	0.89470D 00	0.85076D 00	0.80609D 00	0.76069D 00	0.73781D 00
TCO(I)=	0.46633D 03	0.46357D 03	0.46102D 03	0.47163D 03	0.46897D 03	0.46894D 03	0.46627D 03	0.46364D 03
	0.46096D 03	0.45333D 03	0.45836D 03	0.45571D 03	0.47693D 03	0.47428D 03	0.47424D 03	0.47157D 03
	0.47151D 03	0.46382D 03	0.45521D 03	0.46352D 03	0.46091D 03	0.45821D 03	0.45560D 03	0.45566D 03
	0.45302D 03	0.45305D 03	0.45040D 03	0.47950D 03	0.47933D 03	0.47702D 03	0.47664D 03	0.47437D 03
	0.47389D 03	0.47158D 03	0.45908D 03	0.46853D 03	0.46405D 03	0.46325D 03	0.45890D 03	0.45796D 03
	0.45370D 03	0.45129D 03	0.45277D 03	0.44891D 03	0.45022D 03	0.44641D 03	0.44762D 03	0.44381D 03
	0.44332D 03	0.44468D 03	0.44326D 03	0.44179D 03	0.44030D 03	0.43778D 03	0.43815D 03	0.43534D 03
	0.43250D 03	0.42963D 03	0.42704D 03	0.42760D 03	0.42627D 03	0.42489D 03	0.42350D 03	0.42183D 03
TCL(I)=	0.47883D 03	0.47565D 03	0.47250D 03	0.48517D 03	0.48199D 03	0.48196D 03	0.47876D 03	0.47562D 03
	0.47243D 03	0.46929D 03	0.45932D 03	0.46616D 03	0.49151D 03	0.48834D 03	0.48829D 03	0.48510D 03
	0.48503D 03	0.48181D 03	0.47870D 03	0.47548D 03	0.47236D 03	0.46915D 03	0.46603D 03	0.46610D 03
	0.46295D 03	0.46299D 03	0.45983D 03	0.49511D 03	0.49442D 03	0.49209D 03	0.49120D 03	0.48890D 03
	0.48792D 03	0.48557D 03	0.43255D 03	0.48151D 03	0.47648D 03	0.47519D 03	0.47031D 03	0.46888D 03
	0.46408D 03	0.46118D 03	0.46268D 03	0.45831D 03	0.45964D 03	0.45532D 03	0.45654D 03	0.45222D 03
	0.45625D 03	0.46078D 03	0.45882D 03	0.45682D 03	0.45479D 03	0.44900D 03	0.45184D 03	0.44800D 03
	0.44413D 03	0.44028D 03	0.43500D 03	0.43744D 03	0.43562D 03	0.43374D 03	0.43185D 03	0.42823D 03
REL(I)=	0.72625D 05	0.72342D 05	0.72059D 05	0.73186D 05	0.72905D 05	0.72902D 05	0.72619D 05	0.72339D 05

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0.72053D 05 0.71771D 05 0.71774D 05 0.71489D 05 0.73743D 05 0.73465D 05 0.73461D 05 0.73180D 05
0.73173D 05 0.72889D 05 0.72612D 05 0.72326D 05 0.72047D 05 0.71758D 05 0.71477D 05 0.71483D 05
0.71198D 05 0.71202D 05 0.70915D 05 0.74035D 05 0.73995D 05 0.73776D 05 0.73713D 05 0.73498D 05
0.73425D 05 0.73203D 05 0.72939D 05 0.72860D 05 0.72406D 05 0.72299D 05 0.71856D 05 0.71732D 05
0.71294D 05 0.71033D 05 0.71173D 05 0.70776D 05 0.70896D 05 0.70503D 05 0.70613D 05 0.70218D 05
0.49936D 05 0.74123D 05 0.74032D 05 0.73862D 05 0.73617D 05 0.49502D 05 0.73366D 05 0.73111D 05
0.72778D 05 0.72375D 05 0.43651D 05 0.72129D 05 0.72042D 05 0.71879D 05 0.71643D 05 0.48234D 05
          ENTHALPY CONTROL SUM= 0.10000000D 01
```

DIMENSIONLESS AXIAL DISTANCE ZR=0.400000D 00   AXIAL DISTANCE Z=0.400000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT=	0.37996D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=	0.11828D 01
AV. HEAT FLUX IN CROSS SECTION=	16.31571D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING=	227.80340 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING=	410.822D 02W/M
PRESSURE=	569.8407D-02BAR
COOLANT TEMPERATURE=	475.9924D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.47519D 00	0.45513D 00	0.43717D 00	0.51321D 00	0.49415D 00	0.49395D 00	0.47478D 00	0.45593D 00
	0.43677D 00	0.41791D 00	0.41811D 00	0.39915D 00	0.55107D 00	0.53216D 00	0.53182D 00	0.51279D 00
	0.51224D 00	0.49300D 00	0.47437D 00	0.45501D 00	0.43636D 00	0.41700D 00	0.39827D 00	0.39875D 00
	0.37982D 00	0.38009D 00	0.36106D 00	0.56423D 00	0.56718D 00	0.54710D 00	0.54797D 00	0.52827D 00
	0.52832D 00	0.50801D 00	0.49048D 00	0.49008D 00	0.45521D 00	0.45233D 00	0.41866D 00	0.41447D 00
	0.38134D 00	0.36444D 00	0.37743D 00	0.34786D 00	0.35920D 00	0.33009D 00	0.34059D 00	0.31139D 00
	0.31116D 00	0.32276D 00	0.31270D 00	0.30209D 00	0.29123D 00	0.27143D 00	0.27566D 00	0.25558D 00
	0.23506D 00	0.21461D 00	0.19449D 00	0.19961D 00	0.19007D 00	0.18012D 00	0.17001D 00	0.15719D 00
RATHR(I)=	0.12506D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12496D 01	0.11999D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14503D 01	0.14006D 01	0.13997D 01	0.13496D 01
	0.13481D 01	0.12975D 01	0.12485D 01	0.11975D 01	0.11484D 01	0.10975D 01	0.10482D 01	0.10494D 01
	0.99962D 00	0.10003D 01	0.95024D 00	0.14850D 01	0.14927D 01	0.14399D 01	0.14422D 01	0.13903D 01
	0.13905D 01	0.13370D 01	0.12909D 01	0.12898D 01	0.11980D 01	0.11905D 01	0.11018D 01	0.10908D 01
	0.10036D 01	0.95915D 00	0.99333D 00	0.91552D 00	0.94535D 00	0.86875D 00	0.89638D 00	0.81952D 00
	0.81891D 00	0.84946D 00	0.82297D 00	0.79506D 00	0.76647D 00	0.71435D 00	0.72549D 00	0.67266D 00
	0.61863D 00	0.56483D 00	0.51187D 00	0.52534D 00	0.50025D 00	0.47405D 00	0.44745D 00	0.41369D 00
QAV(I)=	0.12342D 01	0.11847D 01	0.11355D 01	0.13330D 01	0.12835D 01	0.12829D 01	0.12332D 01	0.11842D 01
	0.11344D 01	0.10854D 01	0.10860D 01	0.10367D 01	0.14317D 01	0.13822D 01	0.13817D 01	0.13319D 01
	0.13308D 01	0.12808D 01	0.12321D 01	0.11821D 01	0.11334D 01	0.10834D 01	0.10347D 01	0.10357D 01
	0.98671D 00	0.98722D 00	0.93798D 00	0.15305D 01	0.14809D 01	0.14804D 01	0.14306D 01	0.14295D 01
	0.13795D 01	0.13779D 01	0.13276D 01	0.12792D 01	0.12289D 01	0.11805D 01	0.11302D 01	0.10818D 01
	0.10315D 01	0.98310D 00	0.98465D 00	0.93593D 00	0.93695D 00	0.88797D 00	0.88848D 00	0.83923D 00
	0.15800D 01	0.15551D 01	0.15049D 01	0.14539D 01	0.14021D 01	0.13760D 01	0.13267D 01	0.12280D 01
	0.11293D 01	0.10306D 01	0.98130D 00	0.95797D 00	0.91092D 00	0.86309D 00	0.81448D 00	0.78999D 00
TCO(I)=	0.49504D 03	0.49123D 03	0.48743D 03	0.50264D 03	0.49883D 03	0.49879D 03	0.49496D 03	0.49119D 03
	0.48735D 03	0.48358D 03	0.48362D 03	0.47983D 03	0.51021D 03	0.50643D 03	0.50636D 03	0.50256D 03
	0.50245D 03	0.49860D 03	0.49487D 03	0.49100D 03	0.48727D 03	0.48340D 03	0.47965D 03	0.47975D 03
	0.47596D 03	0.47602D 03	0.47221D 03	0.51285D 03	0.51344D 03	0.50942D 03	0.50959D 03	0.50565D 03
	0.50566D 03	0.50160D 03	0.49810D 03	0.49802D 03	0.49104D 03	0.49047D 03	0.48373D 03	0.48289D 03
	0.47627D 03	0.47289D 03	0.47549D 03	0.46957D 03	0.47184D 03	0.46602D 03	0.46812D 03	0.46228D 03
	0.46223D 03	0.46455D 03	0.45254D 03	0.46042D 03	0.45825D 03	0.45429D 03	0.45513D 03	0.45112D 03
	0.44701D 03	0.44292D 03	0.43890D 03	0.43992D 03	0.43801D 03	0.43602D 03	0.43400D 03	0.43144D 03
TCL(I)=	0.50861D 03	0.50423D 03	0.49988D 03	0.51736D 03	0.51297D 03	0.51293D 03	0.50852D 03	0.50419D 03
	0.49979D 03	0.49546D 03	0.49550D 03	0.49115D 03	0.52608D 03	0.52172D 03	0.52164D 03	0.51726D 03
	0.51714D 03	0.51271D 03	0.50842D 03	0.50398D 03	0.49969D 03	0.49525D 03	0.49095D 03	0.49106D 03
	0.48672D 03	0.48678D 03	0.43242D 03	0.52982D 03	0.52987D 03	0.52582D 03	0.52544D 03	0.52146D 03
	0.52092D 03	0.51681D 03	0.51272D 03	0.51211D 03	0.50453D 03	0.50342D 03	0.49609D 03	0.49472D 03
	0.48751D 03	0.48359D 03	0.48621D 03	0.47974D 03	0.48203D 03	0.47565D 03	0.47776D 03	0.47136D 03
	0.47620D 03	0.48195D 03	0.47936D 03	0.47665D 03	0.47389D 03	0.46640D 03	0.46991D 03	0.46477D 03
	0.45954D 03	0.45434D 03	0.44748D 03	0.45052D 03	0.44808D 03	0.44555D 03	0.44299D 03	0.43832D 03
REL(I)=	0.75616D 05	0.75225D 05	0.74835D 05	0.76388D 05	0.76002D 05	0.75998D 05	0.75607D 05	0.75221D 05

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0.74826D 05 0.74436D 05 0.74440D 05 0.74046D 05 0.77151D 05 0.76771D 05 0.767764D 05 0.76380D 05
0.76369D 05 0.75979D 05 0.75599D 05 0.75202D 05 0.74818D 05 0.74417D 05 0.74027D 05 0.74037D 05
C.73642D 05 0.73547D 05 0.73247D 05 0.77438D 05 0.77474D 05 0.77096D 05 0.77090D 05 0.76718D 05
0.76695D 05 0.76307D 05 0.75951D 05 0.75921D 05 0.75231D 05 0.75148D 05 0.74476D 05 0.74366D 05
0.73696D 05 0.73341D 05 0.73593D 05 0.72993D 05 0.73209D 05 0.72616D 05 0.72816D 05 0.72216D 05
0.51393D 05 0.763850D 05 0.75234D 05 0.75995D 05 0.75674D 05 0.507850D 05 0.753200D 05 0.74936D 05
0.74465D 05 0.73920D 05 0.49590D 05 0.73572D 05 0.73423D 05 0.73191D 05 0.72882D 05 0.49001D 05
            ENTHALPY CONTROL SUM= 0.10000000D 01
```

DIMENSIONLESS AXIAL DISTANCE ZR=0.500000D 00 AXIAL DISTANCE Z=0.500000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.50000D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.12092D 01
AV. HEAT FLUX IN CROSS SECTION= 16.68022D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 234.3502D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 420.0000D 02W/M
PRESSURE= 566.7842D-02BAR
COOLANT TEMPERATURE= 500.0000D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.62531D 00	0.60023D 00	0.57528D 00	0.67534D 00	0.65026D 00	0.64999D 00	0.62477D 00	0.59996D 00
	0.57475D 00	0.54993D 00	0.55020D 00	0.52525D 00	0.72500D 00	0.70025D 00	0.69968D 00	0.67477D 00
	0.67391D 00	0.64861D 00	0.62421D 00	0.59864D 00	0.57419D 00	0.54863D 00	0.52399D 00	0.52471D 00
	0.49973D 00	0.50015D 00	0.47504D 00	0.73571D 00	0.74457D 00	0.71416D 00	0.71942D 00	0.68958D 00
	0.69357D 00	0.66246D 00	0.63983D 00	0.64347D 00	0.59451D 00	0.59396D 00	0.54678D 00	0.54421D 00
	0.49760D 00	0.47577D 00	0.49568D 00	0.45465D 00	0.47178D 00	0.43144D 00	0.44732D 00	0.40663D 00
	0.41063D 00	0.42315D 00	0.41510D 00	0.40102D 00	0.38639D 00	0.35834D 00	0.36577D 00	0.33942D 00
	0.31217D 00	0.28492D 00	0.25706D 00	0.26504D 00	0.25258D 00	0.23937D 00	0.22585D 00	0.20794D 00
RATHR(I)=	0.12506D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12495D 01	0.11999D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14500D 01	0.14005D 01	0.13994D 01	0.13495D 01
	0.13478D 01	0.12972D 01	0.12434D 01	0.11973D 01	0.11484D 01	0.10973D 01	0.10480D 01	0.10494D 01
	0.99945D 00	0.10003D 01	0.95007D 00	0.14714D 01	0.14891D 01	0.14283D 01	0.14388D 01	0.13792D 01
	0.13871D 01	0.13249D 01	0.12797D 01	0.12869D 01	0.11890D 01	0.11879D 01	0.10936D 01	0.10884D 01
	0.99519D 00	0.95154D 00	0.99135D 00	0.90929D 00	0.94357D 00	0.86288D 00	0.89463D 00	0.81326D 00
	0.82127D 00	0.85531D 00	0.83020D 00	0.80205D 00	0.77279D 00	0.71668D 00	0.73153D 00	0.67884D 00
	0.62434D 00	0.56985D 00	0.51412D 00	0.53008D 00	0.50516D 00	0.47873D 00	0.45169D 00	0.41588D 00
QAV(I)=	0.12618D 01	0.12112D 01	0.11508D 01	0.13627D 01	0.13121D 01	0.13116D 01	0.12607D 01	0.12106D 01
	0.11598D 01	0.11097D 01	0.11102D 01	0.10599D 01	0.14637D 01	0.14131D 01	0.14125D 01	0.13617D 01
	0.13606D 01	0.13094D 01	0.12596D 01	0.12085D 01	0.11587D 01	0.11076D 01	0.10578D 01	0.10588D 01
	0.10088D 01	0.10093D 01	0.95393D 00	0.15647D 01	0.15140D 01	0.15135D 01	0.14626D 01	0.14615D 01
	0.14103D 01	0.14087D 01	0.13573D 01	0.13078D 01	0.12564D 01	0.12069D 01	0.11555D 01	0.11060D 01
	0.10546D 01	0.10051D 01	0.10066D 01	0.95684D 00	0.95789D 00	0.90781D 00	0.90833D 00	0.85798D 00
	0.16153D 01	0.15398D 01	0.15385D 01	0.14864D 01	0.14334D 01	0.14068D 01	0.13563D 01	0.12554D 01
	0.11545D 01	0.10537D 01	0.10032D 01	0.97937D 00	0.93127D 00	0.88237D 00	0.83268D 00	0.80763D 00
TCO(I)=	0.52506D 03	0.52005D 03	0.51506D 03	0.53507D 03	0.53005D 03	0.53000D 03	0.52495D 03	0.51999D 03
	0.51495D 03	0.50999D 03	0.51004D 03	0.50505D 03	0.54500D 03	0.54005D 03	0.53994D 03	0.53495D 03
	0.53478D 03	0.52972D 03	0.52484D 03	0.51973D 03	0.51484D 03	0.50973D 03	0.50480D 03	0.50494D 03
	0.49995D 03	0.50003D 03	0.49501D 03	0.54714D 03	0.54891D 03	0.54283D 03	0.54388D 03	0.53792D 03
	0.53871D 03	0.53249D 03	0.52797D 03	0.52869D 03	0.51890D 03	0.51879D 03	0.50936D 03	0.50884D 03
	0.49952D 03	0.49515D 03	0.49914D 03	0.49093D 03	0.49436D 03	0.48629D 03	0.48946D 03	0.48133D 03
	0.48213D 03	0.48563D 03	0.43302D 03	0.48020D 03	0.47728D 03	0.47167D 03	0.47315D 03	0.46788D 03
	0.46243D 03	0.45598D 03	0.45141D 03	0.45301D 03	0.45052D 03	0.44787D 03	0.44517D 03	0.44159D 03
TCL(I)=	0.53915D 03	0.53353D 03	0.52795D 03	0.55035D 03	0.54473D 03	0.54467D 03	0.53902D 03	0.53347D 03
	0.52783D 03	0.52228D 03	0.52234D 03	0.51676D 03	0.56150D 03	0.55594D 03	0.55582D 03	0.55022D 03
	0.55004D 03	0.54437D 03	0.53890D 03	0.53318D 03	0.52771D 03	0.52200D 03	0.51649D 03	0.51664D 03
	0.51107D 03	0.51116D 03	0.50555D 03	0.56480D 03	0.56601D 03	0.55987D 03	0.56036D 03	0.55433D 03
	0.55456D 03	0.54327D 03	0.54313D 03	0.54332D 03	0.53288D 03	0.53222D 03	0.52215D 03	0.52109D 03
	0.51114D 03	0.50621D 03	0.51023D 03	0.50143D 03	0.50489D 03	0.49623D 03	0.49943D 03	0.49070D 03
	0.49655D 03	0.50360D 03	0.50038D 03	0.49696D 03	0.49341D 03	0.48417D 03	0.48839D 03	0.48195D 03
	0.47534D 03	0.46873D 03	0.45023D 03	0.46391D 03	0.46087D 03	0.45767D 03	0.45440D 03	0.44866D 03
REL(I)=	0.78623D 05	0.78129D 05	0.77634D 05	0.79599D 05	0.79111D 05	0.79106D 05	0.78612D 05	0.78123D 05

```
0.77623D 05 0.77128D 05 0.77133D 05 0.76632D 05 0.80555D 05 0.80080D 05 0.80069D 05 0.79588D 05
0.79571D 05 0.79079D 05 0.78601D 05 0.78097D 05 0.77612D 05 0.77102D 05 0.76606D 05 0.76621D 05
0.76115D 05 0.76124D 05 0.75612D 05 0.80785D 05 0.80930D 05 0.80374D 05 0.80450D 05 0.79901D 05
0.79953D 05 0.79373D 05 0.78932D 05 0.78980D 05 0.78041D 05 0.78006D 05 0.77090D 05 0.77014D 05
0.76096D 05 0.75651D 05 0.76034D 05 0.75220D 05 0.75547D 05 0.74741D 05 0.75045D 05 0.74225D 05
0.52885D 05 0.78718D 05 0.78510D 05 0.78201D 05 0.77801D 05 0.52106D 05 0.77345D 05 0.76834D 05
0.76222D 05 0.75531D 05 0.50564D 05 0.75079D 05 0.74868D 05 0.74564D 05 0.74180D 05 0.49800D 05
          ENTHALPY CONTROL SUM= 0.10000000D 01
```

DIMENSIONLESS AXIAL DISTANCE ZR=0.500000D 00   AXIAL DISTANCE Z=0.500000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.50000D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.12092D 01
AV. HEAT FLUX IN CROSS SECTION= 16.68022D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 234.3502D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 420.000D 02W/M
PRESSURE= 557.8174D-02BAR
COOLANT TEMPERATURE= 500.0000D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.62531D 00	0.60023D 00	0.57528D 00	0.67534D 00	0.65026D 00	0.64999D 00	0.62477D 00	0.59996D 00
	0.57475D 00	0.54993D 00	0.55020D 00	0.52525D 00	0.72500D 00	0.70025D 00	0.69968D 00	0.67477D 00
	0.67391D 00	0.64861D 00	0.62421D 00	0.59864D 00	0.57419D 00	0.54863D 00	0.52399D 00	0.52471D 00
	0.49973D 00	0.50015D 00	0.47504D 00	0.73571D 00	0.74457D 00	0.71416D 00	0.71942D 00	0.68958D 00
	0.69357D 00	0.66245D 00	0.63983D 00	0.64347D 00	0.59451D 00	0.59396D 00	0.54678D 00	0.54421D 00
	0.49760D 00	0.47577D 00	0.49568D 00	0.45465D 00	0.47178D 00	0.43144D 00	0.44732D 00	0.40663D 00
	0.41063D 00	0.42815D 00	0.41510D 00	0.40102D 00	0.38639D 00	0.35834D 00	0.36577D 00	0.33942D 00
	0.31217D 00	0.28492D 00	0.25706D 00	0.26504D 00	0.25258D 00	0.23937D 00	0.22585D 00	0.20794D 00
RATHR(I)=	0.12506D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12495D 01	0.11999D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14500D 01	0.14005D 01	0.13994D 01	0.13495D 01
	0.13478D 01	0.12972D 01	0.12484D 01	0.11973D 01	0.11484D 01	0.10973D 01	0.10480D 01	0.10494D 01
	0.99945D 00	0.10003D 01	0.95007D 00	0.14714D 01	0.14891D 01	0.14283D 01	0.14388D 01	0.13792D 01
	0.13871D 01	0.13249D 01	0.12797D 01	0.12869D 01	0.11890D 01	0.11879D 01	0.10936D 01	0.10884D 01
	0.99519D 00	0.95154D 00	0.99135D 00	0.90929D 00	0.94357D 00	0.86288D 00	0.89463D 00	0.81326D 00
	0.82127D 00	0.85631D 00	0.83020D 00	0.80205D 00	0.77279D 00	0.71668D 00	0.73153D 00	0.67884D 00
	0.62434D 00	0.56985D 00	0.51412D 00	0.53008D 00	0.50516D 00	0.47873D 00	0.45169D 00	0.41588D 00
QAV(I)=	0.12618D 01	0.12112D 01	0.11608D 01	0.13627D 01	0.13121D 01	0.13116D 01	0.12607D 01	0.12106D 01
	0.11598D 01	0.11097D 01	0.11102D 01	0.10599D 01	0.14637D 01	0.14131D 01	0.14125D 01	0.13617D 01
	0.13606D 01	0.13094D 01	0.12596D 01	0.12085D 01	0.11587D 01	0.11076D 01	0.10578D 01	0.10588D 01
	0.10088D 01	0.10093D 01	0.95893D 00	0.15647D 01	0.15140D 01	0.15135D 01	0.14626D 01	0.14615D 01
	0.14103D 01	0.14087D 01	0.13573D 01	0.13078D 01	0.12564D 01	0.12069D 01	0.11555D 01	0.11060D 01
	0.10546D 01	0.10051D 01	0.10066D 01	0.95684D 00	0.95789D 00	0.90781D 00	0.90833D 00	0.85798D 00
	0.16153D 01	0.15398D 01	0.15385D 01	0.14864D 01	0.14334D 01	0.14068D 01	0.13563D 01	0.12554D 01
	0.11545D 01	0.10537D 01	0.10032D 01	0.97937D 00	0.93127D 00	0.88237D 00	0.83268D 00	0.80763D 00
TCO(I)=	0.52506D 03	0.52005D 03	0.51506D 03	0.53507D 03	0.53005D 03	0.53000D 03	0.52495D 03	0.51999D 03
	0.51495D 03	0.50999D 03	0.51004D 03	0.50505D 03	0.54500D 03	0.54005D 03	0.53994D 03	0.53495D 03
	0.53478D 03	0.52972D 03	0.52484D 03	0.51973D 03	0.51484D 03	0.50973D 03	0.50480D 03	0.50494D 03
	0.49995D 03	0.50003D 03	0.49501D 03	0.54714D 03	0.54891D 03	0.54283D 03	0.54388D 03	0.53792D 03
	0.53871D 03	0.53249D 03	0.52797D 03	0.52869D 03	0.51890D 03	0.51879D 03	0.50936D 03	0.50884D 03
	0.49952D 03	0.49515D 03	0.49914D 03	0.49093D 03	0.49436D 03	0.48629D 03	0.48946D 03	0.48133D 03
	0.48213D 03	0.48563D 03	0.48302D 03	0.48020D 03	0.47728D 03	0.47167D 03	0.47315D 03	0.46788D 03
	0.46243D 03	0.45598D 03	0.45141D 03	0.45301D 03	0.45052D 03	0.44787D 03	0.44517D 03	0.44159D 03
TCL(I)=	0.53915D 03	0.53353D 03	0.52795D 03	0.55035D 03	0.54473D 03	0.54467D 03	0.53902D 03	0.53347D 03
	0.52783D 03	0.52228D 03	0.52234D 03	0.51676D 03	0.56150D 03	0.55594D 03	0.55582D 03	0.55022D 03
	0.55004D 03	0.54437D 03	0.53890D 03	0.53318D 03	0.52771D 03	0.52200D 03	0.51649D 03	0.51664D 03
	0.51107D 03	0.51116D 03	0.50555D 03	0.56480D 03	0.56601D 03	0.55987D 03	0.56036D 03	0.55433D 03
	0.55456D 03	0.54827D 03	0.54313D 03	0.54332D 03	0.53288D 03	0.53222D 03	0.52215D 03	0.52109D 03
	0.51114D 03	0.50621D 03	0.51023D 03	0.50143D 03	0.50489D 03	0.49623D 03	0.49943D 03	0.49070D 03
	0.49655D 03	0.50360D 03	0.50038D 03	0.49696D 03	0.49341D 03	0.48417D 03	0.48839D 03	0.48195D 03
	0.47534D 03	0.46373D 03	0.46023D 03	0.46391D 03	0.46087D 03	0.45767D 03	0.45440D 03	0.44866D 03
REL(I)=	0.78623D 05	0.78129D 05	0.77634D 05	0.79599D 05	0.79111D 05	0.79106D 05	0.78612D 05	0.78123D 05

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C.77623D 05 0.77128D 05 0.77133D 05 0.76632D 05 0.80555D 05 0.80080D 05 0.80069D 05 0.79588D 05
0.79571D 05 0.79079D 05 0.73501D 05 0.78097D 05 0.77612D 05 0.77102D 05 0.76606D 05 0.76621D 05
0.76115D 05 0.76124D 05 0.75612D 05 0.80785D 05 0.80930D 05 0.80374D 05 0.80450D 05 0.79901D 05
C.79953D 05 0.79373D 05 0.73932D 05 0.78980D 05 0.78041D 05 0.78006D 05 0.77090D 05 0.77014D 05
C.76096D 05 0.75551D 05 0.75034D 05 0.75220D 05 0.75547D 05 0.74741D 05 0.75045D 05 0.74225D 05
C.52885D 05 0.78718D 05 0.73510D 05 0.78201D 05 0.77801D 05 0.52106D 05 0.77345D 05 0.76834D 05
0.76222D 05 0.75531D 05 0.53564D 05 0.75079D 05 0.74868D 05 0.74564D 05 0.74180D 05 0.49800D 05
                ENTHALPY CONTROL SUM= 0.10000000D 01
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DIMENSIONLESS AXIAL DISTANCE ZR=0.600000D 00 AXIAL DISTANCE Z=0.600000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.62004D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.11828D 01
AV. HEAT FLUX IN CROSS SECTION= 16.31571D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 232.8577D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 410.822D 02W/M
PRESSURE= 554.7610D-02BAR
COOLANT TEMPERATURE= 524.0076D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.77543D 00	0.74433D 00	0.71339D 00	0.83747D 00	0.80637D 00	0.80603D 00	0.77476D 00	0.74400D 00
	0.71273D 00	0.68196D 00	0.63229D 00	0.65134D 00	0.89877D 00	0.86832D 00	0.86741D 00	0.83672D 00
	0.83544D 00	0.80409D 00	0.77403D 00	0.74217D 00	0.71201D 00	0.68015D 00	0.64963D 00	0.65065D 00
	0.61956D 00	0.62020D 00	0.53894D 00	0.90410D 00	0.92079D 00	0.87872D 00	0.88980D 00	0.84846D 00
	0.85773D 00	0.81415D 00	0.78560D 00	0.79591D 00	0.73186D 00	0.73477D 00	0.67310D 00	0.67316D 00
	0.61195D 00	0.58537D 00	0.61327D 00	0.56009D 00	0.58379D 00	0.53153D 00	0.55347D 00	0.50046D 00
	0.51091D 00	0.53516D 00	0.51927D 00	0.50166D 00	0.48306D 00	0.44602D 00	0.45731D 00	0.42477D 00
	0.39068D 00	0.35644D 00	0.32033D 00	0.33162D 00	0.31630D 00	0.29976D 00	0.28271D 00	0.25936D 00
RATHR(I)=	0.12506D 01	0.12005D 01	0.11506D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12495D 01	0.11999D 01
	0.11495D 01	0.10999D 01	0.11004D 01	0.10505D 01	0.14495D 01	0.14004D 01	0.13990D 01	0.13495D 01
	0.13474D 01	0.12968D 01	0.12484D 01	0.11970D 01	0.11483D 01	0.10970D 01	0.10477D 01	0.10494D 01
	0.99923D 00	0.10003D 01	0.94984D 00	0.14581D 01	0.14851D 01	0.14172D 01	0.14351D 01	0.13684D 01
	0.13833D 01	0.13131D 01	0.12586D 01	0.12836D 01	0.11803D 01	0.11850D 01	0.10856D 01	0.10857D 01
	0.98695D 00	0.94408D 00	0.98909D 00	0.90332D 00	0.94154D 00	0.85725D 00	0.89264D 00	0.80714D 00
	0.82400D 00	0.86311D 00	0.83747D 00	0.80907D 00	0.77909D 00	0.71934D 00	0.73756D 00	0.68506D 00
	0.63008D 00	0.57487D 00	0.51563D 00	0.53484D 00	0.51012D 00	0.48346D 00	0.45596D 00	0.41830D 00
QAV(I)=	0.12342D 01	0.11847D 01	0.11355D 01	0.13330D 01	0.12835D 01	0.12829D 01	0.12332D 01	0.11842D 01
	0.11344D 01	0.10854D 01	0.10860D 01	0.10367D 01	0.14317D 01	0.13822D 01	0.13817D 01	0.13319D 01
	0.13308D 01	0.12308D 01	0.12321D 01	0.11821D 01	0.11334D 01	0.10834D 01	0.10347D 01	0.10357D 01
	0.98671D 00	0.98722D 00	0.93798D 00	0.15305D 01	0.14809D 01	0.14804D 01	0.14306D 01	0.14295D 01
	0.13795D 01	0.13779D 01	0.13276D 01	0.12792D 01	0.12289D 01	0.11805D 01	0.11302D 01	0.10818D 01
	0.10315D 01	0.98310D 00	0.98465D 00	0.93593D 00	0.93695D 00	0.88797D 00	0.88848D 00	0.83923D 00
	0.15800D 01	0.15551D 01	0.15049D 01	0.14539D 01	0.14021D 01	0.13760D 01	0.13267D 01	0.12280D 01
	0.11293D 01	0.10306D 01	0.98130D 00	0.95797D 00	0.91092D 00	0.86309D 00	0.81448D 00	0.78999D 00
TCO(I)=	0.55509D 03	0.54387D 03	0.54268D 03	0.56749D 03	0.56127D 03	0.56121D 03	0.55495D 03	0.54880D 03
	0.54255D 03	0.53539D 03	0.53546D 03	0.53027D 03	0.57975D 03	0.57366D 03	0.57348D 03	0.56734D 03
	0.56709D 03	0.56082D 03	0.55481D 03	0.54843D 03	0.54240D 03	0.53603D 03	0.52993D 03	0.53013D 03
	0.52391D 03	0.52404D 03	0.51779D 03	0.58082D 03	0.58416D 03	0.57574D 03	0.57796D 03	0.56969D 03
	0.57155D 03	0.56283D 03	0.55732D 03	0.55918D 03	0.54637D 03	0.54695D 03	0.53462D 03	0.53463D 03
	0.52239D 03	0.51707D 03	0.52265D 03	0.51202D 03	0.51676D 03	0.50631D 03	0.51069D 03	0.50009D 03
	0.50218D 03	0.50703D 03	0.50385D 03	0.50033D 03	0.49661D 03	0.48920D 03	0.49146D 03	0.48495D 03
	0.47814D 03	0.47129D 03	0.46407D 03	0.46632D 03	0.46326D 03	0.45995D 03	0.45654D 03	0.45187D 03
TCL(I)=	0.56907D 03	0.56224D 03	0.55546D 03	0.58269D 03	0.57586D 03	0.57578D 03	0.56892D 03	0.56217D 03
	0.55532D 03	0.54357D 03	0.54865D 03	0.54187D 03	0.59618D 03	0.58947D 03	0.58928D 03	0.58252D 03
	0.58225D 03	0.57537D 03	0.56876D 03	0.56178D 03	0.55516D 03	0.54819D 03	0.54150D 03	0.54172D 03
	0.53492D 03	0.53505D 03	0.52822D 03	0.59838D 03	0.60118D 03	0.59269D 03	0.59435D 03	0.58600D 03
	0.58730D 03	0.57850D 03	0.57238D 03	0.57370D 03	0.56023D 03	0.56027D 03	0.54729D 03	0.54676D 03
	0.53389D 03	0.52800D 03	0.53363D 03	0.52240D 03	0.52717D 03	0.51612D 03	0.52054D 03	0.50934D 03
	0.51644D 03	0.52479D 03	0.52101D 03	0.51688D 03	0.51254D 03	0.50154D 03	0.50650D 03	0.49882D 03
	0.49085D 03	0.48286D 03	0.47275D 03	0.47705D 03	0.47344D 03	0.46959D 03	0.46562D 03	0.45882D 03
REL(I)=	0.81514D 05	0.80924D 05	0.80332D 05	0.82676D 05	0.82096D 05	0.82089D 05	0.81501D 05	0.80918D 05

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0.80320D 05 0.79727D 05 0.79733D 05 0.79132D 05 0.83807D 05 0.83247D 05 0.83231D 05 0.82662D 05
0.82638D 05 0.82053D 05 0.81487D 05 0.80883D 05 0.80306D 05 0.79692D 05 0.79099D 05 0.79119D 05
0.78510D 05 0.78522D 05 0.77905D 05 0.83930D 05 0.84210D 05 0.83467D 05 0.83644D 05 0.82908D 05
0.83053D 05 0.82267D 05 0.81750D 05 0.81901D 05 0.80713D 05 0.80743D 05 0.79582D 05 0.79558D 05
0.78384D 05 0.77858D 05 0.78387D 05 0.77357D 05 0.77804D 05 0.76784D 05 0.77200D 05 0.76154D 05
0.54350D 05 0.81020D 05 0.80762D 05 0.80385D 05 0.79907D 05 0.53406D 05 0.79352D 05 0.78722D 05
0.77973D 05 0.77138D 05 0.51532D 05 0.76584D 05 0.76315D 05 0.75942D 05 0.75481D 05 0.50599D 05
                  ENTHALPY CONTROL SUM= 0.10000000D 01
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DIMENSIONLESS AXIAL DISTANCE ZR=0.700000D 00   AXIAL DISTANCE Z=0.700000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT=	0.73483D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=	0.11047D 01
AV. HEAT FLUX IN CROSS SECTION=	15.23814D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING=	223.3889D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING=	383.689D 02W/M
PRESSURE=	542.7377D-02BAR
COOLANT TEMPERATURE=	546.9659D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.91858D 00	0.88212D 00	0.84546D 00	0.99250D 00	0.95565D 00	0.95524D 00	0.91819D 00	0.88173D 00
	0.84467D 00	0.80820D 00	0.80860D 00	0.77192D 00	0.10647D 01	0.10290D 01	0.10276D 01	0.99155D 00
	0.98970D 00	0.95260D 00	0.91727D 00	0.87927D 00	0.84377D 00	0.80578D 00	0.76964D 00	0.77106D 00
	0.73406D 00	0.73498D 00	0.69775D 00	0.10617D 01	0.10879D 01	0.10334D 01	0.10514D 01	0.99775D 00
	0.10134D 01	0.95519D 00	0.92412D 00	0.94052D 00	0.86109D 00	0.86843D 00	0.79196D 00	0.79551D 00
	0.71920D 00	0.68826D 00	0.72494D 00	0.65949D 00	0.69021D 00	0.62588D 00	0.65429D 00	0.58863D 00
	0.60780D 00	0.63931D 00	0.62088D 00	0.59982D 00	0.57720D 00	0.53082D 00	0.54647D 00	0.50810D 00
	0.46734D 00	0.42520D 00	0.38169D 00	0.39658D 00	0.37861D 00	0.35884D 00	0.33826D 00	0.30934D 00
RATHR(I)=	0.12506D 01	0.12004D 01	0.11505D 01	0.13507D 01	0.13005D 01	0.13000D 01	0.12495D 01	0.11999D 01
	0.11495D 01	0.10998D 01	0.11004D 01	0.10505D 01	0.14489D 01	0.14003D 01	0.13984D 01	0.13494D 01
	0.13468D 01	0.12963D 01	0.12483D 01	0.11966D 01	0.11483D 01	0.10966D 01	0.10474D 01	0.10493D 01
	0.99895D 00	0.10002D 01	0.94955D 00	0.14448D 01	0.14804D 01	0.14062D 01	0.14308D 01	0.13578D 01
	0.13791D 01	0.13012D 01	0.12576D 01	0.12799D 01	0.11718D 01	0.11818D 01	0.10778D 01	0.10826D 01
	0.97873D 00	0.93562D 00	0.98654D 00	0.89747D 00	0.93928D 00	0.85173D 00	0.89039D 00	0.80104D 00
	0.82714D 00	0.87002D 00	0.84493D 00	0.81628D 00	0.78549D 00	0.72237D 00	0.74367D 00	0.69146D 00
	0.63599D 00	0.58000D 00	0.51942D 00	0.53969D 00	0.51523D 00	0.48833D 00	0.46032D 00	0.42097D 00
QAV(I)=	0.11527D 01	0.11065D 01	0.10605D 01	0.12449D 01	0.11987D 01	0.11982D 01	0.11517D 01	0.11060D 01
	0.10595D 01	0.10138D 01	0.10142D 01	0.96825D 00	0.13372D 01	0.12909D 01	0.12904D 01	0.12439D 01
	0.12429D 01	0.11962D 01	0.11507D 01	0.11040D 01	0.10585D 01	0.10118D 01	0.96632D 00	0.96729D 00
	0.92154D 00	0.92202D 00	0.87603D 00	0.14294D 01	0.13831D 01	0.13826D 01	0.13361D 01	0.13351D 01
	0.12884D 01	0.12869D 01	0.12399D 01	0.11947D 01	0.11478D 01	0.11025D 01	0.10556D 01	0.10104D 01
	0.96341D 00	0.91817D 00	0.91961D 00	0.87411D 00	0.87507D 00	0.82932D 00	0.82980D 00	0.78380D 00
	0.14756D 01	0.14524D 01	0.14055D 01	0.13579D 01	0.13095D 01	0.12851D 01	0.12391D 01	0.11469D 01
	0.10547D 01	0.96257D 00	0.91549D 00	0.89470D 00	0.85076D 00	0.80609D 00	0.76069D 00	0.73781D 00
TCO(I)=	0.58380D 03	0.57642D 03	0.55909D 03	0.59850D 03	0.59113D 03	0.59105D 03	0.58364D 03	0.57635D 03
	0.56893D 03	0.56164D 03	0.55172D 03	0.55438D 03	0.61294D 03	0.60580D 03	0.60552D 03	0.59831D 03
	0.59794D 03	0.59052D 03	0.53345D 03	0.57585D 03	0.56875D 03	0.56116D 03	0.55393D 03	0.55421D 03
	0.54681D 03	0.54700D 03	0.53955D 03	0.61234D 03	0.61757D 03	0.60667D 03	0.61028D 03	0.59955D 03
	0.60267D 03	0.59124D 03	0.58482D 03	0.58810D 03	0.57222D 03	0.57369D 03	0.55839D 03	0.55910D 03
	0.54384D 03	0.53765D 03	0.54499D 03	0.53190D 03	0.53804D 03	0.52518D 03	0.53086D 03	0.51773D 03
	0.52156D 03	0.52786D 03	0.52418D 03	0.51996D 03	0.51544D 03	0.50616D 03	0.50929D 03	0.50162D 03
	0.49347D 03	0.48524D 03	0.47634D 03	0.47932D 03	0.47572D 03	0.47177D 03	0.46765D 03	0.46187D 03
TCL(I)=	0.59704D 03	0.58309D 03	0.58119D 03	0.61292D 03	0.60496D 03	0.60487D 03	0.59687D 03	0.58901D 03
	0.58102D 03	0.57316D 03	0.57325D 03	0.56535D 03	0.62854D 03	0.62080D 03	0.62052D 03	0.61271D 03
	0.61233D 03	0.60431D 03	0.59668D 03	0.58849D 03	0.58083D 03	0.57265D 03	0.56487D 03	0.56517D 03
	0.55721D 03	0.55740D 03	0.54940D 03	0.62901D 03	0.63375D 03	0.62275D 03	0.62585D 03	0.61502D 03
	0.61762D 03	0.60608D 03	0.59908D 03	0.60186D 03	0.58533D 03	0.58629D 03	0.57037D 03	0.57057D 03
	0.55469D 03	0.54796D 03	0.55535D 03	0.54169D 03	0.54787D 03	0.53443D 03	0.54014D 03	0.52644D 03
	0.53501D 03	0.54461D 03	0.54035D 03	0.53556D 03	0.53045D 03	0.51778D 03	0.52346D 03	0.51468D 03
	0.50543D 03	0.49612D 03	0.43450D 03	0.48940D 03	0.48529D 03	0.48082D 03	0.47618D 03	0.46839D 03
REL(I)=	0.84176D 05	0.83501D 05	0.82824D 05	0.85502D 05	0.84840D 05	0.84833D 05	0.84161D 05	0.83494D 05

0.82810D 05	0.82130D 05	0.82137D 05	0.81447D 05	0.86781D 05	0.86152D 05	0.86127D 05	0.85485D 05
0.85452D 05	0.84785D 05	0.84145D 05	0.83449D 05	0.82793D 05	0.82085D 05	0.81404D 05	0.81431D 05
0.80728D 05	0.80746D 05	0.80032D 05	0.86755D 05	0.87188D 05	0.86257D 05	0.86549D 05	0.85624D 05
0.85876D 05	0.84876D 05	0.84295D 05	0.84568D 05	0.83141D 05	0.83251D 05	0.81852D 05	0.81893D 05
0.80469D 05	0.79874D 05	0.80555D 05	0.79317D 05	0.79888D 05	0.78660D 05	0.79191D 05	0.77923D 05
0.55728D 05	0.83198D 05	0.82899D 05	0.82461D 05	0.81906D 05	0.54636D 05	0.81259D 05	0.80523D 05
0.79647D 05	0.78675D 05	0.52455D 05	0.78026D 05	0.77706D 05	0.77267D 05	0.76732D 05	0.51365D 05

ENTHALPY CONTROL SUM= 0.10000000D 01

DIMENSIONLESS AXIAL DISTANCE ZR=0.800000D 00 AXIAL DISTANCE Z=0.800000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.83936D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.97826D 00
AV. HEAT FLUX IN CROSS SECTION= 13.49458D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 206.3558D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 339.787D 02W/M
PRESSURE= 539.6813D-02BAR
COOLANT TEMPERATURE= 567.8716D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.10497D 01	0.10076D 01	0.95571D 00	0.11337D 01	0.10916D 01	0.10911D 01	0.10488D 01	0.10071D 01
	0.96481D 00	0.92315D 00	0.92361D 00	0.88172D 00	0.12155D 01	0.11753D 01	0.11732D 01	0.11325D 01
	0.11299D 01	0.10876D 01	0.10477D 01	0.10039D 01	0.96371D 00	0.91997D 00	0.87876D 00	0.88067D 00
	0.83818D 00	0.83946D 00	0.79669D 00	0.12013D 01	0.12382D 01	0.11711D 01	0.11970D 01	0.11307D 01
	0.11535D 01	0.10821D 01	0.10461D 01	0.10708D 01	0.97639D 00	0.98893D 00	0.89802D 00	0.90576D 00
	0.81450D 00	0.77978D 00	0.82565D 00	0.74838D 00	0.78627D 00	0.71028D 00	0.74524D 00	0.66716D 00
	0.69727D 00	0.73524D 00	0.71572D 00	0.69145D 00	0.66486D 00	0.60922D 00	0.62952D 00	0.58598D 00
	0.53900D 00	0.49129D 00	0.43862D 00	0.45722D 00	0.43696D 00	0.41417D 00	0.39019D 00	0.35584D 00
RATHR(I)=	0.12506D 01	0.12004D 01	0.11505D 01	0.13506D 01	0.13005D 01	0.12999D 01	0.12495D 01	0.11999D 01
	0.11495D 01	0.10998D 01	0.11004D 01	0.10505D 01	0.14482D 01	0.14002D 01	0.13978D 01	0.13492D 01
	0.13461D 01	0.12957D 01	0.12482D 01	0.11961D 01	0.11482D 01	0.10960D 01	0.10469D 01	0.10492D 01
	0.99859D 00	0.10001D 01	0.94916D 00	0.14313D 01	0.14752D 01	0.13952D 01	0.14261D 01	0.13471D 01
	0.13742D 01	0.12892D 01	0.12463D 01	0.12757D 01	0.11633D 01	0.11782D 01	0.10699D 01	0.10791D 01
	0.97038D 00	0.92902D 00	0.98366D 00	0.89161D 00	0.93675D 00	0.84621D 00	0.88787D 00	0.79485D 00
	0.83072D 00	0.87714D 00	0.85269D 00	0.82379D 00	0.79210D 00	0.72582D 00	0.75000D 00	0.69813D 00
	0.64216D 00	0.58532D 00	0.52256D 00	0.54473D 00	0.52058D 00	0.49344D 00	0.46487D 00	0.42395D 00
QAV(I)=	0.10208D 01	0.97987D 00	0.93914D 00	0.11025D 01	0.10615D 01	0.10611D 01	0.10199D 01	0.97943D 00
	0.93827D 00	0.89776D 00	0.89819D 00	0.85747D 00	0.11842D 01	0.11432D 01	0.11428D 01	0.11016D 01
	0.11007D 01	0.10593D 01	0.10191D 01	0.97769D 00	0.93741D 00	0.89604D 00	0.85575D 00	0.85661D 00
	0.81610D 00	0.81552D 00	0.77579D 00	0.12658D 01	0.12249D 01	0.12244D 01	0.11833D 01	0.11824D 01
	0.11410D 01	0.11396D 01	0.10981D 01	0.10580D 01	0.10164D 01	0.97638D 00	0.93481D 00	0.89475D 00
	0.85318D 00	0.81311D 00	0.81439D 00	0.77410D 00	0.77495D 00	0.73443D 00	0.73485D 00	0.69412D 00
	0.13068D 01	0.12862D 01	0.12447D 01	0.12025D 01	0.11597D 01	0.11381D 01	0.10973D 01	0.10157D 01
	0.93405D 00	0.85243D 00	0.81162D 00	0.79233D 00	0.75342D 00	0.71385D 00	0.67365D 00	0.65339D 00
TCO(I)=	0.60994D 03	0.60152D 03	0.59314D 03	0.62673D 03	0.61832D 03	0.61822D 03	0.60976D 03	0.60143D 03
	0.59296D 03	0.58463D 03	0.58472D 03	0.57634D 03	0.64311D 03	0.63505D 03	0.63465D 03	0.62650D 03
	0.62598D 03	0.61751D 03	0.60953D 03	0.60079D 03	0.59274D 03	0.58399D 03	0.57575D 03	0.57613D 03
	0.56764D 03	0.56789D 03	0.55934D 03	0.64027D 03	0.64765D 03	0.63422D 03	0.63940D 03	0.62615D 03
	0.63069D 03	0.61542D 03	0.60922D 03	0.61416D 03	0.59528D 03	0.59779D 03	0.57960D 03	0.58115D 03
	0.56290D 03	0.55596D 03	0.55513D 03	0.54968D 03	0.55725D 03	0.54206D 03	0.54905D 03	0.53343D 03
	0.53945D 03	0.54725D 03	0.54314D 03	0.53829D 03	0.53297D 03	0.52184D 03	0.52590D 03	0.51720D 03
	0.50780D 03	0.49826D 03	0.43772D 03	0.49144D 03	0.48739D 03	0.48283D 03	0.47804D 03	0.47117D 03
TCL(I)=	0.62183D 03	0.61288D 03	0.60399D 03	0.63969D 03	0.63073D 03	0.63063D 03	0.62164D 03	0.61279D 03
	0.60380D 03	0.59495D 03	0.59505D 03	0.58616D 03	0.65714D 03	0.64854D 03	0.64813D 03	0.63944D 03
	0.63890D 03	0.62990D 03	0.62140D 03	0.61212D 03	0.60356D 03	0.59429D 03	0.58555D 03	0.58594D 03
	0.57694D 03	0.57720D 03	0.55814D 03	0.65525D 03	0.66220D 03	0.64866D 03	0.65340D 03	0.64003D 03
	0.64413D 03	0.62973D 03	0.62201D 03	0.62651D 03	0.60703D 03	0.60909D 03	0.59032D 03	0.59142D 03
	0.57260D 03	0.55517D 03	0.57440D 03	0.55842D 03	0.56604D 03	0.55032D 03	0.55735D 03	0.54121D 03
	0.55147D 03	0.56222D 03	0.55760D 03	0.55223D 03	0.54638D 03	0.53222D 03	0.53855D 03	0.52885D 03
	0.51847D 03	0.50795D 03	0.49499D 03	0.50042D 03	0.49591D 03	0.49089D 03	0.48562D 03	0.47697D 03
REL(I)=	0.86517D 05	0.85771D 05	0.85022D 05	0.87981D 05	0.87251D 05	0.87243D 05	0.86501D 05	0.85763D 05

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0.85005D 05 0.84252D 05 0.84260D 05 0.83494D 05 0.89380D 05 0.88696D 05 0.88661D 05 0.87961D 05
0.87916D 05 0.87181D 05 0.86481D 05 0.85706D 05 0.84986D 05 0.84194D 05 0.83440D 05 0.83475D 05
0.82689D 05 0.82713D 05 0.81914D 05 0.89168D 05 0.89765D 05 0.88654D 05 0.89068D 05 0.87960D 05
0.88324D 05 0.87113D 05 0.85481D 05 0.86889D 05 0.85242D 05 0.85440D 05 0.83821D 05 0.83936D 05
0.82274D 05 0.81521D 05 0.82457D 05 0.81028D 05 0.81720D 05 0.80299D 05 0.80943D 05 0.79465D 05
0.56970D 05 0.85173D 05 0.88843D 05 0.84350D 05 0.83724D 05 0.55748D 05 0.82996D 05 0.82171D 05
0.81181D 05 0.80084D 05 0.53298D 05 0.79350D 05 0.78988D 05 0.78490D 05 0.77885D 05 0.52068D 05
          ENTHALPY CONTROL SUM= 0.10000000D 01
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DIMENSIONLESS AXIAL DISTANCE ZR=0.900000D 00   AXIAL DISTANCE Z=0.900000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.92905D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.80911D 00
AV. HEAT FLUX IN CROSS SECTION= 11.16124D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 182.5017D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 281.035D 02W/M
PRESSURE= 536.6249D-02BAR
COOLANT TEMPERATURE= 585.8110D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.11619D 01	0.11153D 01	0.10539D 01	0.12548D 01	0.12082D 01	0.12077D 01	0.11608D 01	0.11148D 01
	0.10679D 01	0.10218D 01	0.10223D 01	0.97592D 00	0.13445D 01	0.13007D 01	0.12979D 01	0.12533D 01
	0.12498D 01	0.12030D 01	0.11595D 01	0.11106D 01	0.10666D 01	0.10177D 01	0.97215D 00	0.97468D 00
	0.92734D 00	0.92907D 00	0.83138D 00	0.13166D 01	0.13651D 01	0.12857D 01	0.13200D 01	0.12414D 01
	0.12717D 01	0.11861D 01	0.11470D 01	0.11808D 01	0.10726D 01	0.10908D 01	0.98652D 00	0.99891D 00
	0.89352D 00	0.85580D 00	0.91087D 00	0.82281D 00	0.86766D 00	0.78095D 00	0.82224D 00	0.73252D 00
	0.77561D 00	0.82187D 00	0.79985D 00	0.77274D 00	0.74237D 00	0.67798D 00	0.70298D 00	0.65519D 00
	0.60270D 00	0.54902D 00	0.48878D 00	0.51103D 00	0.48895D 00	0.46349D 00	0.43637D 00	0.39697D 00
RATHR(I)=	0.12506D 01	0.12004D 01	0.11505D 01	0.13506D 01	0.13005D 01	0.12999D 01	0.12495D 01	0.11999D 01
	0.11494D 01	0.10998D 01	0.11004D 01	0.10504D 01	0.14472D 01	0.14000D 01	0.13970D 01	0.13490D 01
	0.13452D 01	0.12949D 01	0.12480D 01	0.11954D 01	0.11480D 01	0.10954D 01	0.10464D 01	0.10491D 01
	0.99815D 00	0.10000D 01	0.94868D 00	0.14172D 01	0.14694D 01	0.13839D 01	0.14208D 01	0.13362D 01
	0.13688D 01	0.12767D 01	0.12346D 01	0.12710D 01	0.11545D 01	0.11741D 01	0.10618D 01	0.10752D 01
	0.96175D 00	0.92115D 00	0.98042D 00	0.88564D 00	0.93392D 00	0.84058D 00	0.88503D 00	0.78845D 00
	0.83484D 00	0.88463D 00	0.85093D 00	0.83175D 00	0.79906D 00	0.72975D 00	0.75666D 00	0.70522D 00
	0.64872D 00	0.59095D 00	0.52610D 00	0.55006D 00	0.52628D 00	0.49888D 00	0.46969D 00	0.42729D 00
QAV(I)=	0.84430D 00	0.81044D 00	0.77675D 00	0.91185D 00	0.87799D 00	0.87762D 00	0.84358D 00	0.81008D 00
	0.77604D 00	0.74253D 00	0.74289D 00	0.70920D 00	0.97941D 00	0.94554D 00	0.94517D 00	0.91112D 00
	0.91039D 00	0.87617D 00	0.84286D 00	0.80864D 00	0.77532D 00	0.74111D 00	0.70778D 00	0.70849D 00
	0.67499D 00	0.67534D 00	0.64165D 00	0.10470D 01	0.10131D 01	0.10127D 01	0.97866D 00	0.97792D 00
	0.94370D 00	0.94259D 00	0.90819D 00	0.87508D 00	0.84068D 00	0.80756D 00	0.77317D 00	0.74004D 00
	0.70566D 00	0.67252D 00	0.67358D 00	0.64025D 00	0.64095D 00	0.60744D 00	0.60779D 00	0.57410D 00
	0.10808D 01	0.10638D 01	0.10295D 01	0.99458D 00	0.95915D 00	0.94131D 00	0.90755D 00	0.84005D 00
	0.77254D 00	0.70504D 00	0.67128D 00	0.65533D 00	0.62314D 00	0.59042D 00	0.55717D 00	0.54041D 00
TCO(I)=	0.63237D 03	0.62305D 03	0.61378D 03	0.65096D 03	0.64164D 03	0.64154D 03	0.63217D 03	0.62295D 03
	0.61358D 03	0.60436D 03	0.60446D 03	0.59518D 03	0.66890D 03	0.66013D 03	0.65957D 03	0.65066D 03
	0.64996D 03	0.64061D 03	0.63139D 03	0.62212D 03	0.61331D 03	0.60354D 03	0.59443D 03	0.59494D 03
	0.58547D 03	0.58581D 03	0.57628D 03	0.66333D 03	0.67302D 03	0.65715D 03	0.66400D 03	0.64829D 03
	0.65433D 03	0.63722D 03	0.62941D 03	0.63616D 03	0.61452D 03	0.61817D 03	0.59730D 03	0.59978D 03
	0.57870D 03	0.57116D 03	0.58217D 03	0.56456D 03	0.57353D 03	0.55619D 03	0.56445D 03	0.54650D 03
	0.55512D 03	0.56437D 03	0.55997D 03	0.55455D 03	0.54847D 03	0.53560D 03	0.54060D 03	0.53104D 03
	0.52054D 03	0.50980D 03	0.49776D 03	0.50221D 03	0.49779D 03	0.49270D 03	0.48727D 03	0.47939D 03
TCL(I)=	0.64232D 03	0.63256D 03	0.62285D 03	0.66181D 03	0.65204D 03	0.65193D 03	0.64211D 03	0.63245D 03
	0.62263D 03	0.61298D 03	0.61309D 03	0.60338D 03	0.68067D 03	0.67144D 03	0.67087D 03	0.66150D 03
	0.66079D 03	0.65098D 03	0.64182D 03	0.63160D 03	0.62236D 03	0.61214D 03	0.60261D 03	0.60312D 03
	0.59323D 03	0.59358D 03	0.58362D 03	0.67587D 03	0.68522D 03	0.66924D 03	0.67572D 03	0.65990D 03
	0.66558D 03	0.64836D 03	0.64009D 03	0.64649D 03	0.62433D 03	0.62761D 03	0.60625D 03	0.60836D 03
	0.58679D 03	0.57384D 03	0.53991D 03	0.57185D 03	0.58086D 03	0.56307D 03	0.57136D 03	0.55298D 03
	0.56514D 03	0.57687D 03	0.57203D 03	0.56617D 03	0.55965D 03	0.54424D 03	0.55113D 03	0.54074D 03
	0.52942D 03	0.51787D 03	0.50380D 03	0.50967D 03	0.50487D 03	0.49939D 03	0.49358D 03	0.48421D 03
REL(I)=	0.88466D 05	0.87663D 05	0.86855D 05	0.90041D 05	0.89256D 05	0.89247D 05	0.88449D 05	0.87654D 05

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0.86837D 05 0.86024D 05 0.86033D 05 0.85205D 05 0.91529D 05 0.90806D 05 0.90759D 05 0.90017D 05
0.89958D 05 0.89159D 05 0.88425D 05 0.87583D 05 0.86814D 05 0.85951D 05 0.85137D 05 0.85183D 05
0.84328D 05 0.84359D 05 0.83488D 05 0.91098D 05 0.91867D 05 0.90588D 05 0.91127D 05 0.89847D 05
0.90325D 05 0.88909D 05 0.88239D 05 0.88792D 05 0.86948D 05 0.87240D 05 0.85423D 05 0.85618D 05
0.83737D 05 0.83042D 05 0.84029D 05 0.82430D 05 0.83237D 05 0.81645D 05 0.82394D 05 0.80724D 05
0.58034D 05 0.86877D 05 0.86528D 05 0.85989D 05 0.85296D 05 0.56704D 05 0.84501D 05 0.83608D 05
0.82521D 05 0.81313D 05 0.54030D 05 0.80506D 05 0.80113D 05 0.79564D 05 0.78897D 05 0.52682D 05
                  ENTHALPY CONTROL SUM= 0.10000000D 01
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DIMENSIONLESS AXIAL DISTANCE ZR=0.900000D 00   AXIAL DISTANCE Z=0.900000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.92905D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.80911D 00
AV. HEAT FLUX IN CROSS SECTION= 11.16124D 05W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 182.5017D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 281.035D 02W/M
PRESSURE= 527.6581D-02BAR
COOLANT TEMPERATURE= 585.8110D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.11619D 01	0.11153D 01	0.10589D 01	0.12548D 01	0.12082D 01	0.12077D 01	0.11608D 01	0.11148D 01
	0.10679D 01	0.10218D 01	0.10223D 01	0.97592D 00	0.13445D 01	0.13007D 01	0.12979D 01	0.12533D 01
	0.12498D 01	0.12030D 01	0.11595D 01	0.11106D 01	0.10666D 01	0.10177D 01	0.97215D 00	0.97468D 00
	0.92734D 00	0.92907D 00	0.88138D 00	0.13166D 01	0.13651D 01	0.12857D 01	0.13200D 01	0.12414D 01
	0.12717D 01	0.11361D 01	0.11470D 01	0.11808D 01	0.10726D 01	0.10908D 01	0.98652D 00	0.99891D 00
	0.89352D 00	0.85580D 00	0.91087D 00	0.82281D 00	0.86766D 00	0.78095D 00	0.82224D 00	0.73252D 00
	0.77561D 00	0.82187D 00	0.79985D 00	0.77274D 00	0.74237D 00	0.67798D 00	0.70298D 00	0.65519D 00
	0.60270D 00	0.54902D 00	0.48878D 00	0.51103D 00	0.48895D 00	0.46349D 00	0.43637D 00	0.39697D 00
RATHR(I)=	0.12506D 01	0.12004D 01	0.11505D 01	0.13506D 01	0.13005D 01	0.12999D 01	0.12495D 01	0.11999D 01
	0.11494D 01	0.10998D 01	0.11004D 01	0.10504D 01	0.14472D 01	0.14000D 01	0.13970D 01	0.13490D 01
	0.13452D 01	0.12949D 01	0.12480D 01	0.11954D 01	0.11480D 01	0.10954D 01	0.10464D 01	0.10491D 01
	0.99815D 00	0.10000D 01	0.94868D 00	0.14172D 01	0.14694D 01	0.13839D 01	0.14208D 01	0.13362D 01
	0.13688D 01	0.12767D 01	0.12346D 01	0.12710D 01	0.11545D 01	0.11741D 01	0.10618D 01	0.10752D 01
	0.96175D 00	0.92115D 00	0.98042D 00	0.88564D 00	0.93392D 00	0.84058D 00	0.88503D 00	0.78845D 00
	0.83484D 00	0.88463D 00	0.86093D 00	0.83175D 00	0.79906D 00	0.72975D 00	0.75666D 00	0.70522D 00
	0.64872D 00	0.59095D 00	0.52510D 00	0.55006D 00	0.52628D 00	0.49888D 00	0.46969D 00	0.42729D 00
QAV(I)=	0.84430D 00	0.81044D 00	0.77675D 00	0.91185D 00	0.87799D 00	0.87762D 00	0.84358D 00	0.81008D 00
	0.77604D 00	0.74253D 00	0.74289D 00	0.70920D 00	0.97941D 00	0.94554D 00	0.94517D 00	0.91112D 00
	0.91039D 00	0.87517D 00	0.84286D 00	0.80864D 00	0.77532D 00	0.74111D 00	0.70778D 00	0.70849D 00
	0.67499D 00	0.67534D 00	0.64165D 00	0.10470D 01	0.10131D 01	0.10127D 01	0.97866D 00	0.97792D 00
	0.94370D 00	0.94259D 00	0.90819D 00	0.87508D 00	0.84068D 00	0.80756D 00	0.77317D 00	0.74004D 00
	0.70566D 00	0.67252D 00	0.67358D 00	0.64025D 00	0.64095D 00	0.60744D 00	0.60779D 00	0.57410D 00
	0.10808D 01	0.10638D 01	0.10295D 01	0.99458D 00	0.95915D 00	0.94131D 00	0.90755D 00	0.84005D 00
	0.77254D 00	0.70504D 00	0.67128D 00	0.65533D 00	0.62314D 00	0.59042D 00	0.55717D 00	0.54041D 00
TCO(I)=	0.63237D 03	0.62305D 03	0.61378D 03	0.65096D 03	0.64164D 03	0.64154D 03	0.63217D 03	0.62295D 03
	0.61358D 03	0.60436D 03	0.60446D 03	0.59518D 03	0.66890D 03	0.66013D 03	0.65957D 03	0.65066D 03
	0.64996D 03	0.64061D 03	0.63189D 03	0.62212D 03	0.61331D 03	0.60354D 03	0.59443D 03	0.59494D 03
	0.58547D 03	0.58581D 03	0.57628D 03	0.66333D 03	0.67302D 03	0.65715D 03	0.66400D 03	0.64829D 03
	0.65433D 03	0.63722D 03	0.62941D 03	0.63616D 03	0.61452D 03	0.61817D 03	0.59730D 03	0.59978D 03
	0.57870D 03	0.57116D 03	0.58217D 03	0.56456D 03	0.57353D 03	0.55619D 03	0.56445D 03	0.54650D 03
	0.55512D 03	0.56437D 03	0.55397D 03	0.55455D 03	0.54847D 03	0.53560D 03	0.54060D 03	0.53104D 03
	0.52054D 03	0.50980D 03	0.49776D 03	0.50221D 03	0.49779D 03	0.49270D 03	0.48727D 03	0.47939D 03
TCL(I)=	0.64232D 03	0.63256D 03	0.62285D 03	0.66181D 03	0.65204D 03	0.65193D 03	0.64211D 03	0.63245D 03
	0.62263D 03	0.61298D 03	0.61309D 03	0.60338D 03	0.68067D 03	0.67144D 03	0.67087D 03	0.66150D 03
	0.66079D 03	0.65098D 03	0.64182D 03	0.63160D 03	0.62236D 03	0.61214D 03	0.60261D 03	0.60312D 03
	0.59323D 03	0.59358D 03	0.58362D 03	0.67587D 03	0.68522D 03	0.66924D 03	0.67572D 03	0.65990D 03
	0.66558D 03	0.64835D 03	0.64009D 03	0.64649D 03	0.62433D 03	0.62761D 03	0.60625D 03	0.60836D 03
	0.58679D 03	0.57884D 03	0.58991D 03	0.57185D 03	0.58086D 03	0.56307D 03	0.57136D 03	0.55298D 03
	0.56514D 03	0.57587D 03	0.57203D 03	0.56617D 03	0.55965D 03	0.54424D 03	0.55113D 03	0.54074D 03
	0.52942D 03	0.51787D 03	0.50380D 03	0.50967D 03	0.50487D 03	0.49939D 03	0.49358D 03	0.48421D 03
REL(I)=	0.88466D 05	0.87663D 05	0.86855D 05	0.90041D 05	0.89256D 05	0.89247D 05	0.88449D 05	0.87654D 05

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0.86837D 05 0.86024D 05 0.86033D 05 0.85205D 05 0.91529D 05 0.90806D 05 0.90759D 05 0.90017D 05
0.89958D 05 0.89169D 05 0.83425D 05 0.87583D 05 0.86814D 05 0.85951D 05 0.85137D 05 0.85183D 05
0.84328D 05 0.84359D 05 0.83488D 05 0.91098D 05 0.91867D 05 0.90588D 05 0.91127D 05 0.89847D 05
0.90325D 05 0.88909D 05 0.88239D 05 0.88792D 05 0.86948D 05 0.87240D 05 0.85423D 05 0.85618D 05
0.83737D 05 0.83042D 05 0.84029D 05 0.82430D 05 0.83237D 05 0.81645D 05 0.82394D 05 0.80724D 05
0.58034D 05 0.86377D 05 0.85528D 05 0.85989D 05 0.85296D 05 0.56704D 05 0.84501D 05 0.83608D 05
0.82521D 05 0.81313D 05 0.54030D 05 0.80506D 05 0.80113D 05 0.79564D 05 0.78897D 05 0.52682D 05
            ENTHALPY CONTROL SUM= 0.10000000D 01
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DIMENSIONLESS AXIAL DISTANCE ZR=0.950000D 00   AXIAL DISTANCE Z=0.950000D 00M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT=	0.96709D 00
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=	0.71075D 00
AV. HEAT FLUX IN CROSS SECTION=	98.04385D 04W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING=	168.3321D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING=	246.870D 02W/M
PRESSURE=	526.1298D-02BAR
COOLANT TEMPERATURE=	593.4172D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.12094D 01	0.11509D 01	0.11127D 01	0.13061D 01	0.12577D 01	0.12571D 01	0.12083D 01	0.11604D 01
	0.11116D 01	0.10636D 01	0.10641D 01	0.10159D 01	0.13990D 01	0.13538D 01	0.13505D 01	0.13045D 01
	0.13004D 01	0.12518D 01	0.12058D 01	0.11557D 01	0.11101D 01	0.10590D 01	0.10116D 01	0.10145D 01
	0.96505D 00	0.96704D 00	0.91718D 00	0.13635D 01	0.14179D 01	0.13328D 01	0.13712D 01	0.12868D 01
	0.13208D 01	0.12284D 01	0.11881D 01	0.12266D 01	0.11121D 01	0.11334D 01	0.10229D 01	0.10377D 01
	0.92577D 00	0.88588D 00	0.94544D 00	0.85352D 00	0.90168D 00	0.81012D 00	0.85439D 00	0.75930D 00
	0.80957D 00	0.85931D 00	0.83579D 00	0.80844D 00	0.77630D 00	0.70784D 00	0.73513D 00	0.68563D 00
	0.63072D 00	0.57436D 00	0.51067D 00	0.53467D 00	0.51188D 00	0.48525D 00	0.45669D 00	0.41499D 00
RATHR(I)=	0.12506D 01	0.12004D 01	0.11505D 01	0.13506D 01	0.13005D 01	0.12999D 01	0.12495D 01	0.11999D 01
	0.11494D 01	0.10998D 01	0.11004D 01	0.10504D 01	0.14466D 01	0.13999D 01	0.13965D 01	0.13489D 01
	0.13447D 01	0.12944D 01	0.12479D 01	0.11951D 01	0.11479D 01	0.10950D 01	0.10461D 01	0.10490D 01
	0.99789D 00	0.99995D 00	0.94840D 00	0.14099D 01	0.14661D 01	0.13781D 01	0.14179D 01	0.13306D 01
	0.13658D 01	0.12702D 01	0.12286D 01	0.12684D 01	0.11500D 01	0.11719D 01	0.10577D 01	0.10730D 01
	0.95728D 00	0.91706D 00	0.97865D 00	0.88257D 00	0.93237D 00	0.83769D 00	0.88347D 00	0.78514D 00
	0.83712D 00	0.88856D 00	0.85527D 00	0.83595D 00	0.80272D 00	0.73193D 00	0.76015D 00	0.70897D 00
	0.65219D 00	0.59391D 00	0.52805D 00	0.55286D 00	0.52930D 00	0.50176D 00	0.47223D 00	0.42912D 00
QAV(I)=	0.74166D 00	0.71191D 00	0.63232D 00	0.80100D 00	0.77125D 00	0.77093D 00	0.74103D 00	0.71160D 00
	0.68169D 00	0.65226D 00	0.65258D 00	0.62299D 00	0.86034D 00	0.83059D 00	0.83027D 00	0.80036D 00
	0.79972D 00	0.76965D 00	0.74039D 00	0.71033D 00	0.68107D 00	0.65101D 00	0.62174D 00	0.62236D 00
	0.59293D 00	0.59324D 00	0.56365D 00	0.91968D 00	0.88993D 00	0.88960D 00	0.85969D 00	0.85904D 00
	0.82897D 00	0.82300D 00	0.79779D 00	0.76869D 00	0.73848D 00	0.70938D 00	0.67918D 00	0.65007D 00
	0.61987D 00	0.59076D 00	0.59169D 00	0.56241D 00	0.56303D 00	0.53359D 00	0.53390D 00	0.50431D 00
	0.94943D 00	0.93447D 00	0.90431D 00	0.87367D 00	0.84255D 00	0.82687D 00	0.79722D 00	0.73793D 00
	0.67863D 00	0.61933D 00	0.53958D 00	0.57566D 00	0.54739D 00	0.51865D 00	0.48944D 00	0.47472D 00
TCO(I)=	0.64189D 03	0.63218D 03	0.62253D 03	0.66123D 03	0.65153D 03	0.65142D 03	0.64167D 03	0.63208D 03
	0.62232D 03	0.61272D 03	0.61283D 03	0.60317D 03	0.67980D 03	0.67076D 03	0.67010D 03	0.66090D 03
	0.66009D 03	0.65037D 03	0.64136D 03	0.63115D 03	0.62203D 03	0.61179D 03	0.60232D 03	0.60290D 03
	0.59301D 03	0.59341D 03	0.58344D 03	0.67269D 03	0.68357D 03	0.66655D 03	0.67424D 03	0.65736D 03
	0.66417D 03	0.64568D 03	0.63762D 03	0.64532D 03	0.62243D 03	0.62667D 03	0.60458D 03	0.60755D 03
	0.58515D 03	0.57738D 03	0.53929D 03	0.57070D 03	0.58034D 03	0.56202D 03	0.57088D 03	0.55186D 03
	0.56191D 03	0.57186D 03	0.55736D 03	0.56169D 03	0.55526D 03	0.54157D 03	0.54703D 03	0.53713D 03
	0.52614D 03	0.51487D 03	0.50213D 03	0.50693D 03	0.50238D 03	0.49705D 03	0.49134D 03	0.48300D 03
TCL(I)=	0.65067D 03	0.64057D 03	0.63053D 03	0.67081D 03	0.66071D 03	0.66060D 03	0.65044D 03	0.64046D 03
	0.63031D 03	0.62033D 03	0.62044D 03	0.61040D 03	0.69019D 03	0.68074D 03	0.68008D 03	0.67047D 03
	0.66965D 03	0.65952D 03	0.65013D 03	0.63951D 03	0.63001D 03	0.61938D 03	0.60954D 03	0.61012D 03
	0.59986D 03	0.60026D 03	0.58991D 03	0.68376D 03	0.69435D 03	0.67722D 03	0.68460D 03	0.66762D 03
	0.67410D 03	0.65550D 03	0.64705D 03	0.65444D 03	0.63108D 03	0.63500D 03	0.61247D 03	0.61511D 03
	0.59228D 03	0.58414D 03	0.59611D 03	0.57712D 03	0.58680D 03	0.56809D 03	0.57697D 03	0.55756D 03
	0.57075D 03	0.58288D 03	0.57799D 03	0.57193D 03	0.56511D 03	0.54918D 03	0.55631D 03	0.54567D 03
	0.53396D 03	0.52197D 03	0.50745D 03	0.51351D 03	0.50861D 03	0.50294D 03	0.49688D 03	0.48724D 03
REL(I)=	0.89277D 05	0.88450D 05	0.87618D 05	0.90896D 05	0.90090D 05	0.90080D 05	0.89259D 05	0.88441D 05

0.87599D 05	0.86762D 05	0.85771D 05	0.85918D 05	0.92416D 05	0.91680D 05	0.91627D 05	0.90869D 05
0.90802D 05	0.89992D 05	0.89233D 05	0.88361D 05	0.87574D 05	0.86680D 05	0.85843D 05	0.85894D 05
0.85010D 05	0.85045D 05	0.84143D 05	0.91867D 05	0.92723D 05	0.91366D 05	0.91966D 05	0.90606D 05
0.91141D 05	0.89626D 05	0.88943D 05	0.89569D 05	0.87638D 05	0.87978D 05	0.86072D 05	0.86307D 05
0.84326D 05	0.83515D 05	0.84675D 05	0.83001D 05	0.83862D 05	0.82193D 05	0.82991D 05	0.81234D 05
0.58488D 05	0.87610D 05	0.87256D 05	0.86698D 05	0.85975D 05	0.57115D 05	0.85151D 05	0.84231D 05
0.83103D 05	0.81847D 05	0.54346D 05	0.81009D 05	0.80604D 05	0.80033D 05	0.79338D 05	0.52950D 05

ENTHALPY CONTROL SUM= 0.10000000D 01

DIMENSIONLESS AXIAL DISTANCE ZR=0.100000D 01 AXIAL DISTANCE Z=0.100000D 01M

RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN FUEL ELEMENT= 0.10000D 01
RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX= 0.60460D 00
AV. HEAT FLUX IN CROSS SECTION= 83.40108D 04W/SQ.M
FUEL CENTRE TEMP. OF ROD WITH MAX RATING= 152.8693D 01 DEG.C
LINEAL POWER OF ROD WITH MAX. RATING= 210.000D 02W/M
PRESSURE= 524.6016D-02BAR
COOLANT TEMPERATURE= 600.0000D 00 DEG.C

	1	2	3	4	5	6	7	8
HR(I)=	0.12506D 01	0.12004D 01	0.11505D 01	0.13506D 01	0.13005D 01	0.12999D 01	0.12495D 01	0.11999D 01
	0.11494D 01	0.10998D 01	0.11004D 01	0.10504D 01	0.14460D 01	0.13997D 01	0.13959D 01	0.13488D 01
	0.13441D 01	0.12939D 01	0.12478D 01	0.11947D 01	0.11478D 01	0.10946D 01	0.10457D 01	0.10490D 01
	0.99760D 00	0.99987D 00	0.94308D 00	0.14023D 01	0.14627D 01	0.13721D 01	0.14148D 01	0.13248D 01
	0.13626D 01	0.12635D 01	0.12223D 01	0.12656D 01	0.11454D 01	0.11696D 01	0.10535D 01	0.10708D 01
	0.95267D 00	0.91285D 00	0.97575D 00	0.87942D 00	0.93073D 00	0.83473D 00	0.88181D 00	0.78173D 00
	0.83958D 00	0.89263D 00	0.86980D 00	0.84033D 00	0.80652D 00	0.73426D 00	0.76379D 00	0.71287D 00
	0.65581D 00	0.59700D 00	0.53014D 00	0.55578D 00	0.53245D 00	0.50477D 00	0.47489D 00	0.43107D 00
RATHR(I)=	0.12506D 01	0.12004D 01	0.11505D 01	0.13506D 01	0.13005D 01	0.12999D 01	0.12495D 01	0.11999D 01
	0.11494D 01	0.10998D 01	0.11004D 01	0.10504D 01	0.14460D 01	0.13997D 01	0.13959D 01	0.13488D 01
	0.13441D 01	0.12939D 01	0.12478D 01	0.11947D 01	0.11478D 01	0.10946D 01	0.10457D 01	0.10490D 01
	0.99760D 00	0.99987D 00	0.94308D 00	0.14023D 01	0.14627D 01	0.13721D 01	0.14148D 01	0.13248D 01
	0.13626D 01	0.12635D 01	0.12223D 01	0.12656D 01	0.11454D 01	0.11696D 01	0.10535D 01	0.10708D 01
	0.95267D 00	0.91285D 00	0.97675D 00	0.87942D 00	0.93073D 00	0.83473D 00	0.88181D 00	0.78173D 00
	0.83958D 00	0.89263D 00	0.85980D 00	0.84033D 00	0.80652D 00	0.73426D 00	0.76379D 00	0.71287D 00
	0.65581D 00	0.59700D 00	0.53014D 00	0.55578D 00	0.53245D 00	0.50477D 00	0.47489D 00	0.43107D 00
QAV(I)=	0.63090D 00	0.60559D 00	0.58042D 00	0.68137D 00	0.65607D 00	0.65579D 00	0.63035D 00	0.60532D 00
	0.57988D 00	0.55485D 00	0.55512D 00	0.52994D 00	0.73185D 00	0.70654D 00	0.70627D 00	0.68083D 00
	0.68028D 00	0.65471D 00	0.62981D 00	0.60424D 00	0.57935D 00	0.55378D 00	0.52888D 00	0.52941D 00
	0.50438D 00	0.50464D 00	0.47947D 00	0.78233D 00	0.75702D 00	0.75674D 00	0.73130D 00	0.73074D 00
	0.70517D 00	0.70434D 00	0.67364D 00	0.65389D 00	0.62819D 00	0.60344D 00	0.57774D 00	0.55298D 00
	0.52729D 00	0.50253D 00	0.50332D 00	0.47842D 00	0.47894D 00	0.45390D 00	0.45416D 00	0.42899D 00
	0.80763D 00	0.79491D 00	0.75925D 00	0.74319D 00	0.71672D 00	0.70338D 00	0.67816D 00	0.62772D 00
	0.57727D 00	0.52683D 00	0.50161D 00	0.48969D 00	0.46564D 00	0.44119D 00	0.41634D 00	0.40382D 00
TCO(I)=	0.65012D 03	0.64008D 03	0.63010D 03	0.67011D 03	0.66009D 03	0.65997D 03	0.64989D 03	0.63998D 03
	0.62988D 03	0.61996D 03	0.62007D 03	0.61008D 03	0.68919D 03	0.67994D 03	0.67919D 03	0.66975D 03
	0.66882D 03	0.65378D 03	0.64956D 03	0.63893D 03	0.62956D 03	0.61892D 03	0.60914D 03	0.60979D 03
	0.59952D 03	0.59997D 03	0.58962D 03	0.68046D 03	0.69254D 03	0.67443D 03	0.68295D 03	0.66496D 03
	0.67252D 03	0.65270D 03	0.64446D 03	0.65312D 03	0.62907D 03	0.63391D 03	0.61069D 03	0.61415D 03
	0.59053D 03	0.58257D 03	0.59535D 03	0.57588D 03	0.58615D 03	0.56695D 03	0.57636D 03	0.55635D 03
	0.56792D 03	0.57353D 03	0.57396D 03	0.56807D 03	0.56130D 03	0.54685D 03	0.55276D 03	0.54257D 03
	0.53116D 03	0.51940D 03	0.50603D 03	0.51116D 03	0.50649D 03	0.50095D 03	0.49498D 03	0.48621D 03
TCL(I)=	0.65762D 03	0.64725D 03	0.63594D 03	0.67830D 03	0.66794D 03	0.66781D 03	0.65739D 03	0.64714D 03
	0.63671D 03	0.62645D 03	0.62657D 03	0.61626D 03	0.69808D 03	0.68848D 03	0.68772D 03	0.67793D 03
	0.67699D 03	0.66660D 03	0.65704D 03	0.64608D 03	0.63638D 03	0.62540D 03	0.61529D 03	0.61596D 03
	0.60536D 03	0.60582D 03	0.59514D 03	0.68992D 03	0.70175D 03	0.68354D 03	0.69180D 03	0.67372D 03
	0.68101D 03	0.65109D 03	0.65250D 03	0.66091D 03	0.63646D 03	0.64103D 03	0.61742D 03	0.62061D 03
	0.59661D 03	0.58834D 03	0.60117D 03	0.58136D 03	0.59166D 03	0.57212D 03	0.58156D 03	0.56121D 03
	0.57546D 03	0.58793D 03	0.53303D 03	0.57681D 03	0.56971D 03	0.55335D 03	0.56068D 03	0.54987D 03
	0.53783D 03	0.52545D 03	0.51056D 03	0.51676D 03	0.51180D 03	0.50598D 03	0.49970D 03	0.48983D 03
REL(I)=	0.89971D 05	0.89124D 05	0.88272D 05	0.91628D 05	0.90802D 05	0.90793D 05	0.89952D 05	0.89115D 05

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C.88253D 05 0.87394D 05 0.87404D 05 0.86530D 05 0.93172D 05 0.92428D 05 0.92367D 05 0.91598D 05
0.91522D 05 0.90594D 05 0.89924D 05 0.89026D 05 0.88225D 05 0.87304D 05 0.86446D 05 0.86504D 05
C.85593D 05 0.85534D 05 0.84704D 05 0.92499D 05 0.93441D 05 0.92010D 05 0.92673D 05 0.91235D 05
0.91826D 05 0.90216D 05 0.89522D 05 0.90224D 05 0.88212D 05 0.88600D 05 0.86612D 05 0.86889D 05
0.84813D 05 0.84090D 05 0.85221D 05 0.83479D 05 0.84391D 05 0.82653D 05 0.83497D 05 0.81658D 05
0.58887D 05 0.88257D 05 0.87901D 05 0.87326D 05 0.86574D 05 0.57475D 05 0.85725D 05 0.84785D 05
0.83620D 05 0.82320D 05 0.54626D 05 0.81456D 05 0.81042D 05 0.80452D 05 0.79731D 05 0.53187D 05
          ENTHALPY CONTROL SUM= 0.10000000D 01
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ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
ROOM 0208  HASP-II   ..END JOB 348   10.33.01 AM 27 OCT 72   ROOM 0208   HERA2   NIJSING   HASP-II***HASP-II
```

APPENDIX 2

PROGRAMME LISTING

```
C       R.NIJSING-W.EIFLER
C       *****************
C
C
C       H E R A - 1 A
C
C
C
C       =============================================================
C       COMPUTER PROGRAMME FOR STEADY-STATE THERMO-HYDRAULIC ANALYSIS OF
C       MULTIROD FUEL BUNDLES COOLED BY LIQUID METAL IN SINGLE PHASE FLOW
C       =============================================================
C
C
C       **CONDITIONS
C       ------------
C
C       THIS PROGRAMME COMPUTES SUBCHANNEL COOLANT ENTHALPY DISTRIBUTIONS
C       APPLYING  AN ANALYTICAL MATHEMATICAL SOLUTION PROCEDURE
C
C       HEXAGONAL GEOMETRY
C
C       SINGLE PHASE FLOW
C
C       SODIUM COOLANT
C
C       GRID SPACERS OR HELICAL SPACERS
C
C       IN PRESENT HERA VERSION FOR CASE OF HELICAL SPACERS INTERSUBCHAN-
C       NEL MIXING IS DESCRIBED IN SIMPLIFIED MANNER FOR THE PERIPHERAL
C       SUBCHANNELS
C
C       FOR CALCULATION OF GEOMETRY PARAMETERS HELICAL SPACER IS ASSUMED
C       TO BE A WIRE
C
C       TURBULENT INTERSUBCHANNEL MIXING COEFFICIENTS ARE NOT GIVEN AS IN-
C       PUT,BUT ARE CALCULATED IN PROGRAMME
C
C
C
C
C       **NOTICE
C       --------
C       DIMENSIONS ASSIGNED TO VECT,SVD,DC,BMH,DA,VE,EIVR AND /MAT/VM,/MAT
C       /A IN MAIN AND IN SUBROUTINES INMAT,MIFU AND HELMIX DEPEND ON TO-
C       TAL NUMBER OF SUBCHANNELS
C
C       FOR GEOMETRIES CORRESPONDING TO NGE=2,NGE=3 AND NGE=4 NMIH IS RE-
C       QUIRED TO BE 2
```

```
C
C     ZUN MUST BE INTEGER NUMBER OF TIMES ZG
C
C
C     SELECTION NUMBERS GOVERNING COMPUTATION CONDITIONS
C     --------------------------------------------------
C
C     NGE DENOTES TYPE OF GEOMETRY
C     NGE=1,HALF HEXAGONON/ NGE=2,SINGLE ROW OF SUBCHANNELS ALONG DIAGO-
C     NAL/ NGE=3,TWO ROWS OF SUBCHANNELS ALONG DIAGONAL/ NGE=4,NRY ROWS
C     OF PERIPHERAL SUBCHANNELS IN HALF HEXAGONON
C
C     NSP DENOTES TYPE OF SPACER
C     NSP=1,GRID SPACER/ NSP=2,HELICAL SPACER
C
C     NFLOW DENOTES TYPE OF INPUT FOR FLOWRATE
C     NFLOW=2,MASS FLOW RATE PRESCRIBED/ NFLOW=1,MASS FLOW RATE IS COM-
C     PUTED FROM PRESCRIBED AXIAL COOLANT TEMPERATURE RISE
C
C     NMIMO REGARDS INTERSUBCHANNEL MOMENTUM TRANSPORT
C     NMIMO=1,NO INTERSUBCHANNEL MOMENTUM TRANSPORT
C     NMIMO=2,DIFFUSIVE MOMENTUM INTERCHANGE BETWEEN SUBSUBCHANNELS
C
C     NMIH REGARDS INTERSUBCHANNEL HEAT TRANSPORT
C     NMIH=1,NO INTERSUBCHANNEL HEAT TRANSPORT
C     NMIH=2,INTERSUBCHANNEL HEAT TRANSPORT
C
C     NCON(APPLIES TO NSP=1 ONLY)REGARDS CONDUCTION HEAT TRANSPORT BE-
C     TWEEN SUBCHANNELS
C     NCON=1,NO CONDUCTION HEAT TRANSPORT
C     NCON=2,CONDUCTION HEAT TRANSPORT
C
C     NKG(APPLIES TO NSP=1 ONLY)REGARDS INTERSUBCHANNEL MIXING BY GRIDS
C     NKG=1,NO MIXING AT GRIDS
C     NKG=2,MIXING DUE TO GRIDS(AT POSITION OF GRIDS)
C
C     NMIX REGARDS MIXING WITH HELICAL SPACERS
C     NMIX=1,MIXING INPUT DATA ARE USED IN COMPUTATION
C     NMIX=2,MAXIMUM MIXING RATE EXPRESSION IN CODE IS USED
C
C
C
C
C
C     ------------------------------------------------------------------
C     DOUBLE PRECISION VERSION
      IMPLICIT REAL*8(A-H,O-Z)
C     ------------------------------------------------------------------
C
C     * FUNCTIONS (PHYSICAL PROPERTIES OF SODIUM)
```

```
C     ------------------------------------
      FUNH(T)=1.260D+3*(T-4.0D+2)
      FUNT(H)=H/1.260D+3+4.0D+2
      FUNRO(T)=8.56D+2-0.24D0*(T-4.0D+2)
      FUNLA(T)=71.2D0-0.0417D0*(T-4.0D+2)
      FUNMU(T)=(0.8D0+8.0D+2/T)*1.0D-4
C
C     MODIFIED BOBKOV RELATION FOR RATIO HEAT DIFFUSIVITY TO MOMENTUM
C     DIFFUSIVITY
      RABO(RE,PR,HYDR,ANF)=1.38*(1.0D0-DEXP(-1.24D-4*ANF*HYDR*RE*PR**(1.
     10D0/3.0D0)))
C
C     * COMMON STATEMENTS
C     -----------------
      COMMON/MAT/VM(130,130)
      COMMON/INA2/NSS(334)
      COMMON/IND1/NROW(334),NUMS(334)/IND2/NOT(11,60)/IND3/NTYP(334)
      COMMON/INA/NER(334),NIS(334,3)
      COMMON/RODFL1/RR(11,31)/RODFL2/QLR(11,31)/RODSU/CQS(334)
      COMMON/FLOW1/FMR(334),FRIC(334)/FLOW2/FMS(60,11),FRICS(60,11)
      COMMON/FLOW3/UR(334)
      COMMON/GEO1/S(334)/GEO2/DH(334),HPER(334),WPER(334),CGI(334)
C
C     * DIMENSIONS
C     ------------
      DIMENSION UMV(100)
      DIMENSION VECT(8600),SVD(16900)
      DIMENSION VE( 64),EIVR( 64),DA( 64,10)
      DIMENSION FMRE(60)
      DIMENSION SN(334),DHN(334),SR(334),HPERN(334)
      DIMENSION H(334),HR(334),HT(334),HRS(334),HTO(334),RATHR(334),TCL(
     1334),TCO(334)
      DIMENSION NUR6(11),NUR12(11),NURT(11)
      DIMENSION NUM3(11),NUM6(11),NUM12(11),NUMT(11)
      DIMENSION BMH(334),CQSN(334),CAZ(334),QAV(334),CAIN(334)
      DIMENSION CA(334)
      DIMENSION QFRZ(25),AFZ(25,25),AFL(25),SUT(25),ZI(25),QFRZR(25)
      DIMENSION VL1(201),X(334),REL(334),REF(334)
      DIMENSION DSITR(3),DSIR(6),DSIAA(2),DSIAB(2)
      DIMENSION DELPG(120),PFR(120)
      DIMENSION BL(100),DC(100)
C
C     *EQUIVALENCE STATEMENTS
C     -----------------------
      EQUIVALENCE (CA(1),SN(1))
      EQUIVALENCE(HRS(1),FMS(1,1)),(HTO(1),FRICS(1,1)),(RATHR(1),CGI(1))
      EQUIVALENCE (CAZ(1),RR(1,1))
      EQUIVALENCE    (QAV(1),DHN(1)),(CAIN(1),HPERN(1)),(BMH(1),CQSN(1)),
     1(TCL(1),REF(1)),(TCO(1),X(1))
C
```

```
      EQUIVALENCE (VM(1,1),SVD(1))
C
C
      KSIG=1
C     KSIG STEERS PROGRAMME IF DIFFERENT HEAT GENERATION DISTRIBUTIONS
C     ARE CONSIDERED (NCA EXCEEDING 1)
C
C
C
C     *READING OF INPUT DATA
C     ----------------------
C     ----------------------
      WRITE(6,1)
C     CARD NUMBER 1
C     -------------
      READ (5,5) NGE,NSP,NFLOW,NMIMO,NMIH,NCON,NKG,NMIX
      WRITE(6,6) NGE,NSP,NFLOW,NMIMO,NMIH,NCON,NKG,NMIX
C
C     OPTIONS
C     -------
C     FOR NOP HAVING VALUES EXCEEDING 1 CONTROLL DATA ARE PRINTED
C     NCA=NUMBER OF COMPUTATION CASES WITH DIFFERENT SPATIAL HEAT GENE-
C     RATION DISTRIBUTIONS,BUT WITH THE SAME FUEL ELEMENT POWER
C     CARD NUMBER 2
C     -------------
      READ (5,5) NOP,NCA
      WRITE(6,3) NOP,NCA
C
C     GEOMETRY PARAMETERS
C     A.) IN THE CROSS SECTION
C     CARD NUMBER 3
C     -------------
      READ (5,5) NROMA,NRY
C
C
C     CARD NUMBER 4
C     -------------
      READ(5,7) P,PW,RF,RC
      WRITE(6,8) NROMA,NRY,P,PW,RF,RC
C
C     B.) IN THE LENGTH DIRECTION
      IF(NSP-1) 60,60,61
C     CARD NUMBER 5
C     -------------
   60 READ (5,7) ZUN,ZTOT,YO1,YO2,Z1G,ZG
      WRITE(6,9) ZUN,ZTOT,YO1,YO2,Z1G,ZG
      GO TO 62
C
C     CARD NUMBER 5
C     -------------
```

```
   61 READ (5,7) ZTOT,YO1,YO2,ZG
      WRITE(6,10) ZTOT,YO1,YO2,ZG
C
C     FUEL BUNDLE MASS FLOWRATE
   62 IF(INFLOW-1) 64,64,63
C     CARD NUMBER 6
C     -------------
   63 READ (5,7) FMTOT
      WRITE(6,11)FMTOT
      GO TO 65
C
C     CARD NUMBER 6
C     -------------
   64 READ(5,7) DELTC
      WRITE(6,12)DELTC
C
C     FLOWRESISTANCE AND MIXING COEFFICIENTS
C     A.) FOR GRID TYPE SPACERS
   65 IF(NSP-1) 66,66,67
C     CARD NUMBER 7
C     -------------
   66 READ (5,7) CFR,EXF,CG1,CG2,CG3,CEF,GAMMA
      WRITE(6,13)CFR,EXF,CG1,CG2,CG3,CEF,GAMMA
      GO TO 68
C
C     CARD NUMBER 7
C     -------------
C     B.) FOR HELICAL SPACERS
   67 READ (5,7) CFR,EXF,CMIX1,CMIX2
      WRITE(6,14)CFR,EXF,CMIX1,CMIX2
C
C     FUEL ROD CONDUCTIVITIES AND CONTACTRESISTANCE
C     CARD NUMBER 8
C     -------------
   68 READ(5,7) VLF,VLCL,BETA
      WRITE(6,15) VLF,VLCL,BETA
C
C     TEMPERATURE AND PRESSURE OF COOLANT AT START OF HEATING IN BUNDLE
C     CARD NUMBER 9
C     -------------
      READ (5,7) TIN,PIN
C
C     MAX. HEAT GENERATION VALUE IN ROD BUNDLE
C     CARD NUMBER 10
C     --------------
      READ (5,7) QLMAX
      WRITE(6,17)TIN,PIN,QLMAX
C
C     SPATIAL DISTRIBUTION OF HEAT GENERATION
C     IN CROSS SECTION
```

```
C     CARD NUMBER 11
C     --------------
 4000 READ (5,7) VX,RO,RATA
C
C     IN AXIAL DIRECTION (A)NUMBER OF AX.POSITIONS (B) AX.POSITIONS (C)
C     HEAT GENERATION VALUES AT SPEC. AX.POSITIONS(ARBITRARY UNITS)
C     NAX=NUMBER OF AXIAL POSITIONS AT WHICH RESULTS ARE FURNISHED A.)
C     FOR CASE OF GRID SPACERS BETWEEN TWO GRIDS B.) FOR CASE OF HELICAL
C     SPACERS OVER ENTIRE HEATED LENGTH
C     CARD NUMBER 12
C     --------------
      READ (5,5) NAX,NAT
C
C     CARD NUMBER 13
C     --------------
      READ (5,7) (ZI(NA),NA=1,NAT)
C
C     CARD NUMBER 14
C     --------------
      READ (5,7) CONS,QFRO,QFRMA,(QFRZ(NA),NA=1,NAT)
C
      WRITE(6,16) NAX,NAT,(ZI(NA),NA=1,NAT)
      WRITE (6,19) VX,RO,RATA
      WRITE(6,20) CONS,QFRO,QFRMA,(QFRZ(NA),NA=1,NAT)
C
C                            0.VARIOUS CONSTANTS
C                            *******************
C
      IF(KSIG.GT.1) GO TO 106
C
C     NOTE ANF IS FACTOR DENOTING RATIO OF TURBULENT DIFFUSIVITY FOR
C     TRANSPORT IN CIRCUMFERENTIAL DIRECTION TO THAT IN RADIAL DIRECTION
      PI=3.14159265359D0
      HYDR=0.5D0*(1.0D0/(1.0D0+P*(6.0D0/PI*DTAN(PI/6.D0))**(0.5D0)))
      LINT=100
      ANF=2.0D0
      IF(NSP.EQ.2) VNG=0.0D0
      IF(NSP.EQ.2) GO TO 98
      GO TO 99
   98 CG1=0.0D0
      CG2=0.0D0
      CG3=0.0D0
      ZUN=1.0D0
C     FOR HELICAL SPACERS NKG=1
      NKG=1
   99 CONTINUE
C
C         1. CALCULATION OF GEOMETRY PARAMETERS(HEXAGONAL CHANNEL)
C         ********************************************************
C
```

```
C                   PARAMETERS RELATED TO AXIAL DISTANCES
C                   -------------------------------------
C
      IF(NSP.EQ.1) VNG=ZUN/ZG+1.0D0
      DFNAX=NAX-1
      ZR1G=Z1G/ZTOT
      ZRG=ZG/ZTOT
      FNZGI=(1.0D0-ZR1G)/ZRG
      NZGI=FNZGI
      ZREG=1.0D0-ZR1G-DFLOAT(NZGI)*ZRG
      ZEG=ZREG*ZTOT
      DZR1=ZR1G/DFNAX
      DZR=ZRG/DFNAX
      DZRE=ZREG/DFNAX
      NGI=NZGI+2
      IF(NSP.EQ.2) NGI=1
      IF(NSP.EQ.2) DZR=1.0D0/DFNAX
      NTOT=NGI*NAX
      LINT1=LINT+1
C
C
C
C                      CHANNEL DIMENSIONS AND SECTIONS
C                      -------------------------------
C
      NROT=1
      DO 100 NRO=1,NROMA
  100 NROT=NROT+NRO*6
C
C     HEXAGONON DIMENSIONS
      RHEX=NROMA*P*RC*2.0D0+PW*RC/DCOS(PI/6.0D0)
      WSHEX=2.0D0*RHEX*DCOS(PI/6.0D0)
      WLHEX=2.0D0*RHEX
C
C     HEXAGONON SECTIONS
      SH60=RHEX*RHEX*DCOS(PI/6.0D0)/2.0D0
      DNROT=NROT
      S60=SH60-DNROT/6.0D0*PI*RC*RC
      STOT=6.0D0*S60
      SS=3.0D0*S60
      S30=SS/6.0D0
C
C     SUBCHANNEL SECTIONS
      STR=2.0D0*P*P*RC*RC*DCOS(PI/6.0D0)-PI*RC*RC/2.0D0
      SREC=PW*RC*RC*2.0D0*P-PI*RC*RC/2.0D0
      SAN1=PW*RC*PW*RC*0.5D0*DTAN(PI/6.0D0)-PI*RC*RC/12.0D0
      SAN2=2.0D0*SAN1
      WPTR=PI*RC
      WPREC=PI*RC+P*RC*2.0D0
      WPAN1=PI*RC/6.0D0+PW*RC*DTAN(PI/6.0D0)
```

```
      WPAN2=2.0D0*WPAN1
      HPTR=WPTR
      HPREC=PI*RC
      HPAN1=PI*RC/6.0D0
      HPAN2=2.0D0*HPAN1
      PERS=DNROT*PI*RC
C     PERS=HEATED PERIMETER IN 180 DEG. REGION
C
      WPERS=PERS+3.0D0*RHEX
C
      IF(NSP.EQ.1) GO TO 101
C
      CG1=0.0D0
      CG2=0.0D0
      CG3=0.0D0
C
C
      DSPAC=(P-1.0D0)*RC*2.0D0
      SSPAC=PI/4.0D0*DSPAC**2
      WSPAC=PI*DSPAC
      SS=SS-DNROT*SSPAC/2.0D0
      S60=SS/3.0D0
      S30=SS/6.0D0
      STR=STR-SSPAC/2.0D0
      SREC=SREC-SSPAC/2.0D0
      SAN2=SAN2-SSPAC/6.0D0
      SAN1=SAN2/2.0D0
      WPTR=WPTR-WSPAC/2.0D0
      WPREC=WPREC-WSPAC/2.0D0
      WPAN2=WPAN2-WSPAC/6.0D0
      WPAN1=WPAN2/2.0D0
      WPERS=WPERS-DNROT*WSPAC/2.0D0
C
C
C
C                         HYDRAULIC AND THERMAL DIAMETERS
C                         -------------------------------
C
  101 CONTINUE
C
      DHF=4.0D0*SS/WPERS
      DTF=4.0D0*SS/PERS
      DHTR=4.0D0*STR/WPTR
      DTTR=DHTR
      DHREC=4.0D0*SREC/WPREC
      DTREC=4.0D0*SREC/(PI*RC)
      DHAN=4.0D0*SAN2/WPAN2
      DTHAN=4.0D0*SAN2/HPAN2
C
      IF(NOP.EQ.1) GO TO 9010
```

```
      WRITE(6,32)
      WRITE(6,52) NROMA,NROT
      WRITE(6,49) RHEX,WSHEX,WLHEX,SH60,S60,S30,STOT
      WRITE (6,49) STR,SREC,SAN1,SAN2
      WRITE(6,49) WPTR,HPTR,WPREC,HPREC,WPAN1,HPAN1
      WRITE(6,49) HPAN2,PERS,WPERS
      WRITE (6,49) DHF,DTF,DHTR,DTTR
      WRITE (6,49) DHREC,DTREC,DHAN,DTHAN
      IF(NSP.EQ.1) GO TO 9010
      WRITE(6,49) DSPAC,SSPAC,WSPAC
 9010 CONTINUE
C
C
C
      IF((NMIX.EQ.2).AND.(NSP.EQ.2)) GO TO 104
      GO TO 106
  104 CMIX1=DSPAC*PI*(2.0D0*RC+DSPAC)/ZG
      CMIX2=0.5D0*CMIX1
  106 CONTINUE
C
C         2. SPATIAL DISTRIBUTION OF HEAT GENERATION AND HEAT FLUXES
C         **********************************************************
C
C                   QUANTITIES PERTAINING TO AXIAL FLUX VARIATION
C                   ---------------------------------------------
C
C
      Y0=Y01
      ZEX=ZTOT+Y01+Y02
      REX=ZEX/ZTOT
      YE=ZTOT+Y0
      ZRIN=Y0/ZTOT
      YEF=PI*YE/ZEX
      Y0F=PI*Y0/ZEX
C
      DO 102 NA=1,NAT
      QFRZR(NA)=QFRZ(NA)/QFR0-CONS
      DO 103 NAS=1,NAT
      ZR=ZI(NA)/ZTOT
      DNA=NAS
      AFZ(NA,NAS)=DSIN(DNA*PI/REX*(ZR+ZRIN))
  103 VM(NA,NAS)=AFZ(NA,NAS)
  102 CONTINUE
C
      CALL INMAT(NAT)
C
      DO 105 I=1,NAT
      SUM=0.0D0
      DO 110 J=1,NAT
  110 SUM=SUM+VM(I,J)*QFRZR(J)
  105 AFL(I)=SUM
```

```
C
      ZR=0.5D0
      SUM=0.0D0
      DO 115 NA=1,NAT
      DNA=NA
  115 SUM=SUM+AFL(NA)*DSIN(DNA*PI/REX*(ZR+ZRIN))
C
      IF(NOP.EQ.1) GO TO 9020
      WRITE(6,33)
      ZR=0.0D0
      DZRS=1.0D-2
      DO 120 L=1,LINT,4
      SUM=0.0D0
      DO 121 NA=1,NAT
      DNA=NA
  121 SUM=SUM+AFL(NA)*DSIN(DNA*PI/REX*(ZR+ZRIN))
      SUM=SUM*QFRO
      Z=ZR*ZTOT
      WRITE (6,49) ZR,Z,SUM
  120 ZR=ZR+4.0D0*DZRS
 9020 CONTINUE
C
C
      SUM1=0.0D0
      SUM2=0.0D0
      DO 125 NA=1,NAT
      DNA=NA
      SUM1=SUM1+AFL(NA)*DCOS(DNA*YOF)/DNA
  125 SUM2=SUM2+AFL(NA)*DCOS(DNA*YEF)/DNA
      QFRAT=REX/PI*(SUM1-SUM2)+CONS
C
C     QFRAT=QFRAV/QFRO
C     QFRO=QFRZ(HEAT FLUX) AT Z=ZTOT/2
C
      QLRO=QLMAX*QFRO/QFRMA
      QLFRAV=QFRAT*QLRO
C
C
C     *AXIALLY AVERAGED HEAT FLUX IN ROD WITH HIGHEST RATING
      QFRAV=QLFRAV/(2.0D0*PI*RC)
C
C
C                SPATIALLY AVERAGED HEAT FLUX,FUEL ASSEMBLY POWER
C                ---------------------------------------------------
C
      DNROMA=NRCMA
C
      CALL RODFLU(NOP,NROMA,P,RC,RO,VX,RATA,NUR6,NUR12,NURT,QLRO,QFRAT2)
C
      QFAV=QFRAT2*QFRAV
```

```
      DNROT=NROT
C
      IF(KSIG.GT.1) GO TO 116
      GO TO 117
  116 QFAV=POW/(DNROT*ZTOT*PI*2.0D0*RC)
      QFRAV=QFAV/QFRAT2
      QLFRAV=QFRAV*2.0D0*PI*RC
      QLRO=QLFRAV/QFRAT
      QLMAX=QLRO*QFRMA/QFRO
      GO TO 207
C
  117 POW=DNROT*ZTOT*PI*2.0D0*RC*QFAV
C
      IF(NOP.EQ.1) GO TO 9030
      WRITE(6,34)
      WRITE(6,49) REX,YO,YE,ZRIN,QFRAT,QLRO,QLFRAV,QFRAV,POW
      WRITE (6,49) (AFL(NA),NA=1,NAT)
 9030 CONTINUE
C
C
C                    3. ASPECTS RELATED TO COOLANT FLOW
C                    **********************************
C
C     (*SINGLE PHASE FLOW,UNIFORM DENSITY AND VISCOSITY)
C
C         PHYSICAL PROPERTIES AND BULK FLOW ASPECTS IN FUEL ELEMENT
C
      IF(NFLOW-1) 126,127,126
  127 TOU=TIN+DELTC
      HOUT=FUNH(TOU)
      HIN=FUNH(TIN)
      HTOT=HOUT-HIN
      TCAV=(TIN+TOU)/2.0D0
      FMTOT=QFAV*ZTOT*PERS*2.0D0/HTOT
      GO TO 128
  126 HIN=FUNH(TIN)
      FMCS=FMTOT/2.0D0
      HTOT=QFAV*ZTOT*PERS/FMCS
      HOUT=HIN+HTOT
      TOU=FUNT(HOUT)
      TCAV=(TIN+TOU)/2.0D0
  128 CONTINUE
      FMCS=FMTOT/2.0D0
C
      VRHO=FUNRO(TCAV)
      VA=FUNLA(TCAV)/(1.26D+3*VRHO)
      VMLF=FUNMU(TCAV)
C     ABOVE PROPERTIES ARE BASED ON BULK AVERAGE COOLANT TEMPERATURE IN
C     FUEL ELEMENT
C
```

```
      REFU=FMCS*DHF/(SS*VMUF)
      UB=FMCS/(SS*VRHO)
C
      IF(NOP.EQ.1) GO TO 9040
      WRITE(6,35)
      WRITE(6,49) HIN,HOUT,TIN,TOU,TCAV
      WRITE(6,49) VRHO,VMUF,VA
      WRITE(6,49) FMCS,UB,REFU
 9040 CONTINUE
C
C                DISTRIBUTION OF SUBCHANNEL MASS FLOW RATES
C                ------------------------------------------
C                FOR CASE OF ZERO INTERSUBCHANNEL MIXING
C                ---------------------------------------
C
C     ** ONE-TWELFTH OF FUEL ELEMENT SECTION IS CONSIDERED
C
C     * INDEXING OF SUBCHANNELS
      NSEL=3
      CALL INDEX(NSEL,NROMA,NUM3,NUM6,NUM12,NUMT,NSTR30,NST30)
C
      IF(NOP.EQ.1) GO TO 9050
      WRITE(6,36)
      WRITE(6,52) NSTR30
      WRITE(6,52) NST30
      WRITE(6,52) (NUM3(NRO),NRO=1,NROMA)
      WRITE(6,52) (NUM6(NRO),NRO=1,NROMA)
      WRITE(6,52) (NUM12(NRO),NRO=1,NROMA)
      WRITE(6,52) (NUMT(NRO),NRO=1,NROMA)
      WRITE(6,52) (NUMS(NS),NS=1,NST30)
      WRITE(6,52) (NTYP(NS),NS=1,NST30)
 9050 CONTINUE
C
C     * INDEXING OF SUBCHANNEL-SECTIONS AND -HYDRAULIC DIAMETERS
C
C
C     NSEL=2 IS FOR MOMENTUM TRANSFER CASE
      CALL SECDIA(NSEL,NST30,NROMA,NUM6,NUM12,DHTR,DHREC,DHAN,WPTR,WPREC
     1,WPAN1,HPTR,HPREC,HPAN1,STR,SREC,SAN1,CG1,CG2,CG3)
      NM=NST30
      FMCS=FMTOT/12.0D0
C
      DO 130 NS=1,NM
  130 SR(NS)=S(NS)/S30
C
C
      NHALF=NROMA/2
      NEWN=2*NHALF
      DO 122 I=1,NM
      NRC=NROW(I)
```

```
      NUM=NUMS(I)
      NUMSP=NUM3(NRO)
      IF((I.LE.NSTR30).AND.(NUM.EQ.NUMSP)) GO TO 123
      IF((I.EQ.NM).AND.(NROMA.GT.NEWN)) GO TO 123
      GO TO 122
  123 WPER(I)=WPER(I)/2.0D0
      S(I)=S(I)/2.0D0
      SR(I)=SR(I)/2.0D0
  122 CONTINUE
C
      IF(NOP.EQ.1) GO TO 9060
      WRITE(6,37)
      WRITE(6,49) (WPER(NS),NS=1,NST30)
      WRITE(6,49) ( S(NS),NS=1,NST30)
      WRITE(6,49) (SR(NS),NS=1,NST30)
      WRITE(6,49) (DH(NS),NS=1,NST30)
 9060 CONTINUE
C
      DO 131 I=1,NM
  131 FRIC(I)=CFR*(DH(I)*VRHO*UB/VMUF)**(-EXF)
      NIT=1
  132 CONTINUE
      DO 133 I=1,NM
      IF(NSP.EQ.1)REF(I)=(0.5D0*FRIC(I)*FMCS**2*WPER(I)/(S(I)**3*VRHO)+0
     1.5D0*VNG*CGI(I)*FMCS**2/(S(I)**2*ZUN*VRHO))**(-0.5D0)
      IF(NSP.EQ.2)REF(I)=(0.5D0*FRIC(I)*FMCS**2*WPER(I)/(S(I)**3*VRHO))*
     1*(-.5D0)
  133 CONTINUE
      SUM=0.0D0
      DO 134 I=1,NM
  134 SUM=SUM+REF(I)
      PRGA=1.0D0/SUM
      PRG=PRGA**2
      DO 136 I=1,NM
      FMR(I)=REF(I)*PRGA
      FRIC(I)=CFR*(DH(I)*FMR(I)*FMCS/(S(I)*VMUF))**(-EXF)
  136 UR(I)=FMR(I)/SR(I)
      NIT=NIT+1
      IF(NIT-6) 132,132,138
C
  138 CONTINUE
      SUM=0.0D0
      DO 7000 I=1,NM
      TERM=FMR(I)
 7000 SUM=SUM+TERM
      DO 7005 I=1,NM
 7005 FMR(I)=FMR(I)/SUM
C
      IF(NOP.EQ.1) GO TO 9070
      WRITE (6,39)
```

```
      WRITE (6,40) PRG
      WRITE (6,41) (FMR(I),I=1,NM)
      WRITE (6,42) (UR(I),I=1,NM)
      WRITE(6,45) (FRIC(I),I=1,NM)
 9070 CONTINUE
C
C
      IF(NMIMO.EQ.1) GO TO 139
C
C                DISTRIBUTION OF SUBCHANNEL MASS FLOW RATES
C                ------------------------------------------
C                WITH INTERSUBCHANNEL MIXING TAKEN INTO ACCOUNT
C                ----------------------------------------------
C
C
      CALL INAC(3,5,1,NSTR30,NST30,NROMA,NUM3,NUM6,NUM12,NUMT)
      IF(NSP.EQ.2) GO TO 135
C
C
C     ** EVALUATION OF SUBCHANNEL MIXING TERMS MIFU(I,J) FOR THE TURBU-
C     -----------------------------------------------------------------
C     LENT CASE (NOT APPLYING FOR HELICAL SPACERS)
C     --------------------------------------------
C
C     *GEOMETRY PARAMETERS
C
C     ANGLES REGARDING SUBCHANNEL INTERACTIONS
      FTRTR=PI/6.0D0
      FTRREC=PI/6.0D0
C     FOR FLOW ONLY
      YL=(RC*RC*(P-1.0D0)+PW*PW*RC*RC)/(2.0D0*(RC+PW*RC))
      FRECTR=DARCOS(P*RC/(YL+RC))
      FREREC=PI/2.0D0-FRECTR
      FRECAN=FREREC
C
      FANREC=PI/6.0D0
C     ANGLES AND SINUS TERMS RELATED TO SUBCH. HEAT FLUX
C
      FITR=PI/3.0D0
C
      FITR1=0.0D0
      FITR2=PI/3.0D0
      FITR3=2.0D0*PI/3.0D0
      FITR4=PI
C
      FIRE=PI/2.0D0
C
      FIRE1=PI/6.0D0
      FIRE2=2.0D0*PI/3.0D0
      FIRE3=-PI/6.0D0
```

```
      FIRE4=PI/3.0D0
      FIRE5=PI/2.0D0
      FIRE6=PI
      FIRE7=0.0D0
      FIRE8=PI/2.0D0
      FIRE9=5.0D0*PI/6.0D0
      FIRE10=4.0D0*PI/3.0D0
      FIRE11=PI/3.0D0
      FIRE12=5.0D0*PI/6.0D0
C
      FIAA=PI/6.0D0
      FIAB=PI/3.0D0
C
      FIAA1=0.0D0
      FIAA2=PI/6.0D0
      FIAA3=5.0D0*PI/6.0D0
      FIAA4=PI
C
      FIAB1=PI/6.0D0
      FIAB2=PI/2.0D0
      FIAB3=5.0D0*PI/6.0D0
C
C
      DSITR(1)=DSIN(FITR2)
      DSITR(2)=DSIN(FITR3)-DSIN(FITR2)
      DSITR(3)=DSIN(FITR4)-DSIN(FITR3)
      DSIR(1)=DSIN(FIRE2)-DSIN(FIRE1)
      DSIR(2)=DSIN(FIRE4)-DSIN(FIRE3)
      DSIR(3)=DSIN(FIRE6)-DSIN(FIRE5)
      DSIR(4)=DSIN(FIRE8)-DSIN(FIRE7)
      DSIR(5)=DSIN(FIRE10)-DSIN(FIRE9)
      DSIR(6)=DSIN(FIRE12)-DSIN(FIRE11)
C
      DSIAA(1)=DSIN(FIAA2)-DSIN(FIAA1)
      DSIAA(2)=DSIN(FIAA4)-DSIN(FIAA3)
      DSIAB(1)=DSIN(FIAB2)-DSIN(FIAB1)
      DSIAB(2)=DSIN(FIAB3)-DSIN(FIAB2)
C
      IF(NOP.EQ.1) GO TO 9080
      WRITE(6,38)
      WRITE (6,49) FTRTR,FTRREC,FRECTR
      WRITE (6,49) FREREC,FRECAN,FANREC
      WRITE (6,49) (DSITR(N),N=1,3)
      WRITE (6,49) (DSIR(N),N=1,6)
      WRITE (6,49) (DSIAA(N),N=1,2)
      WRITE (6,49) (DSIAB(N),N=1,2)
C9080 CONTINUE
C
      NCAN=1
      EHRAT=1.0D0
```

```
      CALL FIFU(NCAN,P,PW,RC,FTRTR,FRECTR,FREREC,FANREC,LINT,DHF,DHTR,DH
     1REC,DHAN,PRG,VRHO,EHRAT,CEF,VA,FSF1,FSF2,FSF3,FSF4)
C
      IF(NOP.EQ.1) GO TO 9090
      WRITE(6,53)
      WRITE (6,49) FSF1
      WRITE (6,49) FSF2
      WRITE (6,49) FSF3
      WRITE (6,49) FSF4
 9090 CONTINUE
C
  140 CONTINUE
      NSEL=2
      CALL MIFU(NSEL,NM,FSF1,FSF2,FSF3,FSF4,RC,FMCS,P,PW,CEF,VRHO)
      GO TO 145
  135 CONTINUE
C
C     ** EVALUATION OF MIXING COEFFICIENT FOR HELICAL SPACERS
      CALL HELMIX(5,1,NM,VRHO,UB,CMIX1,CMIX2)
C
  145 CONTINUE
      DO 141 I=1,NM
      NRO=NROW(I)
      NUMI=NUMS(I)
      NUMSPI=NUM3(NRO)
      NERT=NER(I)
      DO 142 L=1,NERT
      J=NIS(I,L)
      NRO=NROW(J)
      NUMJ=NUMS(J)
      NUMSPJ=NUM3(NRO)
      IF((NUMI.EQ.NUMSPI).AND.(NUMJ.EQ.NUMSPJ)) GO TO 143
      GO TO 142
  143 VM(I,J)=VM(I,J)/2.0D0
      VM(I,I)=VM(I,I)-VM(I,J)
  142 CONTINUE
  141 CONTINUE
C
C
C
      DO 175 I=1,NM
      SUM=VM(I,I)
      IF(NSP.EQ.2) GO TO 182
      FUFM=0.5D0*FRIC(I)*FMR(I)*FMCS**2*WPER(I)/(VRHO*S(I)**3)+0.5D0*VNG
     1*CGI(I)*FMR(I)*FMCS**2/(VRHO*S(I)**2*ZUN)
      GO TO 183
  182 FUFM=0.5D0*FRIC(I)*FMR(I)*FMCS**2*WPER(I)/(VRHO*S(I)**3)
  183 CONTINUE
      VM(I,I)=FUFM+FMCS/(S(I)*S(I))*SUM
  175 CONTINUE
```

```
      NMA=NM+1
      DO 184 I=1,NM
      DO 185 J=1,NM
      IF(I.EQ.J) GO TO 185
      VM(I,J)=-FMCS*VM(I,J)/(S(I)*S(J))
  185 CONTINUE
      VM(I,NMA)=-1.0D0
      VM(NMA,I)=1.0D0
      VE(I)=0.0D0
  184 CONTINUE
      VM(NMA,NMA)=0.0D0
      VE(NMA)=1.0D0
C
      CALL INMAT(NMA)
C
      DO 186 IE=1,NMA
      SUM=0.0D0
      DO 187 JE=1,NMA
  187 SUM=SUM+VM(IE,JE)*VE(JE)
  186 X(IE)=SUM
C
      IF(NOP.EQ.1) GO TO 9110
      WRITE (6,43) (X(IE),IE=1,NMA)
 9110 CONTINUE
C
      DO 190 I=1,NM
      VB=DABS((X(I)-FMR(I))/FMR(I))
      IF(VB-1.0D-3) 190,190,192
  190 CONTINUE
      GO TO 193
  192 DO 195 I=1,NM
      FMR(I)=(X(I)+FMR(I))/2.0D0
      FRIC(I)=CFR*(DH(I)*FMR(I)*FMCS/(S(I)*VMUF))**(-EXF)
  195 CONTINUE
      IF(NSP.EQ.1) GO TO 140
      IF(NSP.EQ.2) GO TO 135
C
  193 DO 196 IE=1,NMA
      IF(IE-NM) 197,197,198
  197 FMR(IE)=X(IE)
      GO TO 196
  198 PRG=X(IE)
  196 CONTINUE
  139 CONTINUE
      DO 199 I=1,NM
      UR(I)=FMR(I)/SR(I)
      DELPG(I)=0.5D0*CGI(I)*(FMR(I)*FMCS)**2/(VRHO*S(I)**2)
      PFR(I)=PRG-VNG*DELPG(I)/ZUN
  199 CONTINUE
C
```

```
      IF(NOP.EQ.1) GO TO 9120
      WRITE (6,44)
      WRITE (6,40) PRG
      WRITE (6,41) (FMR(I),I=1,NM)
      WRITE (6,42) (UR(I),I=1,NM)
      WRITE(6,45) (FRIC(I),I=1,NM)
      WRITE(6,48) (PFR(I),I=1,NM)
      WRITE(6,55) (DELPG(I),I=1,NM)
 9120 CONTINUE
C
      DPGA=DELPG(1)
      PFRA=PFR(1)
      NIP=NSTR30+1
      SUM=0.0D0
      DO 200 NS=NIP,NST30
      TERM=FMR(NS)
  200 SUM=SUM+TERM
      PERCFL=SUM
C
      DO 202 I=1,NM
      NRO=NROW(I)
      NUM=NUMS(I)
      NUMSP=NUM3(NRO)
      IF((I.LE.NSTR30).AND.(NUM.EQ.NUMSP)) GO TO 203
      IF((I.EQ.NM).AND.(NROMA.GT.NEWN)) GO TO 203
      GO TO 202
  203 FMR(I)=FMR(I)*2.0D0
  202 CONTINUE
C                   4.ASPECTS RELATED TO AXIAL DISTRIBUTION OF
C                   SUBCHANNEL COOLANT ENTHALPIES AND TEMPERATURES
C                   **********************************************
C
C           4.1 SPECIFICATION OF SUBCHANNEL MASS FLOW RATES AND MIXING
C           ----------------------------------------------------------
C           COEFFICIENTS FOR THE CHARACTERISTIC FUEL ELEMENT SECTION
C           ----------------------------------------------------------
C
      CALL TRANS(NST30,NROMA,NUM3,NUM6,NUM12,NUMT)
C
C
      NSEL=1
      CALL INDEX(NSEL,NROMA,NUM3,NUM6,NUM12,NUMT,NSTR,NSTOT)
C
C
      CALL SECDIA(NSEL,NSTOT,NROMA,NUM6,NUM12,DHTR,DHREC,DHAN,WPTR,WPREC
     1,WPAN1,HPTR,HPREC,HPAN1,STR,SREC,SAN1,CG1,CG2,CG3)
C
C
      NM=NSTOT
      DO 204 NS=1,NSTOT
```

```
      NUM=NUMS(NS)
      NRO=NROW(NS)
      FMR(NS)=FMS(NUM,NRO)
      FRIC(NS)=FRICS(NUM,NRO)
      SR(NS)=S(NS)/SS
  204 UR(NS)=FMR(NS)/SR(NS)
C
      DO 920 NW=1,NM
  920 UR(NW)=FMR(NW)/SR(NW)
C
      FMCS=FMTOT/2.0D0
      CALL RODSUB(NSTOT,NSTR,NUM6,NUM12,NUMT,NUR6,NUR12,NURT,QFRAT2,QLRO
     1)
C
      IF(NOP.EQ.1) GO TO 9130
      WRITE(6,56)
      WRITE(6,49) (SR(NS),NS=1,NSTOT)
      WRITE(6,49) (DH(NS),NS=1,NSTOT)
      WRITE(6,49) (UR(NS),NS=1,NSTOT)
      WRITE(6,49) (FMR(NS),NS=1,NSTOT)
      WRITE(6,49) (FRIC(NS),NS=1,NSTOT)
      WRITE(6,49) (CQS(NS),NS=1,NSTOT)
 9130 CONTINUE
C
      IF(NMIH-2) 207,206,206
  206 CONTINUE
      IF(NGE.EQ.2) GO TO 2001
      IF(NGE.EQ.3) GO TO 2002
      GO TO 2005
 2001 NEX=2
      GO TO 2003
 2002 NEX=1
 2003 CALL INAC2(NEX,NROMA,NUMT,NTTOT,NWTOT)
      IF(NEX.GT.1) NM=NTTOT
      IF(NEX.EQ.1) NM=NWTOT
      DO 1820 NS=1,NSTOT
      HPERN(NS)=HPER(NS)
      DHN(NS)=DH(NS)
      SN(NS)=S(NS)
 1820 CQSN(NS)=CQS(NS)
      DO 1830 NW=1,NM
      NS=NSS(NW)
      NUM=NUMS(NS)
      NRO=NROW(NS)
      HPER(NW)=HPERN(NS)
      CQS(NW)=CQSN(NS)
      S(NW)=SN(NS)
      DH(NW)=DHN(NS)
      FMR(NW)=FMS(NUM,NRO)
      FRIC(NW)=FRICS(NUM,NRO)
```

```
      SR(NW)=S(NW)/SS
 1830 UR(NW)=FMR(NW)/SR(NW)
      GO TO 2010
 2005 CONTINUE
      CALL INAC(1,NGE,NRY,NSTR,NSTOT,NROMA,NUM3,NUM6,NUM12,NUMT)
      IF(NGE.EQ.4) NRMAX=NROMA-NRY+2
      IF(NGE.EQ.4) NM=NSTOT-NOT(NRMAX,1)+1
      IF(NGE.EQ.4) GO TO 2030
      GO TO 2010
 2030 DO 212 KS=1,NM
      NS=KS+NSTOT-NM
      HPER(KS)=HPER(NS)
      CQS(KS)=CQS(NS)
      S(KS)=S(NS)
      DH(KS)=DH(NS)
      FMR(KS)=FMR(NS)
      FRIC(KS)=FRIC(NS)
      SR(KS)=SR(NS)
  212 UR(KS)=UR(NS)
 2010 CONTINUE
      IF(NSP-2) 205,208,208
  205 CONTINUE
      VA=FUNLA(TCAV)/(1.26D+3*VRHO)
      SPECFU=1.26D+3
      PR=VMUF/(VRHO*VA)
      EHRAT=RABO(REFU,PR,HYDR,ANF)
      CALL FIFU(NCON,P,PW,RC,FTRTR,FRECTR,FREREC,FANREC,LINT,DHF,DHTR,DH
     1REC,DHAN,PFRA,VRHO,EHRAT,CEF,VA,FSF1,FSF2,FSF3,FSF4)
C
      CALL MIFU(NSEL,NM,FSF1,FSF2,FSF3,FSF4,RC,FMCS,P,PW,CEF,VRHO)
      GO TO 209
  208 CALL HELMIX(NGE,2,NM,VRHO,UB,CMIX1,CMIX2)
  209 CONTINUE
C
      IF(NOP.EQ.1) GO TO 9140
      WRITE(6,49) EHRAT
      DO 1810 I=1,NM
 1810 WRITE(6,47) I,(VM(I,J),J=1,NM)
 9140 CONTINUE
C
      DO 2022 I=1,NM
      NERT=NER(I)
      NTYPI=NTYP(I)
      DO 2022 L=1,NERT
      J=NIS(I,L)
      NTYPJ=NTYP(J)
      IF((NTYPI.EQ.3).AND.(NTYPJ.EQ.2))VANRE=VM(I,J)
      IF((NTYPI.EQ.1).AND.(NTYPJ.EQ.1)) VTRTR=VM(I,J)
      IF((NTYPI.EQ.2).AND.(NTYPJ.EQ.2))VRERE=VM(I,J)
      IF((NTYPI.EQ.1).AND.(NTYPJ.EQ.2))VRETR=VM(I,J)
```

```
 2022 CONTINUE
C
C              4.2 SOLUTION OF DIFFERENTIAL EQUATION SYSTEM FOR
C              --------------------------------------------------
C              AXIAL VARIATION OF SUBCHANNEL COOLANT ENTHALPIES
C              --------------------------------------------------
C
C                     ELEMENTS OF COEFFICIENT MATRIX
C                     ------------------------------
C
      DO 210 I=1,NM
      DO 210 J=1,NM
      VM(I,J)=ZTOT/FMCS*VM(I,J)
  210 CONTINUE
C
C
      DO 211 I=1,NM
  211 VM(I,I)=-VM(I,I)
C
C                DETERMINATION EIGENVALUES AND EIGENVECTORS
C                ------------------------------------------
C
C     *SYMMETRIZE MATRIX
C
      DO 213 I=1,NM
      DO 213 J=1,NM
  213 VM(I,J)=VM(I,J)*1.0D0/DSQRT(FMR(I)*FMR(J))
C
      DO 214 I=1,NM
  214 BMH(I)=1.0D0/DSQRT(FMR(I))
C
      K=1
      VECT(1)=VM(1,1)
      DO 217 J=2,NM
      DO 217 I=1,J
      K=K+1
  217 VECT(K)=VM(I,J)
C
      TIND=0.0D0
      CALL STCLCK
C
      CALL EIVA(VECT,BMH,SVD,NM,EIVR,UMV,0)
      CALL TIME(TIMINT)
C
      IF(NOP.EQ.1) GO TO 9150
      WRITE(6,57) TIMINT
 9150 CONTINUE
C
C
C
```

```
      WRITE (6,28)
      WRITE (6,49) (EIVR(I),I=1,NM)
C
C
C       EVALUATION OF HEAT TRANSFER QUANTITIES AT GIVEN AXIAL POSITIONS
C       ---------------------------------------------------------------
C
C
C
  207 CONTINUE
      NROM1=NROMA+1
      NRMAX=NROMA-NRY+2
      NSIN=NOT(NRMAX,1)
C
      DO 2500 I=1,NM
      NK=I
      IF((NGE.EQ.2).OR.(NGE.EQ.3)) NK=NSS(I)
C
      NUM=NUMS(NK)
      NRO=NROW(NK)
      IF((NUM.EQ.1).AND.(NRO.EQ.NROMA)) I1=I
      IF((NUM.EQ.1).AND.(NRO.EQ.NROM1)) I2=I
      IF((NUM.EQ.2).AND.(NRO.EQ.NROM1)) I3=I
 2500 CONTINUE
      TEFA=0.25D0/(PI*VLF)
      TEFB=BETA*0.5D0/(PI*RF)
      TEFC=DLOG(RC/RF)*0.5D0/(PI*VLCL)
C
      PR=VMUF*1.26D+3/FUNLA(TCAV)
      PECL=REFU*PR
      WRITE (6,800)
      IF(NSP-1) 701,701,702
  701 WRITE(6,801)
      GO TO 703
  702 WRITE(6,802)
  703 CONTINUE
      IF (NMIMO-2) 743,744,744
  743 WRITE (6,804)
      GO TO 745
  744 WRITE (6,803)
  745 IF(NMIH-2) 747,748,748
  747 WRITE (6,806)
      GO TO 749
  748 WRITE (6,805)
  749 CONTINUE
      IF(NSP.EQ.2) GO TO 752
      IF(NCON.EQ.1) GO TO 751
      WRITE(6,849)
      GO TO 752
```

```
751 WRITE(6,850)
752 CONTINUE
    IF(NSP.EQ.2) GO TO 710
    GO TO 720
710 IF(NMIX-2) 715,716,716
715 WRITE(6,859)
    GO TO 759
716 WRITE(6,860)
    GO TO 759
720 CONTINUE
    IF (NKG.EQ.1) GO TO 750
    WRITE (6,808)
    GO TO 759
750 WRITE (6,807)
759 CONTINUE
    WRITE (6,809)
    WRITE(6,843) NROMA
    WRITE(6,844) NM
    WRITE (6,810) RF,RC,WLHEX,WSHEX,ZTOT
    WRITE (6,811) P
    WRITE (6,812) PW
    WRITE (6,813) NROT
    SHTOT=6.0D0*SH60
    WRITE (6,814) SHTOT
    WRITE (6,815) STOT
    IF(NSP.EQ.2) GO TO 730
    WRITE (6,816) Z1G,ZG,ZEG
    NUGRI=NGI-1
    WRITE (6,817) NUGRI
    GO TO 735
730 WRITE(6,861) ZG
735 CONTINUE
    WRITE (6,818) DHF
    PINBA=PIN/1.0D+5
    WRITE (6,819) DHTR,DHREC,DHAN
    WRITE (6,820) DTTR,DTREC,DTHAN
    POWMEG=POW/1.0D+6
    WRITE (6,821)
    WRITE(6,846) QLMAX
    WRITE (6,822) FMTOT,TIN,PINBA,TOU,POWMEG,QLFRAV,VX,VLF,VLCL,BETA,R
   1EX
    WRITE (6,823) HTOT,UB
    WRITE(6,845) PERCFL
    AXSHA=QLFRAV/QLMAX
    WRITE(6,847) AXSHA
    WRITE(6,851) REFU
    WRITE(6,852) PR
    WRITE(6,858) PECL
    IF((NCON.EQ.1).OR.(NSP.EQ.2)) GO TO 754
    WRITE(6,857) EHRAT
```

```
  754 CONTINUE
      IF(NMIH.EQ.1) GO TO 753
      WRITE(6,853) VTRTR
      WRITE(6,854) VANRE
      WRITE(6,855) VRETR
      IF(NGE.EQ.2) GO TO 753
      WRITE(6,856) VRERE
  753 CONTINUE
      DO 220 M=1,NM
      CA(M)=CQS(M)*HPER(M)/(PERS*FMR(M)*QFRAT)
      BL(M)=CA(M)*CONS
  220 CAIN(M)=CQS(M)*HPER(M)/(PERS*FMR(M))
      WRITE (6,824)
      WRITE (6,825) (CQS(M),M=1,NM)
      WRITE (6,826) (FMR(M),M=1,NM)
      WRITE (6,827) (UR(M),M=1,NM)
      WRITE (6,828) (CAIN(M),M=1,NM)
C
      WRITE (6,829)
C
      NO1=1
      NO2=NAX
      ZRC=0.0D0
      DO 224 I=1,NM
  224 HTC(I)=0.0D0
      PFI=PIN
      DOZR=DZR1
      IF(NSP.EQ.2) DOZR=DZR
      DO 225 NG=1,NGI
      ZR=ZRO
      NSIG=1
      DO 230 NP=NO1,NO2
C
      YR=PI/REX*(ZR+YO/ZTOT)
      SUM1=0.0D0
      SUM2=0.0D0
      DO 232 NA=1,NAT
      DNA=NA
      SUM1=SUM1+AFL(NA)*DCOS(DNA*YOF)/DNA
  232 SUM2=SUM2+AFL(NA)*DCOS(DNA*YR)/DNA
      FCZ=REX/PI*(SUM1-SUM2)+CONS*ZR
C
      SUM=0.0D0
      DO 236 NA=1,NAT
      DNA=NA
  236 SUM=SUM+AFL(NA)*DSIN(DNA*PI/REX*(ZR+ZRIN))
      CZ=SUM
      IF(NMIH-2) 227,226,226
C
  226 DO 235 I=1,NM
```

```
  235 CAZ(I)=CZ*CA(I)
C
      DO 240 I=1,NM
      SUM1=0.0D0
      DO 245 J=1,NM
      MI =(I-1)*NM+J
      VMJI=SVD(MI)
      SUM1=SUM1+UMV(I)**2*FMR(J)*VMJI*BL(J)
  245 CONTINUE
      DC(I)=SUM1
      DO 246 NA=1,NAT
      SUT(NA)=0.0D0
      DO 247 J=1,NM
      MI =(I-1)*NM+J
      VMJI=SVD(MI)
      SUT(NA)=SUT(NA)+UMV(I)**2*FMR(J)*VMJI*CA(J)*AFL(NA)
  247 CONTINUE
  246 DA(I,NA)=SUT(NA)
  240 CONTINUE
C
      CALL ERRSET(208,256,-1,1,1)
      DO 265 I=1,NM
      NIR=1
      ZS=ZRO
  244 SUM1=0.0D0
      SUM2=0.0D0
      DO 241 NA=1,NAT
      DNA=NA
      COO=DNA*PI/REX
      SUM1=SUM1+EIVR(I)/(COO*COO+EIVR(I)*EIVR(I))*DA(I,NA)*DSIN(COO*(ZS+
     1ZRIN))
  241 SUM2=SUM2+COO/(COO*COO+EIVR(I)*EIVR(I))*DA(I,NA)*DCOS(COO*(ZS+ZRIN
     1))
      IF(DABS(EIVR(I)).LT.1.0D-7) GO TO 248
      CE1=DC(I)/EIVR(I)
      GO TO 249
  248 CE1=-DC(I)*ZS
  249 CONTINUE
      IF(NIR-2) 242,243,243
  242 CE8=DEXP(EIVR(I)*(ZR-ZRO))
      CE9=HTO(I)+SUM1+SUM2+CE1
      NIR=2
      ZS=ZR
      GO TO 244
  243 CE10=CE9*CE8
      CE11=SUM1+SUM2+CE1
      HT(I)=CE10-CE11
C
  265 CONTINUE
      HFR=FCZ/QFRAT
```

```
C
      KS=1
      DO 270 I=1,NM
      K=KS
      SUM=0.0D0
      DO 275 J=1,NM
      SUM=SUM+SVD(K)*HT(J)
  275 K=K+NM
      HR(I)=SUM
  270 KS=KS+1
C
      GO TO 286
  227 DO 250 I=1,NM
      HR(I)=CA(I)*FCZ
  250 CONTINUE
      HFR=FCZ/QFRAT
      GO TO 286
  286 Z=ZR*ZTOT
      HF=HTOT*HFR+HIN
      QAVCD=CZ/QFRAT
      QAVC=QAVCD*QFAV
      PF=PFI-PFRA*Z
      PFBA=PF*1.0D-5
C
      TCOF=FUNT(HF)
C
      VMULF=FUNMU(TCOF)
C
      RHCLF=FUNRO(TCOF)
C
      DO 300 I=1,NM
      H(I)=HTOT*HR(I)+HIN
      QAV(I)=CQS(I)*QAVCD
      IF(HFR) 302,302,303
  302 RATHR(I)=CAIN(I)
      GO TO 304
  303 RATHR(I)=HR(I)/HFR
  304 CONTINUE
C
      HC=H(I)
C
      TCO(I)=FUNT(HC)
C
      TCS=TCO(I)
C
      RHOL=FUNRO(TCS)
C
      VMUL=FUNMU(TCS)
C
      REL(I)=FMCS*FMR(I)*DH(I)/(VMUL*S(I))
```

```
C
      VLABL=FUNLA(TCS)
C
      SPECHL=1.26D+3
C
      VPR=VMUL*SPECHL/VLABL
C
      ALFA=(7.0D0+0.025*(REL(I)*VPR)**0.800)*VLABL/DH(I)
C
      TCL(I)=TCS+QAV(I)/ALFA*QFAV
C
  300 CONTINUE
C
C
      TCLAD=(TCL(I1)+TCL(I2)+TCL(I3))/3.0D0
      WRITE (6,830) ZR,Z
      QLRM=CZ*QLMAX*QFRO/QFRMA
      TFC=TCLAD+QLRM*(TEFA+TEFB+TEFC)
      WRITE (6,831) HFR,    QAVCD,QAVC,TFC
      WRITE(6,848) QLRM
      WRITE (6,832) PFBA,TCOF
      WRITE (6,833)
      WRITE (6,834) (HR(I),I=1,NM)
      WRITE (6,836) (RATHR(I),I=1,NM)
      WRITE (6,837) (QAV(I),I=1,NM)
      WRITE (6,838) (TCO(I),I=1,NM)
      WRITE (6,839) (TCL(I),I=1,NM)
      WRITE (6,840) (REL(I),I=1,NM)
      IF((ZR.EQ.0.0D0).OR.(NGE.GT.1)) GO TO 485
      SUM=0.0D0
      DO 480 I=1,NM
  480 SUM=SUM+FMR(I)*HR(I)/HFR
      WRITE(6,50) SUM
  485 CONTINUE
  230 ZR=ZR+DOZR
      IF(NGI-NG-1) 360,360,365
  365 DOZR=DZR
      GO TO 370
  360 DOZR=DZRE
  370 NO1=NO2+1
      NO2=NO2+NAX
C
      IF(NG-1) 371,371,372
  371 ZRC=ZRO+ZR1G
      GO TO 373
  372 ZRC=ZRO+ZRG
  373 CONTINUE
C     EVALUATION GRID MIXING
C     GRIMI=GAM(I,J) IN PAPER
      GRIMI=GAMMA*FMCS/NSTOT
```

```
      IF(NKG-2) 380,375,375
  380 DO 390 I=1,NM
  390 HTC(I)=HT(I)
      GO TO 400
  375 DO 395 I=1,NM
  395 HRS(I)=HR(I)
      DO 399 I=1,NM
      NERT=NER(I)
      SUM=HRS(I)
      DO 397 L=1,NERT
      J=NIS(I,L)
  397 SUM=SUM+GRIMI/(FMR(I)*FMCS)*(HRS(J)-HRS(I))
  399 HR(I)=SUM
C     NOW HR(I) BEHIND GRID IS KNOWN
      IF(NMIH.EQ.1) GO TO 400
      DO 420 I=1,NM
      SUM=0.0D0
      DO 425 J=1,NM
      MI=(I-1)*NM+J
      VMJI=SVD(MI)
  425 SUM=SUM+UMV(I)**2*FMR(J)*VMJI*HR(J)
  420 HTC(I)=SUM
  400 DPGRID=DPGA
C     CAN ALSO BE REPLACED BY LOCAL RELATION
      PFI=PFI-DPGRID
  225 CONTINUE
C
C
C
      KSIG=KSIG+1
      NCA=NCA-1
      IF(NCA-1) 2000,4000,4000
C
C     *FORMAT STATEMENTS
    1 FORMAT('1',38X,'INPUT DATA'//)
    2 FORMAT ('0',5X,'K=',1I10,'I=',1I10,'SUM1=',1D20.12)
    3 FORMAT('0',5X,'NOP=',1I5,'NCA=',1I5///)
    4 FORMAT ('0',25X,'I=',1I15/(5X,4D24.12)/)
    5 FORMAT(9I5)
    6 FORMAT('0', 5X,'NGE=',1I5,'NSP=',1I5,'NFLOW=',1I5,'NMIMO=',1I5,'NM
     1IH=',1I5,'NCON=',1I5,'NKG=',1I5,'NMIX=',1I5///)
    7 FORMAT (7D10.6)
    8 FORMAT(' ',5X,'NROMA=',1I5,'NRY=',1I5,'P=',1D15.8,'PW=',1D15.8,'RF
     1=',1D15.8,'RC=',1D15.8///)
    9 FORMAT(' ',5X,'ZUN=',1D15.8,'ZTOT=',1D15.8,'Y01=',1D15.8,'Y02=',1D
     115.8,'ZIG=',1D15.3,'ZG=',1D15.8///)
   10 FORMAT(' ',5X,'ZTOT=',1D15.8,'Y01=',1D15.8,'Y02=',1D15.8,'ZG=',1D1
     15.8///)
   11 FORMAT(' ',5X,'FMTOT=',1D15.8///)
   12 FORMAT(' ',5X,'DELTC=',1D15.8///)
```

```
13 FORMAT(' ',5X,'CFR=',1D15.8,'EXF=',1D15.8,'CG1=',1D15.8,'CG2=',1D1
  15.8,'CG3=',1D15.8,'CEF=',1D15.8/6X,'GAMMA=',1D15.8///)
14 FORMAT(' ', 5X,'CFR=',1D15.8,' EXF=',1D15.8,'CMIX1=',1D15.8,'CMIX2=
  1',1D15.8///)
15 FORMAT(' ',5X,'VLF=',1D15.8,'VLCL=',1D15.8,'BETA=',1D15.8///)
16 FORMAT (' ',5X,'NAX=',1I10,'NAT=',1I10///,6X,'VALUES OF ZI(NA)'/1X
  1,(4X,8D12.5/)//)
17 FORMAT(' ',5X,'TIN=',1D15.8,'PIN=',1D15.8,'QLMAX=',1D15.8///)
18 FORMAT('0',15X,'FMTOT=',1D15.8,10X,'QLMAX=',1D15.8//)
19 FORMAT ('0',5X,'VX=',1D12.5,'RO=',1D12.5,'RATA=',1D12.5///)
20 FORMAT(' ',5X,'CONS=',1D15.8,'QFRO=',1D15.8,5X,'QFRMA=',1D15.8,5X/
  16X,'QFRZ VALUES ARE'/1X,(5X,9D12.5)////)
21 FORMAT ('0',2X,5I10//)
22 FORMAT ('1',20X,'SIGNAL CKG MAY NOT EXCEED 1'////)
23 FORMAT ('0',5X,'CEF=',1D15.8,5X,'EHRAT=EH/EI=',1D15.8//)
25 FORMAT ('0',10X,'EIGEN VALUE HAS IMAGINARY PART'//)
26 FORMAT ('1',35X,'ELEMENTS AM(I,J) OF COEFFICIENT MATRIX',//)
27 FORMAT (1H0,5D24.12)
28 FORMAT ('0',5X,//,35X,'EIGEN VALUES OF COEFFICIENT MATRIX',//)
29 FORMAT (' ',40X,D20.12)
30 FORMAT ('1',5X,//,35X,'EIGEN VECTORS'//)
31 FORMAT (' ',10X,'J=',I3/(1X,5D20.12)/)
32 FORMAT('1',5X,///28X,'GEOMETRY DATA'//)
33 FORMAT('0',5X///,19X,'AXIAL DISTRIBUTION OF NORMALIZED FLUXES'//)
34 FORMAT('0',5X///19X,'VARIOUS PARAMETERS RELATED TO HEAT GENERATION
  1'//)
35 FORMAT('0',5X,///10X,'BULK CHARACTERISTICS AND PHYSICAL PROPERTIES
  1OF COOLANT'//)
36 FORMAT('0',5X,///30X,'INDEXING OF SUBCHANNELS'//)
37 FORMAT('0',5X///10X,'PERIMETERS,SECTIONS AND HYDRAULIC DIAMETERS
  1OF SUBCHANNELS'//)
38 FORMAT('0',5X///1X,'ANGLES AND SINUS TERMS INVOLVED IN TURBULENT
  1SUBCHANNEL INTERACTIONS'//)
39 FORMAT ('0',20X,'RESULTS FOR ZERO INTERSUBCHANNEL MIXING'//)
40 FORMAT ('0',10X,'PRESSURE GRADIENT - DP/DZ=',1D20.8//)
41 FORMAT ('0',20X,'SUBCH. MASS FLOW RATES RELATIVE TO CHAR. SECTION
  1MASS FLOW RATE'/(10X,4D24.12)/)
42 FORMAT ('0',20X,'SUBCH. BULK VELOCITY RELATIVE TO FUEL ELEMENT BUL
  1K VELOCITY'/(10X,4D24.12)/)
43 FORMAT ('0',40X,'VALUES OF X(IE)'/(5X,9D12.6//))
44 FORMAT ('0',40X,'RESULTS FOR CASE OF INTERSUBCHANNEL MOMENTUM TRAN
  1SPORT'//)
45 FORMAT('0',20X,'FRICTION FACTORS IN SUBCHANNELS'/(10X,4D24.12)/)
46 FORMAT('1',15X,'COEFFICIENTS FOR INTERSUBCHANNEL MIXING OF HEAT'/)
47 FORMAT('0',15X,'I=',1I15/5X(2X,6D15.8)/)
48 FORMAT('0',20X,'FRICTIONAL PRESSURE GRADIENTS IN SUBCHANNELS'/(10X
  1,4D24.12)/)
49 FORMAT('0',5X,(2X,8D14.6)/)
50 FORMAT(' ',25X,'ENTHALPY CONTROL SUM=',1D15.8)
51 FORMAT ('1',5X,'NO1=',1I10,'NO2=',1I10,///)
```

```
52 FORMAT('0',2X,(2X,10I10))
53 FORMAT('0',5X,///21X,'SUBCHANNEL INTERACTION TERMS FSF1 ETC'//)
55 FORMAT('0',20X,'PRESSURE DROP ACROSS GRIDS FOR SUBCHANNELS'/( 10X,4
   1D24.12)/)
56 FORMAT('0',5X,///10X'GEOMETRY,FLOW AND HEATINPUT SUBCHANNEL DATA'/
   1/)
57 FORMAT('0',5X,'TIME FOR SOLVING EIGENVALUE PROBLEM IS',1D12.5,'SEC
   1ONDS'//)
800 FORMAT ('1',20X,'N I J S I N G - E I F L E R   H E A T T R A N S F
   1E R   E U R A T O M   I S P R A',//// 50X,' H E R A - 1A ',/50X '
   2-----------',                                 ////47X,'SITUATION CON
   3SIDERED',//)
801 FORMAT('0',37X,'*** GRID SPACERS'/)
802 FORMAT('0',37X,'*** HELICAL SPACERS'/)
803 FORMAT ('0',37X,'*** INTERSUBCHANNEL MIXING OF COOLANT MOMENTUM'/)
804 FORMAT ('0',37X,'*** NO INTERSUBCHANNEL MIXING OF COOLANT MOMENTUM
   1'/)
805 FORMAT ('0',37X,'*** INTERSUBCHANNEL MIXING OF COOLANT ENTHALPY'/)
806 FORMAT ('0',37X,'*** NO INTERSUBCHANNEL MIXING OF COOLANT ENTHALPY
   1'/)
807 FORMAT ('0',37X,'*** NO COOLANT ENTHALPY MIXING AT GRIDS'/)
808 FORMAT ('0',37X,'*** COOLANT ENTHALPY MIXING AT GRIDS'/)
809 FORMAT ('1',///54X,'GEOMETRY PARAMETERS',/55X,'------------------
   1',/)
810 FORMAT (' ',14X,'FUEL RADIUS=',50X,-2P1D12.5,' M',//15X,'OUTER CLA
   1DDING RADIUS=',40X,-2P1D12.5,'M',//15X,'LENGTH HEXAGONON DIAGONAL=
   2',36X,-1P1D12.5,'M'//15X,'WIDTH OF HEXAGONON IS',41X,-1PD12.5,'M'/
   3/15X'TOTAL HEATED LENGTH=',42X,1P1D12.5,' M'/)
811 FORMAT (' ',14X,'DIMENSIONLESS ROD SPACING=',36X,1P1D12.5/)
812 FORMAT (' ',14X,'DIMENSIONLESS ROD-WALL SPACING=',31X,1P1D12.5/)
813 FORMAT (' ',14X,'TOTAL NUMBER OF RODS IN HEXAGONON=',21X,1I10/)
814 FORMAT (' ',14X,'TOTAL SECTION OF HEXAGONON=',35X,-2P1D12.5,'SQ.M'
   1/)
815 FORMAT (' ',14X,'TOTAL COOLANT SECTION OF HEXAGONON=',27X,-2P1D12.
   15,'SQ.M'/)
816 FORMAT (' ',14X,'AXIAL DISTANCE BETWEEN BEGINNING OF FUEL AND FIRS
   1T GRID=',1D18.5,'M'//15X,'AXIAL DISTANCE INTERVAL BETWEEN 2 GRIDS=
   2',1D34.5,' M'//15X,'AXIAL DISTANCE BETWEEN LAST GRID AND END OF FU
   3EL=',1D25.5,' M'/)
817 FORMAT (' ',14X,'NUMBER OF GRIDS IN HEATED PART OF FUEL ELEMENT=',
   11I17/)
818 FORMAT (' ',14X,'HYDRAULIC DIAMETER OF FUEL ELEMENT=',27X,-1P1D12.
   15,' M'/)
819 FORMAT (' ',14X,'HYDR.DIAMETERS OF TRIANGULAR,RECTANGULAR AND ANGU
   1LAR'/15X,'SUBCHANNELS ARE',47X,-1P2D12.5,'AND',-1P1D12.5,'RESPECTI
   2VELY'/)
820 FORMAT (' ',14X,'THERMAL DIAMETERS OF TRIANGULAR, RECTANGULAR AND
   1ANGULAR'/15X,'SUBCHANNELS ARE',47X,-1P2D12.5,'AND',-1P1D12.5,'RESP
   2ECTIVELY'/)
821 FORMAT ('1'///40X,'HYDRODYNAMIC AND THERMAL PARAMETERS'/40X,'-----
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```
    1-------------------------------'//)
822 FORMAT (' ',14X,'COOLANT MASS FLOW RATE IN FUEL ELEMENT=',2P1D36.5
    1,'KG/SEC'//15X,'COOLANT INLET TEMPERATURE=',3P1D50.5,'DEGR.C'//15X
    2,'COOLANT INLET PRESSURE =',3P1D51.4,'BAR'//15X,'BULK COOLANT OUTL
    3ET TEMPERATURE=',3P1D44.5,'DEGR.C'
    4              //15X,'FUEL ELEMENT POWER=',1P1D55.5,'MEGAWAT
    5T'//15X,'LINEAR POWER OF ROD MAX.RATING=',1P1D43.5,'W/M'//15X,'AMP
    6LITUDE OF LATERAL HEATGENERATION=',0P1D38.5//,15X'CONDUCTIVITIES O
    7F FUEL AND CLADDING ARE',1P1D35.5,2P1D12.5,'W/M DEG.C'//15X'FUEL-C
    8LADDING CONTACT RESISTANCE=',1P1D41.5,'SQ.M*DEG.C/W'//15X'RATIO EX
    9TRAPOLATION LENGTH TO HEATED LENGTH=',1P1D30.5/)
823 FORMAT (' ',14X,                        'BULK ENTHALPY RISE OF
    1COOLANT=',1P1D44.5,'J/KG'//15X,'BULK COOLANT VELOCITY IN FUEL ELEM
    2ENT      =',1P1D30.5,' M/SEC'//)
824 FORMAT ('1'///50X,'SUBCHANNEL QUANTITIES'/50X,'---------------------
    1--',/31X,'1',11X,'2',11X,'3',11X,'4',11X,'5',11X,'6',11X,'7',11X,
    2'8'//)
825 FORMAT (' ',1X'REDUCED AV. HEAT FLUXES',1X,8D12.5//(26X,8D12.5)//)
826 FORMAT (' ',1X'REDUCED MASS FLOWRATES',2X,8D12.5//(26X,8D12.5)//)
827 FORMAT (' ',1X,'REDUCED BULK VELOCITIES',1X,8D12.5//(26X,8D12.5)//
    1)
828 FORMAT (' ',1X,'REDUCED SUBCH. HEATINPUT',8D12.5//(26X,8D12.5)//)
829 FORMAT ('1',2X,///50X,'N O M E N C L A T U R E '/50X'------------
    1----------'//25X,'SIGNIFICANCE OF SYMBOLS DENOTING THERMAL QUANTI
    2TIES RELATED TO SUBCHANNELS'////9X'HR(I)      DENOTES ENTHALPY RISE
    3 IN SUBCHANNEL I TO TOTAL ENTHALPY RISE OVER FUEL ELEMENT'///9X'H(
    4I)       DENOTES ENTHALPY IN SUBCHANNEL' ///9X'RATHR(I)  DENOTES RA
    5TIO ENTHALPY RISE IN SUBCHANNEL TO THAT IN HEXAGONON AT Z'///9X,'Q
    6AV(I)      DENOTES RATIO AV.SUBCHANNEL HEAT FLUX TO SPATIALLY AV. HE
    7AT FLUX'///9X'TCO(I)      DENOTES SUBCHANNEL COOLANT TEMPERATURE'///
    89X,'REL(I)      DENOTES SUBCHANNEL REYNOLDS NUMBER'///9X'TCL(I)     D
    9ENOTES SUBCHANNEL AV. CLADDING TEMPERATURE'/)
830 FORMAT ('1',25X,'DIMENSIONLESS AXIAL DISTANCE ZR=',1D12.6, 5X'AXIA
    1L DISTANCE Z=',1D12.6,'M'//)
831 FORMAT (' ',1X,'RATIO ENTHALPY INCREASE TO TOTAL ENTHALPY RISE IN
    1FUEL ELEMENT=',2X,D12.5/2X,
    2'RATIO CROSS SECTION AV. HEAT FLUX TO SPATIALLY AV. HEAT FLUX=',4X
    3,D12.5/2X,'AV. HEAT FLUX IN CROSS SECTION=',35X,2PD12.5,'W/SQ.M'/2
    4X'FUEL CENTRE TEMP. OF ROD WITH MAX RATING=',25X,3PD12.4,' DEG.C')
832 FORMAT (' ',1X,'PRESSURE=',57X,3PD12.4,'BAR'  / 2X,'COOLANT TEMPER
    1ATURE=',46X,3PD12.4,' DEG.C'/)
833 FORMAT ('0',15X,'1',11X,'2',11X,'3',11X,'4',11X,'5',11X,'6',11X,'7
    1',11X,'8'/)
834 FORMAT ('0',2X,'HR(I)=',3X,8D12.5 /(12X,8D12.5))
836 FORMAT ('0',2X,'RATHR(I)=',8D12.5/(12X,8D12.5))
837 FORMAT ('0',2X,'QAV(I)=',2X,8D12.5/(12X,8D12.5))
838 FORMAT ('0',2X,'TCO(I)=',2X,8D12.5/(12X,8D12.5))
839 FORMAT ('0',2X,'TCL(I)=',2X,8D12.5/(12X,8D12.5))
840 FORMAT ('0',2X,'REL(I)=',2X,8D12.5/(12X,8D12.5))
843 FORMAT(' ',14X,'NUMBER OF ROD ROWS=',40X,1I5/)
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844 FORMAT(' ',14X,'NUMBER OF SUBCHANNELS=',38X,1I5/)
845 FORMAT(' ',14X,'FRACTION OF FLOW IN OUTER SUBCHANNELS=',24X,1D12.5
   1/)
846 FORMAT(' ',14X,'MAX. LINEAL POWER OF ROD WITH MAX. RATING=',20X,3P
   1D12.3,'W/M'/)
847 FORMAT(' ',14X,'AXIAL FLUX SHAPE FACTOR=',38X,1D12.5/)
848 FORMAT(' ',1X,'LINEAL POWER OF ROD WITH MAX. RATING=',28X,3PD12.3,
   1'W/M')
849 FORMAT('0',37X,'*** CONDUCTION CONTRIBUTES TO INTERSUBCHANNEL HEAT
   1TRANSPORT'/)
850 FORMAT('0',37X,'*** NO CONTRIBUTION OF CONDUCTION TO INTERSUBCHANN
   1EL HEAT TRANSPORT'/)
851 FORMAT(' ',14X,'FUEL ELEMENT REYNOLDS NUMBER=',33X,5P1D12.1/)
852 FORMAT(' ',14X,'PRANDTL NUMBER=',48X,-2P1D12.6/)
853 FORMAT(' ',14X,'COEFFICIENT FOR MIXING BETWEEN 2 TRIANG. SUBCHANNE
   1LS=',9X,1D12.5/)
854 FORMAT(' ',14X,'COEFFICIENT FOR MIXING BETWEEN ANGULAR AND RECT. S
   1UBCHANNEL=',2X,1D12.5/)
855 FORMAT(' ',14X,'COEFFICIENT FOR MIXING BETWEEN RECT. AND TRIANG. S
   1UBCHANNEL=',2X,1D12.5/)
856 FORMAT(' ',14X,'COEFFICIENT FOR MIXING BETWEEN 2 RECTANGULAR SUBCH
   1ANNELS=',5X,1D12.5/)
857 FORMAT(' ',14X,'RATIO TURBULENT DIFFUSIVITY FOR HEAT TO THAT FOR
   1MOMENTUM =',2X,1D12.5/)
858 FORMAT(' ',14X,'FUEL ELEMENT PECLET   NUMBER=',33X,5P1D12.1/)
859 FORMAT('0',37X,'*** MIXING DATA SPECIFIED AS INPUT'/)
860 FORMAT('0',37X,'*** MIXING COEFFICIENTS CALCULATED IN PROGRAMME'/)
861 FORMAT(' ',14X,'AXIAL PITCH OF HELICAL SPACER=',1D44.5,' M'/)
C
2000 STOP
     END
```

```
      SUBROUTINE RODFLU(NOP,NROMA,P,RC,RO,VX,RATA,NUR6,NUR12,NURT,QLRO,Q
     1FRAT2)
C
C     *EVALUATES NORMALIZED FUEL ROD FLUXES(OR LINEAR POWERS) QLR(NRR,
C     NUR) AND NORMALIZED 'CROSS SECTIONALLY AVERAGED' ROD FLUX QFRAT2
C
C     ABCVE PARAMETERS ARE NORMALIZED WITH RESPECT TO ROD WITH HIGHEST
C     RATING
C
C     **SITUATION CONSIDERED
C     POWER VARIATION ALONG DIAGONAL OF HEXAGONON
C
C     *SIGNIFICANCE OF SYMBOLS
C     VX=POWER VARIATION ALONG DIAGONAL OF HEXAGONON RELATIVE TO ROD
C     WITH MAXIMUM RATING
C     RO=RADIAL DISTANCE OF ROD WITH HIGHEST RATING FROM REACTOR CORE
C     CENTRE
C     QLRO=NORMALIZED FLUX OF CENTRAL ROD
C     NRR=ROD ROW NUMBER
C     NUR=ROD NUMBER IN ROW
C     RR(NRR,NUR)=RADIAL POSITION OF ROD CENTRE
C     RATA=RATIO COEFFICIENTS B2/B1
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/RODFL1/RR(11,31)/RODFL2/QLR(11,31)
      DIMENSION NUR6(11),NUR12(11),NURT(11)
C
      PI=3.14159265359D0
C     DATA RELATED TO RADIAL POWER DISTRIBUTION
      DNROMA=NROMA
      ZL=4.0D0*P*RC*DNROMA
      ZLD=ZL/(RO+ZL)
      RDO=RO/(RO+ZL)
      B1=VX/(ZLD+RATA*(ZLD*ZLD+2.0D0*RDO*ZLD))
      B2=RATA*B1
      A0=1.0D0+B1*RDO+B2*RDO*RDO
C
C
C
      ZCN=2.0D0*P*RC
      ZCNA=ZCN*DCOS(PI/6.0D0)
      ZCNB=P*RC
      IF(NOP.EQ.1) GO TO 5000
      WRITE (6,50)
      WRITE (6,51) DNROMA,ZL,ZLD,RO,RDO
      WRITE (6,51) VX,RATA,B1,B2,A0
 5000 CONTINUE
      ZZI=RO+ZL/2.0D0-2.0D0*P*RC
      DO 1 NRR=1,NROMA
```

```
      NUR6(NRR)=1+NRR
      NUR12(NRR)=1+2*NRR
      NURT(NRR)=1+3*NRR
      NURTOT=NURT(NRR)
      ZZ=ZZI
      YY=0.0D0
      DO 2 NUR=1,NURTOT
      RR(NRR,NUR)=DSQRT(ZZ**2+YY*YY)
      RD=RR(NRR,NUR)/(RO+ZL)
      QLR(NRR,NUR)=A0-B1*RD-B2*RD*RD
      IF(NUR.GE.1 .AND. NUR.LT.NUR6(NRR)) GO TO 3
      IF(NUR.GE.NUR6(NRR) .AND. NUR.LT.NUR12(NRR)) GO TO 4
      IF(NUR.GE.NUR12(NRR) .AND. NUR.LT.NURT(NRR)) GO TO 5
    3 DYY=ZCNA
      DZZ=ZCNB
      GO TO 10
    4 DYY=0.0D0
      DZZ=ZCN
      GO TO 10
    5 DYY=-ZCNA
      DZZ=ZCNB
   10 YY=YY+DYY
      ZZ=ZZ+DZZ
    2 CONTINUE
    1 ZZI=ZZI-2.0D0*P*RC
C
      RRA=RO+ZL/2.0D0
      RD=RRA/(RO+ZL)
      QLRA=A0-B1*RD-B2*RD*RD
      QLRO=QLRA
      NR=1
      DO 15 NRR=1,NROMA
   15 NR=NR+3*NRR
      DNR=NR
      DNRTOT=DNR-0.5D0
C
      QL=QLRA/2.0D0
      DO 20 NRR=1,NROMA
      NURTOT=NURT(NRR)
      DO 25 NUR=1,NURTOT
      IF(NUR.EQ.1 .OR. NUR.EQ.NURTOT) GO TO 26
      QLA=QLR(NRR,NUR)
      GO TO 25
   26 QLA=QLR(NRR,NUR)/2.0D0
   25 QL=QL+QLA
   20 CONTINUE
C
      QFRAT2=QL/DNRTOT
      IF(NOP.EQ.1) GO TO 5010
      DO 40 NRR=1,NROMA
```

```
      NURTOT=NURT(NRR)
      WRITE (6,51) (RR(NRR,NUR),NUR=1,NURTOT)
   40 WRITE (6,51) (QLR(NRR,NUR),NUR=1,NURTOT)
      WRITE (6,51) DNRTOT,QFRAT2
 5010 CONTINUE
   50 FORMAT ('1',25X,'DATA RODFLU'//)
   51 FORMAT ('0',5X,(2X,8D12.5)/)
      RETURN
      END
```

```
      SUBROUTINE INDEX(NSEL,NROMA,NUM3,NUM6,NUM12,NUMT,NSTR,NSTOT)
C
C     *SIGNIFICANCE OF SYMBOLS
C     *PROVIDES INDICES TO SUBCHANNELS IN HEXAGONON
C     NRCMA=NUMBER OF ROD ROWS
C     NS=SUBCHANNEL INDEX
C     NUM=SUBCHANNEL INDEX PERTAINING TO ROW
C     NRC=ROD ROW INDEX
C     NSTOT=TOT. NUMBER OF SUBCHANNELS
C     NUMS(NS)=VALUE OF NUM ASS. WITH NS
C     NROW(NS)=VALUE OF NRO ASS. WITH NS
C     NOT(NRO,NUM)=VALUE OF NS ASS. WITH (NRO,NUM)
C     NSTR TOT. NUMBER OF TRIANGULAR SUBCH.
C     NUM3(NRO)=NUMBER OF SUBCH.IN 30 DEG REGION
C     NUM6(NRO)=NUMBER OF SUBCH. IN 60 DEG. REGION
C     NUM12(NRO)=NUMBER OF SUBCH. IN 120 DEG. REGION
C     NUMT(NRO)=NUMBER OF SUBCH. IN 180 DEG. REGION
C     NSEL=1 180 DEG. REGION, NSEL=2 60 DEG. REGION. NSEL=3 30 DEG.
C     REGION
C     NTYP(NS)=1 MEANS TRIANGULAR SUBCHANNEL
C     NTYP(NS)=2 MEANS RECTANGULAR SUBCHANNEL
C     NTYP(NS)=3 MEANS ANGULAR SUBCHANNEL
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/IND1/NROW(334),NUMS(334)/IND2/NOT(11,60)/IND3/NTYP(334)
      DIMENSION NUM3(11),NUM6(11),NUM12(11),NUMT(11)
C
      NS=1
      DO 1 NRO=1,NROMA
      NUMT(NRO)=6*NRO-3
      NUM3(NRO)=NRO
      NUM6(NRO)=2*NRO-1
      NUM12(NRO)=4*NRO-2
      IF(NSEL-2) 20,25,22
   25 NUMSP=NUM6(NRO)
      GO TO 30
   20 NUMSP=NUMT(NRO)
      GO TO 30
   22 NUMSP=NUM3(NRO)
   30 DO 2 NUM=1,NUMSP
      NUMS(NS)=NUM
      NROW(NS)=NRO
      NOT(NRO,NUM)=NS
      NTYP(NS)=1
    2 NS=NS+1
    1 CONTINUE
      NSTR=NS-1
      NS=NSTR+1
      NRC=NROMA+1
```

```
      NUM3(NRO) =(NROMA+1)/2+1
      NUM1=NROMA+2
      NUM2=2*NROMA+3
      NUS3=3*NROMA+4
      NUM6(NRO) =NUM1-1
      NUM12(NRO) =NUM2-1
      NUMT(NRO) =NUS3
      IF(NSEL-2) 40,45,48
   45 NUMSP=NUM6(NRO)+1
      GO TO 50
   40 NUMSP=NUMT(NRO)
      GO TO 50
   48 NUMSP=NUM3(NRO)
   50 DO 3 NUM=1,NUMSP
      IF(NUM-1) 4,4,5
    4 NTYP(NS)=3
      GO TO 10
    5 IF(NUM-NUM1) 6,4,8
    6 NTYP(NS)=2
      GO TO 10
    8 IF(NUM-NUM2) 6,4,9
    9 IF(NUM-NUS3) 6,4,6
   10 CONTINUE
      NUMS(NS)=NUM
      NRCW(NS)=NRO
      NOT(NRO,NUM)=NS
    3 NS=NS+1
      NSTOT=NS-1
      NROM1=NROMA+1
C
   60 FORMAT(' ',15X,'DATA INDEX'//)
   51 FORMAT ('0',5X,(2X,6I15)/)
      RETURN
      END
```

```
      SUBROUTINE SECDIA(NSEL,NST,NROMA,NUM6,NUM12,DHTR,DHREC,DHAN,WPTR,W
     1PREC,WPAN1,HPTR,HPREC,HPAN1,STR,SREC,SAN1,CG1,CG2,CG3)
C
C     *PROVIDES INDICES TO THE FOLLOWING SUBCHANNEL QUANTITIES
C     -SECTIONS S(I)
C     -WETTED PERIMETERS WPER(I)
C     -HEATED PERIMETERS HPER(I)
C     -HYDRAULIC DIAMETERS DH(I)
C     NSEL=1 FOR 180 DEG. REGION
C     NSEL=2 FOR 60 DEG. REGION
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/IND3/NTYP(334)/GEO1/S(334)/GEO2/DH(334),HPER(334),WPER(334)
     1,CGI(334)
      DIMENSION NUM6(11),NUM12(11)
C
C
      DO 1 NS=1,NST
      NTY=NTYP(NS)
      IF(NTY-2) 3,4,5
    3 DH(NS)=DHTR
      S(NS)=STR
      WPER(NS)=WPTR
      HPER(NS)=HPTR
      CGI(NS)=CG1
      GO TO 1
    4 DH(NS)=DHREC
      S(NS)=SREC
      WPER(NS)=WPREC
      HPER(NS)=HPREC
      CGI(NS)=CG2
      GO TO 1
    5 DH(NS)=DHAN
      S(NS)=SAN1
      WPER(NS)=WPAN1
      HPER(NS)=HPAN1
      CGI(NS)=CG3
    1 CONTINUE
C     FOR 180 REGION (NSEL=1), BEFORE RETURN
      IF(NSEL-1) 8,8,9
    8 NRO=NROMA+1
      NUM6A=NUM6(NRO)
      NUM12A=NUM12(NRO)
      NSTR=NST-3*NRO-1
      NS=NSTR+NUM6A+1
      S(NS)=2.0D0*SAN1
      HPER(NS)=2.0D0*HPAN1
      WPER(NS)=2.0D0*WPAN1
      NS=NSTR+NUM12A+1
```

```
      HPER(NS)=2.0D0*HPAN1
      WPER(NS)=2.0D0*WPAN1
      S(NS)=2.0D0*SAN1
    9 CONTINUE
   50 FORMAT ('1',15X,'DATA SECDIA'//)
   51 FORMAT ('0',5X,5I15/)
   52 FORMAT ('0',5X,(2X,6D15.8)/)
      RETURN
      END
```

```
      SUBROUTINE INAC(NSEL,NGE,NRY,NSTR,NSTOT,NROMA,NUM3,NUM6,NUM12,NUMT
     1)
C
C      *EVALUATES FOR EACH SUBCHANNEL
C      A.) NUMBER NER(I) OF INTERACTIONS WITH OTHER SUBCHANNELS
C      B.) WHICH SUBCHANNELS J INTERACT WITH SUBCHANNEL I
C      C.) THE ABOVE FOR 180 DEG. REGION(NSEL=1),60DEG. REGION(NSEL=2)
C      30 DEG. REGION (NSEL=3) AND NRY PERIPHERAL SUBCHANNELS OF HALF A
C      HEXAGONON(NGE=4,NSEL=1)
C
C      *SIGNIFICANCE OF SYMBOLS
C      NS=SUBCH. INDEX
C      NSTR=NUMBER OF TRIANGULAR SUBCH.
C      NSTOT=TOTAL NUMBER OF SUBCH.
C      NROMA=NUMBER OF ROD ROWS
C      NRO=ROD ROW INDEX
C      NUMT(NRO)=NUMBER OF SUBCH. IN 180 DEG. REGION
C      NUM12(NRO)=NUMBER OF SUBCH. IN 120 DEG. REGION
C      NUMS(NS)=VALUE OF NUM ASS. WITH NS
C      NROW(NS)=VALUE OF NRO ASS. WITH NS
C      NOT(NRO,NUM)=VALUE OF NS ASS. WITH (NRO,NUM)
C      NER(NS) SPECIFIES HOW MANY INTERSUBCH. INTERACTIONS
C     1A GIVEN SUBCH. NS HAS
C      NIS(NS,1),NIS(NS,2),NIS(NS,3)=SUBCHANNELS
C     1MS HAVING INTERACTIONS WITH SUBCH. NS
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/IND1/NROW(334),NUMS(334)/IND2/NOT(11,60)/INA/NER(334),NIS(3
     134,3)
      COMMON/IND3/NTYP(334)
      DIMENSION NUM3(11),NUM6(11),NUM12(11),NUMT(11)
C
      DO 1 NS=1,NSTOT
      NRO=NROW(NS)
      NUMA3=NUM3(NRO)
      NUMA6=NUM6(NRO)
      NUMA12=NUM12(NRO)
      NUMTA=NUMT(NRO)
      NUM=NUMS(NS)
      IF(NS-NSTR) 38,38,39
   38 IF(NUM-1) 2,2,3
    2 IF(NSEL-2) 81,80,80
   81 NER(NS)=2
      NIS(NS,1)=NS+1
      GO TO 5
   80 IF(NUMA6.EQ.1) GO TO 90
      GO TO 81
   90 NER(NS)=1
      NIS(NS,1)=NOT(2,2)
```

```
      GO TO 1
    3 IF(NSEL-2) 55,56,156
   55 NUMSP=NUMT(NRO)
      GO TO 58
   56 NUMSP=NUMA6
      GO TO 58
  156 NUMSP=NUMA3
   58 IF(NUM-NUMSP) 4,6,6
    6 NER(NS)=2
      NIS(NS,1)=NS-1
      GO TO 5
    4 NER(NS)=3
      NIS(NS,1)=NS+1
      NIS(NS,3)=NS-1
C     TEST WHETHER NUM IS PAIR OR IMPAIR
    5 IF(NUM.LE.NUMA6) NAM=NUM
      IF((NUM.GT.NUMA6).AND.(NUM.LE.NUMA12)) NAM=NUM-NUMA6
      IF((NUM.GT.NUMA12).AND.(NUM.LE.NUMTA)) NAM=NUM-NUMA12
      DNIM=DFLOAT(NAM)/2.0D0
      DNAM=NAM/2
      IF(DABS(DNIM-DNAM)-1.0D-5) 8,8,9
C     8 IS PAIR, 9 IS IMPAIR
    8 IF(NSEL-1) 60,60,10
   60 IF(NUM-NUMA6) 10,10,12
   10 NIS(NS,2)=NOT(NRO-1,NUM-1)
      GO TO 1
   12 IF(NUM-NUMA12) 14,14,16
   14 NUMA=NUM-NUMA6
      NIS(NS,2)=NOT(NRO-1,NUM6(NRO-1)+NUMA-1)
      GO TO 1
   16 NUMB=NUM-NUMA12
      NIS(NS,2)=NOT(NRO-1,NUM12(NRO-1)+NUMB-1)
      GO TO 1
    9 IF(NRO-NROMA) 17,18,18
   17 IF(NSEL-1) 62,62,20
   62 IF(NUM-NUMA6) 20,20,22
   20 NIS(NS,2)=NOT(NRO+1,NUM+1)
      GO TO 1
   22 IF(NUM-NUMA12) 24,24,26
   24 NUMA=NUM-NUMA6
      NIS(NS,2)=NOT(NRO+1,NUM6(NRO+1)+NUMA+1)
      GO TO 1
   26 NUMB=NUM-NUMA12
      NIS(NS,2)=NOT(NRO+1,NUM12(NRO+1)+NUMB+1)
      GO TO 1
   18 IF(NSEL-1) 64,64,30
   64 IF(NUM-NUMA6) 30,30,32
   30 NIS(NS,2)=NOT(NRO+1,(NUM+1)/2+1)
      GO TO 1
   32 IF(NUM-NUMA12) 34,34,36
```

```
   34 NUMA=NUM-NUMA6
      NIS(NS,2)=NOT(NRO+1,NUM6(NRO+1)+(NUMA+1)/2+1)
      GO TO 1
   36 NUMB=NUM-NUMA12
      NIS(NS,2)=NOT(NRO+1,NUM12(NRO+1)+(NUMB+1)/2+1)
      GO TO 1
C
C
   39 IF(NUM-1) 40,40,41
   40 NER(NS)=1
      NIS(NS,1)=NS+1
      GO TO 1
   41 IF(NSEL-2) 66,67,167
   66 NUMSP=NUMT(NRO)
      GO TO 68
   67 NUMSP=NUMA6+1
      GO TO 68
  167 NUMSP=NUM3(NRO)
      IF(NUM-NUMSP) 142,143,143
  142 NER(NS)=3
      NIS(NS,3)=NS+1
  144 NIS(NS,1)=NS-1
      NIS(NS,2)=NOT(NRO-1,(NUM-1)*2-1)
      GO TO 1
  143 NER(NS)=2
      GO TO 144
   68 IF(NUM-NUMSP) 42,43,43
   43 NER(NS)=1
      NIS(NS,1)=NS-1
      GO TO 1
   42 NIS(NS,1)=NS+1
      NIS(NS,2)=NS-1
      IF(NUM-NUMA6-1) 44,45,46
   44 NER(NS)=3
      NIS(NS,3)=NOT(NRO-1,(NUM-1)*2-1)
      GO TO 1
   45 NER(NS)=2
      GO TO 1
   46 IF(NUM-NUMA12-1) 47,48,49
   47 NUMA=NUM-NUMA6
      NER(NS)=3
      NIS(NS,3)=NOT(NRO-1,NUM6(NRO-1) +(NUMA-1)*2-1)
      GO TO 1
   48 NER(NS)=2
      GO TO 1
   49 NUMB=NUM-NUMA12
      NER(NS)=3
      NIS(NS,3)=NOT(NRO-1,NUM12(NRO-1) +(NUMB-1)*2-1)
    1 CONTINUE
C
```

```
      IF(NGE.EQ.4) GO TO 200
      GO TO 400
  200 NRMAX=NROMA-NRY+2
      NROM1=NROMA+1
      NSIN=NOT(NRMAX,1)
      DO 210 NS=NSIN,NSTOT
      NRO=NROW(NS)
      NUMA6=NUM6(NRO)
      NUMA12=NUM12(NRO)
      NUMTA=NUMT(NRO)
      NERT=NER(NS)
      IF(NRMAX.LT.NROM1) GO TO 220
      NTYPI=NTYP(NS)
      IF(NTYPI.EQ.3) GO TO 210
      LI=10
      NER(NS)=NERT-1
      DO 230 L=1,NERT
      MS=NIS(NS,L)
      NROJ=NROW(MS)
      IF(NROJ.LT.NRO) LI=L
  230 CONTINUE
      GO TO 240
  220 IF(NRO.GT.NRMAX) GO TO 210
      NUMI=NUMS(NS)
      IF((NUMI.GT.NUMA6).AND.(NUMI.LE.NUMA12)) NUMI=NUMI-NUMA6
      IF((NUMI.GT.NUMA12).AND.(NUMI.LE.NUMTA)) NUMI=NUMI-NUMA12
      NHALF=NUMI/2
      NEWN=NHALF*2
      IF(NEWN.EQ.NUMI) NER(NS)=NERT-1
      LI=10
      DO 250 L=1,NERT
      MS=NIS(NS,L)
      NROJ=NROW(MS)
      IF((NEWN.EQ.NUMI).AND.(NROJ.LT.NRO)) LI=L
  250 CONTINUE
  240 CONTINUE
C
      DO 260 L=1,NERT
      IF(LI.EQ.3) GO TO 260
      IF(LI.EQ.1) GO TO 265
      IF(LI.EQ.2) GO TO 270
      IF(LI.EQ.10) GO TO 260
  265 IF(L.EQ.1) GO TO 260
      GO TO 280
  270 IF((L.EQ.1).OR.(L.EQ.2)) GO TO 260
  280 LS=L-1
      NIS(NS,LS)=NIS(NS,L)
  260 CONTINUE
  210 CONTINUE
C
```

```
      NEND=NSTOT-NSIN+1
      DO 300 KS=1,NEND
      NS=KS+NSIN-1
      NROW(KS)=NROW(NS)
      NUMS(KS)=NUMS(NS)
      NTYP(KS)=NTYP(NS)
      NER(KS)=NER(NS)
      NERT=NER(NS)
      DO 310 L=1,NERT
  310 NIS(KS,L)=NIS(NS,L)-NSIN+1
  300 CONTINUE
  400 CONTINUE
C
  100 FORMAT ('0',5X,4I15/)
  110 FORMAT ('1',10X,'DATA INAC'///)
      RETURN
      END
```

```
      SUBROUTINE FIFU(NCON,P,PW,RC,FTRTR,FRECTR,FREREC,FANREC,LINT,DHF,D
     1HTR,DHREC,DHAN,PRG,VRHO,EHRAT,CEF,VA,FSF1,FSF2,FSF3,FSF4)
C
C     *EVALUATES INTERACTION TERMS FSF1,FSF2,ETC,PERTAINING TO TURBULENT
C     MOMENTUM OR HEAT INTERCHANGE BETWEEN SUBCHANNELS
C
C     **INSTRUCTIONS
C     MOMENTUM TRANSFER--NCON=1
C     HEAT TRANSFER WITHOUT CONDUCTICN --NCON=1
C     HEAT TRANSFER WITH CONDUCTION    --NCON=2
C
C     *SIGNIFICANCE OF SYMBOLS
C     FSF1=INTERACTION BETWEEN TRIANG SUBCH. AND OTHER SUBCH
C     FSF2=INTERACTION BETWEEN RECT.  SUBCH. AND TRIANG. SUBCH
C     FSF3=INTERACTION BETWEEN RECT.  SUBCH. AND RECT.OR.ANG.SUBCH.
C     FSF4=INTERACTION BETWEEN ANG.   SUBCH. AND RECT.SUBCH.
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION VL1(201)
C
      PI=3.14159265359ODO
      DINT=LINT
      LINT1=LINT+1
      NT=1
      IF(NCON-2) 1,2,2
    1 FACA=1.OD+20
      GO TO 3
    2 FACA=2.ODO*EHRAT*CEF*RC*DSQRT(PRG*DHF/(4.ODO*VRHO))
    3 DFI=FTRTR/DINT
      FAC=FACA*DSQRT(DHTR/DHF)
    4 FI=0.ODO
      DO 5 L=1,LINT1
      YO=P/DCOS(FI)-1.ODO
      VL1(L)=1.ODO/(YO*YO+VA*YO/FAC)
    5 FI=FI+DFI
      CALL INTEG(VL1,LINT,FIF,DFI)
      IF(NT-2) 10,11,11
   10 FSF1=FIF
      NT=NT+1
      FAC=FACA*DSQRT(DHREC/DHF)
      DFI=FRECTR/DINT
      GO TO 4
   11 FSF2=FIF
      NT=1
      DFI=FREREC/DINT
    8 FI=0.ODO
      DO 7 L=1,LINT1
      IF(FI.EQ.0.ODO) YO=(PW*RC-RC)/2.ODO
      IF(FI.EQ.0.ODO) GO TO 9
```

```
      GE1=PW*RC-RC/DCOS(FI)
      GE2=GE1/DTAN(FI)
      YO=(GE2+RC*DSIN(FI))*DTAN(FI/2.0D0)/(1.0D0-DSIN(FI)*DTAN(FI/2.0D0)
     1)
    9 VL1(L)=RC*RC/(YO*YO+VA*RC*YO/FAC)
    7 FI=FI+DFI
      CALL INTEG(VL1,LINT,FIF,DFI)
      IF(NT-2) 12,13,13
   12 FSF3=FIF
      NT=NT+1
      FAC=FACA*DSQRT(DHAN/DHF)
      DFI=FANREC/DINT
      GO TO 8
   13 FSF4=FIF
      IF(NCON.EQ.1) GO TO 20
      FSF1=FSF1/EHRAT
      FSF2=FSF2/EHRAT
      FSF3=FSF3/EHRAT
      FSF4=FSF4/EHRAT
   20 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE INAC2(NEX,NROMA,NUMT,NTTOT,NWTOT)
C
C     CONSIDERS SUBCH.ALONG DIAGONAL CF HEXAGONON(1-NTTOT)
C     AND(FOR NEX=1)+EXTRA ROW+2*2 SUBCH(NWTOT)
C
C     DETERMINES FOR THIS SIMPLIFIED CASE
C     A) NTTOT AND NWTOT
C     B) NUMBER OF SUBCH.INTERACTIONS NER(NW)
C     C) SUBCHANNELS NIS(NW,1),NIS(NW,2),NIS(NW,3) WHICH INTERACT
C     D) SUBCHANNEL TYPE MTYP(NW),1=TR,2=REC,3=ANG.
C     E) SUBCHANNEL NS=NSS(NW) CORRESPONDING TO NW
C
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/IND2/NOT(11,60)/IND3/MTYP(334)/INA/NER(334),NIS(334,3)/INA2
     1/NSS(334)
      DIMENSION NUMT(11)
C
      NTTOT=4*NRCMA+3
      NROM1=NROMA+1
      NM=2*NROM1
      NMH=NROM1
      NMH1=NMH+1
      NRO=NROM1+1
C
      NW=1
      DO 1 N=1,NM
      IF(N .LT.NMH) GO TO 2
      IF(N .EQ.NMH) GO TO 3
      IF(N .EQ.NMH1) GO TO 4
      IF(N .GT.NMH1) GO TO 5
    2 NRO=NRO-1
      DO 6 NUM=1,2
      NS=NOT(NRO,NUM)
      NSS(NW)=NS
    6 NW=NW+1
      GO TO 1
    3 NRO=NRO-1
      NUM=1
      NS=NOT(NRO,NUM)
      NSS(NW)=NS
      NW=NW+1
      GO TO 1
    4 NRO=NRO
    8 DO 7 NUMI=1,2
      NUM=NUMT(NRO)+NUMI-2
      NS=NOT(NRO,NUM)
      NSS(NW)=NS
    7 NW=NW+1
```

```
      GO TO 1
    5 NRO=NRO+1
      GO TO 8
    1 CONTINUE
      DO 10 NW=1,NTTOT
      IF(NW.EQ.1) GO TO 11
      IF(NW.EQ.NTTOT) GO TO 12
      IF(NW.EQ.2 .OR. NW.EQ.NTTOT-1) GO TO 13
      MTYP(NW)=1
      NER(NW)=2
      NIS(NW,1)=NW-1
      NIS(NW,2)=NW+1
      GO TO 10
   11 MTYP(NW)=3
      NER(NW)=1
      NIS(NW,1)=NW+1
      GO TO 10
   12 MTYP(NW)=3
      NER(NW)=1
      NIS(NW,1)=NW-1
      GO TO 10
   13 MTYP(NW)=2
      NER(NW)=2
      NIS(NW,1)=NW-1
      NIS(NW,2)=NW+1
   10 CONTINUE
      NWTOT=8*NROMA+6
      IF(NEX-1) 15,15,16
   15 DO 20 NW=1,NTTOT
      DNW=NW
      DNW2A=DNW/2.0D0
      NW2B=NW/2
      DNW2B=NW2B
      IF(DABS(DNW2A-DNW2B)-1.0D-5) 21,21,20
   21 NER(NW)=3
      IF(NW.EQ.2) GO TO 24
      IF(NW.EQ.NTTOT-1) GO TO 25
      NIS(NW,3)=NTTOT+NW
      GO TO 20
   24 NIS(NW,3)=NTTOT+3
      GO TO 20
   25 NIS(NW,3)=NWTOT-2
   20 CONTINUE
C
      NA=1
      NROS=NROMA+1
      NWH=NTTOT+3+(NROMA-1)*2
      NW1=NTTOT+1
      DO 30 NW=NW1,NWTOT
      IF(NW.EQ.NW1) GO TO 31
```

```
      IF(NW.EQ.NWTOT) GO TO 32
      IF(NW.EQ.NW1+1 .OR. NW.EQ.NWTOT-1) GO TO 33
      IF(NW.EQ.NW1+2) GO TO 34
      IF(NW.EQ.NWTOT-2) GO TO 35
      IF(NW.EQ.NW1+4) GO TO 36
      IF(NW.EQ.NWTOT-4) GO TO 37
      NF=NW-NTTOT
      DNF=NF
      DNF2A=DNF/2.0D0
      NF2B=NF/2
      DNF2B=NF2B
      IF(DABS(DNF2A-DNF2B)-1.0D-5) 41,41,42
   41 NER(NW)=3
      NIS(NW,1)=NW-1
      NIS(NW,2)=NW+1
      NIS(NW,3)=NW-NTTOT
      MTYP(NW)=1
      NROS=NROS-NA
      IF(NROS.GE.2 .AND. NW.LT.NWH) GO TO 61
      IF(NROS.EQ.1) GO TO 62
      IF(NROS.GE.2 .AND. NW.GT.NWH) GO TO 65
   61 NUM=3
      NRO=NROS
      GO TO 50
   62 NRO=NROS+1
      NUM=5
      GO TO 50
   65 NRO=NROS
      IF(NW.EQ.NWTOT-3) NRO=NROMA
      NUM=NUMT(NRO)-2
      GO TO 50
   42 MTYP(NW)=1
      NER(NW)=2
      NIS(NW,1)=NW-1
      NIS(NW,2)=NW+1
      IF(NROS.GE.2 .AND. NW.LE.NWH) GO TO 66
      IF(NROS.EQ.1) GO TO 63
      IF(NROS.GE.2 .AND. NW.GT.NWH) GO TO 64
   66 NRO=NROS
      NUM=4
      GO TO 50
   63 NA=0
      NROS=NROS+1
      NRO=NROS
      NUM=NUMT(NRO)-3
      GO TO 50
   64 NROS=NROS+1
      NRO=NROS
      NUM =NUMT(NRO)-3
      GO TO 50
```

```
31 MTYP(NW)=1
   NER(NW)=2
   NIS(NW,1)=NW+1
   NIS(NW,2)=NW1+4
   NUM=5
   NRO=NROMA
   GO TO 50
32 MTYP(NW)=1
   NER(NW)=2
   NIS(NW,1)=NW-1
   NIS(NW,2)=NWTOT-4
   NRO=NROMA
   NUM=NUMT(NRO)-4
   GO TO 50
33 MTYP(NW)=2
   NER(NW)=2
   NIS(NW,1)=NW-1
   NIS(NW,2)=NW+1
   IF(NW.EQ.NW1+1) GO TO 51
   IF(NW.EQ.NWTOT-1) GO TO 52
51 NRO=NROMA+1
   NUM=4
   GO TO 50
52 NRO=NROMA+1
   NUM=NUMT(NRO)-3
   GO TO 50
34 MTYP(NW)=2
   NER(NW)=3
   NIS(NW,1)=NW-1
   NIS(NW,2)=NW+1
   NIS(NW,3)=2
   NUM=3
   NRO=NROMA+1
   GO TO 50
35 MTYP(NW)=2
   NER(NW)=3
   NIS(NW,1)=NW-1
   NIS(NW,2)=NW+1
   NRO=NROMA+1
   NIS(NW,3)=NTTOT-1
   NUM=NUMT(NRO)-2
   GO TO 50
36 MTYP(NW)=1
   NER(NW)=3
   NIS(NW,1)=NW-1
   NIS(NW,2)=NW+1
   NIS(NW,3)=NW1
   NRO=NROMA
   NUM=4
   GO TO 50
```

```
   37 MTYP(NW)=1                                                       INAC1000
      NER(NW)=3                                                        INAC1005
      NIS(NW,1)=NW-1                                                   INAC1010
      NIS(NW,2)=NW+1                                                   INAC1015
      NIS(NW,3)=NWTOT                                                  INAC1020
      NRO=NROMA                                                        INAC1025
      NUM=NUMT(NRO)-3                                                  INAC1030
   50 NS=NOT(NRC,NUM)                                                  INAC1035
      NSS(NW)=NS                                                       INAC1040
   30 CONTINUE                                                         INAC1045
C                                                                      INAC1050
      NXTOT=NWTOT                                                      INAC1055
   16 CONTINUE                                                         INAC1060
  105 FORMAT ('0',5X,(2X,8I12)/)                                       INAC1065
      RETURN                                                           INAC1070
      END                                                              INAC1075
```

```
      SUBROUTINE MIFU(NSEL,NM,FSF1,FSF2,FSF3,FSF4,RC,FMCS,P,PW,CEF,VRHO)
C
C     *EVALUATES INTERSUBCHANNEL MIXING PARAMETERS VM(NS,MS) FOR TURBU-
C     LENT FLOW CONDITIONS IN ROD ASSEMBLIES WITHOUT HELICAL SPACERS
C     NSEL=2, FOR FLOW, NSEL=1 FOR HEAT TRANSFER(I.E. FOR 180 DEG. REG.)
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/MAT/VM(130,130)
      COMMON/IND3/NTYP(334)/INA/NER(334),NIS(334,3)/GEO1/S(334)/FLOW1/FM
     1R(334),FRIC(334)
C
      FS11=FSF1
      FS12=FSF1
      FS21=FSF2
      FS22=FSF3
      FS23=FSF3
      FS32=FSF4
      DO 1 NS=1,NM
      DO 1 MS=1,NM
    1 VM (NS,MS)=0.0D0
C
      DO 2 NS=1,NM
      NY1=NTYP(NS)
      NERT=NER(NS)
      DO 3 L=1,NERT
      MS=NIS(NS,L)
      NY2=NTYP(MS)
      IF(NY1-2) 5,6,7
    5 IF(NY2-2) 8,9,9
    8 FIF1=FS11*P
      FIF2=FS11*P
      GO TO 15
    9 FIF1=FS12*P
      FIF2=FS21*P
      GO TO 15
    6 IF(NY2-2) 11,12,13
   11 FIF1=FS21*P
      FIF2=FS12*P
      GO TO 15
   12 FIF1=FS22*(PW+1.0D0)*0.5D0
      FIF2=FS22*(PW+1.0D0)*0.5D0
      GO TO 15
   13 FIF1=FS23*(PW+1.0D0)*0.5D0
      FIF2=FS32*(PW+1.0D0)*0.5D0
      GO TO 15
    7 FIF1=FS32*(PW+1.0D0)*0.5D0
      FIF2=FS23*(PW+1.0D0)*0.5D0
   15 CONTINUE
      TERM1=FIF1*S(NS)/(FMR(NS)*FMCS*DSQRT(FRIC(NS)/2.0D0))
```

```
      TERM2=FIF2*S(MS)/(FMR(MS)*FMCS*DSQRT(FRIC(MS)/2.0D0))
      VM(NS,MS)=CEF*RC/((TERM1+TERM2)*VRHO)*2.0D0
      IF(NSEL-2) 16,3,3
   16 VM(NS,MS)=VM(NS,MS)*VRHO
    3 CONTINUE
    2 CONTINUE
      DO 20 NS=1,NM
      SUM=0.0D0
      DO 25 MS=1,NM
      TE=VM(NS,MS)
   25 SUM=SUM+TE
   20 VM(NS,NS)=SUM
C
   50 FORMAT ('1',15X,'DATA MIFU'//)
   51 FORMAT ('0',5X,(2X,6I15)/)
   52 FORMAT ('0',5X,6D15.8/)
      RETURN
      END
```

```
      SUBROUTINE HELMIX(NGE,NTRA,NM,VRHO,UB,CMIX1,CMIX2)
C
C     *EVALUATES INTERSUBCHANNEL MIXING COEFFICIENTS FOR HELICAL SPACERS
C**   NOTE= REQUIRES INPUT DATA FROM INAC
C     VM(I,J)=MIXING COEFFICIENT FOR BI-DIRECTIONAL TRANSPORT
C     NM=TOTAL NUMBER OF SUBCHANNELS
C     NTRA=1 MOMENTUM TRANSPORT, NTRA=2 HEAT TRANSPORT
C     CMIX1=COEFFICIENT PERTAINING TO TRANSPORT BETWEEN PERIPHERAL SUB-
C     CHANNELS
C     CMIX2=COEFFICIENT PERTAINING TO BI-DIRECTIONAL TRANSPORT
C     TAKE NGE=5 IN 30 DEG. REGION
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/MAT/VM(130,130)
      COMMON/IND1/NROW(334),NUMS(334)/INA/NER(334),NIS(334,3)/INA2/NSS(3
     134)/IND3/NTYP(334)
      COMMON/FLCW3/UR(334)
      DIMENSION NUM3(11),NUMT(11)
C
      DO 1 I=1,NM
      DO 1 J=1,NM
    1 VM(I,J)=0.0D0
C
      DO 2 I=1,NM
      NSI=I
      IF((NGE.EQ.2).OR.(NGE.EQ.3)) NSI=NSS(I)
      NRO=NROW(NSI)
      NUM30=NUM3(NRO)
      NUMTA=NUMT(NRO)
      NUMSP=NUMTA
      IF(NGE.EQ.5) NUMSP=NUM30
      NUMI=NUMS(NSI)
      NERT=NER(I)
      NTYPI=NTYP(I)
C
      SUM=0.0D0
      DO 3 L=1,NERT
      J=NIS(I,L)
      NTYPJ=NTYP(J)
      NSJ=J
      IF((NGE.EQ.2).OR.(NGE.EQ.3)) NSJ=NSS(J)
      NUMJ=NUMS(NSJ)
      IF((NTYPI.GE.2).AND.(NTYPJ.GE.2)) GO TO 4
      VM(I,J)=CMIX2*(UR(J)+UR(I))*UB/2.0D0
      IF(NTRA.EQ.2) VM(I,J)=VM(I,J)*VRHO
      TE=VM(I,J)
      GO TO 10
    4 VM(I,J)=CMIX1*(UR(J)+UR(I))*UB/2.0D0
      IF(NTRA.EQ.2) VM(I,J)=VM(I,J)*VRHO
```

```
      TE=VM(I,J)
   10 SUM=SUM+TE
    3 CONTINUE
      VM(I,I)=SUM
    2 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE TRANS(NSTOT3,NROMA,NUM3,NUM6,NUM12,NUMT)
C
C     *EVALUATES NORMALIZED FLOW RATES FMS(NUM,NRO) AND FRICTION FACTORS
C     FRICS(NUM,NRO) IN 180 DEG. REGION FROM DATA ( FMR(NS) AND FRIC(NS))
C     ALREADY AVAILABLE FOR 30 DEG. REGION
C
      IMPLICIT REAL*8(A-H,O-Z)
      COMMON/IND1/NROW(334),NUMS(334)/FLOW1/FMR(334),FRIC(334)/FLOW2/FMS
     1(60,11),FRICS(60,11)
      DIMENSION NUM3(11),NUM6(11),NUM12(11),NUMT(11)
C
      NROM1=NROMA+1
      DO 1 NS=1,NSTOT3
      NUM=NUMS(NS)
      NRO=NROW(NS)
      NUM3A=NUM3(NRO)
      NUM6A=NUM6(NRO)
      NUM12A=NUM12(NRO)
      NUMTA=NUMT(NRO)
      NUMA=NUM+NUM6A
      NUMB=NUM+NUM12A
      NUM1=NUM6A-NUM+1
      NUM2=NUM12A-NUM+1
      NUS3=NUMTA-NUM+1
      FRICS(NUM,NRO)=FRIC(NS)
      FRICS(NUMA,NRO)=FRIC(NS)
      FRICS(NUMB,NRO)=FRIC(NS)
      FMS(NUM,NRO)=FMR(NS)/6.0D0
      FMS(NUMA,NRO)=FMR(NS)/6.0D0
      FMS(NUMB,NRO)=FMR(NS)/6.0D0
      IF(NRO.EQ.NROM1) GO TO 2
      GO TO 3
    2 NUM1=NUM6A-NUM+2
      NUM2=NUM12A-NUM+2
    3 CONTINUE
      IF((NRO.EQ.NROM1).AND.(NUM.EQ.1)) GO TO 1
      FRICS(NUM1,NRO)=FRIC(NS)
      FRICS(NUM2,NRO)=FRIC(NS)
      FRICS(NUS3,NRO)=FRIC(NS)
      FMS(NUM1,NRO)=FMR(NS)/6.0D0
      FMS(NUM2,NRO)=FMR(NS)/6.0D0
      FMS(NUS3,NRO)=FMR(NS)/6.0D0
    1 CONTINUE
C
      FMS(NUM6A+1,NROM1)=2.0D0*FMS(1,NROM1)
      FMS(NUM12A+1,NROM1)=2.0D0*FMS(1,NROM1)
      FMS(NUMT(NROM1),NROM1)=FMS(1,NROM1)
      FRICS(NUMT(NROM1),NROM1)=FRICS(1,NROM1)
C
```

```
50 FORMAT ('1',15X,'DATA TRANS'//)                                TRAN 250
51 FORMAT ('0',5X,(2X,6I15)/)                                     TRAN 255
   RETURN                                                         TRAN 260
   END                                                            TRAN 265
```

```
      SUBROUTINE RODSUB(NSTOT,NSTR,NUM6,NUM12,NUMT,NUR6,NUR12,NURT,QFRAT
     12,QLRO)
C
C     *EVALUATES AVERAGE SUBCHANNEL HEAT FLUXES CQS(NS) NORMALIZED WITH
C     RESPECT TO CROSS SECTION AVERAGE HEAT FLUX
C
C     *SIGNIFICANCE OF SYMBOLS
C     NRR=ROD NUMBER IN ROW (CENTRAL ROD IS CONSIDERED SEPARATELY)
C     QLR(NRR,NUR) ROD FLUXES NORMALIZED WITH RESPECT TO ROD HAVING MAX.
C     RATING
C     NROW(NS)=SUBCHANNEL ROW NUMBER
C     NUMS(NS)=SUBCHANNEL NUMBER IN ROW
C     NUR=ROD NUMBER IN ROW
C
      IMPLICIT REAL*8 (A-H,O-Z)
      COMMON/IND1/NROW(334),NUMS(334)/RODFL2/QLR(11,31)/RODSU/CQS(334)
      DIMENSION NUM6(11),NUM12(11),NUMT(11),NUR6(11),NUR12(11),NURT(11)
C
      DO 1 NS=1,NSTOT
      NUM=NUMS(NS)
      NRO=NROW(NS)
      NUM6A=NUM6(NRO)
      NUM12A=NUM12(NRO)
      NUMTA=NUMT(NRO)
      NRR1=NRO
      NRR2=NRO-1
      IF(NS.GT.NSTR) GO TO 50
      IF(NUM.LE.NUM6A) GO TO 2
      IF(NUM.GT.NUM6A .AND. NUM.LE.NUM12A) GO TO 3
      IF(NUM.GT.NUM12A) GO TO 4
    2 NUMA=NUM
      NURS1=0
      NURS2=0
      GO TO 10
    3 NUMA=NUM-NUM6A
      NURS1=NUR6(NRR1)-1
      IF(NRR1.GT.1)   NURS2=NUR6(NRR2)-1
      IF(NRR1.EQ.1)   NURS2=0
      GO TO 10
    4 NUMA=NUM-NUM12A
      NURS1=NUR12(NRR1)-1
      IF(NRR1.GT.1)   NURS2=NUR12(NRR2)-1
      IF(NRR1.EQ.1)   NURS2=0
   10 DNUMA=NUMA
      DNUM2=DNUMA/2.0D0
      DNUM2B=NUMA/2
      IF(DABS( DNUM2-DNUM2B)-1.0D-5) 5,5,6
C     6 MEANS NUMA=IMPAIR,5MEANS  NUMA=PAIR
    6 NUR=(NUMA+1)/2+NURS1
```

```
      QL1=QLR(NRR1,NUR)
      NUR=(NUMA+3)/2+NURS1
      QL2=QLR(NRR1,NUR)
      NUR=(NUMA+1)/2+NURS2
      IF(NRR1.EQ.1)   QL3=QLRO
      IF(NRR1.GT.1)   QL3=QLR(NRR2,NUR)
      GO TO 15
    5 NUR=NUMA/2+NURS2
      IF(NRR1.EQ.1)   QL1=QLRO
      IF(NRR1.GT.1)   QL1=QLR(NRR2,NUR)
      NUR=NUMA/2+1+NURS2
      IF(NRR1.EQ.1)   QL2=QLRO
      IF(NRR1.GT.1)   QL2=QLR(NRR2,NUR)
      NUR=(NUMA+2)/2+NURS1
      QL3=QLR(NRR1,NUR)
   15 CQS(NS)=(QL1+QL2+QL3)/(3.0D0*QFRAT2)
      GO TO 1
   50 NRR=NRO-1
      IF(NUM.EQ.1) GO TO 21
      IF(NUM.EQ.NUM6A+1) GO TO 22
      IF(NUM.EQ.NUM12A+1) GO TO 23
      IF(NUM.EQ.NUMTA) GO TO 24
      IF(NUM.LE.NUM6A) GO TO 31
      IF(NUM.GT.NUM6A .AND. NUM.LE.NUM12A) GO TO 32
      IF(NUM.GT.NUM12A) GO TO 33
   31 NUMA=NUM
      NURS=0
      GO TO 35
   32 NUMA=NUM-NUM6A
      NURS=NUR6(NRR)-1
      GO TO 35
   33 NUMA=NUM-NUM12A
      NURS=NUR12(NRR)-1
   35 NUR=NUMA-1+NURS
      QL1=QLR(NRR,NUR)
      NUR=NUMA+NURS
      QL2=QLR(NRR,NUR)
      CQS(NS)=(QL1+QL2)/(2.0D0*QFRAT2)
      GO TO 1
   21 NUR=1
      GO TO 25
   22 NUR=NUR6(NRR)
      GO TO 25
   23 NUR=NUR12(NRR)
      GO TO 25
   24 NUR=NURT(NRR)
   25 CQS(NS)=QLR(NRR,NUR)/QFRAT2
    1 CONTINUE
C
  100 FORMAT ('1',15X,'DATA ROD SUB'//)
```

```
105 FORMAT ('0',5X,5I20/)
110 FORMAT ('0',5X,(2X,8D12.5)/)
    RETURN
    END
```

```
      SUBROUTINE INTEG(Z,N,S,H)
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION Z(201),W(10)
C
      IF(N) 11,10,11
   10 S=C.
      RETURN
   11 N1=N+1
      S=C.
      IF(N-7) 12,12,17
   12 GO TO (13,14,15,16,26,27,28),N
   13 S=H*.5*(Z(1)+Z(2))
      GO TO 29
   14 S=H*(Z(1)+4.*Z(2)+Z(3))/3.
      GO TO 29
   15 S=H*(Z(1)+3.*Z(2)+3.*Z(3)+Z(4))*(3./8.)
      GO TO 29
   16 N2=N1
      N3=0
      GO TO 22
   17 N3=N-(N/4)*4
      IF(N3) 22,16,18
   18 GO TO (19,20,21),N3
   19 N2=N-4
      GO TO 22
   20 N2=N-5
      GO TO 22
   21 N2=N-6
      GO TO 22
   22 DO 24 J=5,N2,4
      DO 23 K=1,5
      J5=K+J-5
   23 W(K)=Z(J5)
   24 S=S+(2./45.)*H*(7.*W(1)+32.*W(2)+12.*W(3)+32.*W(4)+7.*W(5))
      IF(N3) 29,29,25
   25 GO TO (26,27,28),N3
   26 S=S+(5./288.)*H*(19.*Z(N-4)+75.*Z(N-3)+50.*Z(N-2)+50.*Z(N-1)+75.*Z
     1(N)+19.*Z(N1))
      GO TO 29
   27 S=S+(H/140.)*(41.*Z(N-5)+216.*Z(N-4)+27.*Z(N-3)+272.*Z(N-2)+27.*Z(
     1N-1)+216.*Z(N)+41.*Z(N1))
      GO TO 29
   28 S=S+(7./17280.)*H*(751.*Z(N-6)+3577.*Z(N-5)+1323.*Z(N-4)+2989.*Z(N
     1-3)+2989.*Z(N-2)+1323.*Z(N-1)+3577.*Z(N)+751.*Z(N1))
   29 RETURN
      END
```

```
      SUBROUTINE INMAT(N)
C
C
C     MATRIX INVERSION IN PLACE
C     NOTE ORIGINAL MATRIX IS DESTROYED
C     IPIV IS ARRAY TO PREVENT DUPLICATE PIVOTINGS
C    1ON SINGLE ROWS(HAVE VALUES 0 OR 1)
C     PUTTING PIVOT ELEMENT ON DIAGONAL IMPLIES ROW INTERCHANGE(IR,IC)
C     INTERCHANGE OF ROWS IN THE INPUT MATRIX REQUIRES
C     SUBSEQUENT INTERCHANGE OF COLUMNS
C
      IMPLICIT REAL*8(A-H,O-Z)
      DIMENSION IPIV(220),IND(220,2),PIV(220)
      COMMON/MAT/ A(130,130)
      EQUIVALENCE (IR,JR),(IC,JC)
C
C     2 STATEMENTS FOR INITIALIZATION
      DO 5 J=1,N
    5 IPIV(J)=0
C
      DO 10 I=1,N
C     12 STATEMENTS FOR SEARCHING PIVOT ELEMENT
      X=0.0D0
      DO 15 J=1,N
      M=0
      IF(IPIV(J)-1) 20,15,20
   20 DO 55 K=1,N
      IF(A(J,K)) 1,2,1
    2 M=M+1
    1 IF(IPIV(K)-1) 25,55,25
   25 IF(DABS(X)-DABS(A(J,K))) 30,55,55
   30 IR=J
      IC=K
      X=A(J,K)
   55 CONTINUE
      IF(M-N) 15,4,4
   15 CONTINUE
      IPIV(IC)=IPIV(IC)+1
C     8 STATEMENTS TO BRING PIVOT ELEMENT IN DIAGONAL POSITION
      IF(IR-IC) 35,40,35
   35 DO 45 L=1,N
      X=A(IR,L)
      A(IR,L)=A(IC,L)
   45 A(IC,L)=X
   40 IND(I,1)=IR
      IND(I,2)=IC
      PIV(I)=A(IC,IC)
C
C     3 STATEMENTS FOR DIVISION OF PIVOT ROW BY PIVOT ELEMENT
```

```
      A(IC,IC)=1.0D0
      DO 50 L=1,N
   50 A(IC,L)=A(IC,L)/PIV(I)
C
C     7 STATEMENTS FOR REDUCING NON-PIVOT ROWS
      DO 10 LI=1,N
      IF(LI-IC) 60,10,60
   60 X=A(LI,IC)
      A(LI,IC)=0.0D0
      DO 65 L=1,N
   65 A(LI,L)=A(LI,L)-A(IC,L)*X
   10 CONTINUE
C
C     11 STATEMENTS FOR INTERCHANGING COLUMNS
      DO 70 I=1,N
      L=N-I+1
      IF(IND(L,1)-IND(L,2)) 75,70,75
   75 JR=IND(L,1)
      JC=IND(L,2)
      DO 80 K=1,N
      X=A(K,JR)
      A(K,JR)=A(K,JC)
      A(K,JC)=X
   80 CONTINUE
   70 CONTINUE
      RETURN
    4 WRITE (6,100)
C
  100 FORMAT ('SIGNAL','MATRIX IS SINGULAR INVERSE DOES NOT EXIST')
      STOP
      END
```

```
      SUBROUTINE EIVA(A,B,R,N,EIVR,UMV,MV)
C
C     *SCLUTION OF EIGENVALUE PROBLEM FOR CASE OF MATRIX THAT CAN BE
C     BROUGHT IN SYMMETRIC FORM A(SEE MAIN)
      DIMENSION A(1),R(1)
      DIMENSION B(1),EIVR(1)
      DIMENSION UMV(1)
      DOUBLE PRECISION A,R,ANORM,ANRMX,THR,X,Y,SINX,SINX2,COSX,COSX2,SIN
     1CS,RANGE,B,EIVR,SUMV,UMV
C
C
    5 RANGE=1.0D-12
      IF(MV-1) 10,25,10
   10 IQ=-N
      DO 20 J=1,N
      IQ=IQ+N
      DO 20 I=1,N
      IJ=IQ+I
      R(IJ)=0.0
      IF(I-J) 20,15,20
   15 R(IJ)=1.0
   20 CONTINUE
C
C
   25 ANORM=0.0
      DO 35 I=1,N
      DO 35 J=I,N
      IF(I-J) 30,35,30
   30 IA=I+(J*J-J)/2
      ANORM=ANORM+A(IA)*A(IA)
   35 CONTINUE
      IF(ANORM) 165,165,40
   40 ANORM=1.414*DSQRT(ANORM)
      ANRMX=ANORM*RANGE/FLOAT(N)
C
C
      IND=0
      THR=ANORM
   45 THR=THR/FLOAT(N)
   50 L=1
   55 M=L+1
C
C
   60 MQ=(M*M-M)/2
      LQ=(L*L-L)/2
      LM=L+MQ
   62 IF(DABS(A(LM))-THR) 130,65,65
   65 IND=1
      LL=L+LQ
```

```
      MM=M+MQ
      X=0.5*(A(LL)-A(MM))
   68 Y=-A(LM)/DSQRT(A(LM)*A(LM)+X*X)
      IF(X) 70,75,75
   70 Y=-Y
   75 SINX=Y/DSQRT(2.0*(1.0+(DSQRT(1.0-Y*Y))))
      SINX2=SINX*SINX
   78 COSX=DSQRT(1.0-SINX2)
      COSX2=COSX*COSX
      SINCS =SINX*COSX
C
C
      ILQ=N*(L-1)
      IMQ=N*(M-1)
      DO 125 I=1,N
      IQ=(I*I-I)/2
      IF(I-L) 80,115,80
   80 IF(I-M) 85,115,90
   85 IM=I+MQ
      GO TO 95
   90 IM=M+IQ
   95 IF(I-L) 100,105,105
  100 IL=I+LQ
      GO TO 110
  105 IL=L+IQ
  110 X=A(IL)*COSX-A(IM)*SINX
      A(IM)=A(IL)*SINX+A(IM)*COSX
      A(IL)=X
  115 IF(MV-1) 120,125,120
  120 ILR=ILQ+I
      IMR=IMQ+I
      X=R(ILR)*COSX-R(IMR)*SINX
      R(IMR)=R(ILR)*SINX+R(IMR)*COSX
      R(ILR)=X
  125 CONTINUE
      X=2.0*A(LM)*SINCS
      Y=A(LL)*COSX2+A(MM)*SINX2-X
      X=A(LL)*SINX2+A(MM)*COSX2+X
      A(LM)=(A(LL)-A(MM))*SINCS+A(LM)*(COSX2-SINX2)
      A(LL)=Y
      A(MM)=X
C
C
C
  130 IF(M-N) 135,140,135
  135 M=M+1
      GO TO 60
C
C
  140 IF(L-(N-1)) 145,150,145
```

```
  145 L=L+1
      GO TO 55
  150 IF(IND-1) 160,155,160
  155 IND=0
      GO TO 50
C
C
  160 IF(THR-ANRMX) 165,155,45
C
C
  165 IQ=-N
      DO 185 I=1,N
      IQ=IQ+N
      LL=I+(I*I-I)/2
      JQ=N*(I-2)
      DO 185 J=I,N
      JQ=JQ+N
      MM=J+(J*J-J)/2
      IF(A(LL)-A(MM)) 170,185,185
  170 X=A(LL)
      A(LL)=A(MM)
      A(MM)=X
      IF(MV-1) 175,185,175
  175 DO 180 K=1,N
      ILR=IQ+K
      IMR=JQ+K
      X=R(ILR)
      R(ILR)=R(IMR)
  180 R(IMR)=X
  185 CONTINUE
      L=0
      DO 200 I=1,N
      L=L+I
  200 EIVR(I)=A(L)
C     COMPUTE NORMALIZED EIGEN VECTORS
C
      L=1
      DO 250 J=1,N
      DO 250 I=1,N
      R(L)=R(L)*B(I)
      L=L+1
  250 CONTINUE
C
      L=0
      K=0
      DO 280 J=1,N
      SUMV=0.0D0
      DO 270 I=1,N
      L=L+1
  270 SUMV=SUMV+R(L)*R(L)
```

```
      SUMV=DSQRT(SUMV)
      UMV(J)=SUMV
      DO 280 I=1,N
      K=K+1
  280 R(K)=R(K)/SUMV
      RETURN
      END
```

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Alfred Nobel

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