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USER'S GUIDE FOR GAPCON-THERMAL-2: A COMPUTER PROGRAM FOR CALCULATING THE THERMAL BEHAVIOR OF AN OXIDE FUEL ROD

by

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INTRODUCTION

This report is being published as a user's manual for GAPCON-THERMAL-2 and provides a general description of the code and instructions for its use. The code is described in more detail and compared with experimental data in a companion report.[1]

The GAPCON-THERMAL-2 code was developed for the Regulatory Staff, NRC, to use as a tool in estimating fuel-cladding gap conductances and fuel stored energy and represents a modification of the GAPCON-THERMAL-1[2] code. The goal of the modifications was to reduce the uncertainties associated with calculating power history and burnup effects and yet retain a relatively flexible and fast running code for parametric studies.

SUMMARY AND CONCLUSIONS

GAPCON-THERMAL-2, a modification of GAPCON-THERMAL-1,[2] can be used to calculate the gap conductance, temperatures, pressure and stored energy in oxide fuel rods. The code is capable of calculating fuel temperatures for several coolant, cladding, and fuel material combinations. The code is also capable of following an actual irradiation history in finite time-power steps (i.e., power history). The mechanisms used to model changes in the fuel-to-cladding gap include differential thermal expansion of fuel and cladding, elastic and creep deformation of the cladding, fuel expansion created by early-in-life fuel swelling and cracking as well as late-in-life swelling induced by the build up of fission products, and fuel contraction caused by densification. In addition to the gap changes, the code simulates the effects of a variety of fill gas compositions and changes to the gas composition (and thus gap conductivity) caused by the release of fission gas and volatile impurities. The reaction of the volatile impurities with the clad is also taken into account.

GENERAL CODE DESCRIPTION

GAPCON-THERMAL-2 calculates the gap conductance, temperatures, pressures and stored thermal energy in a nuclear fuel rod. The code calculates these values for a fuel rod during its operation, following its power history. The current version uses 50 fuel radial nodes and between 1 and 20 axial fuel nodes for as many as 15 time-power steps. A simplified flow chart of the calculation sequence in the code is given in Figure 1. A listing is contained in Appendix A, and Appendix B contains a sample problem with input data and output results.

The GAPCON-THERMAL-2 code is a revised version of the GAPCON-THERMAL-1 code. The following areas of the code were modified or added to improve the thermal performance modeling capability:

- power history
- relocation
- densification
- gas generation
- gas release
- recycled UO_2-PuO_2 fuel
- volatile impurities
- gap conductance
- contact conductance
- axial thermal expansion
- dish volumes
- fuel melting
- SI units
- modular code

The code was modified to follow changes in power with time enabling the user to more realistically follow the history of a fuel rod. The user can use up to 15 time-power steps to model a particular rod power history. The irreversible phenomena of gas release and fuel relocation induced by

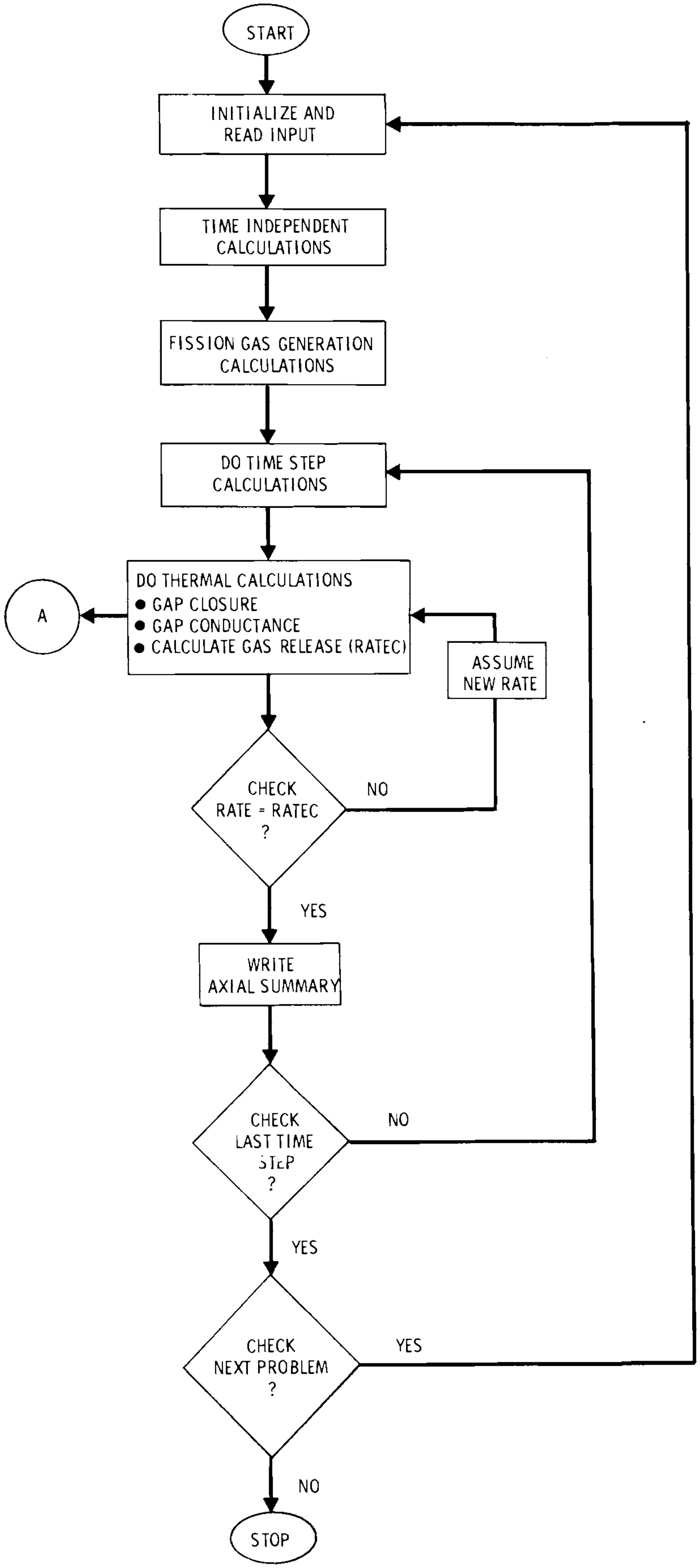

FIGURE 1. GAPCON-THERMAL-2 Flow Sheet

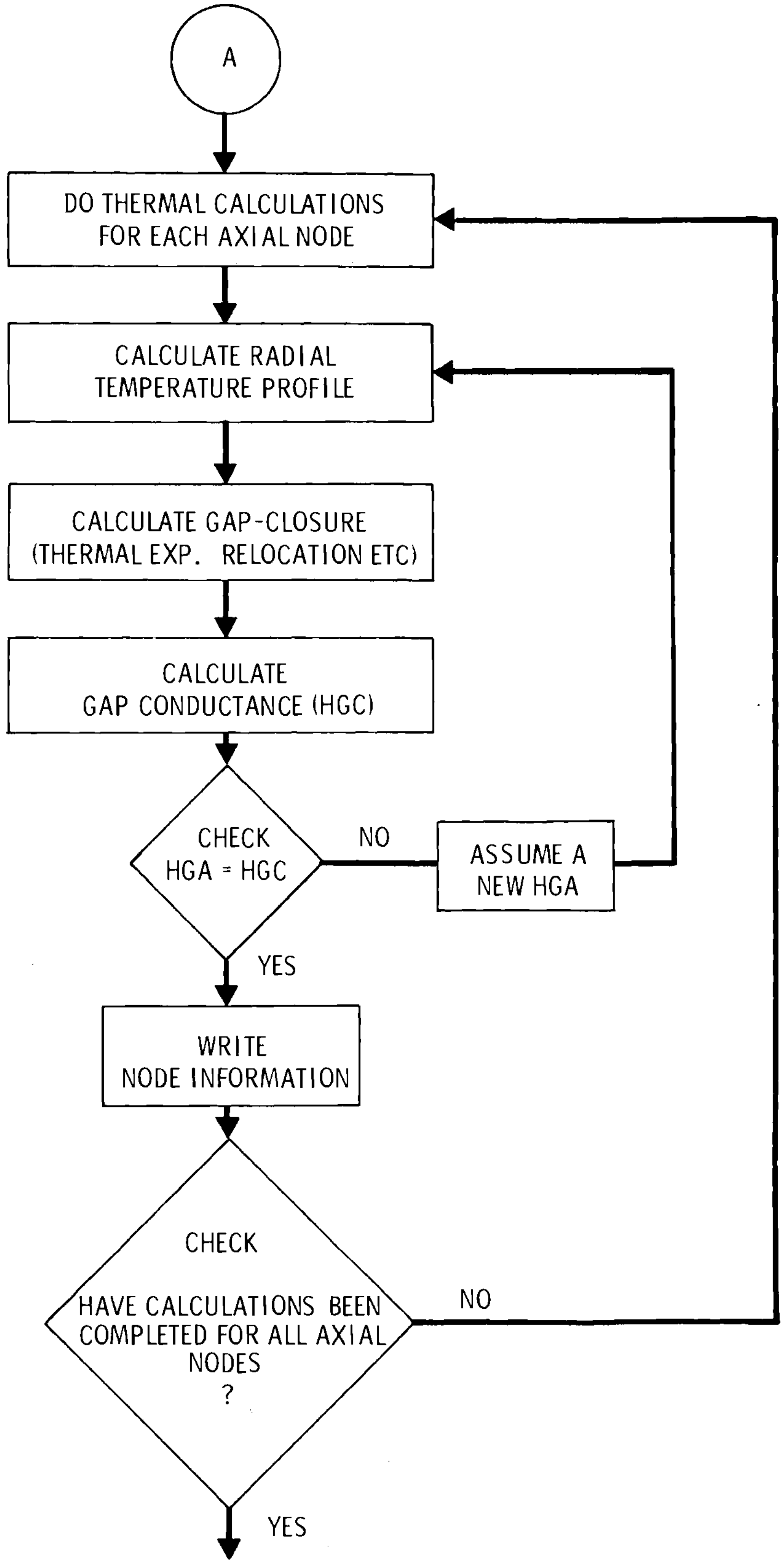

FIGURE 1a. GAPCON-THERMAL-2 Flow Sheet (Detail A)

cracking and fission product swelling required the use of path dependent algorithms. We modified a path dependent algorithm for fission gas release developed by Notley[3] and developed an algorithm for fuel relocation.

The fuel relocation model was added to the code to account for the early-in-life reduction gap size caused by athermal cracking and outward movement of the fuel. The model is based on initial cold gaps and gaps determined from postirradiation micrographs. The model includes best estimate and conservative 95% lower prediction bound equations. The Geithoff model[4] for restrained fission product swelling is retained from GAPCON-THERMAL-1 for later-in-life fuel swelling.

A fuel densification model[5] was added to the code to calculate the reduction of the fuel radius as a function of irradiation time and the fabricated density.

The model for fission gas generation was altered with a more exact solution of the differential equations allowing the ability to change the power with time. The ^{238}U (resonance absorption) $\rightarrow$ ^{239}Pu $\rightarrow$ gaseous fission product reactions were also included. The accuracy of this new model was checked against ALCHEMY,[6] a general purpose transmutation code, with very good agreement for fission gas concentrations.

A new steady-state fission gas release model[7] was added to the code. This model was correlated aginst 45 well characterized data points from the open literature. The model includes both a best estimate and a conservative upper 95% prediction equation.

The material properties of recycled mixed-oxide fuel were also added to the code. Additions of PuO_2 up to $\sim$5 wt% are currently being considered for plutonium recycled fuel. A review of small additions indicated that the effects of PuO_2 on the physical properties of UO_2 are very small and in many instances undetectable. Thermal conductivity and melting temperature data do show some differences and their equations are changed accordingly within the code.

The model for the behavior of volatile impurities was also modified. A review[8] of adsorbed gas data concluded that the release rates of these gases from oxide fuel pellets are very rapid and the reaction of oxygen, hydrogen, and water vapor occurs within a few hours while nitrogen, carbon monoxide, and carbon dioxide react within a few days. Consequently, the code provides for release of the adsorbed gases from the fuel immediately and then calculates the amount that has reacted with the cladding at any given time.

The gap conductance models were modified to be more consistent with theory and data.[9] The Lloyd model[10] was adapted for the calculation of temperature jump distance and the effective gap width (gas conductance after contact) model is based on a linear regression of the Ross and Stoute data.[11] The Mikic-Todreas model[12] for solid-solid conductance was modified to fit the data of Rapier[13] and Ross and Stoute[11] for fuel-cladding contact.

Axial thermal expansion of the fuel was added to provide a more realistic calculation of void volume in the calculation of internal pressures. The axial thermal expansion is computed for each axial segment of the fuel column using the Conway, Fincel, and Hein[14] coefficient of linear expansion.

In order to further improve the calculation of void volumes, the ability to include dished pellets was added. Dish geometry is approximated by a void in the form of a short right cylinder with the radius of the cylinder equal to the radius of the dish. Axial thermal expansion, molten fuel and fission product swelling are allowed to fill the dish volume.

The volume expansion (radial and axial) caused by fuel melting is based on a volume change of 9.6% $\frac{\Delta V}{V}$[15] for the solid-to-liquid transformation. The fuel is assumed to expand isotropically after all internal fuel voidage (i.e., porosity and dish volumes) has been filled. Also, 100% of the fission gases are released from the molten fuel.

The code's output was changed to include the international system of units (SI) as well as English units to reflect the international trend to a standard system of units.

The code also has been broken into modules in that calculational models are separated into discrete subroutines which should make it easier for the user to replace individual models as the need arises without impacting other portions of the code. The subroutine call sequence is given in Figure 2 and the following list briefly identifies each routine:

- INPT - provides the input values
- DEPRES - calculates radial flux depression
- INPOUT - writes input values
- FISSES - controls the time and power steps for the fission gas calculations
- POWDIS - calculates power for fission gas, cladding and fuel temperatures
- FISGAS - calculates the generated fission gas
- RELOC - calculates radial fuel relocation
- DENSF - calculates radial fuel densification
- RTEMP - calculates radial fuel temperature profile
- EXPAND - calculates radial fuel thermal expansion
- GASREL - calculates gas release rate
- OUTPUT - writes pertinent nodal information
- HCAP - calculates volumetric-averaged fuel heat capacity
- CARL - calculates fuel rod stored energy
- AXPRNT - writes summary of pertinent nodal information
- BLKDAT - contains the data used by the program
- HTCW - calculates water coolant film coefficient
- MOVEAA - transforms a one dimensional matrix
- MOVEKA - fills a one dimensional matrix with a constant
- TCOR - Function - calculates LWR fuel thermal conductivity
- TEPP - Function - does linear interpolation with two arrays
- TERP - Function - does linear interpolation with one array
- OMEXP - Function defined as 1 - EXP (-X)
- CORROS - calculates Zr oxide thickness from coolant reaction

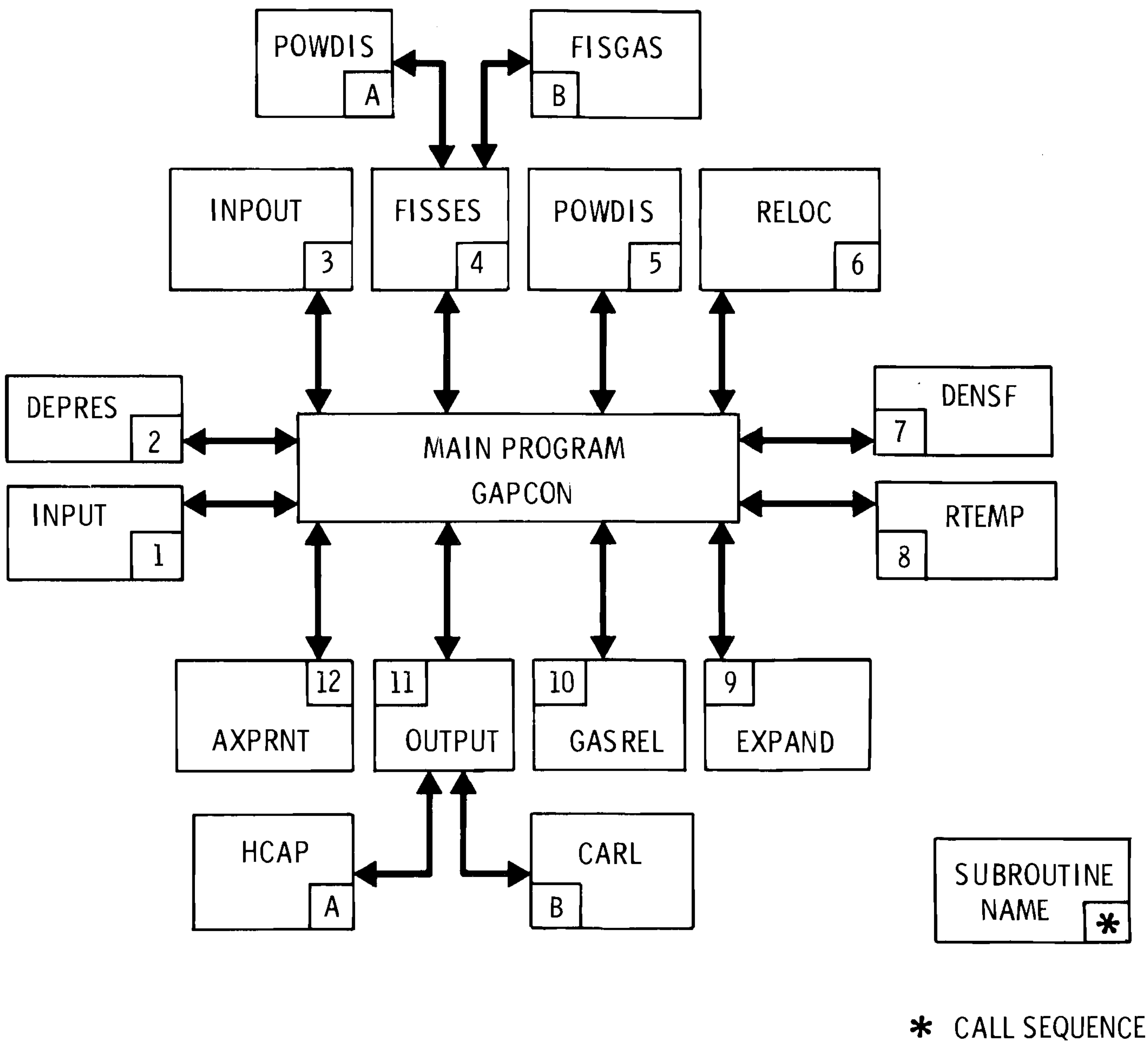

FIGURE 2. GAPCON Thermal Subroutine Flow Chart

INPUT INSTRUCTIONS

The GAPCON-THERMAL-2 code has been developed for use on the CDC 6600 CYBER system and requires approximately 65 K of addressable core storage. Run time will depend on the machine the code is used on, the number of cases input, the number of axial nodes and the number of time-steps per case; but will typically take 1 to 2 min on the CDC 6600.

GAPCON-THERMAL-2 uses a combination of formatted and namelist input. This minimizes errors in input data and simplifies running a number of consecutive cases in which the values of only a few variables change from one case to the next. The following steps are required to input data to GAPCON-THERMAL-2:

- The first card for each case contains the title (in columns 2 through 80) which will be printed at the beginning of the output. If no title is desired a blank card must be inserted.
- The next group of cards contains input data in NAMELIST form. Those variables that may be input in this manner are listed and defined in Tables 1 and 2. The first of these cards must have a dollar sign ($) in column 2 and the name INPUT in columns 3 through 7. Values for the variables are then entered as simple algebraic statements separated by commas, e.g., FRDEN = 0.92, FRSIN = 0.98, etc. Only columns 2 through 72 may be used. As many cards as required may be used but a variable name and its value must be on the same card (e.g., FRDEN = on one card followed by 0.92 on the next card is not allowed). The axial power profile, power history and accumulative time increments are all input as sets with the variable names PROFIL, PSEUDO and TIME [e.g., TIME (1) = 0, 60, 100, 200, 250, - with NTIME = 5].
- A dollar sign ($) must appear somewhere in column 2 through 72 after the last NAMELIST variable entered for each case.
- The next group of cards (optional) contains formatted input for fuel thermal conductivity values. The number of cards in this group is equal to NCON (see Table B-1). On each card, columns 1 through 10

contain a temperature (°C), columns 11 through 20 contain the thermal conductivity values (watts/cm°C), columns 11 through 20 contain the thermal conductivity values (watts/cm°C) for as-fabricated fuel associated with the respective temperatures in columns 1 through 10, and columns 21 through 30 contain the thermal conductivity values (watts/cm°C) for restructured fuel. These data can be input in either exponential or decimal format. The cards in this group must be arranged so that temperatures are in either ascending or descending order.

- The next group of cards (optional) contains formatted input for cladding properties. The number of cards in this group is equal to NCLAD (see Table B-1). On each card, columns 1 through 10 contain a temperature (°F) and the following columns contain cladding properties associated with this temperature. Columns 11 through 20 contain the thermal conductivity value (Btu/hr ft °F); columns 21 through 30 contain the yield strength value (lb/in.^{2}); columns 31 through 40 contain the modulus of elasticity value (lb/in.^{2}); columns 41 through 50 contain the Poisson's ratio; columns 51 through 60 contain the linear coefficient of thermal expansion value (per °F); and columns 61 through 70 contain the Meyer hardness number (kg/cm^2) associated with that temperature. These data can be input in either exponential or decimal format. The cards in this group must be arranged so that temperatures are in either ascending or descending order.
- The next group of cards (optional) contains formatted input for flux depression values. The number of cards in this group is equal to NFLX (see Table B-1). On each card, columns 1 through 10 contain a diameter (inches), and columns 11 through 20 contain the relative neutron flux at that diameter. These data can be input in either exponential or decimal format. The cards in this group must be arranged so that the diameters are in either ascending or descending order.

- The final group of cards (optional) contains formatted input for clad creepdown values. The number of cards in this group is equal to ICREP (see Table B-1). On each card columns 1 through 10 contain the time in days, and columns 11 through 20 the diametral change (inches) at this time. At time zero a diametral change due to elastic deflection of the clad, from the pressure differential, should be input. Also if a creepdown table is input, the option for calculating the elastic clad deflection (see ICDF in Table B-1) should not be used.

An example of input to GAPCON is shown in Appendix B, Figure B-1. The NAMELIST variables need not be input in any particular order and, in fact, it is not necessary to input values for all variables. All but six of the input variables in Table 1 are set equal to zero in the code before the user input data is read. The non-zero values are given in Table 1. Consequently, if a variable is omitted from the input data of the first case read-in, it will be zero. Additional cases added behind the first case will use the previous values entered for those variables unless otherwise changed in the input for the case in question.

TABLE 1. Alphabetical Listing of INPUT Parameters for GAPCON-THERMAL-2

ATMOS		FR35		LVOIDZ		SIGHF	
DBO		FR40		MINI		TIME	
DCI		FR41		NCLAD			
DCO		HBC		NCON		TINLET	(1,1)
DE		HGACEL		NFLX		TM	2790°C
DFS		ICDF		NFUEL		TPLAS	1200°C
DSINZ		ICREP		NOH		V	
DTEMP	100°F	IDENSF		NPOW	10	VPLENZ	
DVOIDZ		ICOR		NPRFIL	1	XCO	
EXTP		IGAS		NTIME		XH	
FRACAR		IPEAK		PRCDH		XN	
FRACH		IRELOC		*PROFIL	(1,1)	ZCLAD	
FRACHE		IRELSE				CRUDTH	
FRACKR		IRL		PSEUDO			
FRACN		ISTOR					
FRACXE		IT		RADS			
FRDEN		KB		ROUC			
FRPUO2		KOOL		ROUF			
FRSIN		LFUEL		S			

* PROFIL(1,1) = 0.23, 0.63, 0.96, 1.21, 1.35, 1.41, 1.35, 1.21, 0.96, 0.63, 0.23

NOTE: All input variables initialized to zero except as shown above.

TABLE 2. Namelist Variables for GAPCON-THERMAL-2

Variable Name	Definition and Comments
DE	Equivalent diameter of the coolant passage (inches). Ignored if SIGHF is greater than zero.
EXTP	Coolant pressure (psi).
HBC	Heat transfer coefficient between basket and cladding (Btu/hr-ft^2°F).
SIGHF	A signal to specify the type of coolant. If SIGHF < 0, coolant is water, a film coefficient will be calcualted. If SIGHF > 0, coolant is unspecified and the film coefficient will be set to SIGHF,
V	Coolant velocity (ft/sec). Ignored if SIGHF is greater than zero.
ICOR	A non-zero signal to specify cladding oxidation rates If ICOR < 3 oxidation rates for a PWR are used. If ICOR > 3 oxidation rates for a BWR are used.
CRUDTH	Thickness of crud on the cladding (inches). Crud thermal conductivity is assumed to be 0.23 Btu/hr-ft^2-°F.
TINLET	Axial coolant temperature array (°F) permits the user to input coolant temperatures at each axial node as an array. NPOW+1 values need to be input with the NPOW+1 value equal to the outlet temperature. If the user does not wish to input the axial coolant temperature array he can input the inlet temperature, TINLET(1), and DTEMP and the code will assume a linear temperature rise across the core.
DTEMP	The axial ΔT across the core, (i.e. T outlet - T inlet), note not used when TINLET array is input.
KΘΘL	If a value (integer) greater than zero is assigned to KΘΘL, the cladding I.D. temperature is the same as the coolant temperature.
NCLAD	An integer signal to specify type of cladding. If NCLAD = 0, cladding is Zircaloy. If NCLAD < 0, cladding is 304SS. If NCLAD > 0, cladding properties are input as described previously with the number of points (temperatures) input equal to NCLAD.
ZCLAD	An integer signal to specify Zr-2 or Zr-4 cladding. Material properties. If ZCLAD > 0, cladding is Zr-4 If ZCLAD < 0, cladding is ZR-2

NOTE: NCLAD must have a value of 0 to use ZCLAD.

Variable Name	Definition and Comments
ICDF	An integer signal that allows the user to include changes in the pellet-to-clad hot gap from elastic deflection of the clad due to differential internal and external pressures. If ICDF≠0, elastic clad deflection is taken into account. If ICDF=0, the option is not used. If a table of creepdown values (see ICREP) is input, this option should not be used.
ICREP	An integer signal to specify the number of cladding creepdown values to be input. If ICREP=0 it is assumed there is no time dependent cladding deformation. If ICREP>0 a table of time versus cladding creepdown values must be used. ICREP must equal the number of time values used in the table. Input format F10.0 and E10.0 (one set of values per card). (Limit of 20 values.)
DBΘ	Outside diameter of a secondary cladding or basket (inches). If DBΘ is omitted, no secondary cladding is assumed to exist.
KB	Thermal conductivity of the secondary cladding or basket (Btu/hr-ft°F).
DCI	Cladding inside diameter (inches).
DCΘ	Cladding outside diameter (inches).
DFS	Fuel pellet diameter (inches).
DSINZ	Initial diameter of restructured fuel (normally equals 0.) (inches).
DVΘIDZ	Diameter of initial central void in the fuel pellets (inches).
RΘUC	Arithmetic mean cladding ID surface roughness (inches).
RΘUF	Arithmetic mean fuel surface roughness (inches).
LFUEL	Length of fuel column (inches).
LVΘIDZ	Length of initial central void in the fuel pellets (inches).
NPΘW	Number of axial fuel segments. (limit of 20.)
FRDEN	Fractional density of the fuel pellet.
FRSIN	Fractional density of restructured fuel.
FR35	The weight fraction of the U which is ^{235}U (the remainder is assumed to be ^{238}U).

Variable Name	Definition and Comments
FR40	The weight fraction of the Pu which is ^{240}Pu.
FR41	The weight fraction of the Pu which is ^{241}Pu. The remaining fraction of Pu is assumed to be ^{239}Pu.
FRPUθ2	The weight fraction of the fuel which is PuO_2 (the remainder is assumed to be UO_2).
NFUEL	An integer signal to specify the use of recycled UO_2-PuO_2; fuel thermal conductivity and melting temperature are changed accordingly. If NFUEL = 0 the thermal conductivity equation for UO_2 is used. If NFUEL < 0 the thermal conductivity equation for recycled UO_2-PuO_2 (PuO_2 additions up to 5 wt%) is used. If NFUEL > 0, a table of thermal conductivity values must be input.
TM	Melting temperature of the fuel (°C). If no value is input the code uses 2790°C.
TPLAS	The temperature at which the fuel becomes plastic. If no value is input the code uses 1200°C.
RADS	Radius of fuel pellet dish, inches.
PRCDH	Percent of fuel column volume that is dish volume (i.e., 100 x total dish volume/total fuel column volume).

Variable	Definition and Comments
NFLX	An integer signal to specify flux depression values used. If NFLX = 0, flux depression values will be estimated in Subroutine DEPRES. NFLX should not be set to less than zero for fuel pins containing PuO_2 or for pins in which ^{235}U enrichment is greater than 4%. If NFLX < 0, it is assumed there is no flux depression. If NFLX > 0, a table of relative flux versus diameter is input as described previously with the number of points (diameters) equal to NFLX.
IRL	An integer to specify the output of flux depression values (from subroutine DEPRESS). If IRL = 0, eleven flux depression values and their respective pellet diameters will be printed out, with the first value given at the pellet centerline and the last at the pellet surface. If IRL > 0 the subroutine DEPRESS will divide the fuel pellet into IRL equal nodes and print out the flux depression values and their appropriate diameters at the midplane of each node.
ISTØR	An integer to specify the calculation of stored energy in the fuel. If ISTØR = 0 no calculation is performed. If ISTØR ≠ 0 the calculation is performed.
IRELOC	A signal that allows the user to use the fuel relocation model developed for this code. If IRELOC = 0 change in fuel diameter due to relocation is 0, (i.e., relocation is not taken into account). If IRELOC > 0 the change in fuel radius due to relocation is taken into account by a best estimate value. If IRELOC < 0 the change in fuel radius due to relocation is taken into account by a conservative estimate i.e. gives less gap closure.
IDENSF	A signal that allows the user to include the effects of radial fuel shrinkage on the fuel-to-clad gap size due to isotropic densification. The code assumes the final density of the densified fuel to be 96.5% of theoretical. If IDENSF = 0 densification is not taken into account. If IDENSF ≠ 0 the change in fuel diameter due to densification is included. Fuel with a density greater than 96.5% will not swell to 96.5% T.D.
IT	A signal that allows the user to input the duration of the irradiation as burnup, MWd/MTM. These burnup values are read through the namelist variable array TIME when It≠0. For input in days set IT = 0 and use array TIME for input

Variable	Definition and Comments
IGAS	An integer signal to designate whether conservative or best estimate calculations are desired for gas release Set IGAS = 0 for best estimate $\neq$ 0 for conservative estimate (i.e., estimate is the 95% confidence boundary and yields more gas release)
IRELSE	An integer signal to designate whether the fission gas is to be released, during the time step (normal power operation) or after the time step (which would correspond to a reactor shut down or change in power). If IRELSE = 0 the gas is released during the time step. If IRELSE $\neq$ 0 the gas is released after the time step.
ATMOS	Initial fill gas pressure (atmospheres).
FRACHE	Fraction of initial fill gas which is helium.
FRACAR	Fraction of initial fill gas which is argon.
FRACH	Fraction of initial fill gas which is hydrogen.
FRACN	Fraction of initial fill gas which is nitrogen.
FRACKR	Fraction of initial fill gas which is krypton.
FRACXE	Fraction of initial fill gas which is xenon.
S	Fuel sorbed gas content (cc/g of fuel).
XCO	Fraction of sorbed gas that is carbon monoxide and carbon dioxide.
XH	Fraction of sorbed gas that is hydrogen and moisture.
XN	Fraction of sorbed gas that is nitrogen. Note: XCO + XH + XN should = 1.0 when S>0.
NOH	An integer signal to specify disposition of the hydrogen present in the sorbed gas. If NØH = 0, the hydrogen is assumed to react with the cladding. If NØH $\neq$ 0, the hydrogen is assumed to remain in the fuel pin as a gas.

Variable Name	Definition and Comments
VPLENZ	Volume of gas plenum included in the fuel pin (cubic inches).
TIME	A set of accumulative time increments (days) that allows the user to follow a power history. NTIME values need to be input. LIMIT (15) values TIME (1) must = 0. Time (x) must be larger than previous time, time (x-1).
NTIME	Number of time increments. LIMIT (15)
PSEUDØ	Power for each time step (kW/ft) allows the user to follow a power history. NTIME values need to be input. PSEUDO (1) and PSEUDO (2) may not = 0. (See IPEAK)
IPEAK	An integer to specify whether an average or peak power is to be input via PSEUDO. If IPEAK $\neq$ 0 an average power needs to be input, if IPEAK = 0 peak power needs to be input via PSEUDO.
PRØFIL	A table that is used to input a normalized axial power profile for the pin. NPOW + 1 values for each profile needs to be input with the first and last values corresponding to the bottom and top of the fuel respectively. If more than one axial profile is to be used, then NPRFIL x (NPØW + 1) values have to be input in this table. If a power profile is not input a standard one in the code will be used.
NPRFIL	An integer signal to specify the number of axial power profiles, PROFIL, to be used for all time steps. If NPRFIL > 1, then NPRFIL = NTIME (i.e. an axial profile for each time step.
MINI	An integer signal to specify the output wanted. If MINI>0 a complete summary is given for each axial segment. If MINI=0 a complete summary is listed for the hottest segment of the pin and a short summary given for all the axial segments. MINI<0 only a short summary is given for the axial segments.

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APPENDIX A

LISTING OF GAPCON-THERMAL-2

```
      PROGRAM GAPCON (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)            GAPCON   2
C                                                                       GAPCON   3
C     GAPCON IS THE MAIN PROGRAM BASED ON GAPCON TO PERFORM FUEL PIN    GAPCON   4
C     POWER HISTORY THERMAL PERFORMANCE CALCULATIONS                    GAPCON   5
C                                                                       GAPCON   6
      COMMON /AC/ VOLCC,N1Z,N7Z,N8Z,N10Z,N9Z                            COMA     2
      REAL N1Z,N7Z,N8Z,N10Z                                             COMA     3
      COMMON/AZ/ TBAR(20),VOLTX(20),TCLINE(20),HGX(20)                  COMB     2
     + ,TAVGXX(20),RDOT(15,20),RGAPX(20),RDP(20),HFLUX(20)              COMB     3
     + ,XMOLS(21),FXMOL(7,21),PRESTO     ,SUMOLS(7)                     COMB     4
      COMMON /AF/ TITLE(20),FRUO2,    BB(2,50),PHICAP(7,7),CSUBP(7),    COMC     2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),    COMC     3
     +Q(50),QIN(50),TS(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,      COMC     4
     +NF,NFUEL,NNN                                                      COMC     5
      COMMON/AD/ JCASE,IPOW,PEAK,P,BURNUP,QOVRAB,KOUNT,G1PG2,           COMD     2
     +QOVRAS,TCOOL,TCOOLC,TBO,TBOC,TBI,TBIC,HF,TCC,TCO,TCOC,N,          COMD     3
     +TCI,TCIC,TFS,TFSC,TMF,DELR,TMELT,RCMELT,TAVGF,TAVGFC,DELRT,       COMD     4
     +DELRB,DELRCI,DELRP,PFACE,HSOLID,PSOLID,HGAS,PGAS,HRAD,PRAD,       COMD     5
     +RSIN,RVOID,RFS,TSIN,TSINC,PCSIN,DSIN,PDSIN,DVOID,PDVOID,VAVGT,    COMD     6
     +XMOTOT,GASKON,G,VAVGTC,RD,QOVRAG,LM,FNPOW,RSINF,RRVOID,QQS,QQU,   COMD     7
     +QTOT,RSINZ,RVOIDZ,T,VVOID,RMELT,GK,ISTOP,DELGD,DELPI,DELRCC,      COMD     8
     +DELRCT,DELRFT,CORR                                                COMD     9
      COMMON/PH/ PSEUDO(15),TIME(15),NTIME,PITI(20),PROFIL(15,21),      COME     2
     +SAVNKR(15,20),SAVNXE(15,20),SUMNKR(15,20),SUMNXE(15,20),CST(20),  COME     3
     +NNKR,NNXE,TVOLAV,VOLGAS,W,NPRFIL,DVBLST(20),DVN3(20),             COME     4
     +SDVN1(20),SDVN2(20),DVBX(20),DVN1(20),DVN2(20),DELVB(20)          COME     5
      REAL NNKR,NNXE                                                    COME     6
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI     2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI     3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI     4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI     5
     +,ICOF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI     6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI     7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI     8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI     9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI    10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI    11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI    12
      COMMON /AG/ PRCDH,RADS,TPLAS                                      COMF     2
      COMMON/ZZ/ TAX(25),TFX(25),CX(25),AX(25),FX(25),                  COMG     2
     +          TY(4,19),Y(4,19),F(19),CAP1,CAP7,CAP8,CAP9,CAP10,DC2,DC3, COMG   3
     +DC85I,DC85,DC21,DC22,DC23,DC26,DC28,DC31,DC33,DC34,DC35,DC25      COMG     4
C                                                                       GAPCON  15
      REAL LFTS,LFT                                                     GAPCON  16
      REAL LM,MTONFT,MTM,MREACO,MREACN                                  GAPCON  17
      DIMENSION DHVOL(20),LFT(20),LSTHIF(20)                            GAPCON  18
      DIMENSION E(7),TMA(7),TMFA(7),PHI(21)                             GAPCON  19
      DIMENSION MREACO(20),MREACN(20),TXMOLS(7)                         GAPCON  20
      DIMENSION DELGOM(15)                                              GAPCON  21
      DIMENSION DISHV(20)                                               GAPCON  22
C                                                                       GAPCON  23
C     INITIALIZE                                                        GAPCON  24
      ICASE=0                                                           GAPCON  25
      IO=0                                                              GAPCON  26
      IOSC=0                                                            GAPCON  27
      NCASE=0                                                           GAPCON  28
   10 CONTINUE                                                          GAPCON  29
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      DELPI=0.0                                                   GAPCON    30
      DELHGO=0.0                                                  GAPCON    31
      DELTAO=0.0                                                  GAPCON    32
      RATOLD=0.0                                                  GAPCON    33
      W5=0.0                                                      GAPCON    34
      W3=0.0                                                      GAPCON    35
      KOUNT=0                                                     GAPCON    36
      HGOLD=0.0                                                   GAPCON    37
      VH=0.0                                                      GAPCON    38
      HF=0.0                                                      GAPCON    39
      TBO=0.0                                                     GAPCON    40
      TBI=0.0                                                     GAPCON    41
      RATEC=0.0                                                   GAPCON    42
      TOTREL=0.0                                                  GAPCON    43
      NCASE=NCASE+1                                               GAPCON    44
      IF (XH+XN+XCO-1.) 20,30,20                                  GAPCON    45
   20 IF (S.EQ.0) GO TO 30                                        GAPCON    46
      WRITE (6,1270) XH,XN,XCO                                    GAPCON    47
      STOP                                                        GAPCON    48
   30 CONTINUE                                                    GAPCON    49
      HG=1000.                                                    GAPCON    50
      TDAYS=0.                                                    GAPCON    51
      CALL INPT                                                   GAPCON    52
C                                                                 GAPCON    53
C     BEGIN TIME INDEPENDENT CALCULATIONS                         GAPCON    54
      FNPOW=FLOAT(NPOW)                                           GAPCON    55
      NPOW1=NPOW+1                                                GAPCON    56
      PEAK=PSEUDO(1)                                              GAPCON    57
      DO 40 N=2,NTIME                                             GAPCON    58
      PEAK=AMAX1(PEAK,PSEUDO(N))                                  GAPCON    59
   40 CONTINUE                                                    GAPCON    60
      LF=LFUEL/FNPOW                                              GAPCON    61
      NCR=ICREP                                                   GAPCON    62
      NF=NFLX                                                     GAPCON    63
      FR38=1.-FR35                                                GAPCON    64
      RSINZ=DSINZ/2.                                              GAPCON    65
      RVOIDZ=DVOIDZ/2.                                            GAPCON    66
      FRUO2=1.-FRPUO2                                             GAPCON    67
      DENSIT=FRPUO2*11.46+FRUO2*10.97                             GAPCON    68
      FR39=1.-FR40-FR41                                           GAPCON    69
      IF (FRPUO2.LE.1.E-10) FR39=0.                               GAPCON    70
      GAP=DCI-DFS                                                 GAPCON    71
      RFS=DFS/2.                                                  GAPCON    72
      RCI=DCI/2.                                                  GAPCON    73
      RCO=DCO/2.                                                  GAPCON    74
      TPLAS=TPLAS*1.8+32.                                         GAP2       1
      IF (TINLET(2).NE.0) DTEMP=0.0                               GAPCON    75
      TPLENA=(TINLET(1)+DTEMP-22.)/1.8+273.                       GAPCON    76
      VVOIDZ=PI*RVOIDZ**2*LVOIDZ/FNPOW                            GAPCON    77
      VOLGAS=PI/4.*(DCI**2-DFS**2)*LF+VVOIDZ                      GAPCON    78
      RHO=DENSIT*FRDEN                                            GAPCON    79
C                                                                 GAPCON    80
C     DETERMINE FLUX DEPRESSION                                   GAPCON    81
      IF (NFLX) 50,60,70                                          GAPCON    82
   50 RV(1,1)=0.                                                  GAPCON    83
      RV(1,2)=1.                                                  GAPCON    84
      RV(2,1)=1.                                                  GAPCON    85
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      RV(2,2)=1.                                                    GAPCON  86
      NF=2                                                          GAPCON  87
      GO TO 70                                                      GAPCON  88
   60 CALL DEPRES                                                   GAPCON  89
      NF=11                                                         GAPCON  90
      IF (IRL.GT.0) NF=IRL+1                                        GAPCON  91
   70 CONTINUE                                                      GAPCON  92
      RHOS=DENSIT*FRSIN                                             GAPCON  93
      VOLUME=PI/4.*(DFS**2-DVOIDZ**2)                               GAPCON  94
      VOLCC=VOLUME*CCPIN3                                           GAPCON  95
      W=RHO*VOLCC                                                   GAPCON  96
      GRPUCC=FRPUO2*RHO                                             GAPCON  97
      GRUCC=RHO-GRPUCC                                              GAPCON  98
      UATWT=235.*FR35+238.*FR38                                     GAPCON  99
      FRUU=UATWT/(UATWT+32.)                                        GAPCON 100
      PUATWT=239.*FR39+240.*FR40+241.*FR41                          GAPCON 101
      FRPUPU=PUATWT/(PUATWT+32.0)                                   GAPCON 102
      N1Z=FR38*FRUU*AVOGAD/238.*VOLCC*GRUCC                         GAPCON 103
      N7Z=FR39*FRPUPU*AVOGAD/239.*VOLCC*GRPUCC                      GAPCON 104
      N8Z=FR40*FRPUPU*AVOGAD/240.*VOLCC*GRPUCC                      GAPCON 105
      N9Z=FR41*FRPUPU*AVOGAD/241.*VOLCC*GRPUCC                      GAPCON 106
      N10Z=FR35*FRUU*AVOGAD/235.*VOLCC*GRUCC                        GAPCON 107
      MTONFT=RHO*VOLCC*12./1.E6                                     GAPCON 108
      MTM=MTONFT*(FRUU*FRUO2+FRPUPU*FRPUO2)                         GAPCON 109
      IF (IT.EQ.0) GO TO 100                                        GAPCON 110
      BURNN=0.0                                                     GAPCON 111
      TIME(1)=0.0                                                   GAPCON 112
      DO 90 I=2,NTIME                                               GAPCON 113
      BURN=BURNN                                                    GAPCON 114
      IF (PSEUDO(I).EQ.0) GO TO 80                                  GAPCON 115
      BURNN=TIME(I)                                                 GAPCON 116
      TIME(I)=TIME(I-1)+(TIME(I)-BURN)*1000.*MTM/PSEUDO(I)          GAPCON 117
      GO TO 90                                                      GAPCON 118
   80 BURNN=BURN                                                    GAPCON 119
      TIME(I)=TIME(I-1)                                             GAPCON 120
   90 CONTINUE                                                      GAPCON 121
  100 CONTINUE                                                      GAPCON 122
C                                                                   GAPCON 123
C     DETERMINE FUEL THERMAL CONDUCTIVITY                           GAPCON 124
      IF (NFUEL) 110,130,150                                        GAPCON 125
  110 FRP=FRPUO2                                                    GAPCON 126
      IF (FRPUO2.GT..05) FRP=.05                                    GAPCON 127
      DO 120 J=1,10                                                 GAPCON 128
      TEMP=260.+277.778*(J-1)                                       GAPCON 129
      CF(1,J)=TEMP*1.8+32.                                          GAPCON 130
      CF(2,J)=(57.8*TCOR(FRDEN,TEMP))/(1.+FRP)                      GAPCON 131
      CF(3,J)=(57.8*TCOR(FRSIN,TEMP))/(1.+FRP)                      GAPCON 132
  120 CONTINUE                                                      GAPCON 133
      NNN=10                                                        GAPCON 134
      GO TO 160                                                     GAPCON 135
  130 DO 140 J=1,10                                                 GAPCON 136
      TEMP=260.+277.7778*(J-1)                                      GAPCON 137
      CF(1,J)=TEMP*1.8+32.                                          GAPCON 138
      CF(2,J)=57.8*TCOR(FRDEN,TEMP)                                 GAPCON 139
      CF(3,J)=57.8*TCOR(FRSIN,TEMP)                                 GAPCON 140
  140 CONTINUE                                                      GAPCON 141
      NNN=10                                                        GAPCON 142
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      GO TO 160
  150 NN=NFUEL
C
C     WRITE OUT THE INPUT
  160 CALL INPOUT (NPRFIL,NTIME)
      IF (NCLAD) 190,170,210
  170 DO 180 I=1,7
      DO 180 J=1,6
      AA(I,J)=ZR(I,J)
      IF (ZCLAD.GT.0) AA(I,J)=ZR4(I,J)
  180 CONTINUE
      NN=6
      GO TO 220
  190 DO 200 I=1,7
      DO 200 J=1,12
      AA(I,J)=ST(I,J)
  200 CONTINUE
      NN=12
      GO TO 220
  210 NN=NCLAD
  220 CONTINUE
      JCASE=0
C
C     DETERMINE KR AND XE PRODUCED PER INCH IN EACH NODE AT THE END
C     OF EVERY TIME STEP
      CALL FISSES
      TDAYS=0.
      DO 230 I=1,NPOW
      DISHV(I)=0.0
      SDVN1(I)=0.
      SDVN2(I)=0.
      PITI(I)=0.0
  230 CONTINUE
      VOD=PI*RADS**2
      TDHVOL=PRCDH/100.*(DFS**2-DVOIDZ**2)*PI*LFUEL/4.
      DHVOLZ=TDHVOL/FNPOW
      PRESTO=ATMOS*14.696*2
      STP=273./298.
      FILMOL=(VOLGAS*FNPOW+VPLENZ+TDHVOL)*STP*CCPIN3*ATMOS/RR
      Z1=PI*DCI*LFUEL*2.54**2
      Z2=W*S*LFUEL/RR
      ANH=XH*Z2
      ANN=XN*Z2
      ANCO=XCO*Z2
      REACT=1./((TINLET(1)+DTEMP/2)/1.8+273.)
      Z3=TEPP(REACT,RTCO,RTC,5)
      Z4=Z1/FNPOW
      DO 240 IPOW=1,NPOW
      DELGDM(IPOW)=0.
  240 LSTHIF(IPOW)=1
C
C     START TIME STEP CALC FOR ALL AXIAL NODES. (POWER HISTORY)
      DO 1240 NT=1,NTIME
      NX=NT
      RATE=.01
      IF (IRELSE.NE.0) NX=NT-1
      IF (NX.EQ.0) NX=1
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            MOL(5)=ANCO                                                 GAPCON  200
            NTT=MAX0(NT-1,1)                                            GAPCON  201
            IF (NPRFIL.EQ.1) NTT=1                                      GAPCON  202
            DO 250 NP=1,NPOW1                                           GAPCON  203
        250 POWER(NP)=PROFIL(NP,NTT)                                    GAPCON  204
            IF (IPEAK) 260,270,260                                      GAPCON  205
        260 CONTINUE                                                    GAPCON  206
            PAVRG=PSEUDO(NT)                                            GAPCON  207
            GO TO 280                                                   GAPCON  208
        270 PKPOWR=PSEUDO(NT)                                           GAPCON  209
        280 CALL POWDIS (PKPOWR,PAVRG)                                  GAPCON  210
            IF (NT.NE.1) TDAYS=TDAYS+(TIME(NT)-TIME(NT-1))              GAPCON  211
            T=TDAYS*SECDAY                                              GAPCON  212
            JCASE=JCASE+1                                               GAPCON  213
            ANKR=0.                                                     GAPCON  214
            ANXE=0.                                                     GAPCON  215
            DO 290 IPOW=1,NPOW                                          GAPCON  216
            ANKR=ANKR+SAVNKR(NX,IPOW)                                   GAPCON  217
            ANXE=ANXE+SAVNXE(NX,IPOW)                                   GAPCON  218
        290 CONTINUE                                                    GAPCON  219
      C                                                                 GAPCON  220
      C     SETUP PLENUM MOLE CONTENT.                                  GAPCON  221
            XMOLS(NPOW1)=VPLENZ*CCPIN3*ATMOS/RR                         GAPCON  222
            FRACTN(1)=FRACHE                                            GAPCON  223
            FRACTN(2)=FRACAR                                            GAPCON  224
            FRACTN(3)=FRACH                                             GAPCON  225
            FRACTN(4)=FRACN                                             GAPCON  226
            FRACTN(5)=0.0                                               GAPCON  227
            FRACTN(6)=FRACKR                                            GAPCON  228
            FRACTN(7)=FRACXE                                            GAPCON  229
            CALL MOVEAA (FRACTN,FXMOL(1,NPOW1),7)                       GAPCON  230
            LFTS=0                                                      GAPCON  231
            DELRFT=0.                                                   GAPCON  232
            TAVGX=0.                                                    GAPCON  233
            VOLTXS=0.                                                   GAPCON  234
            ACELL=.8                                                    GAPCON  235
      C                                                                 GAPCON  236
      C     LOOP STARTS FOR TOTAL MOLES OF GAS                          GAPCON  237
            ISTOP=ISTPLM                                                GAPCON  238
            DO 1200 K=2,11                                              GAPCON  239
            IF (NT.EQ.1) RATE=0.0                                       GAPCON  240
            IF (NT.LT.3.AND.IRELSE.NE.0) RATE=0.0                       GAPCON  241
            E(1)=0.0                                                    GAPCON  242
            E(2)=0.0                                                    GAPCON  243
            E(3)=RATE*ANH                                               GAPCON  244
            IF (NOH.EQ.0) E(3)=0.0                                      GAPCON  245
            T1=SQRT(T)                                                  GAPCON  246
            E(4)=ANN-2.582E-8*T1*Z1/GMWT(4)                             GAPCON  247
            IF (E(4).LT.0.0) E(4)=0.0                                   GAPCON  248
            E(5)=ANCO-(Z3*T+4.2E-5)*Z1/GMWT(5)                          GAPCON  249
            IF (E(5).LT.0.0) E(5)=0.0                                   GAPCON  250
            E(6)=ANKR*RATE*LF/AVOGAD                                    GAPCON  251
            E(7)=ANXE*RATE*LF/AVOGAD                                    GAPCON  252
            TOTMA=0.                                                    GAPCON  253
            DO 300 I=1,7                                                GAPCON  254
            TMA(I)=FILMOL*FRACTN(I)+E(I)                                GAPCON  255
            IF (NOH.EQ.0) TMA(3)=0.0                                    GAPCON  256
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  300 TOTMA=TOTMA+TMA(I)                                         GAPCON  257
      DO 310 I=1,7                                               GAPCON  258
      TMFA(I)=TMA(I)/TOTMA                                       GAPCON  259
  310 CONTINUE                                                   GAPCON  260
      LFTS=0                                                     GAPCON  261
      TAVGX=0.                                                   GAPCON  262
      VOLTXS=0.                                                  GAPCON  263
      DELR=0.                                                    GAPCON  264
      DELRC=0                                                    GAPCON  265
      DELRCO=0.                                                  GAPCON  266
      DFLRCC=0.                                                  GAPCON  267
      DELRP=0.                                                   GAPCON  268
      DELRCT=0.                                                  GAPCON  269
      HGACEL=0.8                                                 GAPCON  270
      DO 320 I=1,7                                               GAPCON  271
      SUMOLS(I)=FXMOL(I,NPOW1)*XMOLS(NPOW1)                      GAPCON  272
  320 CONTINUE                                                   GAPCON  273
C                                                                GAPCON  274
C      BEGIN AXIAL CALCULATIONS                                  GAPCON  275
      DO 1070 IPOW=1,NPOW                                        GAPCON  276
      RADH=RADS                                                  GAPCON  277
      IF (NT.NE.1) GO TO 330                                     GAPCON  278
      DVBX(IPOW)=0.                                              GAPCON  279
      DVBLST(IPOW)=0.                                            GAPCON  280
C                                                                GAPCON  281
C      CALCULATE THE POWER AND TCOOL                             GAPCON  282
  330 CONTINUE                                                   GAPCON  283
      IF (IPEAK.EQ.0) GO TO 340                                  GAPCON  284
      P=.5*(POWER(IPOW+1)+POWER(IPOW))                           GAPCON  285
      GO TO 350                                                  GAPCON  286
  340 P=POWER(IPOW)                                              GAPCON  287
  350 CONTINUE                                                   GAPCON  288
      IF (P.LE.0) RATE=0.0                                       GAPCON  289
      PHI(IPOW)=CST(IPOW)*P                                      GAPCON  290
      IF (TINLET(IPOW).EQ.0) TINLET(IPOW)=TINLET(1)              GAPCON  291
      TCOOL=TINLET(IPOW)+DTEMP*AI(IPOW)                          GAPCON  292
      TCOOLC=(TCOOL-32.)/1.8                                     GAPCON  293
      IF (RSINZ.GT.0.) GO TO 360                                 GAPCON  294
      WGT=RHO*(RFS**2-RVOIDZ**2)*PI                              GAPCON  295
      WGTS=0.                                                    GAPCON  296
      GO TO 370                                                  GAPCON  297
  360 WGT=RHO*(RFS**2-RSINZ**2)*PI                               GAPCON  298
      WGTS=RHOS*(RSINZ**2-RVOIDZ**2)*PI                          GAPCON  299
C     WGTF IN GRAMS PER FOOT                                     GAPCON  300
  370 WGTF=(WGT+WGTS)*196.64477                                  GAPCON  301
      RSIN=RSINZ                                                 GAPCON  302
      DSIN=DSINZ                                                 GAPCON  303
      RVOID=RVOIDZ                                               GAPCON  304
      DVOID=DVOIDZ                                               GAPCON  305
      VVOID=VVOIDZ                                               GAPCON  306
      QTOT=P*3413.                                               GAPCON  307
C                                                                GAPCON  308
C     QGRAM IS IN BTU/HR/GRAM OF FUEL                            GAPCON  309
      QGRAM=QTOT/WGTF                                            GAPCON  310
C                                                                GAPCON  311
C     QQU IS IN BTU/HR/FT3                                       GAPCON  312
      QQU=QGRAM*RHO*28316.8466                                   GAPCON  313
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C
C     QQS IS IN BTU/HR/FT3
      QQS=QGRAM*RHOS*28316.8466
      RSINF=RSIN/12.
      IF (NT.EQ.1.OR.K.NE.2) GO TO 380
      IF (K.NE.2) GO TO 380
      PITI(IPOW)=PITI(IPOW)+P*(TIME(NT)-TIME(NT-1))
  380 BURNUP=0.001*PITI(IPOW)/MTM
      DELGD=0.0
      IF (IRELOC) 390,400,390
  390 CONTINUE
C
C     RELOCATION CALCULATION
      CALL RELOC (DELGD,GAP,BURNUP,P,IRELOC)
      DELGD=AMAX1(DELGD,DELGDM(IPOW))
  400 CONTINUE
C
C     DENSIFICATION CALCULATION
      IF (IDENSF) 410,420,410
  410 CALL DENSF (DELPI.DFS,RHO,RHOS,BURNUP)
  420 CONTINUE
      DBU=0.
      IF (NT.NE.1) DBU=0.001*P*(TIME(NT)-TIME(NT-1))/MTM
      ITER=0
      DELTAO=0.
      IF (NFUEL) 430,440,440
  430 TM=TM-5.*FRPUO2-32.*BURNUP/10000.
  440 CONTINUE
      ITER=ITER+1
      QOVRAC=P*3413./(PI*(DCO+2.*DELRCO))*12.
      HFLUX(IPOW)=QOVRAC
      QOVRAI=P*3413./(PI*(DCI+2.*DELRC))*12.
      QOVRAS=P*3413./(PI*(DFS+2.*DELRFT))*12.
      IF (KOOL.GT.0) GO TO 590
      IF (DBO) 490,490,450
  450 QOVRAB=P*3413./(PI*DBO)*12.
      IF (SIGHF) 460,470,470
  460 CALL HTCW (TCOOL,QOVRAB,V,DE,HF)
      GO TO 480
  470 HF=SIGHF
  480 CONTINUE
      TBO=TCOOL+QOVRAB/HF
      QABLM=0.
      IF (P.GT.0) QABLM=(QOVRAC-QOVRAB)/ALOG(QOVRAC/QOVRAB)
      DELTB=QABLM*(DBO-DCO)/(24.*KB)
      TBI=TBO+DELTB
      TCO=QOVRAC/HBC+TBI
      GO TO 540
  490 IF (SIGHF) 500,510,510
  500 CALL HTCW (TCOOL,QOVRAC,V,DE,HF)
      GO TO 520
  510 HF=SIGHF
  520 CONTINUE
      TCO=TCOOL+QOVRAC/HF
      DELTAT=0.
      IF (ICOR.EQ.0) GO TO 530
      CALL CORROS (ICOR,QOVRAC,TIME(NT),TCO,TIME(NT-1),ZRO2A(IPOW),DELTA
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     +T)                                                          GAPCON   371
      TCO=DELTAT+TCOOL+QOVRAC/HF                                  GAPCON   372
  530 IF (CRUDTH.LE.0.) GO TO 540                                 GAPCON   373
      TCO=TCOOL+DELTAT+CRUDTH/12.*QOVRAC/0.23                     GAPCON   374
  540 CONTINUE                                                    GAPCON   375
      TAVGC=TCO+20.                                               GAPCON   376
      QOVRAA=(QOVRAC+QOVRAI)/2.                                   GAPCON   377
      IITRY=1                                                     GAPCON   378
  550 TCC=TERP(TAVGC,AA,2,NN,7)                                   GAPCON   379
      IITRY=IITRY+1                                               GAPCON   380
      DELTC=QOVRAA*(DCO+2.*DELRCO-DCI-2.*DELRC)/(24.*TCC)         GAPCON   381
      TCI=TCO+DELTC                                               GAPCON   382
      TAVGC1=(TCO+TCI)/2.                                         GAPCON   383
      DEL=ABS(TAVGC1-TAVGC)                                       GAPCON   384
      IF (DEL-1.) 580,580,560                                     GAPCON   385
  560 TAVGC=TAVGC1                                                GAPCON   386
      IF (IITRY-50) 550,550,570                                   GAPCON   387
  570 WRITE (6,1250)                                              GAPCON   388
  580 CONTINUE                                                    GAPCON   389
      GO TO 600                                                   GAPCON   390
  590 TCI=TCOOL                                                   GAPCON   391
      TCO=TCI-.5*(QOVRAC+QOVRAI)*(DCO+2.*DELRCO-DCI-2.*DELRC)/144. GAPCON  392
  600 CONTINUE                                                    GAPCON   393
      QOVRAG=(QOVRAS+QOVRAI)/2.                                   GAPCON   394
C                                                                 GAPCON   395
C     CLACULATE RADIAL TEMPERATURE PROFILE AND AVERAGE VOLUMETRIC GAPCON   396
C     FUEL TEMPERATURE                                            GAPCON   397
      CALL RTEMP                                                  GAPCON   398
      TMF=TM*1.8+32                                               GAPCON   399
      RMELT=TERP(TMF,BB,2,N,2)                                    GAPCON   400
      CALL FXPAND (RFS,RD,TT,TFS,DELRT,DELCT,DELL)                GAPCON   401
      R1700=TERP(3092.,BB,2,N,2)                                  GAPCON   402
      IF (KOUNT.GT.0) R1700=RSIN                                  GAPCON   403
      R1350=TERP(2462.,BB,2,N,2)                                  GAPCON   404
      VH=PI*R1700**2                                              GAPCON   405
      VL=PI*(RFS**2-R1350**2)                                     GAPCON   406
      VC=PI*(R1350**2-R1700**2)                                   GAPCON   407
      DVN1(IPOW)=SDOT*VOLUME*FRDEN*DBU/1.E4                       GAPCON   408
      DVN2(IPOW)=SDOTT*VC*DBU/1.E4                                GAPCON   409
      DVN3(IPOW)=(1.-FRDEN)*(.8*VH+.5*VC+.3*VL)                   GAPCON   410
      DVA=SDVN1(IPOW)+SDVN2(IPOW)                                 GAPCON   411
      DELVC=DVN1(IPOW)+DVN2(IPOW)                                 GAPCON   412
      VZ=0.0                                                      GAPCON   413
      IF (PRCDH.LE.0) GO TO 660                                   GAPCON   414
      IF (VOD-VH) 610,610,620                                     GAPCON   415
  610 VZ=0.8*PRCDH*VOLUME                                         GAPCON   416
      GO TO 650                                                   GAPCON   417
  620 IF (VOD-VH-VC) 630,630,640                                  GAPCON   418
  630 VZ=(0.8*VH+0.5*(VOD-VH))*PRCDH*VOLUME                       GAPCON   419
      GO TO 650                                                   GAPCON   420
  640 VZ=(0.8*VH+0.5*VC+0.3*(VOD-VH-VC))*PRCDH*VOLUME             GAPCON   421
  650 IF (VZ.LT.DISHV(IPOW)) VZ=DISHV(IPOW)                       GAPCON   422
  660 CONTINUE                                                    GAPCON   423
      DELVB(IPOW)=DVA+DELVC-DVN3(IPOW)-VZ                         GAPCON   424
      IF (DVA.LT.DVN3(IPOW).AND.DVBX(IPOW).LE.0.) GO TO 680       GAPCON   425
      IF (DELVB(IPOW)) 700,700,670                                GAPCON   426
  670 DELVB(IPOW)=DELVC+DVBX(IPOW)                                GAPCON   427
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      GO TO 700                                                         GAPCON   428
  680 IF (DELVB(IPOW)) 690,700,700                                      GAPCON   429
  690 DELVB(IPOW)=0.                                                    GAPCON   430
      DELRB=0.                                                          GAPCON   431
      GO TO 710                                                         GAPCON   432
  700 DELRB=AMAX1(DELVB(IPOW),DVBX(IPOW))/(3.*PI*RFS)                   GAPCON   433
  710 CONTINUE                                                          GAPCON   434
      TAVGC=(TCI+TCO)/2.                                                GAPCON   435
      ALPHAC=TERP(TAVGC,AA,6,NN,7)                                      GAPCON   436
      DELRCI=RCI*ALPHAC*(TAVGC-77.)                                     GAPCON   437
      DELRCO=RCO*ALPHAC*(TAVGC-77.)                                     GAPCON   438
      DELRM=0.                                                          GAPCON   439
      DELLM=0.                                                          GAPCON   440
      IF (TT(N).LT.TMF) GO TO 720                                       GAPCON   441
      RTM=TERP(TMF,BB,2,N,2)                                            GAPCON   442
      VOLPOR=PI*(RTM**2)*(1.0-FRDEN)                                    GAPCON   443
      DELVM=PI*(RTM**2)*0.096                                           GAPCON   444
      DELVM=DELVM-VOLPOR                                                GAPCON   445
      IF (DELVM.LE.0) DELVM=0.                                          GAPCON   446
      DELRM=DELVM/(PI*RTM*3.)                                           GAPCON   447
      DELLM=DELVM/(PI*(RTM**2)*3.)*LF                                   GAPCON   448
  720 CONTINUE                                                          GAPCON   449
      DELRCC=0.                                                         GAPCON   450
      DELRCT=0.0                                                        GAPCON   451
      PRESCN=2.0*(EXTP*(RCO+DELRCO)**2-PRESTO*(RCI+DELRC)**2)           GAPCON   452
      IF (ICREP.EQ.0) GO TO 730                                         GAPCON   453
      DELRCC=TERP(TDAYS,CLCRP,2,NCR,2)                                  GAPCON   454
      DELRCC=DELRCC/2.                                                  GAPCON   455
      DELRCO=DELRCO-DELRCC                                              GAPCON   456
      DELRP=0.                                                          GAPCON   457
      PRESCN=0.                                                         GAPCON   458
      GO TO 740                                                         GAPCON   459
  730 CONTINUE                                                          GAPCON   460
      IF (ICDF.EQ.0) GO TO 740                                          GAPCON   461
      DELRC=DELRCI-DELRCC                                               GAPCON   462
      EC=TERP(TAVGC,AA,4,NN,7)                                          GAPCON   463
      CMU=TERP(TAVGC,AA,5,NN,7)                                         GAPCON   464
      DELRP=(RCI+DELRC)/(EC*((RCO+DELRCO)**2-(RCI+DELRC)**2))*((PRESTO*( GAPCON   465
     +RCI+DELRC)**2-EXTP*(RCO+DELRCO)**2)*(1.-CMU)+(PRESTO-EXTP)*((RCO+D GAPCON   466
     +ELRCO)**2)*(1.+CMU))                                              GAPCON   467
      DELRCO=DELRCO+DELRP                                               GAPCON   468
      PRESCN=0.                                                         GAPCON   469
  740 CONTINUE                                                          GAPCON   470
      DELRCT=DELRCI+DELRP-DELRCC                                        GAPCON   471
      DELRC=DELRCT                                                      GAPCON   472
      DELR=DELRT+DELRB                                                  GAPCON   473
      DELRFT=DELRT+DELRB+DELGD+DELPI+DELRM                              GAPCON   474
      TH=GAP/2.+DELRC-DELRFT                                            GAPCON   475
      CRUF=3.6*(ROUC+ROUF)                                              GAPCON   476
      IF (TH.GT.CRUF.OR.DELGD.LE.0) GO TO 760                           GAPCON   477
      ZZ1=TH+DELGD-CRUF                                                 GAPCON   478
      IF (ZZ1.GT.0) GO TO 750                                           GAPCON   479
      DELRFT=DELRFT-DELGD                                               GAPCON   480
      TH=ZZ1+CRUF                                                       GAPCON   481
      GO TO 760                                                         GAPCON   482
  750 CONTINUE                                                          GAPCON   483
      DELRFT=DELRT+DELRB+DELPI+DELRM+ZZ1                                GAPCON   484
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      TH=3.60*(ROUF+ROUC)                                               GAPCON   485
  760 CONTINUE                                                          GAPCON   486
      DELR=DELRT+DELRB                                                  GAPCON   487
      AF=RFS+DELRFT                                                     GAPCON   488
      AC=RCI+DELRC                                                      GAPCON   489
      THR=TH-CRUF                                                       GAPCON   490
      VOLGAP=PI/4.*((DCI+2.*DELRC)**2-(DFS+2.*DELRFT)**2)*LF            GAPCON   491
      VRUF=PI*DFS*CRUF*LF                                               GAPCON   492
      IF (VOLGAP.LE.VRUF) VOLGAP=VRUF                                   GAPCON   493
      TCIK=(TCI-32.)/1.8+273.                                           GAPCON   494
C                                                                       GAPCON   495
C     CALCULATE HOW MUCH SORBED GAS CAN REACT WITH THE CLAD             GAPCON   496
      RTCIK=1/TCIK                                                      GAPCON   497
      REACN=SQRT(2.082E-15)                                             GAPCON   498
      REACO=TEPP(RTCIK,RTCO,RTC,5)                                      GAPCON   499
      GRECO=(REACO*T+4.2E-5)*Z4                                         GAP2       2
      GRECN=REACN*T1*Z4                                                 GAPCON   502
      MREACN(IPOW)=GRECN/GMWT(4)                                        GAPCON   503
      MREACO(IPOW)=GRECO/GMWT(5)                                        GAPCON   504
      TVOLAV=VAVGTC                                                     GAPCON   505
C                                                                       GAPCON   506
C     CALCULATE FISSION GAS RELEASE          BEYER-HANN MODEL           GAPCON   507
C                                                                       GAPCON   508
      CALL GASREL (IPOW,LSTHIF,CORR,RVOID,N,BURNUP,TFS,RTM)             GAPCON   509
      TGAS=(TCI+TFS)/2.                                                 GAPCON   510
      ABTGAS=(TGAS-32.)/1.8+273.                                        GAPCON   511
C                                                                       GAPCON   512
C     CALCULATE THERMAL CONDUCTIVITY OF THE GAS                         GAPCON   513
C                                                                       GAPCON   514
      DO 770 I=1,7                                                      GAPCON   515
      TKE=ABTGAS/EKLJ(I)                                                GAPCON   516
      OMEGA(I)=TERP(TKE,TABLE,2,80,2)                                   GAPCON   517
  770 CONTINUE                                                          GAPCON   518
      DO 780 I=1,7                                                      GAPCON   519
      VISCOS(I)=2.67E-5*SQRT(ABTGAS*GMWT(I))/(OMEGA(I)*SIGLJ(I)**2)     GAPCON   520
  780 CONTINUE                                                          GAPCON   521
      DO 790 I=1,7                                                      GAPCON   522
      DO 790 J=1,7                                                      GAPCON   523
      PHICAP(I,J)=1./SQRT(8.)/(SQRT(1.+GMWT(I)/GMWT(J)))*(1.+SQRT(VISCOS GAPCON   524
     +(I)/VISCOS(J))*((GMWT(J)/GMWT(I))**.25))**2                       GAPCON   525
  790 CONTINUE                                                          GAPCON   526
      DO 800 I=1,7                                                      GAPCON   527
      IF (I.EQ.3) GO TO 800                                             GAPCON   528
      IF (I.EQ.4) GO TO 800                                             GAPCON   529
      IF (I.EQ.5) GO TO 800                                             GAPCON   530
      CON(I)=1.9891E-4*(SQRT(ABTGAS/GMWT(I)))/(SIGLJ(I)**2*OMEGA(I))    GAPCON   531
  800 CONTINUE                                                          GAPCON   532
      CSUBP(3)=6.947-0.20E-3*ABTGAS+4.808E-7*ABTGAS**2                  GAPCON   533
      CSUBP(4)=6.524+1.25E-3*ABTGAS-1.E-9*ABTGAS**2                     GAPCON   534
      CSUBP(5)=CSUBP(4)                                                 GAPCON   535
      DO 810 I=3,5                                                      GAPCON   536
      CON(I)=(CSUBP(I)+1.25*1.987)*VISCOS(I)/GMWT(I)                    GAPCON   537
  810 CONTINUE                                                          GAPCON   538
      GASKON=0.                                                         GAPCON   539
      VISMIX=0.                                                         GAPCON   540
      DO 830 I=1,7                                                      GAPCON   541
      DENOM=0.                                                          GAPCON   542
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      DO 820 J=1,7                                                        GAPCON     543
      DENOM=DENOM+TMFA(J)*PHICAP(I,J)                                     GAPCON     544
  820 CONTINUE                                                            GAPCON     545
      GASKON=GASKON+TMFA(I)*CON(I)/DENOM                                  GAPCON     546
      VISMIX=VISMIX+TMFA(I)*VISCOS(I)/DENOM                               GAPCON     547
  830 CONTINUE                                                            GAPCON     548
      GK=GASKON*241.9                                                     GAPCON     549
      ABTCV=(TT(N)-32.)/1.8+273.                                          GAPCON     550
      EMMIX=0.                                                            GAPCON     551
      DO 840 I=1,7                                                        GAPCON     552
      EMMIX=EMMIX+TMFA(I)*GMWT(I)                                         GAPCON     553
  840 CONTINUE                                                            GAPCON     554
      ABTCI=(TCI-32.)/1.8+273.15                                          GAPCON     555
      ABTFS=(TFS-32.)/1.8+273.15                                          GAPCON     556
      ABT1=(ABTFS+ABTCI)/2.0                                              GAPCON     557
      ABT2=ABT1                                                           GAPCON     558
      P1=TMFA(1)*PRESTO*68947.                                            GAPCON     559
      P2=TMFA(2)*PRESTO*68947.                                            GAPCON     560
      P3=TMFA(3)*PRESTO*68947.                                            GAPCON     561
      P4=TMFA(4)*PRESTO*68947.                                            GAPCON     562
      P5=TMFA(5)*PRESTO*68947.                                            GAPCON     563
      P6=TMFA(6)*PRESTO*68947.                                            GAPCON     564
      P7=TMFA(7)*PRESTO*68947.                                            GAPCON     565
      ACHE1=0.425-2.5E-4*ABT1                                             GAPCON     566
      ACXE1=0.749-2.3E-4*ABT1                                             GAPCON     567
      SLOP=(ACXE1-ACHE1)/128.0                                            GAPCON     568
      RINT=ACHE1-4.0*SLOP                                                 GAPCON     569
      ACAR1=39.9*SLOP+RINT                                                GAPCON     570
      ACH1=2.*SLOP+RINT                                                   GAPCON     571
      ACN1=28.*SLOP+RINT                                                  GAPCON     572
      ACCO1=28.*SLOP+RINT                                                 GAPCON     573
      ACKR1=84.*SLOP+RINT                                                 GAPCON     574
      D11=(4.*ABT1)**0.5                                                  GAPCON     575
      D12=(40.*ABT1)**0.5                                                 GAPCON     576
      D13=(2.*ABT1)**0.5                                                  GAPCON     577
      D14=(28.*ABT1)**0.5                                                 GAPCON     578
      D15=(28.*ABT1)**0.5                                                 GAPCON     579
      D16=(84.*ABT1)**0.5                                                 GAPCON     580
      D17=(131.3*ABT1)**0.5                                               GAPCON     581
      SUM1=P1*ACHE1/D11+ACAR1*P2/D12+ACH1*P3/D13+ACN1*P4/D14+ACCO1*P5/D1  GAPCON     582
     +5+ACKR1*P6/D16+ACXE1*P7/D17                                         GAPCON     583
      ACHE2=0.425-2.5E-4*ABT2                                             GAPCON     584
      ACXE2=0.749-2.3E-4*ABT2                                             GAPCON     585
      SLOP=(ACXE2-ACHE2)/128.0                                            GAPCON     586
      RINT=ACHE2-4.0*SLOP                                                 GAPCON     587
      ACAR2=39.9*SLOP+RINT                                                GAPCON     588
      ACH2=2.*SLOP+RINT                                                   GAPCON     589
      ACN2=28.*SLOP+RINT                                                  GAPCON     590
      ACCO2=28.*SLOP+RINT                                                 GAPCON     591
      ACKR2=84.*SLOP+RINT                                                 GAPCON     592
      D21=(4.*ABT2)**0.5                                                  GAPCON     593
      D22=(40.*ABT2)**0.5                                                 GAPCON     594
      D23=(2.*ABT2)**0.5                                                  GAPCON     595
      D24=(28.*ABT2)**0.5                                                 GAPCON     596
      D25=(28.*ABT2)**0.5                                                 GAPCON     597
      D26=(84.*ABT2)**0.5                                                 GAPCON     598
      D27=(131.3*ABT2)**0.5                                               GAPCON     599
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      SUM2=P1*ACHE2/D21+ACAR2*P2/D22+ACH2*P3/D23+ACN2*P4/D24+ACCO2*P5/D2 GAPCON  600
     +5+ACKR2*P6/D26+ACXE2*P7/D27                                        GAPCON  601
      G1=2876.4*GASKON/SUM1                                              GAPCON  602
      G2=2876.4*GASKON/SUM2                                              GAPCON  603
      DLT1=(QOVRAS/(GK/(G1*0.032808)))/1.8                               GAPCON  604
      DLT2=(QOVRAS/(GK/(G2*0.032808)))/1.8                               GAPCON  605
      ABT1=ABTFS-DLT1                                                    GAPCON  606
      ABT2=ABTCI+DLT2                                                    GAPCON  607
      G1PG2=(G1+G2)*0.7264                                               GAPCON  608
      IF (THR) 860,850,850                                               GAPCON  609
  850 HGAS=GK/(TH+G1PG2)*12.                                             GAPCON  610
      HSOLID=0.                                                          GAPCON  611
      PFACE=0.                                                           GAPCON  612
      GO TO 900                                                          GAPCON  613
  860 CONTINUE                                                           GAPCON  614
      TR=ABS(THR)                                                        GAPCON  615
      EC=TERP(TAVGC,AA,4,NN,7)                                           GAPCON  616
      CMU=TERP(TAVGC,AA,5,NN,7)                                          GAPCON  617
      YDSTR=TERP(TAVGC,AA,3,NN,7)                                        GAPCON  618
      RSQRMC=(RCO+DELRCO)**2-(RCI+DELRC)**2                              GAPCON  619
      RSQRPC=(RCO+DELRCO)**2+(RCI+DELRC)**2                              GAPCON  620
      ALOGC=ALOG((RCO+DELRCO)/(RCI+DELRC))                               GAPCON  621
      STREST=ALPHAC*EC*(TCI-TCO)/(2.*(1.-CMU)*ALOGC)*(1.-(2.*(RCO+DELRCO GAPCON  622
     +)**2/RSQRMC*ALOGC))                                                GAPCON  623
      PFACE=(TR*EC/(RCI+DELRC)+PRESCN/RSQRMC)/(RSQRPC/RSQRMC+CMU+EC*(1.- GAPCON  624
     +MUF)/EF)                                                           GAPCON  625
      PRMAX=((YDSTR-STREST)*RSQRMC+PRESCN)/RSQRPC                        GAPCON  626
      IF (PFACE.GT.PRMAX) PFACE=PRMAX                                    GAPCON  627
      IF (PFACE.LT.0.0) PFACE=0.0                                        GAPCON  628
      TFSC=(TFS-32.)/1.8                                                 GAPCON  629
      FK=TERP(TFS,CF,2,NFUEL,3)                                          GAPCON  630
      CK=TERP(TCI,AA,2,NN,7)                                             GAPCON  631
      KM=2.*FK*CK/(FK+CK)                                                GAPCON  632
      CPFACE=PFACE/14.223                                                GAPCON  633
      CEE=3.69*EXP(-0.00124*CPFACE)                                      GAPCON  634
      HMEYER=TERP(TCI,AA,7,NN,7)                                         GAPCON  635
      PREL=CPFACE/HMEYER                                                 GAPCON  636
      RKM=2.*FK*CK/(FK+CK)                                               GAPCON  637
      R1=ROUF*1.0E+6                                                     GAPCON  638
      R=(ROUC**2+ROUF**2)**0.5                                           GAPCON  639
      IF (PREL.GT.0.010) GO TO 870                                       GAPCON  640
      IF (PREL.LT.0.0001) GO TO 880                                      GAPCON  641
      HSOLID=5.0E-2*RKM/(R*EXP(5.738-0.5285*ALOG(R1)))                   GAPCON  642
      GO TO 890                                                          GAPCON  643
  870 HSOLID=5.*RKM*PREL/(R*EXP(5.738-0.5285*ALOG(R1)))                  GAPCON  644
      GO TO 890                                                          GAPCON  645
  880 HSOLID=5.*RKM*PREL**0.5/(R*EXP(5.738-0.5285*ALOG(R1)))             GAPCON  646
  890 CONTINUE                                                           GAPCON  647
      THC=CEE*(ROUF+ROUC)-5.E-6+G1PG2                                    GAPCON  648
      IF (THC.LE.2.E-5) THC=2.E-5                                        GAPCON  649
      HGAS=GK/THC*12.                                                    GAPCON  650
  900 CONTINUE                                                           GAPCON  651
      TFSR=TFS+460.                                                      GAPCON  652
      TCISR=TCI+460.                                                     GAPCON  653
      HRAD=.1713E-8/(1./EPSIF+AF/AC*(1./EPSIC-1.))*(TFSR**2+TCISR**2)*(T GAPCON  654
     +FSR+TCISR)                                                         GAPCON  655
      HGC=HSOLID+HGAS+HRAD                                               GAPCON  656
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      C
      C     BEGIN CONVERGENCE OF HG
            DELTA=HGC-HG
            DELHG=HG-HGOLD
            HGOLD=HG
            IF (ABS(DELTA/HG).LT.0.01) GO TO 950
            IF (ITER.GT.50) GO TO 940
      C
      C     TEST FOR SIMILAR SLOPES IN THE CONVERGENCE APPROACH AND
      C     IF THE LAST TWO ITERATIONS HAVE HAD SIMILAR VALUES, USE
      C     A DIFFERENT ITERATION SCHEME. GAPCON CAN ENCOUNTER
      C     TWO BASIC TYPES AND THEY ARE: (1) OSCILATING (UNDERDAMPED),
      C     OR (2) OVERDAMPED.
            IF (IOSC.EQ.1) GO TO 910
            IF (DELTA*DELTAO.LT.0.) IOSC=1
            IF (DELTA*DELTAO.LE.0.) GO TO 910
      C
      C     SINCE THE LAST TWO ITERATIONS HAS SIMILAR SLOPES,
      C     I.E., BOTH POSITIVE OR NEGATIVE. USE AN EFFECTIVE ACCELERATION
      C     PARAMETER OF 1.4.
            HG=HGC+0.4*DELTA
            IF (HG.GT.0.) GO TO 930
            IOSC=1
            HG=HGOLD
      C
      C     THE SOLUTION IS OSCILATING ABOUT WHAT SHOULD BECOME THE
      C     CONVERGED SOLUTION AND THE CONVERGENCE MUST BE CONSTRAINED
      C     TO FORCE A FASTER SOLUTION.  THE EFFECTIVE ACCELERATION
      C     PARAMETER USED IS REDUCED TO HALF OF IT'S ORIGINAL
      C     VALUE TO DAMPEN THE OSCILLATION.
        910 CONTINUE
            IF (ITER.LE.5) GO TO 920
            IF (ABS(DELHGO/DELHG).LT.1.2) HGACEL=0.5*HGACEL
            IF (HGACEL.LT.0.01) HGACEL=.01
        920 CONTINUE
            HG=HG+HGACEL*DELTA
            IF ((HG+HGC).LT.1000.AND.ITER.LE.5) HGACEL=0.5
        930 CONTINUE
            DELTAO=DELTA
            DELHGO=DELHG
            GO TO 440
        940 CONTINUE
            IF (ISTEP.LE.1) GO TO 950
            WRITE (6,1260) HG,HGC,ISTEP,IPOW,NPOW
        950 CONTINUE
            HGACEL=0.8
            V1=PI*((RCI+DELRC)**2-(RFS+DELRFT)**2)*LF
            V2=VVOID
            IF (V1.LE.VRUF) V1=VRUF
            VOLTX(IPOW)=(V1/ABTGAS)+(V2/ABTCV)
            IF (THR.GT.0.) GO TO 960
            DELGD=ZZ1
            IF (DELGD.LE.0) DELGD=0.
        960 CONTINUE
            IF (THR.GT.CRUF) PFACE=0.
            IF (KOUNT.EQ.0) ICASE=ICASE+1
            TBIC=(TBI-32.)/1.8
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      TBOC=(TBO-32.)/1.8                                                   GAPCON   714
      TCOC=(TCO-32.)/1.8                                                   GAPCON   715
      TCIC=(TCI-32.)/1.8                                                   GAPCON   716
      TFSC=(TFS-32.)/1.8                                                   GAPCON   717
      IF (KOUNT.NE.0) GO TO 970                                            GAPCON   718
      HGX(IPOW)=HG                                                         GAPCON   719
      TCLINE(IPOW)=TT(N)                                                   GAPCON   720
      ROP(IPOW)=RFS+DELRFT                                                 GAPCON   721
      RGAPX(IPOW)=TH                                                       GAPCON   722
  970 CONTINUE                                                             GAPCON   723
      IF (K.LT.ISTOP) GO TO 980                                            GAPCON   724
      IF (MINI.LT.0) GO TO 980                                             GAPCON   725
C                                                                          GAPCON   726
C     WRITE PEAK NODE INFORMATION                                          GAPCON   727
      IF (MINI.EQ.0.AND.LPMAX.EQ.IPOW) CALL OUTPUT (PHI(IPOW),TIME)        GAPCON   728
C                                                                          GAPCON   729
C     WRITE INFORMATION FOR EVERY NODE                                     GAPCON   730
      IF (MINI.GT.0) CALL OUTPUT (PHI(IPOW),TIME)                          GAPCON   731
  980 CONTINUE                                                             GAPCON   732
      IF (KOUNT.GT.0) GO TO 1010                                           GAPCON   733
      IF (T.LE..001.OR.FRDEN.GE.FRSIN) GO TO 1010                          GAPCON   734
      KOUNT=1                                                              GAPCON   735
      IF (FRDEN.GE.FRSIN) FRSIN=FRDEN                                      GAPCON   736
      IF (T.LE..0) GO TO 990                                               GAPCON   737
      RETEM=.00001367*ALOG10(T/3600.)+.000480                              GAPCON   738
      TSINC=1./RETEM-273.                                                  GAPCON   739
      TSIN=1.8*TSINC+32.                                                   GAPCON   740
      RRSIN=RSIN                                                           GAPCON   741
      GO TO 1000                                                           GAPCON   742
  990 TSIN=1.E10                                                           GAPCON   743
      ITER=0                                                               GAPCON   744
      GO TO 440                                                            GAPCON   745
 1000 RSIN=TERP(TSIN,BB,2,N,2)                                             GAPCON   746
      IF (RSIN.LE.RRSIN) RSIN=RRSIN                                        GAPCON   747
      DSIN=2.*RSIN                                                         GAPCON   748
      RRVOID=RVOID                                                         GAPCON   749
      RVOID=SQRT((RSIN**2)*(FRSIN-FRDEN)/FRSIN+(RVOIDZ**2)*FRDEN/FRSIN)    GAPCON   750
      IF (RVOID.LE.RRVOID) RVOID=RRVOID                                    GAPCON   751
      DVOID=2.*RVOID                                                       GAPCON   752
      ELTC=LF-LVOIDZ/FNPOW                                                 GAPCON   753
      VTC=PI*ELTC*RVOIDZ**2                                                GAPCON   754
      VVOID=(PI*LF*RVOID**2-VTC)                                           GAPCON   755
      ITER=0                                                               GAPCON   756
      GO TO 440                                                            GAPCON   757
 1010 KOUNT=0                                                              GAPCON   758
      TAVGX=TAVGX+TBAR(IPOW)                                               GAPCON   759
C                                                                          GAPCON   760
C     CALCULATE DISH EFFECTS AND AXIAL THERMAL EXPANSION                   GAPCON   761
      TRADH=TEPP(RADH,TT,TS,N)                                             GAPCON   762
      IF (TRADH.LE.TPLAS) GO TO 1020                                       GAPCON   763
      RPLAS=TERP(TPLAS,BB,2,N,2)                                           GAPCON   764
      RADH=RPLAS                                                           GAPCON   765
      TRADH=TPLAS                                                          GAPCON   766
 1020 CONTINUE                                                             GAPCON   767
      TRADHC=(TRADH-32.)/1.8                                               GAPCON   768
      CST1=2.896E-9*(TRADHC**2-25**2)+6.797E-6*(TRADHC-25.)                GAPCON   769
      DELTL=CST1*LF                                                        GAPCON   770
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      DHVOL(IPOW)=0.0                                                   GAPCON   771
      IF (PRCDH.LE.0) GO TO 1060                                        GAPCON   772
      DO 1030 I=1,N                                                     GAPCON   773
      IF (TSR(I).LT.RADH) GO TO 1040                                    GAPCON   774
 1030 CONTINUE                                                          GAPCON   775
 1040 M=I                                                               GAPCON   776
      TAVGD=(RADH**2-TSR(M)**2)*PI*((TRADH+TT(M-1))*.5)                 GAPCON   777
      DO 1050 I=M,N                                                     GAPCON   778
      TAVGD=TAVGD+(TSR(I)**2-TSR(I+1)**2)*((TT(I)+TT(I-1))*.5)          GAPCON   779
 1050 CONTINUE                                                          GAPCON   780
      WD=DHVOLZ/(PI*(RADH**2))                                          GAPCON   781
      TAVGDS=TAVGD/((RADH**2-RVOID**2))                                 GAPCON   782
      TAVGDC=(TAVGDS-32.)/1.8                                           GAPCON   783
      CSTD=2.896E-9*(TAVGDC**2-25**2)+6.797E-6*(TAVGDC-25.)             GAPCON   784
      DELTLD=CSTD*(LF-WD)                                               GAPCON   785
      ABTDS=((TAVGDS-32.)/1.8)+273.                                     GAPCON   786
      DHVOL(IPOW)=(PI*(RADH**2-RVOIDZ**2)*(DELTL+WD-DELTLD))/(ABTDS)    GAPCON   787
      IF (DHVOL(IPOW).LE.0) DHVOL(IPOW)=0                               GAPCON   788
 1060 CONTINUE                                                          GAPCON   789
      VOLTXS=VOLTXS+VOLTX(IPOW)+DHVOL(IPOW)                             GAPCON   790
      LFT(IPOW)=DELTL                                                   GAPCON   791
      LFTS=LFTS+LFT(IPOW)                                               GAPCON   792
      IF (K.EQ.ISTOP) DELGDM(IPOW)=DELGD                                GAPCON   793
      DISHV(IPOW)=VZ                                                    GAPCON   794
 1070 CONTINUE                                                          GAPCON   795
      IF (IPOW.GT.NPOW) IPOW=NPOW                                       GAPCON   796
      TAVGXX(ISTEP+1)=TAVGX/FNPOW                                       GAPCON   797
      VPLENT=VPLENZ*((RCI+DELRC)**2)/(RCI**2)-(LFTS*PI*(RFS+DELRFT)**2) GAPCON   798
      IF (VPLENT.LT.0) VPLENT=0                                         GAPCON   799
      VOLTXS=VOLTXS+VPLENT/TPLENA                                       GAPCON   800
      TVOLAV=(TAVGXX(ISTEP+1)-32.)/1.8                                  GAPCON   801
C                                                                       GAPCON   802
C     CALCULATE HOW MUCH SORBED GAS REMAINS IN THE PIN                  GAPCON   803
      TXMOLS(5)=0.0                                                     GAPCON   804
      DO 1080 IPOW=1,NPOW                                               GAPCON   805
      TXMOLS(5)=TXMOLS(5)+MREACO(IPOW)                                  GAPCON   806
 1080 CONTINUE                                                          GAPCON   807
      MOL(5)=MOL(5)-TXMOLS(5)                                           GAPCON   808
      IF (MOL(5).LE.0) MOL(5)=0.0                                       GAPCON   809
C                                                                       GAPCON   810
C     CALCULATE MOLE FRACTIONS OF GAS IN THE FUEL PIN.                  GAPCON   811
      MOL(1)=TMA(1)                                                     GAPCON   812
      MOL(2)=TMA(2)                                                     GAPCON   813
      MOL(3)=TMA(3)                                                     GAPCON   814
      MOL(4)=TMA(4)                                                     GAPCON   815
      MOL(6)=FRACKR*FILMOL                                              GAPCON   816
      MOL(7)=FRACXE*FILMOL                                              GAPCON   817
      DO 1090 I=1,NPOW                                                  GAPCON   818
      MOL(6)=MOL(6)+SUMNKR(NX,I)                                        GAPCON   819
 1090 MOL(7)=MOL(7)+SUMNXE(NX,I)                                        GAPCON   820
      XMOTOT=0                                                          GAPCON   821
      DO 1100 I=1,7                                                     GAPCON   822
      XMOTOT=XMOTOT+MOL(I)                                              GAPCON   823
 1100 CONTINUE                                                          GAPCON   824
      DO 1110 I=1,7                                                     GAPCON   825
      FXMOL(I,1)=MOL(I)/XMOTOT                                          GAPCON   826
      MOLEFR(I)=FXMOL(I,1)                                              GAPCON   827
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 1110 CONTINUE                                                    GAPCON   828
C                                                                 GAPCON   829
C     CALCULATE THE PRESSURE FOR THE PIN                          GAPCON   830
      PRESTO=73.604*XMOTOT/VOLTXS                                 GAPCON   831
      XMOLS(NPOW1)=PRESTO*VPLENT/(73.604*TPLENA)                  GAPCON   832
      DO 1120 I=1,NPOW                                            GAPCON   833
      CALL MOVEAA (FXMOL(1,1),FXMOL(1,I),7)                       GAPCON   834
      XMOLS(I)=PRESTO*VOLTX(I)/73.604                             GAPCON   835
 1120 CONTINUE                                                    GAPCON   836
      IF (NT.EQ.1.OR.IRELSE.NE.0.AND.NT.LT.3) GO TO 1130          GAPCON   837
      RATEC=(XMOTOT-FILMOL)/(E(3)+((ANKR+ANXE)/AVOGAD*LF))        GAPCON   838
      IF (K.EQ.2.AND.ISTEP.EQ.1) GO TO 1190                       GAPCON   839
      IF (RATE.LT.0.) RATE=0.                                     GAPCON   840
 1130 CONTINUE                                                    GAPCON   841
      IF (K.EQ.ISTOP) GO TO 1210                                  GAPCON   842
      IF (NT.EQ.1) GO TO 1180                                     GAPCON   843
      IF (RATE.LE.0) RATE=0.                                      GAPCON   844
      IF (IRELSE.NE.0) ISTOP=K+1                                  GAPCON   845
      IF (IRELSE.NE.0) GO TO 1200                                 GAPCON   846
      W1=RATEC-RATE                                               GAPCON   847
      W2=RATE-RATOLD                                              GAPCON   848
      IF (RATE.LE.0..AND.RATEC.LE.0.) GO TO 1180                  GAPCON   849
      IF (RATE.LE.0.) GO TO 1190                                  GAPCON   850
      IF (ABS(W1/RATE).LT..005) GO TO 1180                        GAPCON   851
      RATOLD=RATE                                                 GAPCON   852
      IF (K.GT.11) GO TO 1180                                     GAPCON   853
      IF (K.GT.7) GO TO 1140                                      GAPCON   854
      RATE=RATEC                                                  GAPCON   855
      GO TO 1170                                                  GAPCON   856
 1140 CONTINUE                                                    GAPCON   857
      IF (IO.EQ.1) GO TO 1150                                     GAPCON   858
      IF (W1*W3.LT.0) IO=1                                        GAPCON   859
      IF (W1*W3.LE.0) GO TO 1150                                  GAPCON   860
      RATE=RATEC+.4*W1                                            GAPCON   861
      IF (RATE.GT.0) GO TO 1170                                   GAPCON   862
      IO=1                                                        GAPCON   863
      RATE=RATOLD                                                 GAPCON   864
 1150 CONTINUE                                                    GAPCON   865
      IF (K.LE.5) GO TO 1160                                      GAPCON   866
      IF (ABS(W5/W2).LT.1.2) ACELL=.5*ACELL                       GAPCON   867
      IF (ACELL.LT..1) ACELL=.1                                   GAPCON   868
 1160 CONTINUE                                                    GAPCON   869
      RATE=RATE+ACELL*W1                                          GAPCON   870
      IF (RATE+RATEC.LT.0.01.AND.K.LE.5) ACELL=.5                 GAPCON   871
 1170 CONTINUE                                                    GAPCON   872
      W3=W1                                                       GAPCON   873
      W5=W2                                                       GAPCON   874
      GO TO 1200                                                  GAPCON   875
 1180 CONTINUE                                                    GAPCON   876
      ISTOP=K+1                                                   GAPCON   877
 1190 CONTINUE                                                    GAPCON   878
      RATE=RATEC                                                  GAPCON   879
      IF (RATE.LT.0) RATE=0.0                                     GAPCON   880
 1200 CONTINUE                                                    GAPCON   881
 1210 CONTINUE                                                    GAPCON   882
      ACELL=.8                                                    GAPCON   883
      RATE=RATEC                                                  GAPCON   884
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      ISTOP=ISTEP                                                        GAPCON   885
C                                                                        GAPCON   886
C      BEGIN AXIAL PRINTOUT.                                             GAPCON   887
      IF (NT.EQ.1) GO TO 1230                                            GAPCON   888
      TOTREL=(MOL(6)+MOL(7)-(FRACKR+FRACXE)*FILMOL)/((ANKR+ANXE)/AVOGAD* GAPCON   889
     +LF)                                                                GAPCON   890
      DO 1220 I=1,NPOW                                                   GAPCON   891
      K9=LSTHIF(I)                                                       GAPCON   892
 1220 IF (RDOT(NT,I).GE.RDOT(K9,I)) LSTHIF(I)=NT                         GAPCON   893
 1230 CONTINUE                                                           GAPCON   894
      CALL AXPRNT (TOTREL,ISTEP)                                         GAPCON   895
      RATE=RATEC                                                         GAPCON   896
 1240 CONTINUE                                                           GAPCON   897
      GO TO 10                                                           GAPCON   898
C                                                                        GAPCON   899
 1250 FORMAT (10X,*NO CONVERGENCE IN TCC*)                               GAPCON   900
 1260 FORMAT (*0NON-CONVERGENCE IN HGC -- HG =*,F9.1,*,  HGC =*,F9.1,2X, GAPCON   901
     +*ISTEP =*,I2,*  IPOW =*,I2,* OF *,I2)                              GAPCON   902
 1270 FORMAT (5X,*SORBED GAS FRACTION SUM.NE.1, XH,XN, AND XCO VALUES AR GAPCON   903
     +E =*,1X,3(2X,F10.5))                                               GAPCON   904
      END                                                                GAPCON   905
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      BLOCK DATA                                                        BLKDAT     2
      COMMON/AZ/ TBAR(20),VOLTX(20),TCLINE(20),HGX(20)                  COMB       2
     + ,TAVGXX(20),RDOT(15,20),RGAPX(20),ROP(20),HFLUX(20)              COMB       3
     + ,XMOLS(21),FXMOL(7,21),PRESTO     ,SUMOLS(7)                     COMB       4
      COMMON /AF/ TITLE(20),FRUO2,    BB(2,50),PHICAP(7,7),CSUBP(7),    COMC       2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),    COMC       3
     +Q(50),QIN(50),TS(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,      COMC       4
     +NF,NFUEL,NNN                                                      COMC       5
      COMMON/PH/ PSEUDO(15),TIME(15),NTIME,PITI(20),PROFIL(15,21),      COME       2
     +SAVNKR(15,20),SAVNXE(15,20),SUMNKR(15,20),SUMNXE(15,20),CST(20),  COME       3
     +NNKR,NNXE,TVOLAV,VOLGAS,W,NPRFIL,DVBLST(20),DVN3(20),             COME       4
     +SDVN1(20),SDVN2(20),DVBX(20),DVN1(20),DVN2(20),DELVB(20)          COME       5
      REAL NNKR,NNXE                                                    COME       6
      COMMON /AG/ PRCDH,RADS,TPLAS                                      COMF       2
      COMMON/ZZ/ TAX(25),TFX(25),CX(25),AX(25),FX(25),                  COMG       2
     +          TY(4,19),Y(4,19),F(19),CAP1,CAP7,CAP8,CAP9,CAP10,DC2,DC3, COMG     3
     +DC85I,DC85,DC21,DC22,DC23,DC26,DC28,DC31,DC33,DC34,DC35,DC25      COMG       4
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI       2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI       3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI       4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI       5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI       6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI       7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI       8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI       9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI      10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI      11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI      12
      DATA PI, CCPIN3, SECDAY, AVOGAD,RR, CONEN/3.14159, 16.387, 86400.,BLKDAT     9
     +6.023E23, 22400., 3.2E-14/                                        BLKDAT    10
      DATA SDOT,SDOTT,EF,MUF,EPSIF,EPSIC/.016,.004,22.E6,.30,.8,.9/     BLKDAT    11
      DATA CAP1,CAP7,CAP8,CAP9,CAP10 /5*3.2E-14/                        BLKDAT    12
      DATA DC2,DC3/4.915E-04,3.413E-06/                                 BLKDAT    13
      DATA DC85I,DC85,DC21,DC22,DC23,DC26,DC28,DC31,DC33,DC34,DC35,DC25/ BLKDAT   14
     +4.375E-05,2.042E-09,6.684E-06,4.620E-04,9.964E-07,9.167E-06,2.873E BLKDAT   15
     +-05,8.370E-05,1.526E-06,7.219E-04,2.092E-05,2.468E-06/            BLKDAT    16
      DATA FRACTN,RVE,POWER,CF,AI,CLCRP,MOL,RV,AA,MOLEFR/374*0.0/       BLKDAT    17
      DATA TITLE,PHICAP,DUM,DELL,Q,TT,CSUBP,DDUM,OMEGA,QIN,VISCOS,BB,   BLKDAT    18
     +CON,DELCT,PCFR,TS,TSR/698*0.0/                                    BLKDAT    19
      DATA TBAR,HGX,RGAPX,XMOLS,SUMOLS,VOLTX,TAVGXX,FXMOL,TCLINE,RDOT,  BLKDAT    20
     +HFLUX,PRESTO,ROP/636*0.0/                                         BLKDAT    21
      DATA SAVNXE,SAVNKR,SUMNXE,SUMNKR,CST,DVBLST,SDVN1,SDVN2,DVBX,DVN1, BLKDAT   22
     +DVN2,DELVB,PITI,DVN3/1400*0.0/                                    BLKDAT    23
      DATA TAX/                                                         BLKDAT    24
     + 2.70E-24, 36.E-24, 60.E-24, 0., 0., 0., 1110.E-24, 290.E-24,     BLKDAT    25
     + 1350.E-24, 693.E-24, 6.E-24, 0., 170.E-24, 1600.E-24, 597.E-24,  BLKDAT    26
     +4*0.,180.E-24, 15.E-24, 85.E-24, 5.E-24, 190.E-24, 2.7E-18/       BLKDAT    27
      DATA TFX/                                                         BLKDAT    28
     + 0., 14.E-24, 0., 0., 0., 0., 740.E-24, 0., 950.E-24, 553.E-24,   BLKDAT    29
     + 0., 0., 0., 0., 17.E-24,10*0.0/                                  BLKDAT    30
      DATA TY/                                                          BLKDAT    31
     +    .00520,   .0     ,   .00290,    .00208,                       BLKDAT    32
     +    .00970,   .0     ,   .00470,    .00341,                       BLKDAT    33
     +    .01300,   .0     ,   .00535,    .00300,                       BLKDAT    34
     +    .0    ,   .0     ,   .0    ,    .0    ,                       BLKDAT    35
     +    .01930,   .0     ,   .00750,    .00400,                       BLKDAT    36
     +    .00440,   .0     ,   .0    ,    .0    ,                       BLKDAT    37
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     +   .02520,  .0    ,  .03700,  .03010,                                 BLKDAT   38
     +   .0    ,  .0    ,  .00090,  .0    ,                                 BLKDAT   39
     +   .0    ,  .0    ,  .0    ,  .0    ,                                 BLKDAT   40
     +   .04330,  .0    ,  .05200,  .04440,                                 BLKDAT   41
     +   .0    ,  .0    ,  .00150,  .00030,                                 BLKDAT   42
     +   .0    ,  .0    ,  .0    ,  .0    ,                                 BLKDAT   43
     +   .06690,  .0    ,  .05300,  .06540,                                 BLKDAT   44
     +   .0    ,  .0    ,  .01200,  .0    ,                                 BLKDAT   45
     +   .07920,  .0    ,  .07470,  .07810,                                 BLKDAT   46
     +   .06170,  .0    ,  .05700,  .07230,                                 BLKDAT   47
     +   .0    ,  .0    ,  .0    ,  .0    ,                                 BLKDAT   48
     +   .00130,  .0    ,  .01510,  .00070,                                 BLKDAT   49
     +   .06460,  .0    ,  .06660,  .07040/                                 BLKDAT   50
      DATA ISTPLM/11/                                                       BLKDAT   51
      DATA WORD1/6HSTOP  /                                                  BLKDAT   52
      DATA ZR/                                                              BLKDAT   53
     +   75.,  7.30,  4.48E4, 1.38E7, .370,   3.24E-6,     9470.,           BLKDAT   54
     +  212.,  7.74,  3.48E4, 1.30E7, .400,   3.47E-6,     7360.,           BLKDAT   55
     +  392.,  8.38,  2.38E4, 1.21E7, .446,   3.70E-6,     5030.,           BLKDAT   56
     +  572.,  9.02,  1.58E4, 1.11E7, .492,   3.87E-6,     3340.,           BLKDAT   57
     +  752.,  9.83,  1.21E4, 1.31E7, .492,   3.99E-6,     2560.,           BLKDAT   58
     +  932., 10.64,  1.00E4, 9.09E6, .492,   4.08E-6,     2110./           BLKDAT   59
C                                                                           BLKDAT   60
C     ZIRC-4 DATA BY D.B. SCOTT (WCAP-3629-41) PAGE 8                       BLKDAT   61
      DATA ZR4/                                                             BLKDAT   62
     +   75.,  7.45,  4.48E4, 1.38E7, .370,   3.24E-6,     9470.,           BLKDAT   63
     +  212.,  7.86,  3.48E4, 1.30E7, .400,   3.47E-6,     7360.,           BLKDAT   64
     +  392.,  8.27,  3.48E4, 1.30E7, .400,   3.47E-6,     7360.,           BLKDAT   65
     +  572.,  8.79,  3.48E4, 1.30E7, .400,   3.47E-6,     7360.,           BLKDAT   66
     +  752.,  9.48,  3.48E4, 1.30E7, .400,   3.47E-6,     7360.,           BLKDAT   67
     +  932., 10.40,  3.48E4, 1.30E7, .400,   3.47E-6,     7360./           BLKDAT   68
      DATA ((ST(I,J),I=1,7),J=1,12)/                                        BLKDAT   69
     +   100.,  8.50,   30.0E3,   28.1E6,   .261,    9.15E-6,   6.34E3,     BLKDAT   70
     +   200.,  8.93,   25.3E3,   27.7E6,   .266,    9.33E-6,   5.35E3,     BLKDAT   71
     +   300.,  9.36,   22.5E3,   27.2E6,   .271,    9.48E-6,   4.76E3,     BLKDAT   72
     +   400.,  9.80,   20.7E3,   26.6E6,   .276,    9.60E-6,   4.36E3,     BLKDAT   73
     +   500., 10.24,   19.3E3,   26.0E6,   .280,    9.71E-6,   4.08E3,     BLKDAT   74
     +   600., 10.68,   18.2E3,   25.4E6,   .285,    9.82E-6,   3.85E3,     BLKDAT   75
     +   700., 11.12,   17.5E3,   24.7E6,   .290,    9.95E-6,   3.70E3,     BLKDAT   76
     +   800., 11.56,   16.9E3,   24.1E6,   .295,   10.08E-6,   3.57E3,     BLKDAT   77
     +   900., 12.00,   16.2E3,   23.4E6,   .300,   10.19E-6,   3.42E3,     BLKDAT   78
     +  1000., 12.44,   15.6E3,   22.6E6,   .304,   10.30E-6,   3.30E3,     BLKDAT   79
     +  1100., 12.87,   14.9E3,   21.8E6,   .309,   10.40E-6,   3.15E3,     BLKDAT   80
     +  1200., 13.32,   14.2E3,   20.9E6,   .314,   10.46E-6,   3.00E3/     BLKDAT   81
      DATA ((TABLE(I,J),I=1,2),J=1,40)/                                     BLKDAT   82
     +.0,2.785,.3,2.785,.35,2.628,.40,2.492,.45,2.368,                      BLKDAT   83
     +.50,2.257,.55,2.156,.60,2.065,.65,1.982,.70,1.908,                    BLKDAT   84
     +.75,1.841,.80,1.780,.85,1.725,.90,1.675,.95,1.629,                    BLKDAT   85
     +1.0,1.587,1.05,1.549,1.10,1.514,1.15,1.482,1.20,1.424,                BLKDAT   86
     +1.25,1.424,1.30,1.399,1.35,1.375,1.40,1.353,1.45,1.333,               BLKDAT   87
     +1.50,1.314,1.55,1.296,1.60,1.279,1.65,1.264,1.70,1.248,               BLKDAT   88
     +1.75,1.234,1.80,1.221,1.85,1.209,1.90,1.197,                          BLKDAT   89
     +1.95,1.186,2.00,1.175,2.10,1.156,2.20,1.138,2.30,1.122,2.4,1.107/     BLKDAT   90
      DATA ((TABLE(I,J),I=1,2),J=41,80)/                                    BLKDAT   91
     +2.50,1.093,2.60,1.081,2.7,1.069,2.8,1.058,2.9,1.048,                  BLKDAT   92
     +3.0,1.039,3.1,1.030,3.2,1.022,3.3,1.014,3.4,1.007,                    BLKDAT   93
     +3.5,.9999,3.6,.9932,3.7,.9870,3.8,.9811,3.9,.9755,                    BLKDAT   94
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```
     +4.0,.9700,4.1,.9649,4.2,.9600,4.3,.9533,4.4,.9507,                 BLKDAT    95
     +4.5,.9464,4.6,.9422,4.7,.9382,4.8,.9343,4.9,.9305,                 BLKDAT    96
     +5.0,.9269,6.0,.8963,7.,.8727,8.,.8538,9.,.8379,                    BLKDAT    97
     +10.,.8242,20.,.7432,30.,.7005,40.,.6718,50.,.6504,                 BLKDAT    98
     +60.,.6335,70.,.6194,80.,.6076,90.,.5973,200.,.5882/                BLKDAT    99
      DATA RTC/1.876E-3,1.699E-3,1.622E-3,1.513E-3,1.429E-3/             BLKDAT   100
      DATA RTCO/2.09E-7,3.8E-7,4.93E-7,7.21E-7,9.48E-7/                  BLKDAT   101
      DATA  GMWT          /4.003,39.944,2.016,28.02,28.01,83.8,131.3/    BLKDAT   102
      DATA  SIGLJ          /2.576,3.418,2.915,3.59,3.681,3.498,4.055/    BLKDAT   103
      DATA  EKLJ          /10.2,124.,38.,91.5,110.3,225.,229./           BLKDAT   104
      DATA ISTOR,XN,XH,XCO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,      BLKDAT   105
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,ROUF,ROUC,EXTP,TINLET      BLKDAT   106
     +,DE,V,ICREP,PRCDH,RADS,NTIME,IGAS,NFUEL,DBO,KB,HBC,SIGHF,          BLKDAT   107
     +        NCLAD,      NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,    BLKDAT   108
     +FRACXE,ICDF,TIME,LVOIDZ,NOH,ZCLAD,MINI,PSEUDO/93*0/                BLKDAT   109
      DATA IT,IDENSF,IRELSE,ICOR,CRUDTH,ZRO2A/25*0/                      BLKDAT   110
      DATA DTEMP/100./,IRELOC/0/,TPLAS/2192./,TM/2790./,IRL/0/           BLKDAT   111
      DATA DTEMP/100./,IRELOC/0/,TPLAS/1200./,TM/2790./,IRL/0/           GAP2       3
      DATA PROFIL/.23,.63,.96,1.21,1.35,1.4,1.35,1.21,.96,.63,.23,10*0., BLKDAT   113
     +294*0./                                                            BLKDAT   114
      END                                                                BLKDAT   115
```

```
      SUBROUTINE AXPRNT (TOTREL,ISTEP)                                  AXPRNT     2
      COMMON /AC/ VOLCC,N1Z,N7Z,N8Z,N10Z,N9Z                            COMA       2
      REAL N1Z,N7Z,N8Z,N10Z                                             COMA       3
      COMMON/AZ/ TBAR(20),VOLTX(20),TCLINE(20),HGX(20)                  COMB       2
     + ,TAVGXX(20),RDOT(15,20),RGAPX(20),ROP(20),HFLUX(20)              COMB       3
     + ,XMOLS(21),FXMOL(7,21),PRESTO     ,SUMOLS(7)                     COMB       4
      COMMON /AF/ TITLE(20),FRUO2,    BB(2,50),PHICAP(7,7),CSUBP(7),    COMC       2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),    COMC       3
     +Q(50),QIN(50),TS(50),TT(50),VISCO8(7),TSR(51),FR38,FR39,GAP,      COMC       4
     +NF,NFUEL,NNN                                                      COMC       5
      COMMON/AD/ JCASE,IPOW,PEAK,P,BURNUP,QOVRAB,KOUNT,G1PG2,           COMD       2
     +QOVRAS,TCOOL,TCOOLC,TBO,TBOC,TBI,TBIC,HF,TCC,TCO,TCOC,N,          COMD       3
     +TCI,TCIC,TFS,TFSC,TMF,DELR,TMELT,RCMELT,TAVGF,TAVGFC,DELRT,       COMD       4
     +DELRB,DELRCI,DELRP,PFACE,HSOLID,PSOLID,HGAS,PGAS,HRAD,PRAD,       COMD       5
     +RSIN,RVOID,RFS,TSIN,TSINC,PCSIN,DSIN,PDSIN,DVOID,PDVOID,VAVGT,    COMD       6
     +XMOTOT,GASKON,G,VAVGTC,RD,QOVRAG,LM,FNPOW,RSINF,RRVOID,QQS,QQU,   COMD       7
     +QTOT,RSINZ,RVOIDZ,T,VVOID,RMELT,GK,ISTOP,DELGD,DELPI,DELRCC,      COMD       8
     +DELRCT,DELRFT,CORR                                                COMD       9
      COMMON/PH/ PSEUDO(15),TIME(15),NTIME,PITI(20),PROFIL(15,21),      COME       2
     +SAVNKR(15,20),SAVNXE(15,20),SUMNKR(15,20),SUMNXE(15,20),CST(20),  COME       3
     +NNKR,NNXE,TVOLAV,VOLGAS,W,NPRFIL,DVBLST(20),DVN3(20),             COME       4
     +SDVN1(20),SDVN2(20),DVBX(20),DVN1(20),DVN2(20),DELVB(20)          COME       5
      REAL NNKR,NNXE                                                    COME       6
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI       2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI       3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI       4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI       5
     +,ICOF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI       6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI       7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI       8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI       9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI      10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI      11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI      12
     (WRITE (6,60)                                                      AXPRNT     9
     (WRITE (6,20) JCASE,TIME(NT)                                       AXPRNT    10
     (WRITE (6,70) TITLE                                                AXPRNT    11
      XL0=-LF*0.5                                                       AXPRNT    12
      WRITE (6,30)                                                      AXPRNT    13
      DO 10 I=1,NPOW                                                    AXPRNT    14
      SDVN1(I)=SDVN1(I)+DVN1(I)                                         AXPRNT    15
      SDVN2(I)=SDVN2(I)+DVN2(I)                                         AXPRNT    16
      DVBX(I)=AMAX1(DVBX(I),DELVB(I))                                   AXPRNT    17
      DVBLST(I)=DELVB(I)                                                AXPRNT    18
      P=(POWER(I)+POWER(I+1))*0.5                                       AXPRNT    19
      XL=XL0+FLOAT(I)*LF                                                AXPRNT    20
      SIXL=XL*0.0254                                                    AXPRNT    21
      SIP=P*3280.84                                                     AXPRNT    22
      SIHFLX=HFLUX(I)*3.15248                                           AXPRNT    23
      SITCLN=(TCLINE(I)-32.)/1.8                                        AXPRNT    24
      SITBAR=(TBAR(I)-32.0)/1.8                                         AXPRNT    25
      SIHGX=HGX(I)*5.678263                                             AXPRNT    26
      SIRGAP=RGAPX(I)*0.0254                                            AXPRNT    27
      WRITE (6,40) SIXL,SIP,SIHFLX,SITCLN,SITBAR,SIHGX,SIRGAP,RDOT(NT,I) AXPRNT   28
     +,FXMOL(1,I)                                                       AXPRNT    29
   10 CONTINUE                                                          AXPRNT    30
C                                                                       AXPRNT    31
```

```
C      PRINT SUMMARY OF AVERAGED TEMP AND PRESSURE.                        AXPRNT     32
       SITAV=(TAVGXX(ISTEP+1)-32.)/1.8                                     AXPRNT     33
       SIPRES=PRESTO*175.1268                                              AXPRNT     34
       WRITE (6,50) SITAV,SIPRES,TOTREL                                    AXPRNT     35
       WRITE (6,80)                                                        AXPRNT     36
       RETURN                                                              AXPRNT     37
C                                                                          AXPRNT     38
    20 FORMAT (# CASE ##,I2,10X,#AXIAL SUMMARY#/1H0,10X,#TIME AT POWER IN AXPRNT     39
      + DAYS #,F10.1)                                                      AXPRNT     40
    30 FORMAT (1H0,35X,#CLAD#,6X,#CENTER#,7X,#AVERAGE#,8X,#GAP#,8X,#RADIA AXPRNT     41
      +L#,/,10X,#AXIAL#,6X,#HEAT#,9X,#SURFACE#,6X,#LINE#,10X,#VOL.#,5X,#C AXPRNT     42
      +ONDUCTANCE#,5X,#HOT#,12X,#GAS#,9X,#MOLE#,/,8X,#DISTANCE#,4X,#RATIN AXPRNT     43
      +G#,7X,#HEAT FLUX#,5X,#TEMP.#,7X,#FUEL TEMP.#,3X,#(W/M2-#,8X,#GAP#, AXPRNT     44
      +10X,#RELEASE#,6X,#FRACTION#,/,8X,#(METERS)#,4X,#(W/M)#,8X,#  (W/M2) AXPRNT     45
      + #,5X,#(DEG.C)#,7X,#(DEG.C)#,6X,# DEG.C)#,5X,#(METERS)#,6X,#FRACTI AXPRNT     46
      +ON#,6X,#HELIUM#,/)                                                  AXPRNT     47
    40 FORMAT (3X,10(3X,1PE10.3))                                          AXPRNT     48
    50 FORMAT (///,40X,#TOTAL PIN CONDITIONS#,/,15X,#-------------------- AXPRNT     49
      +----------------------------------------------#,/,15X,#VOLUME AV AXPRNT     50
      +ERAGED#,15X,#INTERNAL GAS#,15X,#FISSION GAS #,/,17X,#TEMPERATURE#, AXPRNT     51
      +19X,#PRESSURE#,19X,#RELEASE #,/,19X,#(DEG.C)#,23X,#(PA)#,20X,#FRAC AXPRNT     52
      +TION#,//,17X,E10.4,18X,E10.4,17X,E10.4,/////////)                   AXPRNT     53
    60 FORMAT (1H1)                                                        AXPRNT     54
    70 FORMAT (1H0,20A4)                                                   AXPRNT     55
    80 FORMAT (///20X,#TO CONVERT FROM#,8X,#TO THE FOLLOWING#,5X,#MULTIPL AXPRNT     56
      +Y BY#,//,25X,#W/M2#,16X,#BTU/HR-FT2#,10X,#0.3172E+00#,/,25X,#W/M#, AXPRNT     57
      +20X,#KW/FT#,12X,#3.0480E-04#,/,25X,#W/M2-DEG.C#,9X,#BTU/HR-FT2-DEG AXPRNT     58
      +.F#,5X,#0.1761E+00#,/,25X,#PA #,20X,#PSI#,14X,#5.7100E-03#,/,)      AXPRNT     59
       END                                                                 AXPRNT     60
```

```
      SUBROUTINE CARL (TSS,TFS,TT,N,PI,DFS,STORE)
      DIMENSION AREA(50),TVOL(50),HCAT(50)
      DIMENSION TSS(50),TT(50)
      REAL K1,K2,K3
      DO 10 I=1,N
   10 AREA(I)=((TSS(I)**2-TSS(I+1)**2)*PI)
      TVOL(1)=((((TFS+TT(1))*.5)-32.)/1.8)+273.
      DO 20 I=2,N
   20 TVOL(I)=((((TT(I)+TT(I-1))*.5)-32.)/1.8)+273.
      TKEL=535.285
      ED=37.6946
      K1=19.1450
      K2=.000784733
      K3=5643730.0
      R=.001986
      CL=1.0
      STORE=0.
      DO 30 I=1,N
      TEMPK=TVOL(I)
      HCAT(I)=CL*(K2*(TEMPK**2-298.**2)+K3*EXP(-ED/R/TEMPK)+K1*TKEL*(1./
     +(EXP(TKEL/TEMPK)-1.)-1./(EXP(TKEL/298.)-1.)))
      STORE=STORE+HCAT(I)*AREA(I)
   30 CONTINUE
      STORE=STORE*4./(PI*DFS**2)
C
C       WE NOW HAVE STORE IN CAL/MOLE OF U O2.
C     NOW CONVERT IT TO CAL./GRAM OF U.O2
      STORE=STORE/270.
      RETURN
      END
```

```
      SUBROUTINE CORROS (ICOR,QC,T,TCO,TP,ZRO2A,DTEMP)                  CORROS  2
      IF (TCO.LE.200.0) GO TO 70                                        CORROS  3
      ACOR=1.                                                           CORROS  4
      KOXI=0                                                            CORROS  5
      TCOK=(TCO+460.)/1.8                                               CORROS  6
      ZOTCON=1.9599-2.41E-4*TCOK+6.43E-7*TCOK**2.-1.946E-10*TCOK**3     CORROS  7
      ZOXK=ZOTCON/1.7296                                                CORROS  8
      IF (ICOR.GE.3) GO TO 10                                           CORROS  9
      WTRAN=6.75E-6                                                     CORROS 10
      WGK1=0.709875E-3                                                  CORROS 11
      WACT1=6906.6                                                      CORROS 12
      WGK2=40.05                                                        CORROS 13
      WACT2=23141.0                                                     CORROS 14
      GO TO 20                                                          CORROS 15
   10 WTRAN=26.9029E-6*EXP(-1422./(TCO+QC*ZRO2A/ZOXK+460.))             CORROS 16
      WGK1=5.927E-3                                                     CORROS 17
      WACT1=9396.0                                                      CORROS 18
      WGK2=5.03062E+2                                                   CORROS 19
      WACT2=25920.0                                                     CORROS 20
   20 IF (ZRO2A.GT.WTRAN) GO TO 50                                      CORROS 21
      DO 30 I=1,5                                                       CORROS 22
   30 OXIDE1=WGK1*EXP(-WACT1/(TCO+QC*OXIDE1/ZOXK+460.))*(TP)**0.3*ACOR** CORROS 23
     +0.3                                                               CORROS 24
      DO 40 I=1,5                                                       CORROS 25
   40 OXIDE2=WGK1*EXP(-WACT1/(TCO+QC*OXIDE2/ZOXK+460.))*(T)**0.3*ACOR**0 CORROS 26
     +.3                                                                CORROS 27
      ZROXB=ZRO2A+OXIDE2-OXIDE1                                         CORROS 28
      IF (ZROXB.LE.WTRAN) GO TO 70                                      CORROS 29
      KOXI=1                                                            CORROS 30
      OXIDE3=ZROXB                                                      CORROS 31
   50 CONTINUE                                                          CORROS 32
      DELTOX=0.0                                                        CORROS 33
      DELH=T-TP                                                         CORROS 34
      DO 60 I=1,5                                                       CORROS 35
      OXIDE=ZRO2A+DELTOX                                                CORROS 36
   60 DELTOX=WGK2*EXP(-WACT2/(TCO+QC*OXIDE/ZOXK+460.))*DELH*ACOR        CORROS 37
      ZROXB=ZRO2A+DELTOX                                                CORROS 38
      IF (KOXI.EQ.0) GO TO 70                                           CORROS 39
      ZRO2A=(OXIDE3-WTRAN)*(ZROXB-OXIDE3)/(OXIDE3-ZRO2A)+OXIDE3         CORROS 40
   70 CONTINUE                                                          CORROS 41
      DTEMP=QC*ZRO2A/ZOXK                                               CORROS 42
      RETURN                                                            CORROS 43
      END                                                               CORROS 44
```

```
          SUBROUTINE DENSF (DELPI,DFS,ROW,ROWS,BN)                      DESN1    2
C         DELRHO=M*ALOG(BU)+B                                           DESN1    3
C         ALOG5=1.6094                                                  DESN1    4
C         ALOG 20=2.996                                                 DESN1    5
C         ALOG 2000=7.601                                               DESN1    6
          BU=BN                                                         DESN1    7
          DELPI=0.                                                      DESN1    8
          IF (BU.LE.20) GO TO 30                                        DESN1    9
          IF (ROWS.LE.ROW) GO TO 30                                     DESN1   10
          DR=ROWS-ROW                                                   DESN1   11
          IF (BU.GT.2000) BU=2000.                                      DESN1   12
          IF (ROW.GT.10.08) GO TO 10                                    DESN1   13
          DELR=0.1669*ALOG(BU/5.)*DR                                    DESN1   14
          GO TO 20                                                      DESN1   15
       10 DELR=0.2171*DR*ALOG(BU/20)                                    DESN1   16
       20 DELPI=-DELR*DFS/4./ROW                                        DESN1   17
       30 RETURN                                                        DESN1   18
          END                                                           DESN1   19
```

```
      SUBROUTINE DEPRES                                                 DEPRES    2
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI      2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI      3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI      4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI      5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI      6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI      7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI      8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI      9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI     10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI     11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI     12
      DATA SIGA5,SIGA8,SIGAO,SIGT5,SIGT8,SIGTO/578.,2.33,0.,586.5,10.8, DEPRES    4
     +4.2/                                                              DEPRES    5
      FR38=1.-FR35                                                      DEPRES    6
      EN5=RHO*FR35*.00225927                                            DEPRES    7
      EN8=RHO*FR38*.00223079                                            DEPRES    8
      ENO=(EN5+EN8)*2.                                                  DEPRES    9
      SGA=(EN5*SIGA5+EN8*SIGA8+ENO*SIGAO)                               DEPRES   10
      SGT=(EN5*SIGT5+EN8*SIGT8+ENO*SIGTO)                               DEPRES   11
      CAPSQ=3.*SGA*SGT/(1.-.8*SGA/SGT)                                  DEPRES   12
      CAPPA=SQRT(CAPSQ)                                                 DEPRES   13
      IZ=11                                                             DEPRES   14
      RV(1,1)=0.                                                        DEPRES   15
      RV(2,1)=1.                                                        DEPRES   16
      IF (IRL.GT.0) IZ=IRL+1                                            DEPRES   17
      DO 10 I=2,IZ                                                      DEPRES   18
      RV(1,I)=RV(1,I-1)+DFS/10.                                         DEPRES   19
      R=RV(1,I)*2.54/4.*CAPPA                                           DEPRES   20
   10 RV(2,I)=1.+R**2+R**4/4.+R**6/36.+R**8/576.                        DEPRES   21
      IF (IRL.GT.0) GO TO 20                                            DEPRES   22
      RETURN                                                            DEPRES   23
   20 DO 30 I=1,IRL                                                     DEPRES   24
      RVE(1,I)=(RV(1,I)+RV(1,I+1))*.5                                   DEPRES   25
   30 RVE(2,I)=(RV(2,I)+RV(2,I+1))*.5                                   DEPRES   26
      RETURN                                                            DEPRES   27
      END                                                               DEPRES   28
```

```
      SUBROUTINE EXPAND (RFS,RD,TT,TFS,DELRT,DELCT,DELL)              EXPAND  2
      DIMENSION TT(50),DELCT(50),DELL(50)                             EXPAND  3
      TA(T1,T2)=((T1+T2)/2.-32.)/1.8                                  EXPAND  4
      DELRT=0.                                                        EXPAND  5
      DO 10 I=1,50                                                    EXPAND  6
      DELL(I)=0.                                                      EXPAND  7
   10 DELCT(I)=0.                                                     EXPAND  8
      DO 40 I=1,50                                                    EXPAND  9
      RIN=RFS-RD*I                                                    EXPAND 10
      RON=RIN+RD                                                      EXPAND 11
      IF (I.GT.1) GO TO 20                                            EXPAND 12
      TAC=TA(TFS,TT(1))                                               EXPAND 13
      GO TO 30                                                        EXPAND 14
   20 TAC=TA(TT(I-1),TT(I))                                           EXPAND 15
   30 CONTINUE                                                        EXPAND 16
      CST=2.896E-9*(TAC**2-25.**2)+6.797E-6*(TAC-25.)                 EXPAND 17
      RAVG=(RIN+RON)*.5                                               EXPAND 18
      DELCT(I)=CST*RAVG                                               EXPAND 19
      DELL(I)=CST*RD                                                  EXPAND 20
   40 CONTINUE                                                        EXPAND 21
      BIG=ABS(DELCT(1))                                               EXPAND 22
      L=1                                                             EXPAND 23
      DO 60 I=2,50                                                    EXPAND 24
      AB=ABS(DELCT(I))                                                EXPAND 25
      IF (AB-BIG) 60,60,50                                            EXPAND 26
   50 BIG=ABS(DELCT(I))                                               EXPAND 27
      L=I                                                             EXPAND 28
   60 CONTINUE                                                        EXPAND 29
      DO 70 I=1,L                                                     EXPAND 30
   70 DELRT=DELRT+DELL(I)                                             EXPAND 31
      DELRT=DELRT-DELL(L)/2.+DELCT(L)                                 EXPAND 32
      RETURN                                                          EXPAND 33
      END                                                             EXPAND 34
```

```
      SUBROUTINE FISGAS (TIN,P,EPSP,KFC,MTIME,IPOW,NT1)                 FISGAS   2
C                                                                       FISGAS   3
C      SUBROUTINE FISGAS IS USED TO CALCULATE THE AMOUNT                FISGAS   4
C      OF FISSION GAS PRODUCED FOR A GIVEN TIME AND POWER.              FISGAS   5
C      CALCULATIONS ARE BASED ON TWO MODELS.  THE FIRST ASSUMES         FISGAS   6
C      A PRIMARILY FAST SPECTRUM,  AND THE SECOND ASSUMES A             FISGAS   7
C      THERMAL SPECTRUM.                                                FISGAS   8
C                                                                       FISGAS   9
C                  FISGAS MODIFICATIONS                  11-2-73  JLC   FISGAS  10
C        SOLUTIONS OF EQUATIONS HAVE BEEN REFORMULATED.  FUEL ISOTOPE   FISGAS  11
C      EQUATIONS ARE A SHORTENED SET FROM EARLIER VERSION OF FISGAS,    FISGAS  12
C      EXPLICITLY INCLUDING ONLY U235, U238, PU239, PU240, PU241, AND   FISGAS  13
C      NP239.                                                           FISGAS  14
C        FLUX IS ASSUMED CONSTANT IN EACH TIME STEP.  BY DEFAULT OPTION, FISGAS 15
C      FLUX IS RECALCULATED WITH FUEL COMPOSITION AT END OF INPUT STEP  FISGAS  16
C      AND IS SUBDIVIDED SO THAT RELATIVE CHANGE IN FLUX IS LESS THAN A FISGAS  17
C      SPECIFIED QUANTITY,  EPSP.  TO OVERRIDE THIS OPTION AND THUS KEEP FISGAS 18
C      FLUX AT ITS T=0 VALUE, SET  KFC=1.                               FISGAS  19
C        THE CODING HAS PROVISIONS FOR A MIXED THERMAL-FAST SPECTRUM AND FISGAS 20
C      FOR ISOTOPE DEPENDENCE OF ENERGY PER FISSION.                    FISGAS  21
      COMMON /AC/ VOLCC,N1Z,N7Z,N8Z,N10Z,N9Z                            COMA     2
      REAL N1Z,N7Z,N8Z,N10Z                                             COMA     3
      COMMON/PH/ PSEUDO(15),TIME(15),NTIME,PITI(20),PROFIL(15,21),      COME     2
     +SAVNKR(15,20),SAVNXE(15,20),SUMNKR(15,20),SUMNXE(15,20),CST(20),  COME     3
     +NNKR,NNXE,TVOLAV,VOLGAS,W,NPRFIL,DVBLST(20),DVN3(20),             COME     4
     +SDVN1(20),SDVN2(20),DVBX(20),DVN1(20),DVN2(20),DELVB(20)          COME     5
      REAL NNKR,NNXE                                                    COME     6
      COMMON/ZZ/ TAX(25),TFX(25),CX(25),AX(25),FX(25),                  COMG     2
     +         TY(4,19),Y(4,19),F(19),CAP1,CAP7,CAP8,CAP9,CAP10,DC2,DC3, COMG    3
     +DC85I,DC85,DC21,DC22,DC23,DC26,DC28,DC31,DC33,DC34,DC35,DC25      COMG     4
      REAL N1,N3,N7,N8,N9,N10                                           FISGAS  25
      IF (MTIME.GT.0) GO TO 40                                          FISGAS  26
      C103=0.0                                                          FISGAS  27
      C104=0.0                                                          FISGAS  28
      C106=0.0                                                          FISGAS  29
      C107=0.0                                                          FISGAS  30
      C108=0.0                                                          FISGAS  31
      C109=0.0                                                          FISGAS  32
      C110=0.0                                                          FISGAS  33
      C111=0.0                                                          FISGAS  34
      C112=0.0                                                          FISGAS  35
      C113=0.0                                                          FISGAS  36
      C114=0.0                                                          FISGAS  37
      C116=0.0                                                          FISGAS  38
      C117=0.0                                                          FISGAS  39
      C118=0.0                                                          FISGAS  40
      N1=N1Z                                                            FISGAS  41
      N3=0.                                                             FISGAS  42
      N7=N7Z                                                            FISGAS  43
      N8=N8Z                                                            FISGAS  44
      N9=N9Z                                                            FISGAS  45
      N10=N10Z                                                          FISGAS  46
      EPS=.0000001                                                      FISGAS  47
      KSAT=0                                                            FISGAS  48
      LSAT=0                                                            FISGAS  49
      MSAT=0                                                            FISGAS  50
      NSAT=1                                                            FISGAS  51
```

```
      KFS=0
      TPREV=0.
      NNKR=0.
      NNXE=0.
      DO 10 I=1,25
      AX(I)=TAX(I)
   10 FX(I)=TFX(I)
      DO 20 I=1,15
   20 CX(I)=AX(I)-FX(I)
      DO 30 I=1,4
      DO 30 J=1,19
   30 Y(I,J)=TY(I,J)
      X103=DC85I
      X106=DC21
      X107=DC22
      X108=DC23
      X110=DC25
      X111=DC31
      X113=DC26
      X116=DC28
      X117=DC34
   40 CONTINUE
      T=TIN-TPREV
      IT=0
      IF (KFC.EQ.1) IT=1
      NT=1
C
C     CONVERT POWER FROM KW/FT TO KW/INCH
      PFORIN=P/12.
   50 CONTINUE
      IF (KFS.EQ.1) GO TO 60
      PHI=PFORIN/(CAP1*N1*FX(1)+CAP7*N7*FX(7)+CAP8*N8*FX(8)+CAP9*N9*FX(9
     +)+CAP10*N10*FX(10))
      CST(IPOW)=PHI/P
      KFS=1
C
C        CALCULATION FOR FUEL ISOTOPES
   60 CONTINUE
      PHI=CST(IPOW)*P
      X1=PHI*AX(1)
      X2=PHI*AX(2)+DC2
      X3=PHI*AX(3)+DC3
      X7=PHI*AX(7)
      X8=PHI*AX(8)
      X9=PHI*AX(9)
      X10=PHI*AX(10)
      A1=CX(1)/AX(1)
      B2=DC2/X2
      A3=CX(3)*PHI/X3
      B3=DC3/X3
      A7=CX(7)/AX(7)
      A8=CX(8)/AX(8)
   70 CONTINUE
      TN1=N1*EXP(-X1*T)
      TN10=N10*EXP(-X10*T)
      G1=A1*X1/(X1-X2)*B2*X2/(X1-X3)
      C3=-G1*N1+N3
```

```
      TC3=C3*EXP(-X3*T)
      TN3=TC3+G1*TN1
      IF (P.LE.0.) G1=0.
      IF (P.GT.0.) G1=B3*X3/(X1-X7)*G1
      G3=B3*X3/(X3-X7)
      C7=G1*N1+G3*C3+N7
      TC7=C7*EXP(-X7*T)
      TN7=TC7-G1*TN1-G3*TC3
      IF (P.LE.0.) G1=0.
      IF (P.GT.0.) G1=A7*X7/(X1-X8)*G1
      G3=A7*X7/(X3-X8)*G3
      G7=A7*AX(7)/(AX(7)-AX(8))
      C8=-G1*N1-G3*C3+G7*C7+N8
      TC8=C8*EXP(-X8*T)
      TN8=TC8+G1*TN1+G3*TC3-G7*TC7
      G1=A8*AX(8)/(AX(1)-AX(9))*G1
      G3=A8*X8/(X3-X9)*G3
      G7=A8*AX(8)/(AX(7)-AX(9))*G7
      G8=A8*AX(8)/(AX(8)-AX(9))
      C9=G1*N1+G3*C3-G7*C7+G8*C8+N9
      TC9=C9*EXP(-X9*T)
      TN9=TC9-G1*TN1-G3*TC3+G7*TC7-G8*TC8
      IF (IT.GT.0) GO TO 90
      PHIP=PFORIN/(CAP1*TN1*FX(1)+CAP7*TN7*FX(7)+CAP8*TN8*FX(8)+CAP9*TN9
     +*FX(9)+CAP10*TN10*FX(10))
      RPHI=ABS((PHIP-PHI)/PHI)
      IF (RPHI.LT.EPSP) GO TO 80
      NT=NT*2
      T=T/2.
      GO TO 70
   80 CONTINUE
      IT=1
   90 CONTINUE
      DO 100 J=1,19
      F(J)=PHI*(FX(10)*N10Z*Y(1,J)+FX(1)*N1Z*Y(2,J)+FX(7)*N7Z*Y(3,J)+FX(
     +9)*N9Z*Y(4,J))
  100 CONTINUE
      N1=TN1
      N3=TN3
      N7=TN7
      N8=TN8
      N9=TN9
      N10=TN10
      A3=0.21
      A6=0.18
      A16=0.3
      X104=PHI*AX(21)+DC85
      X109=PHI*AX(22)
      X112=PHI*AX(23)
      X114=PHI*AX(24)+DC33
      X118=PHI*AX(25)+DC35
C
C        CALCULATION FOR KRYPTON ISOTOPES
      A4=PHI*AX(21)/X104
      DNKR=(F(1)+F(2)+A4*(A3*F(3)+F(4))+F(5))*T
      B3=A3*X103/(X103-X104)
      DC=((B3*F(3)+F(4))/X104-C104)*OMEXP(X104*T)
```

```
      DNKR=DNKR+(1.-A4)*DC                                              FISGAS   166
      C104=C104+DC                                                      FISGAS   167
      IF (KSAT.EQ.1) GO TO 110                                          FISGAS   168
      DC=(F(3)/X103-C103)*OMEXP(X103*T)                                 FISGAS   169
      DCOR=(1.-A3*A4-B3*(1.-A4))*DC                                     FISGAS   170
      IF (ABS(DCOR).LT.ABS(EPS*DNKR)) KSAT=KSAT+1                       FISGAS   171
      DNKR=DNKR+DCOR                                                    FISGAS   172
      C103=C103+DC                                                      FISGAS   173
  110 CONTINUE                                                          FISGAS   174
      SAVNKR(NT1,IPOW)=NNKR+DNKR                                        FISGAS   175
      NNKR=SAVNKR(NT1,IPOW)                                             FISGAS   176
C                                                                       FISGAS   177
C        CALCULATION FOR XENON ISOTOPES                                 FISGAS   178
      A14=PHI*AX(24)/X114                                               FISGAS   179
      A18=PHI*AX(25)/X118                                               FISGAS   180
C                                                                       FISGAS   181
C        LINEAR CHANGE WITH TIME                                        FISGAS   182
      DNXE=(A14*(F(13)+F(14))+F(15)+A18*(F(16)+F(17)+F(18))+F(19))*T    FISGAS   183
C                                                                       FISGAS   184
C        CONTRIBUTION OF XE132 TRANSMUTATION RATE                       FISGAS   185
      PC1=X111/(X111-X112)*(F(11)+X110/(X110-X112)*F(10))               FISGAS   186
      FAC=1.0                                                           FISGAS   187
      IF ((X109-X112).NE.0.) FAC=X109/(X109-X112)                       FISGAS   188
      PC2=FAC*(F(9)+X108/(X108-X112)*(F(8)+X107/(X107-X112)*F(7)+(1.+A6* FISGAS   189
     +X112/(X107-X112))*X106/(X106-X112)*F(6)))                         FISGAS   190
      FAC=T                                                             FISGAS   191
      IF (X112*T.NE.0) FAC=OMEXP(X112*T)/X112                           FISGAS   192
      DC=(PC1+PC2+F(12)-X112*C112)*FAC                                  FISGAS   193
      C112=C112+DC                                                      FISGAS   194
      DNXE=DNXE+DC                                                      FISGAS   195
C                                                                       FISGAS   196
C        CONTRIBUTION OF XE131 TRANSMUTATION RATE                       FISGAS   197
      PC1=X108/(X108-X109)*(F(8)+X107/(X107-X109)*F(7)+(1.+A6*X109/(X107 FISGAS   198
     +-X109))*X106/(X106-X109)*F(6))                                    FISGAS   199
      FAC=T                                                             FISGAS   200
      IF (X109*T.NE.0.) FAC=OMEXP(X109*T)/X109                          FISGAS   201
      DC=(PC1+F(9)-X109*C109)*FAC                                       FISGAS   202
      IF ((X109-X112).NE.0.) DNXE=DNXE-X112/(X109-X112)*DC              FISGAS   203
      C109=C109+DC                                                      FISGAS   204
C                                                                       FISGAS   205
C                                                                       FISGAS   206
C        CORRECTION FOR RAPIDLY SATURATING CONTRIBUTIONS                FISGAS   207
      COR=0.                                                            FISGAS   208
      IF (LSAT.EQ.1) GO TO 120                                          FISGAS   209
      DC=((X116/(X116-X118)*(1.+A16*X118/(X117-X118))*F(16)+X117/(X117-X FISGAS   210
     +118)*F(17)+F(18))/X118-C118)*OMEXP(X118*T)                        FISGAS   211
      DCOR=(1.-A18)*DC                                                  FISGAS   212
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) LSAT=LSAT+1                       FISGAS   213
      C118=C118+DC                                                      FISGAS   214
      COR=COR+DCOR                                                      FISGAS   215
  120 CONTINUE                                                          FISGAS   216
      IF (MSAT.EQ.1) GO TO 130                                          FISGAS   217
      DC=((X113/(X113-X114)*F(13)+F(14))/X114-C114)*OMEXP(X114*T)       FISGAS   218
      DCOR=(1.-A14)*DC                                                  FISGAS   219
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) MSAT=MSAT+1                       FISGAS   220
      C114=C114+DC                                                      FISGAS   221
      COR=COR+DCOR                                                      FISGAS   222
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  130 CONTINUE
      NN=MINO(NSAT,9)
      NSAT=NN
      IF (NN.GT.8) GO TO 220
      GO TO (140,150,160,170,180,190,200,210), NN
  140 CONTINUE
      DC=((A16*X116/(X116-X117)*F(16)+F(17))/X117-C117)*OMEXP(X117*T)
      DCOR=-(1.-A18)*X118/(X117-X118)*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C117=C117+DC
      COR=COR+DCOR
  150 CONTINUE
      DC=((A6*X106/(X106-X107)*F(6)+F(7))/X107-C107)*OMEXP(X107*T)
      DCOR=-X107/(X107-X108)*X108/(X107-X109)*(X109/(X107-X112)-1.)*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C107=C107+DC
      COR=COR+DCOR
  160 CONTINUE
      DC=((X110/(X110-X111)*F(10)+F(11))/X111-C111)*OMEXP(X111*T)
      DCOR=-X111/(X111-X112)*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C111=C111+DC
      COR=COR+DCOR
  170 CONTINUE
      DC=(F(16)/X116-C116)*OMEXP(X116*T)
      B16=A16*X116/(X116-X117)
      DCOR=-(A18+(1.-A18)*(X116/(X116-X118)*(1.-B16)+B16))*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C116=C116+DC
      COR=COR+DCOR
  180 CONTINUE
      DC=(F(13)/X113-C113)*OMEXP(X113*T)
      DCOR=-(A14+(1.-A14)*X113/(X113-X114))*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C113=C113+DC
      COR=COR+DCOR
  190 CONTINUE
      DC=(F(6)/X106-C106)*OMEXP(X106*T)
      DCOR=-X106/(X106-X108)*X108/(X106-X109)*(1.-A6*X106/(X106-X107))*(
     +X109/(X106-X112)-1.)*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C106=C106+DC
      COR=COR+DCOR
  200 CONTINUE
      DC=(F(10)/X110-C110)*OMEXP(X110*T)
      DCOR=X110/(X110-X111)*X111/(X110-X112)*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C110=C110+DC
      COR=COR+DCOR
  210 CONTINUE
      DC=((X106/(X106-X108)*(1.+A6*X108/(X107-X108))*F(6)+X107/(X107-X10
     +8)*F(7)+F(8))/X108-C108)*OMEXP(X108*T)
      DCOR=(X108/(X108-X109)*(X109/(X108-X112)-1.))*DC
      IF (ABS(DCOR).LT.ABS(EPS*DNXE)) NSAT=NSAT+1
      C108=C108+DC
      COR=COR+DCOR
      DNXE=DNXE+COR
```

```
  220 CONTINUE                                                   FISGAS     280
      SAVNXE(NT1,IPOW)=NNXE+DNXE                                 FISGAS     281
      NNXE=SAVNXE(NT1,IPOW)                                      FISGAS     282
      NT=NT-1                                                    FISGAS     283
      IF (NT.EQ.0) GO TO 230                                     FISGAS     284
      IF (KFC.EQ.1) GO TO 60                                     FISGAS     285
      KFS=0                                                      FISGAS     286
      GO TO 50                                                   FISGAS     287
  230 CONTINUE                                                   FISGAS     288
      TPREV=TIN                                                  FISGAS     289
      RETURN                                                     FISGAS     290
      END                                                        FISGAS     291
```

```
      SUBROUTINE FISSES                                                 FISSES      2
      COMMON /AC/ VOLCC,N1Z,N7Z,N8Z,N10Z,N9Z                            COMA        2
      REAL N1Z,N7Z,N8Z,N10Z                                             COMA        3
      COMMON/AZ/ TBAR(20),VOLTX(20),TCLINE(20),HGX(20)                  COMB        2
     + ,TAVGXX(20),RDOT(15,20),RGAPX(20),ROP(20),HFLUX(20)              COMB        3
     + ,XMOLS(21),FXMOL(7,21),PRESTO     ,SUMOLS(7)                     COMB        4
      COMMON /AF/ TITLE(20),FRUO2,   BB(2,50),PHICAP(7,7),CSUBP(7),     COMC        2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),    COMC        3
     +Q(50),QIN(50),TS(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,      COMC        4
     +NF,NFUEL,NNN                                                      COMC        5
      COMMON/PH/ PSEUDO(15),TIME(15),NTIME,PITI(20),PROFIL(15,21),      COME        2
     +SAVNKR(15,20),SAVNXE(15,20),SUMNKR(15,20),SUMNXE(15,20),CST(20),  COME        3
     +NNKR,NNXE,TVOLAV,VOLGAS,W,NPRFIL,DVBLST(20),DVN3(20),             COME        4
     +SDVN1(20),SDVN2(20),DVBX(20),DVN1(20),DVN2(20),DELVB(20)          COME        5
      REAL NNKR,NNXE                                                    COME        6
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI        2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI        3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI        4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOM,HGACEL,ZCLAD,MINI,LVOIDZ         COMI        5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI        6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI        7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI        8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI        9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI       10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI       11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI       12
C                                                                       FISSES      8
C     INITIALIZE (P*T) FOR EACH AXIAL NODE, FOR BURNUP CALC.            FISSES      9
      NPOW1=NPOW+1                                                      FISSES     10
      DO 10 IPOW=1,NPOW                                                 FISSES     11
   10 PITI(IPOW)=0.                                                     FISSES     12
C                                                                       FISSES     13
C     SET UP LOOPS TO COMPUTE GAS RELEASE AT EACH NODE FOR EACH TIME STE FISSES    14
      DO 70 IPOW=1,NPOW                                                 FISSES     15
      SAVNKR(1,IPOW)=0.                                                 FISSES     16
      SAVNXE(1,IPOW)=0.                                                 FISSES     17
      TDAYS=0.                                                          FISSES     18
      MTIME=-1                                                          FISSES     19
      DO 60 NT=2,NTIME                                                  FISSES     20
      NTT=MAX0(NT-1,1)                                                  FISSES     21
      IF (NPRFIL.EQ.1) NTT=1                                            FISSES     22
      DO 20 NP=1,NPOW1                                                  FISSES     23
   20 POWER(NP)=PROFIL(NP,NTT)                                          FISSES     24
      IF (IPEAK) 30,40,30                                               FISSES     25
   30 CONTINUE                                                          FISSES     26
      PAVRG=PSEUDO(NT)                                                  FISSES     27
      GO TO 50                                                          FISSES     28
   40 PKPOWR=PSEUDO(NT)                                                 FISSES     29
   50 CALL POWDIS (PKPOWR,PAVRG)                                        FISSES     30
      TDAYS=TDAYS+(TIME(NT)-TIME(NT-1))                                 FISSES     31
      T=TDAYS*SECDAY                                                    FISSES     32
      RDOT(NT,IPOW)=0.0                                                 FISSES     33
      MTIME=MTIME+1                                                     FISSES     34
      P=0.5*(POWER(IPOW)+POWER(IPOW+1))                                 FISSES     35
      CALL FISGAS (T,P,0.,1,MTIME,IPOW,NT)                              FISSES     36
   60 CONTINUE                                                          FISSES     37
   70 CONTINUE                                                          FISSES     38
```

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      RETURN                                                         FISSES     39
      END                                                            FISSES     40
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      SUBROUTINE GASREL (IPOW,LSTHIF,CORR,RVOID,N,BURNUP,TFS,RTM)        GASREL     2
      COMMON /AC/ VOLCC,N1Z,N7Z,N8Z,N10Z,N9Z                             COMA       2
      REAL N1Z,N7Z,N8Z,N10Z                                              COMA       3
      COMMON/AZ/ TBAR(20),VOLTX(20),TCLINE(20),HGX(20)                   COMB       2
     + ,TAVGXX(20),RDOT(15,20),RGAPX(20),ROP(20),HFLUX(20)               COMB       3
     + ,XMOLS(21),FXMOL(7,21),PRESTO     ,SUMOLS(7)                      COMB       4
      COMMON /AF/ TITLE(20),FRUO2,    BB(2,50),PHICAP(7,7),CSUBP(7),     COMC       2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),     COMC       3
     +Q(50),QIN(50),T8(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,       COMC       4
     +NF,NFUEL,NNN                                                       COMC       5
      COMMON/PH/ PSEUDO(15),TIME(15),NTIME,PITI(20),PROFIL(15,21),       COME       2
     +SAVNKR(15,20),SAVNXE(15,20),SUMNKR(15,20),SUMNXE(15,20),CST(20),   COME       3
     +NNKR,NNXE,TVOLAV,VOLGAS,W,NPRFIL,DVBLST(20),DVN3(20),              COME       4
     +SDVN1(20),SDVN2(20),DVBX(20),DVN1(20),DVN2(20),DELVB(20)           COME       5
      REAL NNKR,NNXE                                                     COME       6
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,      COMI       2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP          COMI       3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),      COMI       4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ          COMI       5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,   COMI       6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,     COMI       7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)     COMI       8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)   COMI       9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),       COMI      10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE  COMI      11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                   COMI      12
      REAL LR,LGSR                                                       GASREL     8
C                                                                        GASREL     9
C     LSTHIF=LAST HIGHEST RELEASED FRACTION                              GASREL    10
      DIMENSION LSTHIF(20)                                               GASREL    11
      DIMENSION SVT(9),TD(9)                                             GASREL    12
      DATA SVT/1800.,1200.,850.,570.,300.,160.,75.,27.,7.5/              GASREL    13
      DATA TD/.91,.92,.93,.94,.95,.96,.97,.98,.99/                       GASREL    14
      DATA VOL,LR/2.E-21,7.E-4/                                          GASREL    15
      LGSR=0.                                                            GASREL    16
      ATPRC=BURNUP/9390.                                                 GASREL    17
      SVI=TEPP(FRDEN,SVT,TD,9)                                           GASREL    18
      FT=2.604E16*FRDEN*BURNUP                                           GASREL    19
      VFT=VOL*FT                                                         GASREL    20
      IF (BURNUP.LT.20000.) GO TO 10                                     GASREL    21
      SV=SVI*.1938*(EXP(.9391*ATPRC))                                    GASREL    22
      GO TO 20                                                           GASREL    23
   10 CONTINUE                                                           GASREL    24
      SV=SVI                                                             GASREL    25
   20 CONTINUE                                                           GASREL    26
      R1200=TERP(2192.,BB,2,N,2)                                         GASREL    27
      R1700=TERP(3092.,BB,2,N,2)                                         GASREL    28
      R1400=TERP(2552.,BB,2,N,2)                                         GASREL    29
      R1214=.5*(R1200+R1400)                                             GASREL    30
      R1417=.5*(R1400+R1700)                                             GASREL    31
      R17=.5*(R1700+RTM)                                                 GASREL    32
      RFS=DFS/2.                                                         GASREL    33
      XSRF12=(RFS**2-R1200**2)/(RFS**2-RVOID**2)                         GASREL    34
      X1214=(R1200**2-R1400**2)/(RFS**2-RVOID**2)                        GASREL    35
      X1417=(R1400**2-R1700**2)/(RFS**2-RVOID**2)                        GASREL    36
      X17=(R1700**2-RTM**2)/(RFS**2-RVOID**2)                            GASREL    37
      D1214=2*R1214                                                      GASREL    38
```

```
      D1417=2*R1417
      D17=2*R17
      XRTM=0.
      IF (RTM.LE.RVOID) GO TO 30
      XRTM=(RTM**2-RVOID**2)/(RFS**2-RVOID**2)
      RTMA=.5*(RTM+RVOID)
      DTM=2.*RTMA
      RATRM=TERP(DTM,RV,2,NF,2)
   30 CONTINUE
      RAT12=TERP(D1214,RV,2,NF,2)
      RAT14=TERP(D1417,RV,2,NF,2)
      RAT17=TERP(D17,RV,2,NF,2)
      F1417=X1417*RAT14*CORR
      F17=X17*RAT17*CORR
      IF (BURNUP.LE.0) GO TO 40
      LGSR=SV*LR*(.75-(3./VFT)*(1.-EXP(-VFT/4)))
   40 CONTINUE
      RDOT(NT,IPOW)=(.05*X1214*RAT12+.141*X1417*RAT14+.807*X17*RAT17+1.0
     +*XRTM*RATRM)*CORR+LGSR*XSRF12*CORR
      IF (IGAS.EQ.0) GO TO 50
      RDOT(NT,IPOW)=RDOT(NT,IPOW)+1.68*(.002112+.0052*F1417**2-(.00269*F
     +1417*F17)+.00217*F17**2)**.5+LGSR
   50 CONTINUE
      SUM6=0.0
      SUM7=0.0
      NX=NT-1
      IF (NT.EQ.1) GO TO 80
      IF (RDOT(NT,IPOW).LE.RDOT(NX,IPOW)) GO TO 70
      LSL=LSTHIF(IPOW)
      N1X=NX
      L=0
      DO 60 NLL=LSL,N1X
      L=L+1
      NL=N1X-L
      IF (RDOT(NT,IPOW).GE.RDOT(NL,IPOW)) GO TO 60
      NX=NL
      GO TO 70
   60 CONTINUE
      NX=1
C
C     SAVNXX(A,B)= TOTAL ATOMS/IN IN AXIAL NODE B THRU TIME STEP A
   70 CONTINUE
      SUM6=SAVNKR(NX,IPOW)
      SUM7=SAVNXE(NX,IPOW)
C
C     SUMNXX(A,B)=ATOMS/NODE B RELEASED
   80 SUMNKR(NT,IPOW)=RDOT(NT,IPOW)*(SAVNKR(NT,IPOW)-SUM6)*LF/AVOGAD
      SUMNXE(NT,IPOW)=RDOT(NT,IPOW)*(SAVNXE(NT,IPOW)-SUM7)*LF/AVOGAD
      IF (NT.EQ.1) GO TO 90
      SUMNKR(NT,IPOW)=SUMNKR(NT,IPOW)+SUMNKR(NX,IPOW)
      SUMNXE(NT,IPOW)=SUMNXE(NT,IPOW)+SUMNXE(NX,IPOW)
   90 RETURN
      END
```

```
      SUBROUTINE HCAP (TEMP,CPNOM)                                      HCAP   2
      DIMENSION TTK(10),CLMIN(10),CLMAX(10)                             HCAP   3
      REAL K1,K2,K3                                                     HCAP   4
      DATA (TTK(I),I=1,10)/0.0,298.,500.,1000.,1500.,2000.,2500.,3000.,3 HCAP   5
     +100.,6000./                                                       HCAP   6
      DATA (CLMIN(I),I=1,10)/0.,0.,.02,.02,.02,.02,.03,.06,.10,.10/     HCAP   7
      DATA (CLMAX(I),I=1,10)/1.0,1.0,1.02,1.02,1.02,1.02,1.03,1.06,1.1,1 HCAP   8
     +.1/                                                               HCAP   9
   10 TKEL=535.285                                                      HCAP  10
      ED=37.6946                                                        HCAP  11
      K1=19.1450                                                        HCAP  12
      K2=.000784733                                                     HCAP  13
      K3=5643730.0                                                      HCAP  14
      R=.001986                                                         HCAP  15
C                                                                       HCAP  16
C     TEMP= AVERAGE VOLUMETRIC FUEL TEMPERATURE                         HCAP  17
      TEMPK=TEMP+273.0                                                  HCAP  18
      CL=1.0                                                            HCAP  19
      CPNOM=CL*(((K1*TKEL**2*EXP(TKEL/TEMPK))/(TEMPK**2*(EXP(TKEL/TEMPK) HCAP  20
     +-1)**2))+(2*K2*TEMPK)+(((K3*ED)/(R*TEMPK**2))*EXP(-ED/(R*TEMPK)))) HCAP  21
      RETURN                                                            HCAP  22
      END                                                               HCAP  23
```

```
              SUBROUTINE HTCW (T,FLUX,V,D,H)                                       HTCW       2
              DIMENSION TTTB(2,12)                                                 HTCW       3
              DATA((TTTB(I,J),I=1,2),J=1,12)/32.,203.6,100.,320.6,150.,392.7,      HTCW       4
             +200.,453.4,250.,497.0,300.,536.0,350.,565.3,400.,577.3,450.,584.6,   HTCW       5
             +500.,585.3,550.,577.2,600.,561.1/                                    HTCW       6
        C     T = COOLANT TEMPERATURE, F                                           HTCW       7
        C     FLUX = HEAT FLUX, BTU/HR/FT2/F                                       HTCW       8
        C     TW = TEMP AT CLAD (OR BASKET) OD                                     HTCW       9
              ITRY=0                                                               HTCW      10
              TF1=T                                                                HTCW      11
              C=V**.8/D**.2                                                        HTCW      12
           10 B=TERP(TF1,TTTB,2,12,2)                                              HTCW      13
              H=B*C                                                                HTCW      14
              TW=T+FLUX/H                                                          HTCW      15
              TF=(TW+T)/2.                                                         HTCW      16
              DIFF=ABS(TF-TF1)                                                     HTCW      17
              IF (DIFF-2.) 50,50,20                                                HTCW      18
           20 ITRY=ITRY+1                                                          HTCW      19
              IF (ITRY-50) 30,30,40                                                HTCW      20
           30 TF1=(TF+TF1)/2.                                                      HTCW      21
              GO TO 10                                                             HTCW      22
           40 WRITE (6,60)                                                         HTCW      23
           50 RETURN                                                               HTCW      24
        C                                                                          HTCW      25
           60 FORMAT (10X,# NO CONVERGENCE IN CHEAT ITRY#)                         HTCW      26
              END                                                                  HTCW      27
```

```
      SUBROUTINE INPOUT (NPRFIL,NTIME)                                   INPOUT     2
      COMMON /AF/ TITLE(20),FRUO2,    BB(2,50),PHICAP(7,7),CSUBP(7),     COMC       2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),     COMC       3
     +Q(50),QIN(50),TS(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,       COMC       4
     +NF,NFUEL,NNN                                                       COMC       5
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,      COMI       2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP          COMI       3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),      COMI       4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ          COMI       5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,   COMI       6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,     COMI       7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)     COMI       8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)   COMI       9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),       COMI      10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE  COMI      11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                   COMI      12
      WRITE (6,160)                                                      INPOUT     5
      ADATE=DATE(L)                                                      INPOUT     6
      WRITE (6,170) ADATE                                                INPOUT     7
      WRITE (6,180) TITLE                                                INPOUT     8
      WRITE (6,190)                                                      INPOUT     9
      WRITE (6,200) FRPUO2,FR39,FR40,FR41,FRUO2,FR35,FR38,FRDEN,FRSIN,DF INPOUT    10
     +S,DSINZ,DVOIDZ                                                     INPOUT    11
      WRITE (6,210) GAP,DCI,DCO,LFUEL,S,XH                               INPOUT    12
      WRITE (6,220) VPLENZ,TINLET(1),DTEMP,DE,V,EXTP,ROUF,ROUC           INPOUT    13
      WRITE (6,230) DBO,KB,HBC                                           INPOUT    14
      WRITE (6,240) ATMOS                                                INPOUT    15
      WRITE (6,330) CRUDTH                                               INPOUT    16
      WRITE (6,260) FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE              INPOUT    17
      WRITE (6,440)                                                      INPOUT    18
      IF (SIGHF) 10,20,30                                                INPOUT    19
   10 WRITE (6,340)                                                      INPOUT    20
      GO TO 40                                                           INPOUT    21
   20 WRITE (6,350)                                                      INPOUT    22
      GO TO 40                                                           INPOUT    23
   30 WRITE (6,360) SIGHF                                                INPOUT    24
   40 WRITE (6,440)                                                      INPOUT    25
      WRITE (6,440)                                                      INPOUT    26
      IF (NCLAD) 70,50,80                                                INPOUT    27
   50 CONTINUE                                                           INPOUT    28
      IF (ZCLAD.GT.0.) GO TO 60                                          INPOUT    29
      WRITE (6,370)                                                      INPOUT    30
      GO TO 90                                                           INPOUT    31
   60 CONTINUE                                                           INPOUT    32
      WRITE (6,380)                                                      INPOUT    33
      GO TO 90                                                           INPOUT    34
   70 WRITE (6,390)                                                      INPOUT    35
      GO TO 90                                                           INPOUT    36
   80 WRITE (6,400)                                                      INPOUT    37
   90 WRITE (6,440)                                                      INPOUT    38
      IF (NFUEL) 120,100,110                                             INPOUT    39
  100 WRITE (6,410)                                                      INPOUT    40
      GO TO 130                                                          INPOUT    41
  110 WRITE (6,420)                                                      INPOUT    42
      GO TO 130                                                          INPOUT    43
  120 WRITE (6,430)                                                      INPOUT    44
  130 CONTINUE                                                           INPOUT    45
```

```
      WRITE (6,440)
      WRITE (6,250)
      WRITE (6,270) ((CF(I,J),I=1,3),J=1,NNN)
      WRITE (6,280)
      IF (IRL.GT.0) GO TO 140
      WRITE (6,290) (RV(1,J),RV(2,J),J=1,NF)
      WRITE (6,310)
      GO TO 150
  140 WRITE (6,290) (RVE(1,J),RVE(2,J),J=1,IRL)
  150 CONTINUE
      WRITE (6,320) NPOW,IPEAK,IGAS,MINI,NTIME,IRELSE,ICOF,NPRFIL,ICOR,I
     +STOR,NFUEL,NFLX,ICREP,NOH,IDENSF,NCLAD,IRL,IRELOC,IT
      WRITE (6,300)
      RETURN
C
  160 FORMAT (1H1)
  170 FORMAT (//,20X,≠GAPCON-THERMAL-2 VERSION 9-1-74  (VALUES OF NAMELI
     +ST VARIABLES - SEE ABOVE)≠,20X,1A10,)
  180 FORMAT (1H0,20A4)
  190 FORMAT (58X,≠*******************≠,/,58X,≠*  INPUT VALUES  *≠,/,20X,
     +≠*****************************************************************
     +******************************≠/20X,≠*≠,91X,≠*≠)
  200 FORMAT (20X,≠*≠,8X,≠FUEL COMPOSITION≠,67X,≠*≠/20X,≠*≠,10X,F6.4,≠
     +WEIGHT FRACTION PUO2≠,27X,≠FRPUO2≠,20X,≠*≠/20X,≠*≠,13X,F6.4,≠  WEI
     +GHT FRACTION PU239≠,23X,≠FR39  ≠,20X,≠*≠/20X,≠*≠,13X,F6.4,≠  WEIGH
     +T FRACTION PU240≠,23X,≠FR40  ≠,20X,≠*≠/20X,≠*≠,13X,F6.4,≠  WEIGHT
     +FRACTION PU241≠,23X,≠FR41  ≠,20X,≠*≠/20X,≠*≠,09X,F6.4,≠  WEIGHT FR
     +ACTION UO2≠,29X,≠FRUO2 ≠,20X,≠*≠/20X,≠*≠,13X,F6.4,≠  WEIGHT FRACTI
     +ON U235≠,24X,≠FR35  ≠,20X,≠*≠/20X,≠*≠,13X,F6.4,≠  WEIGHT FRACTION
     +U238≠,24X,≠FR38  ≠,20X,≠*≠/20X,≠*≠,91X,≠*≠/20X,≠*≠,8X,≠FUEL DENSIT
     +Y≠,28X,≠(FRACTION TD)   FRDEN≠,6X,F5.3,11X,≠*≠/20X,≠*≠,8X,≠RESTRUC
     +TURED FUEL DENSITY≠,15X,≠(FRACTION TD)   FRSIN≠,6X,F5.3,11X,≠*≠/20
     +X,≠*≠,8X,≠PELLET DIAMETER≠,25X,≠(INCHES)≠,8X,≠DFS≠,8X,F6.4,10X,≠*≠
     +/20X,≠*≠,8X,≠INITIAL RESTRUCTURED FUEL DIAM.≠,9X,≠(INCHES)≠,8X,≠DS
     +IN≠,7X,F6.4,10X,≠*≠/20X,≠*≠,8X,≠INITIAL CENTER HOLE DIAMETER≠,12X,
     +≠(INCHES)≠,8X,≠DVOIDZ≠,5X,F6.4,10X,≠*≠)
  210 FORMAT (20X,≠*≠,8X,≠PELLET-TO-CLAD GAP≠,22X,≠(INCHES)≠,8X,≠GAP≠,8X
     +,F6.4,10X,≠*≠/20X,≠*≠,8X,≠CLAD INSIDE DIAMETER≠,20X,≠(INCHES)≠,8X,
     +≠DCI≠,8X,F6.4,10X,≠*≠/20X,≠*≠,8X,≠CLAD OUTSIDE DIAMETER≠,19X,≠(INC
     +HES)≠,8X,≠DCO≠,8X,F6.4,10X,≠*≠/20X,≠*≠,8X,≠FUEL LENGTH≠,29X,≠(INCH
     +ES)≠,8X,≠LFUEL≠,4X,F6.2,12X,≠*≠/20X,≠*≠,8X,≠SORBED GAS CONTENT≠,22
     +X,≠(CC/GRAM)≠,7X,≠S≠,10X,F6.4,10X,≠*≠/20X,≠*≠,8X,≠FRACTION OF SORB
     +ED GAS WHICH IS H2≠,22X,≠XH≠,9X,F6.4,10X,≠*≠)
  220 FORMAT (20X,≠*≠,8X,≠PLENUM VOLUME≠,27X,≠(CU. IN.)≠,7X,≠VPLENZ≠,4X,
     +F5.2,12X,≠*≠/20X,≠*≠,8X,≠COOLANT TEMPERATURE≠,21X,≠(DEG F)≠,9X,≠TI
     +NLET(1)≠,F6.1,12X,≠*≠/20X,≠*≠,8X,≠AXIAL TEMPERATURE GRADENT ACROSS
     + CORE    (DEG F)≠,9X,≠DTEMP≠,3X,F6.1,13X,≠*≠/20X,≠*≠,8X,≠COOLANT PA
     +SSAGE EQUIVALENT DIAMETER≠,5X,≠(INCHES)≠,8X,≠DE≠,8X,F7.4,10X,≠*≠/2
     +0X,≠*≠,8X,≠COOLANT VELOCITY≠,24X,≠(FT/SEC)≠,8X,≠V≠,9X,F6.3,11X,≠*≠
     +/20X,≠*≠,8X,≠PRESSURE ON CLAD OD≠,21X,≠(PSI)≠,11X,≠EXTP≠,3X,F7.1,1
     +3X,≠*≠/20X,≠*≠,8X,≠FUEL SURFACE ROUGHNESS, ARITH. MEAN     (INCH)≠
     +,10X,≠ROUF≠,7X,F8.6,8X,≠*≠/20X,≠*≠,8X,≠CLAD ID SURFACE ROUGHNESS,
     +ARITH. MEAN  (INCH)≠,10X,≠ROUC≠,7X,F8.6,8X,≠*≠)
  230 FORMAT (20X,≠*≠,8X,≠DIAMETER OF AUXILIARY BASKET≠,12X,≠(INCHES)≠,8
     +X,≠DBO≠,8X,F6.4,10X,≠*≠/20X,≠*≠,8X,≠BASKET THERMAL CONDUCTIVITY≠,1
     +3X,≠(BTU/HR-FT-F)   KB≠,7X,F6.2,12X,≠*≠/20X,≠*≠,8X,≠BASKET-TO-CLAD
     + HEAT TRANSFER COEFF.      (BTU/HR-FT2-F)  HBC≠,4X,F7.1,13X,≠*≠)
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       240 FORMAT (20X,*H*,8X*FILL GAS PRESSURE*,23X,*(ATMOSPHERES)   ATMOS*, INPOUT  103
          +4X,F5.1,13X,*H*)                                                   INPOUT  104
       250 FORMAT (20X,*H*,91X,*H*/20X,*H*,8X,*FUEL THERMAL CONDUCTIVITY VALU INPOUT  105
          +ES USED*,46X,*H*/20X,*H*,91X,*H*/20X,*H*,16X,*TEMPERATURE*,20X,*TH INPOUT  106
          +ERMAL CONDUCTIVITY*,24X,*H*/20X,*H*,18X,*(DEG F)*,24X,*(BTU/HR-FT- INPOUT  107
          +DEG F)*,25X,*H*/20X,*H*,91X,*H*/20X,*H*,36X,*UNRESTRUCTURED FUEL   INPOUT  108
          +    RESTRUCTURED FUEL*,13X,*H*/20X,*H*,15X,*--------------*,8X,*---- INPOUT  109
          +----------------      ----------------*,13X,*H*/20X,*H*,91X,*H*)  INPOUT  110
       260 FORMAT (20X,*H*,8X,*FILL GAS COMPOSITION*,63X,*H*/20X,*H*,10X,F7.5 INPOUT  111
          +,*  MOLE FRACTION HELIUM*,52X,*H*/20X,*H*,10X,F7.5,*  MOLE FRACTIO INPOUT  112
          +N ARGON*,53X,*H*/20X,*H*,10X,F7.5,*  MOLE FRACTION HYDROGEN*,50X,* INPOUT  113
          +H*/20X,*H*,10X,F7.5,*  MOLE FRACTION NITROGEN*,50X,*H*/20X,*H*,10X INPOUT  114
          +,F7.5,*  MOLE FRACTION KRYPTON*,51X,*H*/20X,*H*,10X,F7.5,*  MOLE F INPOUT  115
          +RACTION XENON*,53X,*H*)                                            INPOUT  116
       270 FORMAT (20X,*H*,18X,F6.0,19X,F5.3,17X,F5.3,21X,*H*)                INPOUT  117
       280 FORMAT (20X,*H*,91X,*H*/20X,*H*,8X,*FLUX DEPRESSION VALUES USED*,5 INPOUT  118
          +6X,*H*/20X,*H*,91X,*H*/20X,*H*,21X,*DIAMETER (IN)*,12X,*FLUX RATIO INPOUT  119
          +*,35X,*H*/20X,*H*,91X,*H*)                                         INPOUT  120
       290 FORMAT (20X,*H*,24X,F6.4,19X,F6.4,36X,*H*)                         INPOUT  121
       300 FORMAT (20X,*H*,91X,*H*/20X,************************************** INPOUT  122
          +*******************************************************)          INPOUT  123
       310 FORMAT (20X,*H*,91X,*H*,/,20X,*H*,10X,***** INPUT OPTIONS *****,58 INPOUT  124
          +X,*H*,/,20X,*H*,91X,*H*)                                           INPOUT  125
       320 FORMAT (20X,*H*,15X,*NPOW  **,I3,15X,*IPEAK **,I3,15X,*IGAS  **,I3 INPOUT  126
          +,16X,*H*,/,20X,*H*,15X,*MINI  **,I3,15X,*NTIME **,I3,15X,*IRELSE** INPOUT  127
          +,I3,16X,*H*,/,20X,*H*,15X,*ICDF  **,I3,15X,*NPRFIL**,I3,15X,*ICOR  INPOUT  128
          + **,I3,16X,*H*,/,20X,*H*,15X,*ISTOR **,I3,15X,*NFUEL **,I3,15X,*NP INPOUT  129
          +LX  **,I3,16X,*H*,/,20X,*H*,15X,*ICREP **,I3,15X,*NOH   **,I3,15X, INPOUT  130
          +*IDENSF**,I3,15X,*H*,/,20X,*H*,15X,*NCLAD Y*,I3,15X,*IRL   **,I3,1 INPOUT  131
          +5X,*IRELOC**,I3,16X,*H*,/,20X,*H*,15X,*IT    **,I3,66X,*H*,)       INPOUT  132
       330 FORMAT (20X,*H*,8X,*CRUD THICKNESS*,26X,*(INCHES)*,8X,*CRUDTH*,5X, INPOUT  133
          +F6.4,10X,*H*,)                                                     INPOUT  134
       340 FORMAT (20X,*H*,8X,*COOLANT IS WATER*,67X,*H*)                     INPOUT  135
       350 FORMAT (20X,*H*,8X,*COOLANT IS SODIUM*,66X,*H*)                    INPOUT  136
       360 FORMAT (20X,*H*,8X,*COOLANT NOT SPECIFIED, FILM COEFFICIENT IS *,F INPOUT  137
          +6.0,34X,*H*)                                                       INPOUT  138
       370 FORMAT (20X,*H*,8X,*CLADDING IS ZIRCALOY-2*,61X,*H*)               INPOUT  139
       380 FORMAT (20X,1H*,8X,*CLADDING IS ZIRCALOY-4*,61X,1H*)               INPOUT  140
       390 FORMAT (20X,*H*,8X,*CLADDING IS 316 STAINLESS STEEL*,52X,*H*)      INPOUT  141
       400 FORMAT (20X,*H*,8X,*CLADDING NOT SPECIFIED, PROPERTIES WERE INPUTT INPOUT  142
          +ED*,35X,*H*)                                                       INPOUT  143
       410 FORMAT (20X,*H*,8X,*FUEL THERMAL CONDUCTIVITY VALUES DETERMINED FR INPOUT  144
          +OM DATA OF LYONS, ET AL*,14X,*H*)                                  INPOUT  145
       420 FORMAT (20X,*H*,8X,*FUEL THERMAL CONDUCTIVITY VALUES WERE INPUTTED INPOUT  146
          +*,37X,*H*)                                                         INPOUT  147
       430 FORMAT (20X,*H*,8X,*FUEL CONTAINS RECYCLE PUO2*,57X,*H*,)          INPOUT  148
       440 FORMAT (20X,*H*,91X,*H*)                                           INPOUT  149
           END                                                                INPOUT  150
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      SUBROUTINE INPT                                                   INPT   2
      COMMON /AF/ TITLE(20),FRUO2,    BB(2,50),PHICAP(7,7),CSUBP(7),    COMC   2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),    COMC   3
     +Q(50),QIN(50),TS(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,      COMC   4
     +NF,NFUEL,NNN                                                      COMC   5
      COMMON/PH/ PSEUDO(15),TIME(15),NTIME,PITI(20),PROFIL(15,21),      COME   2
     +SAVNKR(15,20),SAVNXE(15,20),SUMNKR(15,20),SUMNXE(15,20),CST(20),  COME   3
     +NNKR,NNXE,TVOLAV,VOLGAS,W,NPRFIL,DVBLST(20),DVN3(20),             COME   4
     +SDVN1(20),SDVN2(20),DVBX(20),DVN1(20),DVN2(20),DELVB(20)          COME   5
      REAL NNKR,NNXE                                                    COME   6
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI   2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI   3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI   4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI   5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI   6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI   7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI   8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI   9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI  10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI  11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI  12
      COMMON /AG/ PRCDH,RADS,TPLAS                                      COMF   2
      NAMELIST /INPUT/ ATMOS,CRUDTH,DBO,DCI,DCO,DE,DFS,DSINZ,DTEMP,     INPT   7
     +DVOIDZ,EXTP,FRACAR,FRACH,FRACHE,FRACKR,FRACN,FRACXE,FRDEN,FRSIN,  INPT   8
     +FRPUO2,FR35,FR40,FR41,HBC,ICDF,ICOR,ICREP,IDENSF,IGAS,IPEAK,      INPT   9
     +IRELOC,IRELSE,IRL,ISTOR,IT,KB,KOOL,LFUEL,LVOIDZ,MINI,NCLAD,NFLX,  INPT  10
     +NFUEL,NOH,NPOW,NPRFIL,NTIME,PRCDH,PROFIL,PSEUDO,RADS,ROUC,ROUF,   INPT  11
     +S,SIGHF,TIME,TINLET,TM,TPLAS,V,VPLENZ,XCO,XH,XN,ZCLAD             INPT  12
      READ (5,60) TITLE                                                 INPT  13
      IF (TITLE(1).EQ.WORD1) GO TO 50                                   INPT  14
      READ (5,INPUT)                                                    INPT  15
      WRITE (6,INPUT)                                                   INPT  16
      IF (NFUEL.LE.0) GO TO 10                                          INPT  17
      READ (5,70) ((CF(I,J),I=1,3),J=1,NFUEL)                           INPT  18
   10 IF (NCLAD.LE.0) GO TO 20                                          INPT  19
      READ (5,80) ((AA(I,J),I=1,7),J=1,NCLAD)                           INPT  20
   20 IF (NFLX.LE.0) GO TO 30                                           INPT  21
      READ (5,90) ((RV(I,J),I=1,2),J=1,NFLX)                            INPT  22
   30 CONTINUE                                                          INPT  23
      IF (ICREP.LE.0) GO TO 40                                          INPT  24
      READ (5,100) ((CLCRP(I,J),I=1,2),J=1,ICREP)                       INPT  25
   40 RETURN                                                            INPT  26
   50 CONTINUE                                                          INPT  27
      STOP                                                              INPT  28
C                                                                       INPT  29
   60 FORMAT (20A4)                                                     INPT  30
   70 FORMAT (3E10.4)                                                   INPT  31
   80 FORMAT (7E10.4)                                                   INPT  32
   90 FORMAT (2E10.4)                                                   INPT  33
  100 FORMAT (F10.0,E10.0)                                              INPT  34
      END                                                               INPT  35
```

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      SUBROUTINE MOVEAA (A,B,N)                                   MOVEAA   2
      DIMENSION A(N),B(N)                                         MOVEAA   3
      DO 10 I=1,N                                                 MOVEAA   4
      B(I)=A(I)                                                   MOVEAA   5
   10 CONTINUE                                                    MOVEAA   6
      RETURN                                                      MOVEAA   7
      END                                                         MOVEAA   8
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```
      SUBROUTINE MOVEKA (K,IA,N)                          MOVEKA      2
      DIMENSION IA(N)                                     MOVEKA      3
      DO 10 I=1,N                                         MOVEKA      4
      IA(I)=K                                             MOVEKA      5
   10 CONTINUE                                            MOVEKA      6
      RETURN                                              MOVEKA      7
      END                                                 MOVEKA      8
```

```
      SUBROUTINE OUTPUT (PHI,TIME)                                      OUTPUT   2
      COMMON /AC/ VOLCC,N1Z,N7Z,N8Z,N10Z,N9Z                            COMA     2
      REAL N1Z,N7Z,N8Z,N10Z                                             COMA     3
      COMMON/AZ/ TBAR(20),VOLTX(20),TCLINE(20),HGX(20)                  COMB     2
     + ,TAVGXX(20),RDOT(15,20),RGAPX(20),ROP(20),HFLUX(20)              COMB     3
     + ,XMOLS(21),FXMOL(7,21),PRESTO    ,SUMOLS(7)                      COMB     4
      COMMON /AF/ TITLE(20),FRUO2,   BB(2,50),PHICAP(7,7),CSUBP(7),     COMC     2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),    COMC     3
     +Q(50),QIN(50),TS(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,      COMC     4
     +NF,NFUEL,NNN                                                      COMC     5
      COMMON/AD/ JCASE,IPOW,PEAK,P,BURNUP,QOVRAB,KOUNT,G1PG2,           COMD     2
     +QOVRAS,TCOOL,TCOOLC,TBO,TBOC,TBI,TBIC,HF,TCC,TCO,TCOC,N,          COMD     3
     +TCI,TCIC,TFS,TFSC,TMF,DELR,TMELT,RCMELT,TAVGF,TAVGFC,DELRT,       COMD     4
     +DELRB,DELRCI,DELRP,PFACE,HSOLID,PSOLID,HGAS,PGAS,HRAD,PRAD,       COMD     5
     +RSIN,RVOID,RFS,TSIN,TSINC,PCSIN,DSIN,PDSIN,DVOID,PDVOID,VAVGT,    COMD     6
     +XMOTOT,GASKON,G,VAVGTC,RD,QOVRAG,LM,FNPOW,RSINF,RRVOID,QQS,QQU,   COMD     7
     +QTOT,RSINZ,RVOIDZ,T,VVOID,RMELT,GK,ISTOP,DELGD,DELPI,DELRCC,      COMD     8
     +DELRCT,DELRFT,CORR                                                COMD     9
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI     2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI     3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI     4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI     5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI     6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI     7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI     8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI     9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI    10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI    11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI    12
      REAL MLFR                                                         OUTPUT   8
      DIMENSION TIME(15)                                                OUTPUT   9
      DIMENSION MLFR(6)                                                 OUTPUT  10
C                                                                       OUTPUT  11
C     CONVERT AVG. AND PEAK LINEAR POWER FROM KW/FT TO W/M              OUTPUT  12
      PEAK=AMAX1(POWER(IPOW),POWER(IPOW+1))                             OUTPUT  13
      SIP=P*3280.84                                                     OUTPUT  14
      SIPK=PEAK*3280.84                                                 OUTPUT  15
C                                                                       OUTPUT  16
C     CONVERT TIME IN-REACTOR FROM DAYS TO SECONDS                      OUTPUT  17
      SITIM=TIME(NT)*SECDAY                                             OUTPUT  18
C                                                                       OUTPUT  19
C     CONVERT BURNUP FROM MWD/MTM TO J/KGM                              OUTPUT  20
      SIBRN=BURNUP*8.64E+7                                              OUTPUT  21
C                                                                       OUTPUT  22
C     CONVERT NEUTRON FLUX FROM N/CM2-SEC. TO N/M2.SEC                  OUTPUT  23
      SIPHI=PHI/10000.0                                                 OUTPUT  24
C                                                                       OUTPUT  25
C     CONVERT HEAT FLUXES FROM BTU/HR-FT2 TO  W/M2                      OUTPUT  26
      SIQAC=QOVRAC*3.15248                                              OUTPUT  27
      SIQAS=QOVRAS*3.15248                                              OUTPUT  28
C                                                                       OUTPUT  29
C     CONVERT FILM COEFICIENT AND CONDUCTANCES FROM BTU/HR-FT2-DEG.F TO OUTPUT  30
C     W/M2-DEG.C(INTERNATIONAL TABLES)                                  OUTPUT  31
      SIHF=HF*5.678263                                                  OUTPUT  32
      SIHG=HG*5.678263                                                  OUTPUT  33
      SIHSLD=HSOLID*5.678263                                            OUTPUT  34
      SIHGS=HGAS*5.678263                                               OUTPUT  35
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      SIHRD=HRAD*5.678263                                             OUTPUT      36
C                                                                     OUTPUT      37
C     CONVERT RADIAL DIMENSIONS FROM INCHES TO METERS                  OUTPUT      38
      SIDLRT=DELRT*0.0254                                             OUTPUT      39
      SIDLRB=DELRB*0.0254                                             OUTPUT      40
      SIDLR=DELRFT*.0254                                              OUTPUT      41
      SIDLRC=DELRCI*.0254                                             OUTPUT      42
      SIRGAP=RGAPX(IPOW)*0.0254                                       OUTPUT      43
      SIRMLT=RMELT*.0254                                              OUTPUT      44
      SIGT=G1PG2*.0254                                                OUTPUT      45
      SIDLRP=DELRP*.0254                                              OUTPUT      46
      SIRLT=DELGD*.0254                                               OUTPUT      47
      SIDFT=DELPI*.0254                                               OUTPUT      48
      SICRP=DELRCC*.0254                                              OUTPUT      49
      SITOT=DELRCT*.0254                                              OUTPUT      50
C                                                                     OUTPUT      51
C     CONVERT DEG.F  TO  DEG.C                                        OUTPUT      52
      SITCL=(TCOOL-32.)/1.8                                           OUTPUT      53
C                                                                     OUTPUT      54
C     CONVERT CLAD AND GAS THERMAL CONCUCTIVITY FROM BTU/HR-FT-DEG.F  OUTPUT      55
C     TO W/M-DEG.C*(INTERNATIONAL TABLES)                             OUTPUT      56
      SICC=TCC*1.73073                                                OUTPUT      57
      SIGK=GK*1.73073                                                 OUTPUT      58
C                                                                     OUTPUT      59
C     CONVERT INTERFACIAL AND GAS PRESSURES FROM PSI TO PA            OUTPUT      60
      SIPFC=PFACE*175.127                                             OUTPUT      61
      SIPRES=PRESTO*175.1268                                          OUTPUT      62
C                                                                     OUTPUT      63
C     CONVERT MOLES FROM GRAM-MOLES TO KILOGRAM-MOLES                  OUTPUT      64
      SIXMT=XMOTOT/1000.0                                             OUTPUT      65
      SIMLT=XMOLS(IPOW)/1000.0                                        OUTPUT      66
      WRITE (6,60) JCASE,IPOW,NPOW                                    OUTPUT      67
      IF (KOUNT.GT.0) WRITE (6,70)                                    OUTPUT      68
      WRITE (6,80) TITLE                                              OUTPUT      69
      WRITE (6,90) SIP,P,SIPK,PEAK,SITIM,TIME(NT),SIBRN,BURNUP,SIPHI,PHI OUTPUT   70
      WRITE (6,100) SIQAC,QOVRAC,SIQAS,QOVRAS,SITCL,TCOOL             OUTPUT      71
      WRITE (6,110) SIHF,HF,SICC,TCC,TCOC,TCO,TCIC,TCI,TFSC,TFS       OUTPUT      72
      DO 10 I=1,N                                                     OUTPUT      73
      DUM(I)=(TT(I)-32.)/1.8                                          OUTPUT      74
      DDUM(I)=TS(I)*.0254                                             OUTPUT      75
      PCFR(I)=TS(I)*100./(RFS+DELR)                                   OUTPUT      76
   10 CONTINUE                                                        OUTPUT      77
      WRITE (6,120) (DDUM(I),DUM(I),TS(I),TT(I),PCFR(I),I=5,N,5)      OUTPUT      78
      WRITE (6,130) TM,TMF                                            OUTPUT      79
      PCMELT=100.*RMELT/(RFS+DELR)                                    OUTPUT      80
      WRITE (6,140) SIRMLT,PCMELT                                     OUTPUT      81
      IF (KOUNT.GT.0) GO TO 20                                        OUTPUT      82
      WRITE (6,150) VAVGTC,VAVGT                                      OUTPUT      83
      WRITE (6,170) SIDLRT,DELRT,SIRLT,DELGD,SIDFT,DELPI,SIDLRB,DELRB,SI OUTPUT   84
     +DLR,DELRFT,SIDLRC,DELRCI,SICRP,DELRCC,SIDLRP,DELRP,SITOT,DELRCT  OUTPUT      85
      WRITE (6,180) SIRGAP,RGAPX(IPOW),SIPFC,PFACE                    OUTPUT      86
   20 CONTINUE                                                        OUTPUT      87
      WRITE (6,190) SIHG,HG                                           OUTPUT      88
      WRITE (6,200) SIHSLD,HSOLID,SIHGS,HGAS,SIHRD,HRAD               OUTPUT      89
      IF (KOUNT.EQ.0) GO TO 30                                        OUTPUT      90
      PCSIN=FRSIN*100.                                                OUTPUT      91
      PDSIN=RSIN/RFS*100.                                             OUTPUT      92
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      PDVOID=RVOID/RFS*100.
      WRITE (6,260) TSINC,TSIN,PCSIN
      SIDN=DSIN*.0254
      SIDVD=DVOID*.0254
      WRITE (6,270) SIDN,POSIN,SIDVD,PDVOID,VAVGTC,VAVGT
      IF (KOUNT.GT.0) GO TO 50
   30 CONTINUE
      DO 40 I=1,7
   40 MLFR(I)=MOLEFR(I)
      WRITE (6,160) RDOT(NT,IPOW),SIPRES,PRESTO
      WRITE (6,210) (MLFR(I),MOLEFR(I),I=1,7)
      WRITE (6,220) SIXMT,SIMLT
      WRITE (6,230) SIGK,GK
      WRITE (6,240) SIGT,G1PG2
      IF (ISTOR.EQ.0) GO TO 50
      CALL HCAP (VAVGTC,CPNOM)
      CALL CARL (TSR,TFS,TT,N,PI,DFS,STORE)
      TEMPK=VAVGTC+273.
      C1=7.84733E-4*(TEMPK**2-298**2)+5643730.*EXP(-37.6946/TEMPK/0.0019
     +86)
      C2=535.285*(1.0/(EXP(535.285/TEMPK)-1.)-1./(EXP(535.285/298.)-1.))
      STOR=(C1+19.145*C2)/270.
      STORB=STOR*1.8
      STOREB=STORE*1.8
      STOREC=STORE*RHO*(DFS**2/4)*PI*2.54**2
      STOREF=STOREC*12.*2.54/252.
C
C     CONVERT CPNOM TO UNITS OF BTU/(LB-DEG F)
      CPNOMF=CPNOM*270.
C
C     CONVERT  HEAT CAPACITY FROM BTU/LB-DEG.F TO J/KG-DEG.C
C     (INTERNATIONAL TABLES)
      SICPN=CPNOMF*4186.8
C
C     CONVERT STORED ENERGY FROM BTU/LB TO J/KG
      SISTR=STORB*2326.0
      SISTRE=STOREB*2326.0
      SISTRC=STOREF*2326.0
      WRITE (6,250) SICPN,CPNOMF,SISTR,STORB,SISTRE,STOREB,SISTRC,STOREF
   50 CONTINUE
      RETURN
C
   60 FORMAT (1H1,2X,*CASE*,I3,5X,*AXIAL SEGMENT*,I3,2X,*OF*,I3)
   70 FORMAT (1H0,5X,*CONDITIONS AFTER RESTRUCTURING*)
   80 FORMAT (1H0,20A4)
   90 FORMAT (1H0,9X,*LINEAR HEAT RATING (AVG)     *,5X,1PE10.4,* W/M
     +(*,0PF6.2,* KW/FT)*,/,28X,*(PEAK)*,9X,1PE10.4,* W/M     (*,0PF6.2,*
     + KW/FT)*,/,9X,*TIME IN-REACTOR*,14X,1PE10.4,* SEC.    (*,0PF6.1,* D
     +AYS)*,/,9X,*BURNUP*,23X,1PE10.4,* J/KGM   (*,0PF8.1,* MWD/MTM)*,//,
     +20X,*AVERAGE FLUX IN FUEL*,15X,1PE10.4,* N/M2-S*,12X,*(*,1PE10.4,*
     + N/CM2-SEC.)*)
  100 FORMAT (20X,*CLAD OD SURFACE HEAT FLUX*,10X,1PE10.4,* W/M2*,14X,*(
     +*,1PE10.4,* BTU/HR-FT2)*,/,20X,*FUEL SURFACE HEAT FLUX*,13X,1PE10.
     +4,* W/M2*,14X,*(*,1PE10.4,* BTU/HR-FT2)*,/,20X,*COOLANT TEMERATURE
     +*,17X,0PF10.2,* DEG.C*,13X,*(*,F10.2,* DEG.F)*)
  110 FORMAT (20X,*FILM COEFFICIENT*,19X,1PE10.4,* W/M2-DEG.C*8X,*(*,1PE
     +10.4,* BTU/HR-FT2-DEG.F)*,/,20X,*CLAD THERMAL CONDUCTIVITY*,10X,1P
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     +E10.4,# W/M-DEG.C #,8X,#(#,1PE10.4,# BTU/HR-FT-DEG.F)#,/,20X,#CLAD OUTPUT     150
     + OD TEMPERATURE#,16X,0PF10.1,# DEG.C#,13X,#(#,F10.1,# DEG.F)#,/,20 OUTPUT     151
     +X,#CLAD ID TEMPERATURE#16X,F10.1,# DEG.C#,13X,#(#,F10.1,# DEG.F)#, OUTPUT     152
     +/,20X,#FUEL SURFACE TEMPERATURE#,11X,F10.1,# DEG.C#,13X,#(#,F10.1, OUTPUT     153
     +# DEG F)#)                                                         OUTPUT     154
 120 FORMAT (1H0,24X,#RADIUS#,10X,#TEMPERATURE#,15X,#RADIUS#,12X,#TEMPE OUTPUT     155
     +RATURE#,10X,#PERCENT OF#,/,24X,#(METERS)#,11X,#(DEG C)#,15X,#(INCH OUTPUT     156
     +ES)#,12X,#(DEG F)#,12X,#FUEL RADIUS#,//,(23X,F8.6,8X,F10.0,17X,F6. OUTPUT     157
     +4,13X,F8.0,10X,F10.2))                                             OUTPUT     158
 130 FORMAT (1H0,19X,#MELT TEMPERATURE#,15X,F10.0,#  DEG.C     (#,F7.0, OUTPUT     159
     +# DEG.F)#)                                                         OUTPUT     160
 140 FORMAT (20X,#MELT RADIUS#,21X,F10.5,# METERS#,4X,#(#,F6.2,# PERCEN OUTPUT     161
     +T OF FUEL RADIUS)#)                                                OUTPUT     162
 150 FORMAT (/,20X,#VOLUME AVERAGE FUEL TEMPERATURE#,1X,0PF10.1,# DEG.C OUTPUT     163
     +#,5X,#(#,F10.1,# DEG.F)#,/,)                                       OUTPUT     164
 160 FORMAT (1H0,19X,#GAS RELEASE FRACTION DURING CURRENT TIME STEP#,5X OUTPUT     165
     +,F10.4,/,20X,#INTERNAL GAS PRESSURE#,32X,1PE10.4,# PA #,8X,#(#,0PF OUTPUT     166
     +8.2,# PSI)#,/,)                                                    OUTPUT     167
 170 FORMAT (20X,#CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION         OUTPUT     168
     +#,1PE10.4,#  METERS#,9X,#(#,0PF10.6,# INCH)#,/,20X,#CHANGE IN FUEL OUTPUT     169
     + RADIUS DUE TO RELOCATION#,13X,1PE11.4,#  METERS#,9X,#(#,0PF10.6,# OUTPUT     170
     + INCH)#,/,20X,#CHANGE IN FUEL RADIUS DUE TO DENSIFICATION#,10X,1PE OUTPUT     171
     +11.4,#  METERS#,9X,#(#,0PF10.6,# INCH)#,/,20X,#CHANGE IN FUEL RADI OUTPUT     172
     +US DUE TO SWELLING  #,14X,1PE10.4,#  METERS#,9X,#(#,0PF10.6,# INCH OUTPUT     173
     +)#,/,20X,#TOTAL CHANGE IN FUEL RADIUS  #,23X,1PE11.4,#  METERS#,9X OUTPUT     174
     +,#(#,0PF10.6,# INCH)#,/,20X,#CHANGE IN CLAD RADIUS DUE TO THERMAL  OUTPUT     175
     +EXPANSION      #,1PE11.4,#  METERS#,9X,#(#,0PF10.6,# INCH)#,/,20X, OUTPUT     176
     +#CHANGE IN CLAD RADIUS DUE TO CREEP                #,1PE11.4,#     OUTPUT     177
     +METERS#,9X,#(#,0PF10.6,# INCH)#,/,20X,#CHANGE IN CLAD RADIUS DUE T OUTPUT     178
     +O  PRESSURE                #,1PE11.4,#  METERS#,9X,#(#,0PF10.6,# INC OUTPUT     179
     +H)#,/,20X,#TOTAL CHANGE IN CLAD RADIUS  #,23X,1PE11.4,#  METERS#,9 OUTPUT     180
     +X,#(#,0PF10.6,# INCH)#,)                                           OUTPUT     181
 180 FORMAT (20X,#HOT GAP (RADIAL)#,36X,1PE11.4,#  METERS#,9X,#(#,0PF10 OUTPUT     182
     +.6,# INCH)#,/,20X,#FUEL-CLAD INTERFACIAL PRESSURE#,23X,1PE10.4,#   OUTPUT     183
     +PA#,13X,#(#,1PE10.4,# PSI)#)                                       OUTPUT     184
 190 FORMAT (1H0,19X,#FUEL TO CLAD GAP CONDUCTANCE#,12X,1PE10.4,# W/M2- OUTPUT     185
     +DEG.C      (#,0PF7.1,# BTU/HR-FT2-DEG.F)#,/)                       OUTPUT     186
 200 FORMAT (25X,#COMPONENT DUE TO SOLID-SOLID CONTACT#,7X,1PE10.4,# W/ OUTPUT     187
     +M2-DEG.C     (#,0PF7.1,# BTU/HR-FT2-DEG.F)#,/,25X,#COMPONENT DUE TO OUTPUT     188
     + CONDUCTION THRU THE GAS    #,1PE10.4,# W/M2-DEG.C     (#,0PF7.1,# B OUTPUT     189
     +TU/HR-FT2-DEG.F)#,/,25X,#COMPONENT DUE TO RADIANT HEAT TRANSFER    OUTPUT     190
     +  #,1PE10.4,# W/M2-DEG.C      (#,0PF7.1,# BTU/HR-FT2-DEG.F)#,/)    OUTPUT     191
 210 FORMAT (20X,#AVERAGE GAS COMPOSITION#,30X,#LOCAL GAS COMPOSITION    OUTPUT     192
     +      #/1H0,26X,F10.6,2X,#MOLE FRACTION HELIUM#,21X,F10.6,#  MOLE F OUTPUT     193
     +RACTION HELIUM#/27X,F10.6,2X,#MOLE FRACTION ARGON#,22X,F10.6,#  MO OUTPUT     194
     +LE FRACTION ARGON#/27X,F10.6,2X,#MOLE FRACTION HYDROGEN#,19X,F10.6 OUTPUT     195
     +,#  MOLE FRACTION HYDROGEN#/27X,F10.6,2X,#MOLE FRACTION NITROGEN#, OUTPUT     196
     +19X,F10.6,#  MOLE FRACTION NITROGEN#/27X,F10.6,2X,#MOLE FRACTION C OUTPUT     197
     +ARBON MONOXIDE#,12X,F10.6,#  MOLE FRACTION CARBON MONOXIDE#,/,27X, OUTPUT     198
     +F10.6,2X,#MOLE FRACTION KRYPTON#,20X,F10.6,#  MOLE FRACTION KRYPTO OUTPUT     199
     +N#/27X,F10.6,2X,#MOLE FRACTION XENON#,22X,F10.6,#  MOLE FRACTION X OUTPUT     200
     +ENON#)                                                             OUTPUT     201
 220 FORMAT (27X,10H----------,44X,10H----------/,27X,1PE10.4,# (ROD AV OUTPUT     202
     +ERAGE) KG-MOLE#,22X,1PE10.4,# (LOCAL) KG-MOLE#,/)                  OUTPUT     203
 230 FORMAT (1H0,19X,#THERMAL CONDUCTIVITY OF FILL GAS#,5X,1PE10.4,# W/ OUTPUT     204
     +M-DEG.C#,8X,#(#,1PE10.4,# BTU/HR-FT-DEG.F)#,)                      OUTPUT     205
 240 FORMAT (20X,#TEMPERATURE JUMP DISTANCE#,12X,1PE10.4,# METERS#,11X, OUTPUT     206
```

```
         +#(#,1PE10.4,# INCH)#)                                          OUTPUT     207
     250 FORMAT (//,20X,#NOMINAL HEAT CAPACITY#,22X,1PE10.4,#   J/KG-DEG.C# OUTPUT     208
         +,4X,#(#,1PE10.4,# BTU/LB-DEG.F)#,/,20X,#STORED ENERGY AT TBAR#,17X OUTPUT     209
         +,#EBAR=#,1PE10.4,#   J/KG#,10X,#(#,1PE10.4,# BTU/LB)#,/,20X,#VOLUM OUTPUT     210
         +E AVERAGE STORED ENERGY#,13X,#E=#,1PE10.4,#   J/KG#,10X,#(#,1PE10. OUTPUT     211
         +4,# BTU/LB)#,/,20X,#STORED ENERGY PER UNIT LENGTH#,10X,#EPL=#,1PE1 OUTPUT     212
         +0.4,2X,# J/M#,11X,#(#,1PE10.4,# BTU/FOOT)#)                        OUTPUT     213
     260 FORMAT (20X,#SINTERING TEPERATURE        #,5X,F10.2,2X,#DEG.C   (#, OUTPUT     214
         +F7.2,# DEG.F)#,/20X,#SINTERED DENSITY           #,11X,F4.1,2X,# PER OUTPUT     215
         +CENT TD#,/)                                                     OUTPUT     216
     270 FORMAT (20X,#DIAMETER OF SINTERED FUEL  #,11X,F6.4,2X,#METERS  (#, OUTPUT     217
         +F5.2,# PER CENT OF ORIGINAL FUEL DIAMETER)#,/20X,#DIAMETER OF CENT OUTPUT     218
         +ER HOLE     #,11X,F6.4,2X,#METERS  (#,F5.2,# PER CENT ORIGINAL FUEL OUTPUT     219
         + DIAMETER)#,/20X,#VOLUME AVERAGE FUEL TEMP. AFTER RESTRUCTURING #, OUTPUT     220
         +2X,F10.2,2X,#DEG. C#,5X,1H(,F8.2,2X,#DEG.F)#,)                   OUTPUT     221
          END                                                            OUTPUT     222
```

```
      SUBROUTINE POWDIS (PKPOWR,PAVRG)                                  POWDIS     2
      COMMON/AB/ ICREP,DBO,FROEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI       2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI       3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI       4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI       5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI       6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI       7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI       8
     +,PI,CCPINS,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI       9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI      10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI      11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI      12
C                                                                       POWDIS     4
C     INTEGRATE THE LOCAL POWER DISTRIBUTION AND NORMALIZE              POWDIS     5
C     THE RESULT TO 1.0.  THUS AINCR REPRESENTS THE .5 OF THE           POWDIS     6
C     AVERAGING TIMES THE X INCREMENT WHICH IS 1.0/NPOW.  NPOW IS       POWDIS     7
C     THE NUMBER OF REGIONS.                                            POWDIS     8
      AINCR=.5/FLOAT(NPOW)                                              POWDIS     9
      NPOW1=NPOW+1                                                      POWDIS    10
      AI(NPOW1)=0.0                                                     POWDIS    11
      AI(1)=(POWER(1)+POWER(2))*AINCR                                   POWDIS    12
      LPMAX=1                                                           POWDIS    13
      POLD=(POWER(1)+POWER(2))*.5                                       POWDIS    14
      IF (NPOW.LE.1) GO TO 20                                           POWDIS    15
      DO 10 I=2,NPOW                                                    POWDIS    16
      P=(POWER(I)+POWER(I+1))*.5                                        POWDIS    17
      AI(I)=AI(I-1)+(POWER(I+1)+POWER(I))*AINCR                         POWDIS    18
      IF (P.LT.POLD) GO TO 10                                           POWDIS    19
      LPMAX=I                                                           POWDIS    20
      POLD=P                                                            POWDIS    21
   10 CONTINUE                                                          POWDIS    22
   20 CONTINUE                                                          POWDIS    23
      AITOT=AI(NPOW)                                                    POWDIS    24
      IF (AITOT.LE.0.) STOP                                             POWDIS    25
C                                                                       POWDIS    26
C     RENORMALIZE THE POWER AND AI SUCH THAT  AI(1)=1.0.                POWDIS    27
      IF (IPEAK) 30,50,30                                               POWDIS    28
   30 CONTINUE                                                          POWDIS    29
      DO 40 I=1,NPOW                                                    POWDIS    30
      POWER(I)=POWER(I)*PAVRG/AITOT                                     POWDIS    31
      AI(I)=AI(I)/AITOT                                                 POWDIS    32
   40 CONTINUE                                                          POWDIS    33
      POWER(NPOW+1)=POWER(NPOW+1)*PAVRG/AITOT                           POWDIS    34
      GO TO 80                                                          POWDIS    35
C                                                                       POWDIS    36
C     CALCULATE POWER DISTRIBUTION BASED ON PEAK POWER (KW/FT)          POWDIS    37
   50 CONTINUE                                                          POWDIS    38
      PEAK=POWER(1)                                                     POWDIS    39
      DO 60 I=2,NPOW1                                                   POWDIS    40
      PEAK=AMAX1(PEAK,POWER(I))                                         POWDIS    41
   60 CONTINUE                                                          POWDIS    42
C                                                                       POWDIS    43
C      NORMALIZE THE POWER DISTRIBUTION TO PKPOWR                        POWDIS    44
      DO 70 I=1,NPOW1                                                   POWDIS    45
      POWER(I)=POWER(I)*PKPOWR/PEAK                                     POWDIS    46
      AI(I)=AI(I)/AITOT                                                 POWDIS    47
   70 CONTINUE                                                          POWDIS    48
```

```
      PAVRG=AITOT*PKPOWR/(PEAK)                                    POWDIS      49
   80 CONTINUE                                                     POWDIS      50
      RETURN                                                       POWDIS      51
      END                                                          POWDIS      52
```

```
      SUBROUTINE RELOC (DELGD,GAP,BURNUP,P,IFLAG)                  RELC1     2
      B=EXP(-4.+BURNUP**.25)                                       RELC1     3
      DELGD=(42.*(B/(1.+B))+0.9*P+3.)*GAP/100.                     RELC1     4
      IF (IFLAG.LT.0) DELGD=DELGD-.28*GAP                          RELC1     5
      IF (DELGD.LT.0) DELGD=0.0                                    RELC1     6
      DELGD=DELGD/2.                                               RELC1     7
      RETURN                                                       RELC1     8
      END                                                          RELC1     9
```

```
      SUBROUTINE RTEMP                                                  RTEMP     2
C     SUBROUTINE RTEMP CALCULATES THE RADIAL TEMPERATURE OF THE FUEL    RTEMP     3
      COMMON/AZ/ TBAR(20),VOLTX(20),TCLINE(20),HGX(20)                  COMB      2
     + ,TAVGXX(20),RDOT(15,20),RGAPX(20),ROP(20),HFLUX(20)              COMB      3
     + ,XMOLS(21),FXMOL(7,21),PRESTO     ,SUMOLS(7)                     COMB      4
      COMMON /AF/ TITLE(20),FRUO2,   BB(2,50),PHICAP(7,7),CSUBP(7),     COMC      2
     +CON(7) ,DUM(50),DDUM(50),DELCT(50),DELL(50),OMEGA(7),PCFR(50),    COMC      3
     +Q(50),QIN(50),TS(50),TT(50),VISCOS(7),TSR(51),FR38,FR39,GAP,      COMC      4
     +NF,NFUEL,NNN                                                      COMC      5
      COMMON/AD/ JCASE,IPOW,PEAK,P,BURNUP,QOVRAB,KOUNT,G1PG2,           COMD      2
     +QOVRAS,TCOOL,TCOOLC,TBO,TBOC,TBI,TBIC,HF,TCC,TCO,TCOC,N,          COMD      3
     +TCI,TCIC,TFS,TFSC,TMF,DELR,TMELT,RCMELT,TAVGF,TAVGFC,DELRT,       COMD      4
     +DELRB,DELRCI,DELRP,PFACE,HSOLID,PSOLID,HGAS,PGAS,HRAD,PRAD,       COMD      5
     +RSIN,RVOID,RFS,TSIN,TSINC,PCSIN,DSIN,PDSIN,DVOID,PDVOID,VAVGT,    COMD      6
     +XMOTOT,GASKON,G,VAVGTC,RD,QOVRAG,LM,FNPOW,RSINF,RRVOID,QQS,QQU,   COMD      7
     +QTOT,RSINZ,RVOIDZ,T,VVOID,RMELT,GK,ISTOP,DELGD,DELPI,DELRCC,      COMD      8
     +DELRCT,DELRFT,CORR                                                COMD      9
      COMMON/AB/ ICREP,DBO,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,     COMI      2
     +DFS,DVOIDZ,DCI,DCO,VPLENZ,ATMOS,LFUEL,S,DE,ROUF,ROUC,EXTP         COMI      3
     +,NCLAD,NFLX,KOOL,FRACHE,FRACAR,FRACH,FRACN,FRACKR,TINLET(15),     COMI      4
     +FRACXE,RTCO(5),RTC(5),XCO,XN,NOH,HGACEL,ZCLAD,MINI,LVOIDZ         COMI      5
     +,ICDF,TM,HBC,HG,XH,DTEMP,ISTOR,IPEAK,NPOW,POWER(21),CRUDTH,ICOR,  COMI      6
     +SDOT,SDOTT,EF,MUF,EPSIF,EPSIC,ISTPLM,WORD1,IGAS,NT,SIGHF,V,KB,    COMI      7
     +ZR(7,6),ZR4(7,6),ST(7,12),TABLE(2,80),GMWT(7),SIGLJ(7),EKLJ(7)    COMI      8
     +,PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN,CF(3,10),RV(2,20),IT,ZRO2A(20)  COMI      9
     +,LF,AI(21),PTOT,LPMAX,CLCRP(2,20),AA(7,23),FRACTN(7),MOL(7),      COMI     10
     +MOLEFR(7),RHO,QOVRAC,MOLTOT,KM,IRELOC,IRL,RVE(2,20),IDENSF,IRELSE COMI     11
      REAL LF,MUF,KB,MOL,MOLTOT,MOLEFR,LVOIDZ,LFUEL,KM                  COMI     12
C                                                                       RTEMP     8
C     SET UP SYSTEM OF N NODES OF EQUAL THICKNESS, RADII IN FEET        RTEMP     9
      TFS=TCI+QOVRAG/HG                                                 RTEMP    10
      N=50                                                              RTEMP    11
      DR=(RFS+DELR-RVOID)/FLOAT(N)/12.                                  RTEMP    12
      R0=(RFS+DELR)/12.                                                 RTEMP    13
      DO 10 I=1,N                                                       RTEMP    14
C                                                                       RTEMP    15
C     R IS IN FEET                                                      RTEMP    16
      R=R0-DR*(I-1)                                                     RTEMP    17
      RRR=(2.*R-DR)*12.                                                 RTEMP    18
      RATIO=TERP(RRR,RV,2,NF,2)                                         RTEMP    19
      RDR=R-DR                                                          RTEMP    20
      IF (RDR.GE.RSINF) Q(I)=PI*(R**2-RDR**2)*RATIO*QQU                 RTEMP    21
      IF (RDR.LT.RSINF.AND.R.GT.RSINF) Q(I)=((R**2-RSINF**2)*QQU+(RSINF* RTEMP    22
     +*2-RDR**2)*QQS)*PI*RATIO                                          RTEMP    23
      IF (RDR.LT.RSINF.AND.R.LE.RSINF) Q(I)=PI*(R**2-RDR**2)*RATIO*QQS  RTEMP    24
   10 CONTINUE                                                          RTEMP    25
C                                                                       RTEMP    26
C     CORRECT FOR ACCUMULATION OF ERROR IN HEAT GENERATION              RTEMP    27
      SUMQ=0.                                                           RTEMP    28
      CORR=0.                                                           RTEMP    29
      IF (P.LE.0.) GO TO 40                                             RTEMP    30
      DO 20 I=1,N                                                       RTEMP    31
   20 SUMQ=SUMQ+Q(I)                                                    RTEMP    32
      CORR=QTOT/SUMQ                                                    RTEMP    33
      DO 30 I=1,N                                                       RTEMP    34
   30 Q(I)=CORR*Q(I)                                                    RTEMP    35
   40 ACC=1.                                                            RTEMP    36
```

```
      FUNCTION TCOR (D,T)                                               TCOR     2
      TCOR=((1.025/.95)*(D/(1.+(1.-D)*.5)))*((38.24/(402.4+T))+(6.1256E-TCOR     3
     +13*((T+273.)**3)))                                                TCOR     4
      END                                                               TCOR     5
```

```
      FUNCTION TEPP (TC,CRF,CRFT,N)                                    TEPP      2
C     TEPP IS A LINEAR INTERPOLATION FUNCTION WHOSE VALUE IS EQUAL TO TH TEPP    3
C     INTERPOLATED VALUE.                                              TEPP      4
C     TC-IS THE VALUE OF THE INDEPENDENT VARIABLE                      TEPP      5
C     CRF-DEPENDENT VARIABLE ARRAY                                     TEPP      6
C     CRFT-INDEPENDENT VARIABLE ARRAY                                  TEPP      7
C     N-NUMBER OF POINTS IN VARIABLE ARRAYS                            TEPP      8
      DIMENSION CRF(N),CRFT(N)                                         TEPP      9
      I=1                                                              TEPP     10
      IF (TC.LT.CRFT(1)) GO TO 20                                      TEPP     11
      I=N                                                              TEPP     12
      IF (TC.GE.CRFT(N)) GO TO 20                                      TEPP     13
      DO 10 I=1,N                                                      TEPP     14
      J=I                                                              TEPP     15
      IF (TC-CRFT(I)) 40,30,10                                         TEPP     16
   10 CONTINUE                                                         TEPP     17
   20 TEPP=CRF(I)                                                      TEPP     18
      RETURN                                                           TEPP     19
   30 TEPP=CRF(I)                                                      TEPP     20
      RETURN                                                           TEPP     21
   40 TEPP=CRF(I-1)+(CRF(I)-CRF(I-1))*(TC-CRFT(I-1))/(CRFT(I)-CRFT(I-1)) TEPP   22
      RETURN                                                           TEPP     23
      END                                                              TEPP     24
```

```
      QIN(1)=QTOT-Q(1)                                                   RTEMP      37
      DO 50 I=2,N                                                        RTEMP      38
   50 QIN(I)=QIN(I-1)-Q(I)                                               RTEMP      39
      IME=0                                                              RTEMP      40
      DO 180 I=1,N                                                       RTEMP      41
      R=(RFS+DELR)/12.-DR*FLOAT(I-1)                                     RTEMP      42
      RDR=R-DR                                                           RTEMP      43
      IF (I.GT.1) GO TO 60                                               RTEMP      44
      TAV=TFS                                                            RTEMP      45
      TZ=TFS                                                             RTEMP      46
      GO TO 70                                                           RTEMP      47
   60 TAV=TT(I-1)                                                        RTEMP      48
      TZ=TT(I-1)                                                         RTEMP      49
   70 CONTINUE                                                           RTEMP      50
      DEN=FRDEN                                                          RTEMP      51
      IF (R.LE.RSINF) DEN=FRSIN                                          RTEMP      52
   80 TAVC=(TAV-32.)/1.8                                                 RTEMP      53
      IF (TAVC.GE.TM) DEN=1.0                                            RTEMP      54
      IF (NFUEL) 90,100,110                                              RTEMP      55
   90 FRP=FRPUO2                                                         RTEMP      56
      IF (FRPUO2.GT..05) FRP=.05                                         RTEMP      57
      C=(57.8*TCOR(DEN,TAVC))/(1.+FRP)                                   RTEMP      58
      GO TO 120                                                          RTEMP      59
  100 C=57.8*TCOR(DEN,TAVC)                                              RTEMP      60
      GO TO 120                                                          RTEMP      61
  110 KK=2                                                               RTEMP      62
      IF (R.LE.RSINF) KK=3                                               RTEMP      63
      C=TERP(TAV,CF,KK,NNN,3)                                            RTEMP      64
  120 CONTINUE                                                           RTEMP      65
      IF (RDR.LT.1.E-20) GO TO 140                                       RTEMP      66
      QINQ=0.                                                            RTEMP      67
      IF (P.LE.0.) GO TO 130                                             RTEMP      68
      QINQ=QIN(I)/Q(I)                                                   RTEMP      69
  130 TERM=(RDR**2/(R**2-RDR**2)-QINQ)*ALOG(R/RDR)                       RTEMP      70
      GO TO 150                                                          RTEMP      71
  140 TERM=0.                                                            RTEMP      72
  150 TT(I)=TZ+Q(I)/(2.*PI*C)*(.5-TERM)                                  RTEMP      73
      TAV1=(TZ+TT(I))/2.                                                 RTEMP      74
      TTAV=TAV                                                           RTEMP      75
      DIFF=ABS(TAV-TAV1)                                                 RTEMP      76
      IF (DIFF-ACC) 180,180,160                                          RTEMP      77
  160 TAV=TAV1                                                           RTEMP      78
      IME=IME+1                                                          RTEMP      79
      IF (IME-10) 80,170,170                                             RTEMP      80
  170 WRITE (6,260) TTAV,TAV1                                            RTEMP      81
  180 IME=0                                                              RTEMP      82
      DO 190 I=1,N                                                       RTEMP      83
      TS(I)=(RFS+DELR)-(RFS+DELR-RVOID)*FLOAT(I)/FLOAT(N)                RTEMP      84
  190 CONTINUE                                                           RTEMP      85
      DO 200 I=1,N                                                       RTEMP      86
      BB(1,I)=TT(I)                                                      RTEMP      87
  200 BB(2,I)=TS(I)                                                      RTEMP      88
      IF (KOUNT.EQ.0) GO TO 220                                          RTEMP      89
      IF (FRDEN.GE.FRSIN) FRSIN=FRDEN                                    RTEMP      90
      TSINC=1350.                                                        RTEMP      91
      IF (T.LE.0.) GO TO 210                                             RTEMP      92
      RETEM=.00001367*ALOG10(T/3600.)+.000480                            RTEMP      93
```

```
      TSINC=1./RETEM-273.
  210 CONTINUE
      TSIN=1.8*TSINC+32.
      RSIN=TERP(TSIN,BB,2,N,2)
      IF (RSIN.LE.RSINZ) RSIN=RSINZ
      DSIN=2.*RSIN
      RSINF=RSIN/12.
      RRVOID=RVOID
      RVOID=SQRT((RSIN**2)*(FRSIN-FRDEN)/FRSIN+(RVOIDZ**2)*FRDEN/FRSIN)
      IF (RVOID.LE.RVOIDZ) RVOID=RVOIDZ
      DVOID=2.*RVOID
      ELTC=LF-LVOIDZ/FNPOW
      VTC=PI*ELTC*RVOIDZ**2
      VVOID=(PI*LF*RVOID**2-VTC)
  220 CONTINUE
C
C      VOLUME AVERAGE THE TEMPERATURE.
      TSR(N+1)=RVOID
      DO 230 I=1,N
      BI=I
  230 TSR(I)=(RFS+DELR)-(((RFS+DELR)-RVOID)/FLOAT(N))*(BI-1.0)
      VAFR=(TSR(1)**2-TSR(2)**2)*PI*((TFS+TT(1))*.5)
      DO 240 I=2,N
      VAFR=VAFR+(TSR(I)**2-TSR(I+1)**2)*PI*((TT(I)+TT(I-1))*.5)
  240 CONTINUE
C
C     VOLUMETRIC AVERAGE RADIAL TEMPERATURE,  DEG.F
      VAVGT=VAFR/(((RFS+DELR)**2-RVOID**2)*PI)
      VAVGTC=(VAVGT-32.)/1.8
      IF (KOUNT.EQ.0) TBAR(IPOW)=VAVGT
C
C     CALCULATE RADIUS AVERAGED FUEL TEMPERATURE
      TEMP=0
      DO 250 I=1,50
      TEMP=TEMP+BB(1,I)*(RFS+DELR+RVOID)/50.
  250 CONTINUE
      TAVGF=TEMP/(RFS+DELR-RVOID)
      TAVGFC=(TAVGF-32.)/1.8
      RD=(RFS-RVOIDZ)/N
      RETURN
C
  260 FORMAT (*0 NOCONVERGENCE IN TEMP CALC AFTER 10 ITERATIONS, ASSUMED
     + TEMP =*,F7.2,*  ,CALCULATED TEMP =*,F7.2//)
      END
```

```
      FUNCTION TERP (TT,TABLE,L,N,IX)                                  TERP        2
C                                                                      TERP        3
C     L = THE INDEX TO THE TABLE                                       TERP        4
      DIMENSION TABLE(IX,N)                                            TERP        5
      I=1                                                              TERP        6
      IF (TABLE(I,1).GT.TABLE(I,N)) GO TO 60                           TERP        7
      IF (TT.LE.TABLE(I,1)) GO TO 20                                   TERP        8
      IF (TT.GE.TABLE(I,N)) GO TO 30                                   TERP        9
      DO 10 J=1,N                                                      TERP       10
      IF (TT-TABLE(1,J)) 50,40,10                                      TERP       11
   10 CONTINUE                                                         TERP       12
   20 TERP=TABLE(L,1)                                                  TERP       13
      RETURN                                                           TERP       14
   30 TERP=TABLE(L,N)                                                  TERP       15
      RETURN                                                           TERP       16
   40 TERP=TABLE(L,J)                                                  TERP       17
      RETURN                                                           TERP       18
   50 TERP=TABLE(L,J-1)+(TABLE(L,J)-TABLE(L,J-1))*(TT-TABLE(I,J-1))/(TAB TERP       19
     +LE(I,J)-TABLE(I,J-1))                                            TERP       20
      RETURN                                                           TERP       21
   60 IF (TT.GE.TABLE(I,1)) GO TO 20                                   TERP       22
      IF (TT.LE.TABLE(I,N)) GO TO 30                                   TERP       23
      DO 70 J=1,N                                                      TERP       24
      IF (TT-TABLE(1,J)) 70,40,50                                      TERP       25
   70 CONTINUE                                                         TERP       26
      END                                                              TERP       27
```

```
      FUNCTION OMEXP (X)                                    OMEXP      2
      DATA ZMAX/741./,ZMIN/-675./                           OMEXP      3
      X=AMAX1(AMIN1(X,ZMAX),ZMIN)                           OMEXP      4
      OMEXP=1.0-EXP(-X)                                     OMEXP      5
      RETURN                                                OMEXP      6
      END                                                   OMEXP      7
```

APPENDIX B

SAMPLE PROBLEM AND OUTPUT FROM GAPCON-THERMAL-2

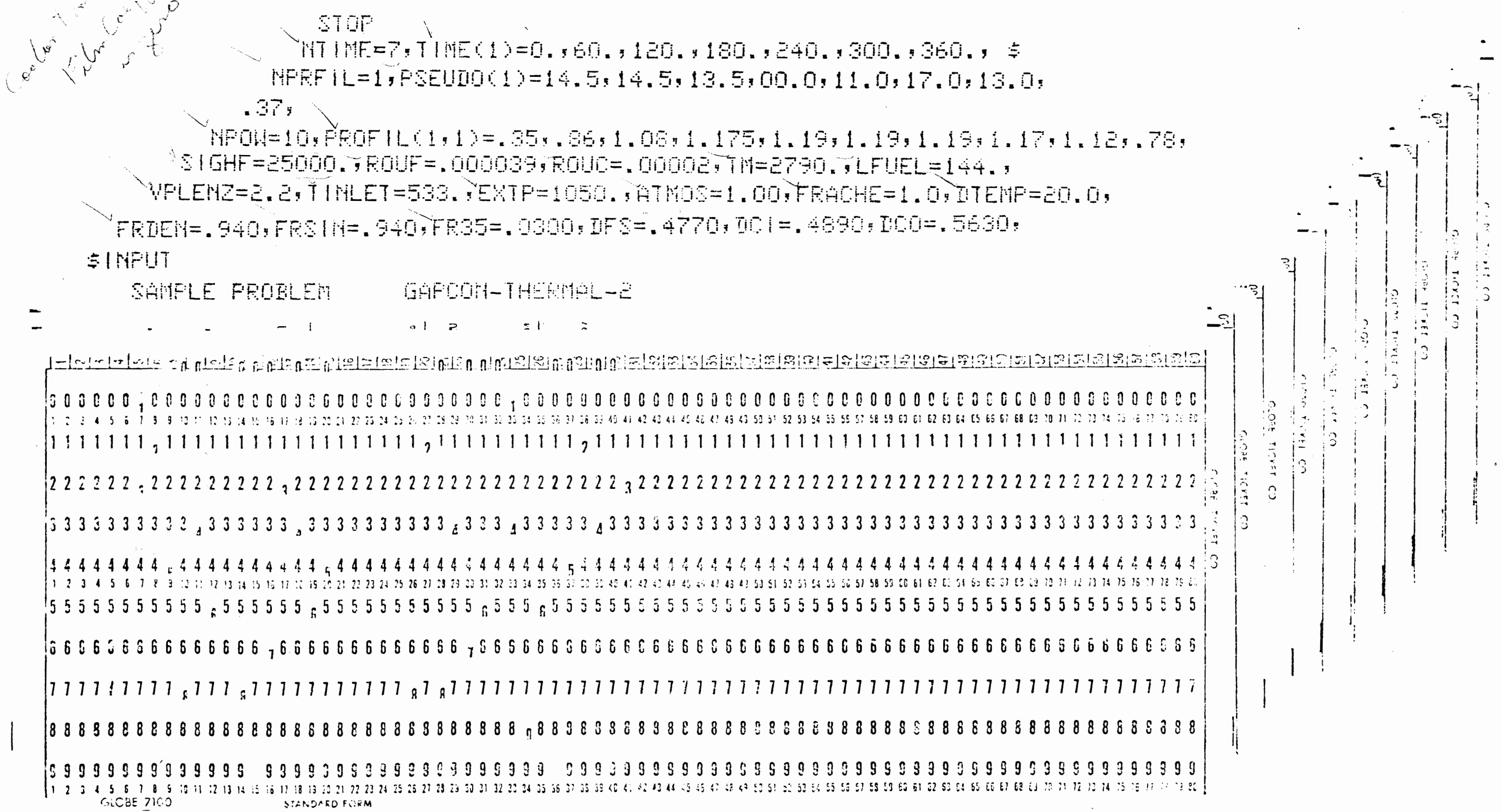

FIGURE B-1. EXAMPLE OF INPUT TO GAPCON-THERMAL-2

```
$INPUT
ATMOS   = .1E+01,
CRUDTH  = 0.0,
DBO     = 0.0,
DCI     = .489E+00,
DCO     = .563E+00,
DE      = 0.0,
DFS     = .477E+00,
DSINZ   = 0.0,
DTEMP   = .2E+02,
DVOIDZ  = 0.0,
EXTP    = .105E+04,
FRACAR  = 0.0,
FRACH   = 0.0,
FRACHE  = .1E+01,
FRACKR  = 0.0,
FRACN   = 0.0,
FRACXE  = 0.0,
FRDEN   = .94E+00,
FRSIN   = .94E+00,
FRPUO2  = 0.0,
FR35    = .3E-01,
FR40    = 0.0,
FR41    = 0.0,
HBC     = 0.0,
ICDF    = 0,
ICOR    = 0,
ICREP   = 0,
IDENSF  = 0,
IGAS    = 0,
IPEAK   = 0,
IRELOC  = 0,
```

```
IRELSE  = 0,
IRL     = 0,
ISTOR   = 1,
IT      = 0,
KB      = 0.0,
KOOL    = 0,
LFUEL   = .144E+03,
LVOIDZ  = 0.0,
MINI    = 0,
NCLAD   = 0,
NFLX    = 0,
NFUEL   = 0,
NOH     = 0,
NPOW    = 10,
NPRFIL  = 1,
NTIME   = 7,
PRCOH   = 0.0,
PROFIL  = .35E+00, .86E+00, .108E+01, .117E+01, .119E+01, .119E+01, .119E+01,   .117E+01, .112E+01, .78E+00, .37E+00,
          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, 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, 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, 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, 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,
PSEUDO  = .145E+02, .145E+02, .135E+02, 0.0, .11E+02, .17E+02, .13E+02, 0.0,    0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
RADS    = 0.0,
ROUC    = .2E-04,
ROUF    = .39E-04,
S       = 0.0,
SIGHF   = .25E+05,
TIME    = 0.0, .6E+02, .12E+03, .18E+03, .24E+03, .3E+03, .36E+03, 0.0, 0.0,    0.0, 0.0, 0.0, 0.0, 0.0, 0.0,
```

```
TINLET  = .533E+03, 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,
TM      = .279E+04,
TPLAS   = .2192E+04,
V       = 0.0,
VPLENZ  = .22E+01,
XCO     = 0.0,
XH      = 0.0,
XN      = 0.0,
ZCLAD   = 0.0,
$END
```

```
GAPCON-THERMAL-2   SAMPLE PROBLEM
                                        *******************
                                        *  INPUT VALUES  *
*********************************************************************************************
*                                                                                           *
*       FUEL COMPOSITION                                                                    *
*         0.0000  WEIGHT FRACTION PUO2                          FRPUO2                      *
*            0.0000  WEIGHT FRACTION PU239                      FR39                        *
*            0.0000  WEIGHT FRACTION PU240                      FR40                        *
*            0.0000  WEIGHT FRACTION PU241                      FR41                        *
*        1.0000  WEIGHT FRACTION UO2                            FRUO2                       *
*             .0300  WEIGHT FRACTION U235                       FR35                        *
*             .9700  WEIGHT FRACTION U238                       FR38                        *
*                                                                                           *
*       FUEL DENSITY                          (FRACTION TD)   FRDEN       .940              *
*       RESTRUCTURED FUEL DENSITY             (FRACTION TD)   FRSIN       .940              *
*       PELLET DIAMETER                       (INCHES)        DFS         .4770             *
*       INITIAL RESTRUCTURED FUEL DIAM.       (INCHES)        DSIN       0.0000             *
*       INITIAL CENTER HOLE DIAMETER          (INCHES)        DVOIDZ     0.0000             *
*       PELLET-TO-CLAD GAP                    (INCHES)        GAP         .0120             *
*       CLAD INSIDE DIAMETER                  (INCHES)        DCI         .4890             *
*       CLAD OUTSIDE DIAMETER                 (INCHES)        DCO         .5630             *
*       FUEL LENGTH                           (INCHES)        LFUEL    144.00               *
*       SORBED GAS CONTENT                    (CC/GRAM)       S          0.0000             *
*       FRACTION OF SORBED GAS WHICH IS H2                    XH         0.0000             *
*       PLENUM VOLUME                         (CU. IN.)       VPLENZ     2.20               *
*       COOLANT TEMPERATURE                   (DEG F)         TINLET(1) 533.0               *
*       AXIAL TEMPERATURE GRADENT ACROSS CORE (DEG F)         DTEMP     20.0                *
*       COOLANT PASSAGE EQUIVALENT DIAMETER   (INCHES)        DE         0.0000             *
*       COOLANT VELOCITY                      (FT/SEC)        V          0.000              *
*       PRESSURE ON CLAD OD                   (PSI)           EXTP    1050.0                *
*       FUEL SURFACE ROUGHNESS, ARITH. MEAN   (INCH)          ROUF        .000039           *
*       CLAD ID SURFACE ROUGHNESS, ARITH. MEAN (INCH)         ROUC        .000020           *
*       DIAMETER OF AUXILIARY BASKET          (INCHES)        DBO        0.0000             *
*       BASKET THERMAL CONDUCTIVITY           (BTU/HR-FT-F)   KB         0.00               *
*       BASKET-TO-CLAD HEAT TRANSFER COEFF.   (BTU/HR-FT2-F)  HBC        0.0                *
*       FILL GAS PRESSURE                     (ATMOSPHERES)   ATMOS      1.0                *
*       CRUD THICKNESS                        (INCHES)        CRUDTH     0.0000             *
*       FILL GAS COMPOSITION                                                                *
*         1.00000  MOLE FRACTION HELIUM                                                     *
*         0.00000  MOLE FRACTION ARGON                                                      *
*         0.00000  MOLE FRACTION HYDROGEN                                                   *
*         0.00000  MOLE FRACTION NITROGEN                                                   *
*         0.00000  MOLE FRACTION KRYPTON                                                    *
*         0.00000  MOLE FRACTION XENON                                                      *
*                                                                                           *
*       COOLANT NOT SPECIFIED, FILM COEFFICIENT IS 25000.                                   *
*                                                                                           *
*                                                                                           *
*       CLADDING IS ZIRCALOY-2                                                              *
*                                                                                           *
*       FUEL THERMAL CONDUCTIVITY VALUES DETERMINED FROM DATA OF LYONS, ET AL               *
*                                                                                           *
*                                                                                           *
*       FUEL THERMAL CONDUCTIVITY VALUES USED                                               *
*                                                                                           *
*               TEMPERATURE                     THERMAL CONDUCTIVITY                        *
*                 (DEG F)                         (BTU/HR-FT-DEG F)                         *
```

	UNRESTRUCTURED FUEL	RESTRUCTURED FUEL
500.	3.291	3.291
1000.	2.333	2.333
1500.	1.832	1.832
2000.	1.544	1.544
2500.	1.382	1.382
3000.	1.308	1.308
3500.	1.306	1.306
4000.	1.365	1.365
4500.	1.484	1.484
5000.	1.661	1.661

FLUX DEPRESSION VALUES USED

DIAMETER (IN)	FLUX RATIO
0.0000	1.0000
.0477	1.0019
.0954	1.0075
.1431	1.0169
.1908	1.0301
.2385	1.0472
.2862	1.0683
.3339	1.0935
.3816	1.1230
.4293	1.1569
.4770	1.1954

**** INPUT OPTIONS ****

NPOW =	10	IPEAK =	0	IGAS =	0
MINI =	0	NTIME =	7	IRELSE=	0
ICDF =	0	NPRFIL=	1	ICOR =	0
ISTOR =	1	NFUEL =	0	NFLX =	0
ICREP =	0	NOM =	0	IDENSF=	0
NCLAD Y	0	IRL =	0	IRELOC=	0
IT =	0				

```
CASE  1     AXIAL SEGMENT  6  OF 10

    GAPCON-THERMAL-2   SAMPLE PROBLEM

      LINEAR HEAT RATING (AVG)          4.7572E+04 W/M    ( 14.50 KW/FT)
                         (PEAK)         4.7572E+04 W/M    ( 14.50 KW/FT)
     TIME IN-REACTOR              0.          SEC.    (   0.0 DAYS)
     BURNUP                       0.          J/KGM  (     0.0 MWD/MTM)

               AVERAGE FLUX IN FUEL              3.3365E+09 N/M2-S           (3.3365E+13 N/CM2-SEC.)
               CLAD OD SURFACE HEAT FLUX         1.0562E+06 W/M2             (3.3505E+05 BTU/HR-FT2)
               FUEL SURFACE HEAT FLUX            1.2306E+06 W/M2             (3.9036E+05 BTU/HR-FT2)
               COOLANT TEMERATURE                    285.21 DEG.C            (     545.38 DEG.F)
               FILM COEFFICIENT                  1.4196E+05 W/M2-DEG.C       (2.5000E+04 BTU/HR-FT2-DEG.F)
               CLAD THERMAL CONDUCTIVITY         1.5978E+01 W/M-DEG.C        (9.2318E+00 BTU/HR-FT-DEG.F)
               CLAD OD TEMPERATURE                    292.7 DEG.C            (      558.8 DEG.F)
               CLAD ID TEMPERATURE                    359.7 DEG.C            (      679.4 DEG.F)
               FUEL SURFACE TEMPERATURE               691.9 DEG.C            (     1277.5 DEG F)

                  RADIUS          TEMPERATURE            RADIUS          TEMPERATURE          PERCENT OF
                 (METERS)          (DEG C)              (INCHES)          (DEG F)             FUEL RADIUS

                 .005535             914.                 .2179             1677.                 90.00
                 .004920            1140.                 .1937             2084.                 80.00
                 .004305            1359.                 .1695             2477.                 70.00
                 .003690            1558.                 .1453             2836.                 60.00
                 .003075            1730.                 .1211             3146.                 50.00
                 .002460            1871.                 .0969             3399.                 40.00
                 .001845            1979.                 .0726             3593.                 30.00
                 .001230            2055.                 .0484             3730.                 20.00
                 .000615            2100.                 .0242             3811.                 10.00
                0.000000            2114.                0.0000             3838.                  0.00

               MELT TEMPERATURE                   2790.  DEG.C     (  5054. DEG.F)
               MELT RADIUS                       0.00000 METERS    (  0.00 PERCENT OF FUEL RADIUS)

               VOLUME AVERAGE FUEL TEMPERATURE    1364.9 DEG.C     (    2488.8 DEG.F)

               CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION       9.2240E-05  METERS          (   .003632 INCH)
               CHANGE IN FUEL RADIUS DUE TO RELOCATION              0.          METERS          (  0.000000 INCH)
               CHANGE IN FUEL RADIUS DUE TO DENSIFICATION           0.          METERS          (  0.000000 INCH)
               CHANGE IN FUEL RADIUS DUE TO SWELLING                0.          METERS          (  0.000000 INCH)
               TOTAL CHANGE IN FUEL RADIUS                          9.2240E-05  METERS          (   .003632 INCH)
               CHANGE IN CLAD RADIUS DUE TO THERMAL EXPANSION       1.3134E-05  METERS          (   .000517 INCH)
               CHANGE IN CLAD RADIUS DUE TO CREEP                   0.          METERS          (  0.000000 INCH)
               CHANGE IN CLAD RADIUS DUE TO  PRESSURE               0.          METERS          (  0.000000 INCH)
               TOTAL CHANGE IN CLAD RADIUS                          1.3134E-05  METERS          (   .000517 INCH)
               HOT GAP (RADIAL)                                     7.3294E-05  METERS          (   .002886 INCH)
               FUEL-CLAD INTERFACIAL PRESSURE                       0.          PA              (0.         PSI)

               FUEL TO CLAD GAP CONDUCTANCE          3.6845E+03 W/M2-DEG.C     (  648.9 BTU/HR-FT2-DEG.F)

                    COMPONENT DUE TO SOLID-SOLID CONTACT          0.           W/M2-DEG.C    (     0.0 BTU/HR-FT2-DEG.F)
                    COMPONENT DUE TO CONDUCTION THRU THE GAS      3.6170E+03 W/M2-DEG.C    (   637.0 BTU/HR-FT2-DEG.F)
                    COMPONENT DUE TO RADIANT HEAT TRANSFER        8.8838E+01 W/M2-DEG.C    (    15.6 BTU/HR-FT2-DEG.F)

               GAS RELEASE FRACTION DURING CURRENT TIME STEP        .2335
               INTERNAL GAS PRESSURE                                6.6111E+03 PA       (   37.75 PSI)

               AVERAGE GAS COMPOSITION                              LOCAL GAS COMPOSITION

                        1.000000  MOLE FRACTION HELIUM                       1.000000  MOLE FRACTION HELIUM
```

Conversion incorrect

```
     0.000000  MOLE FRACTION ARGON                           0.000000  MOLE FRACTION ARGON
     0.000000  MOLE FRACTION HYDROGEN                        0.000000  MOLE FRACTION HYDROGEN
     0.000000  MOLE FRACTION NITROGEN                        0.000000  MOLE FRACTION NITROGEN
     0.000000  MOLE FRACTION CARBON MONOXIDE                 0.000000  MOLE FRACTION CARBON MONOXIDE
     0.000000  MOLE FRACTION KRYPTON                         0.000000  MOLE FRACTION KRYPTON
     0.000000  MOLE FRACTION XENON                           0.000000  MOLE FRACTION XENON
   ----------                                              ----------
   2.3531E-06 (ROD AVERAGE) KG-MOLE                        4.0351E-08 (LOCAL) KG-MOLE

THERMAL CONDUCTIVITY OF FILL GAS     2.9082E-01 W/M-DEG.C        (1.6803E-01 BTU/HR-FT-DEG.F)
TEMPERATURE JUMP DISTANCE            7.1089E-06 METERS           (2.7988E-04 INCH)

NOMINAL HEAT CAPACITY                        2.4775E+07   J/KG-DEG.C    (5.9174E+03 BTU/LB-DEG.F)
STORED ENERGY AT TBAR                   EBAR=4.1187E+05   J/KG          (1.7707E+02 BTU/LB)
VOLUME AVERAGE STORED ENERGY               E=4.3124E+05   J/KG          (1.8540E+02 BTU/LB)
STORED ENERGY PER UNIT LENGTH            EPL=3.4450E+05   J/M           (1.4811E+02 BTU/FOOT)
```

CASE = 1 AXIAL SUMMARY

TIME AT POWER IN DAYS 0.0

GAPCON-THERMAL-2 SAMPLE PROBLEM

AXIAL DISTANCE (METERS)	HEAT RATING (W/M)	CLAD SURFACE HEAT FLUX (W/M2)	CENTER LINE TEMP. (DEG.C)	AVERAGE VOL. FUEL TEMP. (DEG.C)	GAP CONDUCTANCE (W/M2-DEG.C)	RADIAL HOT GAP (METERS)	GAS RELEASE FRACTION	MOLE FRACTION HELIUM
1.829E-01	2.419E+04	3.107E+05	7.812E+02	6.331E+02	1.889E+03	1.372E-04	0.	1.000E+00
5.486E-01	3.878E+04	7.634E+05	1.622E+03	1.111E+03	2.728E+03	1.001E-04	3.564E-02	1.000E+00
9.144E-01	4.497E+04	9.587E+05	1.957E+03	1.283E+03	3.319E+03	8.279E-05	1.722E-01	1.000E+00
1.280E+00	4.717E+04	1.039E+06	2.084E+03	1.348E+03	3.613E+03	7.481E-05	2.222E-01	1.000E+00
1.646E+00	4.757E+04	1.056E+06	2.113E+03	1.363E+03	3.685E+03	7.339E-05	2.326E-01	1.000E+00
2.012E+00	4.757E+04	1.056E+06	2.114E+03	1.365E+03	3.685E+03	7.329E-05	2.335E-01	1.000E+00
2.377E+00	4.717E+04	1.056E+06	2.116E+03	1.367E+03	3.685E+03	7.319E-05	2.344E-01	1.000E+00
2.743E+00	4.577E+04	1.038E+06	2.089E+03	1.353E+03	3.629E+03	7.461E-05	2.247E-01	1.000E+00
3.109E+00	3.798E+04	9.941E+05	2.023E+03	1.320E+03	3.456E+03	7.978E-05	2.002E-01	1.000E+00
3.475E+00	2.299E+04	6.924E+05	1.504E+03	1.052E+03	2.571E+03	1.061E-04	2.381E-02	1.000E+00

TOTAL PIN CONDITIONS

VOLUME AVERAGED TEMPERATURE (DEG.C)	INTERNAL GAS PRESSURE (PA)	FISSION GAS RELEASE FRACTION
.1219E+04	.6596E+04	0.

TO CONVERT FROM	TO THE FOLLOWING	MULTIPLY BY
W/M2	BTU/HR-FT2	0.3172E+00
W/M	KW/FT	3.0480E-04
W/M2-DEG.C	BTU/HR-FT2-DEG.F	0.1761E+00
PA	PSI	5.7100E-03

```
CASE  2     AXIAL SEGMENT  6  OF 10

    GAPCON-THERMAL-2   SAMPLE PROBLEM

       LINEAR HEAT RATING (AVG)          4.7572E+04 W/M     ( 14.50 KW/FT)
                          (PEAK)         4.7572E+04 W/M     ( 14.50 KW/FT)
      TIME IN-REACTOR              5.1840E+06 SEC.    (  60.0 DAYS)
      BURNUP                       2.3534E+11 J/KGM   (  2723.9 MWD/MTM)

              AVERAGE FLUX IN FUEL               3.3365E+09 N/M2-S          (3.3365E+13 N/CM2-SEC.)
              CLAD OD SURFACE HEAT FLUX          1.0562E+06 W/M2            (3.3505E+05 BTU/HR-FT2)
              FUEL SURFACE HEAT FLUX             1.2229E+06 W/M2            (3.8791E+05 BTU/HR-FT2)
              COOLANT TEMERATURE                    285.21 DEG.C            (    545.38 DEG.F)
              FILM COEFFICIENT                   1.4196E+05 W/M2-DEG.C      (2.5000E+04 BTU/HR-FT2-DEG.F)
              CLAD THERMAL CONDUCTIVITY          1.5978E+01 W/M-DEG.C       (9.2318E+00 BTU/HR-FT-DEG.F)
              CLAD OD TEMPERATURE                   292.7 DEG.C             (      558.8 DEG.F)
              CLAD ID TEMPERATURE                   359.7 DEG.C             (      679.4 DEG.F)
              FUEL SURFACE TEMPERATURE             1053.1 DEG.C             (     1927.5 DEG F)
```

RADIUS (METERS)	TEMPERATURE (DEG C)	RADIUS (INCHES)	TEMPERATURE (DEG F)	PERCENT OF FUEL RADIUS
.005570	1332.	.2193	2429.	90.00
.004951	1600.	.1949	2912.	80.00
.004332	1842.	.1706	3347.	70.00
.003713	2047.	.1462	3717.	60.00
.003094	2215.	.1218	4019.	50.00
.002476	2346.	.0975	4255.	40.00
.001857	2444.	.0731	4431.	30.00
.001238	2511.	.0487	4553.	20.00
.000619	2551.	.0244	4624.	10.00
0.000000	2564.	0.0000	4647.	0.00

```
              MELT TEMPERATURE                   2790.  DEG.C      (  5054. DEG.F)
              MELT RADIUS                        0.00000 METERS    (  0.00 PERCENT OF FUEL RADIUS)

              VOLUME AVERAGE FUEL TEMPERATURE     1819.0 DEG.C      (    3306.1 DEG.F)

              CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION       1.3107E-04  METERS        (   .005160 INCH)
              CHANGE IN FUEL RADIUS DUE TO RELOCATION              0.          METERS        (  0.000000 INCH)
              CHANGE IN FUEL RADIUS DUE TO DENSIFICATION           0.          METERS        (  0.000000 INCH)
              CHANGE IN FUEL RADIUS DUE TO SWELLING                0.          METERS        (  0.000000 INCH)
              TOTAL CHANGE IN FUEL RADIUS                          1.3107E-04  METERS        (   .005160 INCH)
              CHANGE IN CLAD RADIUS DUE TO THERMAL EXPANSION       1.3134E-05  METERS        (   .000517 INCH)
              CHANGE IN CLAD RADIUS DUE TO CREEP                   0.          METERS        (  0.000000 INCH)
              CHANGE IN CLAD RADIUS DUE TO  PRESSURE               0.          METERS        (  0.000000 INCH)
              TOTAL CHANGE IN CLAD RADIUS                          1.3134E-05  METERS        (   .000517 INCH)
              HOT GAP (RADIAL)                                     3.4462E-05  METERS        (   .001357 INCH)
              FUEL-CLAD INTERFACIAL PRESSURE                       0.          PA            (0.          PSI)

              FUEL TO CLAD GAP CONDUCTANCE             1.7599E+03 W/M2-DEG.C      (  309.9 BTU/HR-FT2-DEG.F)

                   COMPONENT DUE TO SOLID-SOLID CONTACT        0.          W/M2-DEG.C    (     0.0 BTU/HR-FT2-DEG.F)
                   COMPONENT DUE TO CONDUCTION THRU THE GAS    1.5750E+03 W/M2-DEG.C    (   277.4 BTU/HR-FT2-DEG.F)
                   COMPONENT DUE TO RADIANT HEAT TRANSFER      1.7648E+02 W/M2-DEG.C    (    31.1 BTU/HR-FT2-DEG.F)

              GAS RELEASE FRACTION DURING CURRENT TIME STEP         .4974
              INTERNAL GAS PRESSURE                                2.6321E+04 PA          (  150.30 PSI)

              AVERAGE GAS COMPOSITION                              LOCAL GAS COMPOSITION

                       .301607  MOLE FRACTION HELIUM                         .301607  MOLE FRACTION HELIUM
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```
      0.000000  MOLE FRACTION ARGON                     0.000000  MOLE FRACTION ARGON
      0.000000  MOLE FRACTION HYDROGEN                  0.000000  MOLE FRACTION HYDROGEN
      0.000000  MOLE FRACTION NITROGEN                  0.000000  MOLE FRACTION NITROGEN
      0.000000  MOLE FRACTION CARBON MONOXIDE           0.000000  MOLE FRACTION CARBON MONOXIDE
       .085250  MOLE FRACTION KRYPTON                    .085250  MOLE FRACTION KRYPTON
       .613142  MOLE FRACTION XENON                      .613142  MOLE FRACTION XENON
    ----------                                       ----------
    7.8017E-06 (ROD AVERAGE) KG-MOLE                 6.2602E-08 (LOCAL) KG-MOLE

THERMAL CONDUCTIVITY OF FILL GAS     5.5414E-02 W/M-DEG.C        (3.2017E-02 BTU/HR-FT-DEG.F)
TEMPERATURE JUMP DISTANCE            7.2090E-07 METERS           (2.8382E-05 INCH)

NOMINAL HEAT CAPACITY                      2.8411E+07   J/KG-DEG.C    (6.7858E+03 BTU/LB-DEG.F)
STORED ENERGY AT TBAR                 EBAR=5.7558E+05   J/KG          (2.4746E+02 BTU/LB)
VOLUME AVERAGE STORED ENERGY             E=6.1945E+05   J/KG          (2.6632E+02 BTU/LB)
STORED ENERGY PER UNIT LENGTH          EPL=4.9485E+05   J/M           (2.1275E+02 BTU/FOOT)
```

CASE = 2 AXIAL SUMMARY

TIME AT POWER IN DAYS 60.0

GAPCON-THERMAL-2 SAMPLE PROBLEM

AXIAL DISTANCE (METERS)	HEAT RATING (W/M)	CLAD SURFACE HEAT FLUX (W/M2)	CENTER LINE TEMP. (DEG.C)	AVERAGE VOL. FUEL TEMP. (DEG.C)	GAP CONDUCTANCE (W/M2-DEG.C)	RADIAL HOT GAP (METERS)	GAS RELEASE FRACTION	MOLE FRACTION HELIUM
1.829E-01	2.419E+04	3.107E+05	1.316E+03	1.113E+03	5.874E+02	1.108E-04	3.260E-02	3.014E-01
5.486E-01	3.878E+04	7.634E+05	2.213E+03	1.655E+03	1.155E+03	5.730E-05	4.166E-01	3.014E-01
9.144E-01	4.497E+04	9.587E+05	2.467E+03	1.781E+03	1.511E+03	4.092E-05	4.852E-01	3.014E-01
1.280E+00	4.717E+04	1.039E+06	2.546E+03	1.811E+03	1.710E+03	3.513E-05	4.950E-01	3.014E-01
1.646E+00	4.757E+04	1.056E+06	2.563E+03	1.818E+03	1.760E+03	3.456E-05	4.966E-01	3.014E-01
2.012E+00	4.757E+04	1.056E+06	2.564E+03	1.819E+03	1.760E+03	3.446E-05	4.974E-01	3.014E-01
2.377E+00	4.717E+04	1.056E+06	2.565E+03	1.820E+03	1.760E+03	3.437E-05	4.981E-01	3.014E-01
2.743E+00	4.577E+04	1.038E+06	2.548E+03	1.814E+03	1.716E+03	3.510E-05	4.963E-01	3.014E-01
3.109E+00	3.798E+04	9.941E+05	2.512E+03	1.805E+03	1.591E+03	3.883E-05	4.957E-01	3.014E-01
3.475E+00	2.299E+04	6.924E+05	2.109E+03	1.600E+03	1.054E+03	6.430E-05	3.758E-01	3.014E-01

TOTAL PIN CONDITIONS

VOLUME AVERAGED TEMPERATURE (DEG.C)	INTERNAL GAS PRESSURE (PA)	FISSION GAS RELEASE FRACTION
.1704E+04	.2634E+05	.4537E+00

TO CONVERT FROM	TO THE FOLLOWING	MULTIPLY BY
W/M2	BTU/HR-FT2	0.3172E+00
W/M	KW/FT	3.0480E-04
W/M2-DEG.C	BTU/HR-FT2-DEG.F	0.1761E+00
PA	PSI	5.7100E-03

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CASE  3     AXIAL SEGMENT  6  OF 10

    GAPCON-THERMAL-2   SAMPLE PROBLEM

      LINEAR HEAT RATING (AVG)          4.4291E+04 W/M     ( 13.50 KW/FT)
                         (PEAK)          4.4291E+04 W/M     ( 13.50 KW/FT)
     TIME IN-REACTOR                 1.0368E+07 SEC.    ( 120.0 DAYS)
     BURNUP                          4.5445E+11 J/KGM   (  5259.9 MWD/MTM)

           AVERAGE FLUX IN FUEL                3.1064E+09 N/M2-S              (3.1064E+13 N/CM2-SEC.)
           CLAD OD SURFACE HEAT FLUX           9.8343E+05 W/M2                (3.1195E+05 BTU/HR-FT2)
           FUEL SURFACE HEAT FLUX              1.1377E+06 W/M2                (3.6088E+05 BTU/HR-FT2)
           COOLANT TEMERATURE                     285.21 DEG.C                (     545.38 DEG.F)
           FILM COEFFICIENT                    1.4196E+05 W/M2-DEG.C          (2.5000E+04 BTU/HR-FT2-DEG.F)
           CLAD THERMAL CONDUCTIVITY           1.5939E+01 W/M-DEG.C           (9.2095E+00 BTU/HR-FT-DEG.F)
           CLAD OD TEMPERATURE                    292.1 DEG.C                 (      557.9 DEG.F)
           CLAD ID TEMPERATURE                    354.7 DEG.C                 (      670.4 DEG.F)
           FUEL SURFACE TEMPERATURE              1163.3 DEG.C                 (     2125.9 DEG F)

               RADIUS          TEMPERATURE              RADIUS           TEMPERATURE          PERCENT OF
              (METERS)           (DEG C)               (INCHES)           (DEG F)            FUEL RADIUS

              .005574             1434.                 .2195              2613.               90.00
              .004955             1688.                 .1951              3071.               80.00
              .004336             1914.                 .1707              3477.               70.00
              .003716             2104.                 .1463              3819.               60.00
              .003097             2258.                 .1219              4097.               50.00
              .002477             2379.                 .0975              4314.               40.00
              .001858             2469.                 .0732              4477.               30.00
              .001239             2532.                 .0488              4589.               20.00
              .000619             2568.                 .0244              4655.               10.00
             0.000000             2580.                0.0000              4676.                0.00

           MELT TEMPERATURE                      2790.  DEG.C      (  5054. DEG.F)
           MELT RADIUS                          0.00000 METERS     (  0.00 PERCENT OF FUEL RADIUS)

           VOLUME AVERAGE FUEL TEMPERATURE      1888.8 DEG.C       (    3431.8 DEG.F)

           CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION        1.3584E-04  METERS         (   .005348 INCH)
           CHANGE IN FUEL RADIUS DUE TO RELOCATION               0.          METERS         (  0.000000 INCH)
           CHANGE IN FUEL RADIUS DUE TO DENSIFICATION            0.          METERS         (  0.000000 INCH)
           CHANGE IN FUEL RADIUS DUE TO SWELLING                 0.          METERS         (  0.000000 INCH)
           TOTAL CHANGE IN FUEL RADIUS                           1.3584E-04  METERS         (   .005348 INCH)
           CHANGE IN CLAD RADIUS DUE TO THERMAL EXPANSION        1.3004E-05  METERS         (   .000512 INCH)
           CHANGE IN CLAD RADIUS DUE TO CREEP                    0.          METERS         (  0.000000 INCH)
           CHANGE IN CLAD RADIUS DUE TO  PRESSURE                0.          METERS         (  0.000000 INCH)
           TOTAL CHANGE IN CLAD RADIUS                           1.3004E-05  METERS         (   .000512 INCH)
           HOT GAP (RADIAL)                                      2.9562E-05  METERS         (   .001164 INCH)
           FUEL-CLAD INTERFACIAL PRESSURE                        0.          PA             (0.          PSI)

           FUEL TO CLAD GAP CONDUCTANCE             1.4046E+03 W/M2-DEG.C     (  247.4 BTU/HR-FT2-DEG.F)

               COMPONENT DUE TO SOLID-SOLID CONTACT         0.          W/M2-DEG.C     (    0.0 BTU/HR-FT2-DEG.F)
               COMPONENT DUE TO CONDUCTION THRU THE GAS     1.1952E+03 W/M2-DEG.C     (  210.5 BTU/HR-FT2-DEG.F)
               COMPONENT DUE TO RADIANT HEAT TRANSFER       2.1161E+02 W/M2-DEG.C     (   37.3 BTU/HR-FT2-DEG.F)

           GAS RELEASE FRACTION DURING CURRENT TIME STEP          .5717
           INTERNAL GAS PRESSURE                                 5.1294E+04 PA         (  292.90 PSI)

           AVERAGE GAS COMPOSITION                               LOCAL GAS COMPOSITION

                    .160579  MOLE FRACTION HELIUM                         .160579  MOLE FRACTION HELIUM
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0.000000  MOLE FRACTION ARGON                     0.000000  MOLE FRACTION ARGON
0.000000  MOLE FRACTION HYDROGEN                  0.000000  MOLE FRACTION HYDROGEN
0.000000  MOLE FRACTION NITROGEN                  0.000000  MOLE FRACTION NITROGEN
0.000000  MOLE FRACTION CARBON MONOXIDE           0.000000  MOLE FRACTION CARBON MONOXIDE
 .102316  MOLE FRACTION KRYPTON                    .102316  MOLE FRACTION KRYPTON
 .737105  MOLE FRACTION XENON                      .737105  MOLE FRACTION XENON
----------                                        ----------
1.4654E-05 (ROD AVERAGE) KG-MOLE                  9.9290E-08 (LOCAL) KG-MOLE

THERMAL CONDUCTIVITY OF FILL GAS     3.5671E-02 W/M-DEG.C        (2.0610E-02 BTU/HR-FT-DEG.F)
TEMPERATURE JUMP DISTANCE            2.8442E-07 METERS           (1.1198E-05 INCH)

NOMINAL HEAT CAPACITY                      2.9352E+07   J/KG-DEG.C    (7.0107E+03 BTU/LB-DEG.F)
STORED ENERGY AT TBAR                 EBAR=6.0323E+05   J/KG          (2.5934E+02 BTU/LB)
VOLUME AVERAGE STORED ENERGY             E=6.4882E+05   J/KG          (2.7894E+02 BTU/LB)
STORED ENERGY PER UNIT LENGTH          EPL=5.1832E+05   J/M           (2.2284E+02 BTU/FOOT)
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CASE = 3 AXIAL SUMMARY

TIME AT POWER IN DAYS 120.0

GAPCON-THERMAL-2 SAMPLE PROBLEM

AXIAL DISTANCE (METERS)	HEAT RATING (W/M)	CLAD SURFACE HEAT FLUX (W/M2)	CENTER LINE TEMP. (DEG.C)	AVERAGE VOL. FUEL TEMP. (DEG.C)	GAP CONDUCTANCE (W/M2-DEG.C)	RADIAL HOT GAP (METERS)	GAS RELEASE FRACTION	MOLE FRACTION HELIUM
1.829E-01	2.252E+04	2.893E+05	1.401E+03	1.205E+03	4.714E+02	1.046E-04	7.274E-02	1.605E-01
5.486E-01	3.610E+04	7.108E+05	2.262E+03	1.742E+03	9.310E+02	5.026E-05	5.097E-01	1.605E-01
9.144E-01	4.187E+04	8.926E+05	2.488E+03	1.852E+03	1.219E+03	3.573E-05	5.618E-01	1.605E-01
1.280E+00	4.392E+04	9.669E+05	2.560E+03	1.878E+03	1.373E+03	3.055E-05	5.679E-01	1.605E-01
1.646E+00	4.429E+04	9.834E+05	2.579E+03	1.888E+03	1.405E+03	2.963E-05	5.711E-01	1.605E-01
2.012E+00	4.429E+04	9.834E+05	2.580E+03	1.889E+03	1.405E+03	2.956E-05	5.717E-01	1.605E-01
2.377E+00	4.392E+04	9.834E+05	2.581E+03	1.890E+03	1.405E+03	2.948E-05	5.724E-01	1.605E-01
2.743E+00	4.262E+04	9.669E+05	2.562E+03	1.881E+03	1.377E+03	3.051E-05	5.692E-01	1.605E-01
3.109E+00	3.536E+04	9.256E+05	2.532E+03	1.876E+03	1.279E+03	3.371E-05	5.717E-01	1.605E-01
3.475E+00	2.140E+04	6.446E+05	2.175E+03	1.700E+03	8.417E+02	5.823E-05	4.828E-01	1.605E-01

TOTAL PIN CONDITIONS

VOLUME AVERAGED TEMPERATURE (DEG.C)	INTERNAL GAS PRESSURE (PA)	FISSION GAS RELEASE FRACTION
.1780E+04	.5131E+05	.5298E+00

TO CONVERT FROM	TO THE FOLLOWING	MULTIPLY BY
W/M2	BTU/HR-FT2	0.3172E+00
W/M	KW/FT	3.0480E-04
W/M2-DEG.C	BTU/HR-FT2-DEG.F	0.1761E+00
PA	PSI	5.7100E-03

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CASE  4     AXIAL SEGMENT  6  OF 10

  GAPCON-THERMAL-2   SAMPLE PROBLEM

   LINEAR HEAT RATING (AVG)          0.          W/M    (  0.00 KW/FT)
                      (PEAK)         0.          W/M    (  0.00 KW/FT)
  TIME IN-REACTOR                1.5552E+07 SEC.   ( 180.0 DAYS)
  BURNUP                         4.5445E+11 J/KGM  (  5259.9 MWD/MTM)

          AVERAGE FLUX IN FUEL               0.          N/M2-S          (0.           N/CM2-SEC.)
          CLAD OD SURFACE HEAT FLUX          0.          W/M2            (0.           BTU/HR-FT2)
          FUEL SURFACE HEAT FLUX             0.          W/M2            (0.           BTU/HR-FT2)
          COOLANT TEMERATURE                    285.21 DEG.C             (     545.38 DEG.F)
          FILM COEFFICIENT                   1.4196E+05 W/M2-DEG.C       (2.5000E+04 BTU/HR-FT2-DEG.F)
          CLAD THERMAL CONDUCTIVITY          1.5447E+01 W/M-DEG.C        (8.9254E+00 BTU/HR-FT-DEG.F)
          CLAD OD TEMPERATURE                    285.2 DEG.C             (      545.4 DEG.F)
          CLAD ID TEMPERATURE                    285.2 DEG.C             (      545.4 DEG.F)
          FUEL SURFACE TEMPERATURE               285.2 DEG.C             (      545.4 DEG F)

             RADIUS          TEMPERATURE            RADIUS          TEMPERATURE         PERCENT OF
            (METERS)           (DEG C)             (INCHES)          (DEG F)            FUEL RADIUS

            .005463             285.                .2151             545.                90.00
            .004856             285.                .1912             545.                80.00
            .004249             285.                .1673             545.                70.00
            .003642             285.                .1434             545.                60.00
            .003035             285.                .1195             545.                50.00
            .002428             285.                .0956             545.                40.00
            .001821             285.                .0717             545.                30.00
            .001214             285.                .0478             545.                20.00
            .000607             285.                .0239             545.                10.00
           0.000000             285.               0.0000             545.                 0.00

          MELT TEMPERATURE                    2790.  DEG.C      (  5054. DEG.F)
          MELT RADIUS                        0.00000 METERS     (  0.00 PERCENT OF FUEL RADIUS)

          VOLUME AVERAGE FUEL TEMPERATURE      285.2 DEG.C      (     545.4 DEG.F)

          CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION       1.2131E-05  METERS         (   .000478 INCH)
          CHANGE IN FUEL RADIUS DUE TO RELOCATION              0.          METERS         (  0.000000 INCH)
          CHANGE IN FUEL RADIUS DUE TO DENSIFICATION           0.          METERS         (  0.000000 INCH)
          CHANGE IN FUEL RADIUS DUE TO SWELLING                0.          METERS         (  0.000000 INCH)
          TOTAL CHANGE IN FUEL RADIUS                          1.2131E-05  METERS         (   .000478 INCH)
          CHANGE IN CLAD RADIUS DUE TO THERMAL EXPANSION       1.1184E-05  METERS         (   .000440 INCH)
          CHANGE IN CLAD RADIUS DUE TO CREEP                   0.          METERS         (  0.000000 INCH)
          CHANGE IN CLAD RADIUS DUE TO  PRESSURE               0.          METERS         (  0.000000 INCH)
          TOTAL CHANGE IN CLAD RADIUS                          1.1184E-05  METERS         (   .000440 INCH)
          HOT GAP (RADIAL)                                     1.5145E-04  METERS         (   .005963 INCH)
          FUEL-CLAD INTERFACIAL PRESSURE                       0.          PA             (0.         PSI)

          FUEL TO CLAD GAP CONDUCTANCE            1.7982E+02 W/M2-DEG.C     (    31.7 BTU/HR-FT2-DEG.F)

               COMPONENT DUE TO SOLID-SOLID CONTACT         0.          W/M2-DEG.C    (     0.0 BTU/HR-FT2-DEG.F)
               COMPONENT DUE TO CONDUCTION THRU THE GAS     1.5108E+02 W/M2-DEG.C     (    26.6 BTU/HR-FT2-DEG.F)
               COMPONENT DUE TO RADIANT HEAT TRANSFER       2.9107E+01 W/M2-DEG.C     (     5.1 BTU/HR-FT2-DEG.F)

          GAS RELEASE FRACTION DURING CURRENT TIME STEP       0.0000
          INTERNAL GAS PRESSURE                              3.0778E+04 PA         (  175.75 PSI)

          AVERAGE GAS COMPOSITION                            LOCAL GAS COMPOSITION

                 .160543  MOLE FRACTION HELIUM                          .160543  MOLE FRACTION HELIUM
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  0.000000  MOLE FRACTION ARGON                              0.000000  MOLE FRACTION ARGON
  0.000000  MOLE FRACTION HYDROGEN                           0.000000  MOLE FRACTION HYDROGEN
  0.000000  MOLE FRACTION NITROGEN                           0.000000  MOLE FRACTION NITROGEN
  0.000000  MOLE FRACTION CARBON MONOXIDE                    0.000000  MOLE FRACTION CARBON MONOXIDE
   .102320  MOLE FRACTION KRYPTON                             .102320  MOLE FRACTION KRYPTON
   .737136  MOLE FRACTION XENON                               .737136  MOLE FRACTION XENON
----------                                                 ----------
1.4657E-05 (ROD AVERAGE) KG-MOLE                          5.5836E-07 (LOCAL) KG-MOLE

THERMAL CONDUCTIVITY OF FILL GAS     2.2906E-02 W/M-DEG.C        (1.3235E-02 BTU/HR-FT-DEG.F)
TEMPERATURE JUMP DISTANCE            1.6567E-07 METERS           (6.5224E-06 INCH)

NOMINAL HEAT CAPACITY                      2.1048E+07   J/KG-DEG.C    (5.0272E+03 BTU/LB-DEG.F)
STORED ENERGY AT TBAR                 EBAR=6.9871E+04   J/KG          (3.0039E+01 BTU/LB)
VOLUME AVERAGE STORED ENERGY             E=7.0151E+04   J/KG          (3.0160E+01 BTU/LB)
STORED ENERGY PER UNIT LENGTH          EPL=5.6041E+04   J/M           (2.4093E+01 BTU/FOOT)
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CASE = 4 AXIAL SUMMARY

TIME AT POWER IN DAYS 180.0

GAPCON-THERMAL-2 SAMPLE PROBLEM

AXIAL DISTANCE (METERS)	HEAT RATING (W/M)	CLAD SURFACE HEAT FLUX (W/M2)	CENTER LINE TEMP. (DEG.C)	AVERAGE VOL. FUEL TEMP. (DEG.C)	GAP CONDUCTANCE (W/M2-DEG.C)	RADIAL HOT GAP (METERS)	GAS RELEASE FRACTION	MOLE FRACTION HELIUM
1.829E-01	0.	0.	2.790E+02	2.790E+02	1.784E+02	1.515E-04	0.	1.605E-01
5.486E-01	0.	0.	2.801E+02	2.801E+02	1.784E+02	1.515E-04	0.	1.605E-01
9.144E-01	0.	0.	2.813E+02	2.813E+02	1.784E+02	1.515E-04	0.	1.605E-01
1.280E+00	0.	0.	2.826E+02	2.826E+02	1.784E+02	1.515E-04	0.	1.605E-01
1.646E+00	0.	0.	2.839E+02	2.839E+02	1.784E+02	1.515E-04	0.	1.605E-01
2.012E+00	0.	0.	2.852E+02	2.852E+02	1.798E+02	1.515E-04	0.	1.605E-01
2.377E+00	0.	0.	2.865E+02	2.865E+02	1.798E+02	1.514E-04	0.	1.605E-01
2.743E+00	0.	0.	2.878E+02	2.878E+02	1.798E+02	1.514E-04	0.	1.605E-01
3.109E+00	0.	0.	2.888E+02	2.888E+02	1.798E+02	1.514E-04	0.	1.605E-01
3.475E+00	0.	0.	2.894E+02	2.894E+02	1.814E+02	1.514E-04	0.	1.605E-01

TOTAL PIN CONDITIONS

VOLUME AVERAGED TEMPERATURE (DEG.C)	INTERNAL GAS PRESSURE (PA)	FISSION GAS RELEASE FRACTION
.2845E+03	.3078E+05	.5278E+00

TO CONVERT FROM	TO THE FOLLOWING	MULTIPLY BY
W/M2	BTU/HR-FT2	0.3172E+00
W/M	KW/FT	3.0480E-04
W/M2-DEG.C	BTU/HR-FT2-DEG.F	0.1761E+00
PA	PSI	5.7100E-03

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CASE  5     AXIAL SEGMENT  6  OF 10

    GAPCON-THERMAL-2    SAMPLE PROBLEM

      LINEAR HEAT RATING (AVG)          3.6089E+04 W/M     ( 11.00 KW/FT)
                         (PEAK)          3.6089E+04 W/M     ( 11.00 KW/FT)
     TIME IN-REACTOR               2.0736E+07 SEC.     ( 240.0 DAYS)
     BURNUP                        6.3299E+11 J/KGM   (  7326.2 MWD/MTM)

               AVERAGE FLUX IN FUEL               2.5311E+09 N/M2-S              (2.5311E+13 N/CM2-SEC.)
               CLAD OD SURFACE HEAT FLUX          8.0135E+05 W/M2                (2.5420E+05 BTU/HR-FT2)
               FUEL SURFACE HEAT FLUX             9.2859E+05 W/M2                (2.9456E+05 BTU/HR-FT2)
               COOLANT TEMERATURE                     285.21 DEG.C               (     545.38 DEG.F)
               FILM COEFFICIENT                   1.4196E+05 W/M2-DEG.C          (2.5000E+04 BTU/HR-FT2-DEG.F)
               CLAD THERMAL CONDUCTIVITY          1.5847E+01 W/M-DEG.C           (9.1563E+00 BTU/HR-FT-DEG.F)
               CLAD OD TEMPERATURE                     290.9 DEG.C               (      555.6 DEG.F)
               CLAD ID TEMPERATURE                     342.1 DEG.C               (      647.8 DEG.F)
               FUEL SURFACE TEMPERATURE               1257.5 DEG.C               (     2295.4 DEG F)
```

RADIUS (METERS)	TEMPERATURE (DEG C)	RADIUS (INCHES)	TEMPERATURE (DEG F)	PERCENT OF FUEL RADIUS
.005565	1483.	.2191	2702.	90.00
.004946	1692.	.1947	3077.	80.00
.004328	1875.	.1704	3408.	70.00
.003710	2031.	.1461	3688.	60.00
.003091	2159.	.1217	3919.	50.00
.002473	2261.	.0974	4101.	40.00
.001855	2337.	.0730	4239.	30.00
.001237	2390.	.0487	4335.	20.00
.000618	2422.	.0243	4391.	10.00
0.000000	2432.	0.0000	4410.	0.00

```
               MELT TEMPERATURE                      2790.  DEG.C      (  5054. DEG.F)
               MELT RADIUS                        0.00000 METERS       (  0.00 PERCENT OF FUEL RADIUS)

               VOLUME AVERAGE FUEL TEMPERATURE     1856.6 DEG.C        (    3373.8 DEG.F)

               CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION       1.2512E-04  METERS        (   .004926 INCH)
               CHANGE IN FUEL RADIUS DUE TO RELOCATION              0.          METERS        (  0.000000 INCH)
               CHANGE IN FUEL RADIUS DUE TO DENSIFICATION           0.          METERS        (  0.000000 INCH)
               CHANGE IN FUEL RADIUS DUE TO SWELLING                0.          METERS        (  0.000000 INCH)
               TOTAL CHANGE IN FUEL RADIUS                          1.2512E-04  METERS        (   .004926 INCH)
               CHANGE IN CLAD RADIUS DUE TO THERMAL EXPANSION       1.2675E-05  METERS        (   .000499 INCH)
               CHANGE IN CLAD RADIUS DUE TO CREEP                   0.          METERS        (  0.000000 INCH)
               CHANGE IN CLAD RADIUS DUE TO  PRESSURE               0.          METERS        (  0.000000 INCH)
               TOTAL CHANGE IN CLAD RADIUS                          1.2675E-05  METERS        (   .000499 INCH)
               HOT GAP (RADIAL)                                     3.9959E-05  METERS        (   .001573 INCH)
               FUEL-CLAD INTERFACIAL PRESSURE                       0.          PA            (0.          PSI)

               FUEL TO CLAD GAP CONDUCTANCE             1.0119E+03 W/M2-DEG.C     (  178.2 BTU/HR-FT2-DEG.F)

                    COMPONENT DUE TO SOLID-SOLID CONTACT       0.         W/M2-DEG.C     (    0.0 BTU/HR-FT2-DEG.F)
                    COMPONENT DUE TO CONDUCTION THRU THE GAS   7.7750E+02 W/M2-DEG.C     (  136.9 BTU/HR-FT2-DEG.F)
                    COMPONENT DUE TO RADIANT HEAT TRANSFER     2.4362E+02 W/M2-DEG.C     (   42.9 BTU/HR-FT2-DEG.F)

               GAS RELEASE FRACTION DURING CURRENT TIME STEP          .5770
               INTERNAL GAS PRESSURE                                6.7140E+04 PA         (  383.38 PSI)

               AVERAGE GAS COMPOSITION                              LOCAL GAS COMPOSITION

                         .121208  MOLE FRACTION HELIUM                        .121208  MOLE FRACTION HELIUM
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```
 0.000000  MOLE FRACTION ARGON                          0.000000  MOLE FRACTION ARGON
 0.000000  MOLE FRACTION HYDROGEN                       0.000000  MOLE FRACTION HYDROGEN
 0.000000  MOLE FRACTION NITROGEN                       0.000000  MOLE FRACTION NITROGEN
 0.000000  MOLE FRACTION CARBON MONOXIDE                0.000000  MOLE FRACTION CARBON MONOXIDE
  .107018  MOLE FRACTION KRYPTON                         .107018  MOLE FRACTION KRYPTON
  .771774  MOLE FRACTION XENON                           .771774  MOLE FRACTION XENON
----------                                             ----------
1.9413E-05 (ROD AVERAGE) KG-MOLE                       1.6878E-07 (LOCAL) KG-MOLE

THERMAL CONDUCTIVITY OF FILL GAS    3.1228E-02 W/M-DEG.C      (1.8043E-02 BTU/HR-FT-DEG.F)
TEMPERATURE JUMP DISTANCE           2.0577E-07 METERS         (8.1013E-06 INCH)

NOMINAL HEAT CAPACITY                    2.8903E+07  J/KG-DEG.C   (6.9033E+03 BTU/LB-DEG.F)
STORED ENERGY AT TBAR               EBAR=5.9036E+05  J/KG         (2.5381E+02 BTU/LB)
VOLUME AVERAGE STORED ENERGY           E=6.2660E+05  J/KG         (2.6939E+02 BTU/LB)
STORED ENERGY PER UNIT LENGTH        EPL=5.0057E+05  J/M          (2.1521E+02 BTU/FOOT)
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CASE = 5 AXIAL SUMMARY

TIME AT POWER IN DAYS 240.0

GAPCON-THERMAL-2 SAMPLE PROBLEM

AXIAL DISTANCE (METERS)	HEAT RATING (W/M)	CLAD SURFACE HEAT FLUX (W/M2)	CENTER LINE TEMP. (DEG.C)	AVERAGE VOL. FUEL TEMP. (DEG.C)	GAP CONDUCTANCE (W/M2-DEG.C)	RADIAL HOT GAP (METERS)	GAS RELEASE FRACTION	MOLE FRACTION HELIUM
1.829E-01	1.835E+04	2.357E+05	1.282E+03	1.128E+03	4.028E+02	1.074E-04	6.225E-02	1.212E-01
5.486E-01	2.942E+04	5.792E+05	2.099E+03	1.672E+03	7.294E+02	6.125E-05	4.611E-01	1.212E-01
9.144E-01	3.412E+04	7.273E+05	2.322E+03	1.793E+03	9.174E+02	4.533E-05	5.445E-01	1.212E-01
1.280E+00	3.579E+04	7.879E+05	2.412E+03	1.844E+03	9.937E+02	4.094E-05	5.710E-01	1.212E-01
1.646E+00	3.609E+04	8.014E+05	2.431E+03	1.855E+03	1.012E+03	4.003E-05	5.762E-01	1.212E-01
2.012E+00	3.609E+04	8.014E+05	2.432E+03	1.857E+03	1.012E+03	3.996E-05	5.770E-01	1.212E-01
2.377E+00	3.579E+04	8.013E+05	2.415E+03	1.838E+03	1.033E+03	3.932E-05	5.649E-01	1.212E-01
2.743E+00	3.472E+04	7.879E+05	2.410E+03	1.842E+03	1.001E+03	4.138E-05	5.697E-01	1.212E-01
3.109E+00	2.881E+04	7.542E+05	2.362E+03	1.815E+03	9.588E+02	4.378E-05	5.564E-01	1.212E-01
3.475E+00	1.744E+04	5.253E+05	2.004E+03	1.616E+03	6.756E+02	6.945E-05	4.084E-01	1.212E-01

TOTAL PIN CONDITIONS

VOLUME AVERAGED TEMPERATURE (DEG.C)	INTERNAL GAS PRESSURE (PA)	FISSION GAS RELEASE FRACTION
.1726E+04	.6714E+05	.5276E+00

TO CONVERT FROM	TO THE FOLLOWING	MULTIPLY BY
W/M2	BTU/HR-FT2	0.3172E+00
W/M	KW/FT	3.0480E-04
W/M2-DEG.C	BTU/HR-FT2-DEG.F	0.1761E+00
PA	PSI	5.7100E-03

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CASE 6     AXIAL SEGMENT  6  OF 10

   GAPCON-THERMAL-2   SAMPLE PROBLEM

     LINEAR HEAT RATING (AVG)          5.5774E+04 W/M     ( 17.00 KW/FT)
                        (PEAK)         5.5774E+04 W/M     ( 17.00 KW/FT)
     TIME IN-REACTOR               2.5920E+07 SEC.    ( 300.0 DAYS)
     BURNUP                        9.0890E+11 J/KGM   ( 10519.7 MWD/MTM)

              AVERAGE FLUX IN FUEL                3.9118E+09 N/M2-S          (3.9118E+13 N/CM2-SEC.)
              CLAD OD SURFACE HEAT FLUX           1.2383E+06 W/M2            (3.9280E+05 BTU/HR-FT2)
              FUEL SURFACE HEAT FLUX              1.4300E+06 W/M2            (4.5360E+05 BTU/HR-FT2)
              COOLANT TEMERATURE                      285.21 DEG.C           (     545.38 DEG.F)
              FILM COEFFICIENT                    1.4196E+05 W/M2-DEG.C      (2.5000E+04 BTU/HR-FT2-DEG.F)
              CLAD THERMAL CONDUCTIVITY           1.6073E+01 W/M-DEG.C       (9.2870E+00 BTU/HR-FT-DEG.F)
              CLAD OD TEMPERATURE                      293.9 DEG.C           (      561.1 DEG.F)
              CLAD ID TEMPERATURE                      372.0 DEG.C           (      701.7 DEG.F)
              FUEL SURFACE TEMPERATURE                1038.7 DEG.C           (     1901.7 DEG F)

                 RADIUS          TEMPERATURE            RADIUS           TEMPERATURE        PERCENT OF
                (METERS)          (DEG C)              (INCHES)          (DEG F)            FUEL RADIUS

                .005585            1366.                 .2199             2492.               90.00
                .004964            1685.                 .1954             3064.               80.00
                .004344            1968.                 .1710             3575.               70.00
                .003723            2205.                 .1466             4001.               60.00
                .003103            2393.                 .1221             4340.               50.00
                .002482            2538.                 .0977             4601.               40.00
                .001862            2645.                 .0733             4793.               30.00
                .001241            2718.                 .0489             4925.               20.00
                .000621            2761.                 .0244             5001.               10.00
               0.000000            2775.                0.0000             5026.                0.00

              MELT TEMPERATURE                     2790.  DEG.C      (  5054. DEG.F)
              MELT RADIUS                        0.00000 METERS      (  0.00 PERCENT OF FUEL RADIUS)

              VOLUME AVERAGE FUEL TEMPERATURE     1932.8 DEG.C      (    3511.1 DEG.F)

              CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION       1.4744E-04  METERS        (   .005805 INCH)
              CHANGE IN FUEL RADIUS DUE TO RELOCATION              0.          METERS        (  0.000000 INCH)
              CHANGE IN FUEL RADIUS DUE TO DENSIFICATION           0.          METERS        (  0.000000 INCH)
              CHANGE IN FUEL RADIUS DUE TO SWELLING                0.          METERS        (  0.000000 INCH)
              TOTAL CHANGE IN FUEL RADIUS                          1.4744E-04  METERS        (   .005805 INCH)
              CHANGE IN CLAD RADIUS DUE TO THERMAL EXPANSION       1.3460E-05  METERS        (   .000530 INCH)
              CHANGE IN CLAD RADIUS DUE TO CREEP                   0.          METERS        (  0.000000 INCH)
              CHANGE IN CLAD RADIUS DUE TO  PRESSURE               0.          METERS        (  0.000000 INCH)
              TOTAL CHANGE IN CLAD RADIUS                          1.3460E-05  METERS        (   .000530 INCH)
              HOT GAP (RADIAL)                                     1.8423E-05  METERS        (   .000725 INCH)
              FUEL-CLAD INTERFACIAL PRESSURE                       0.          PA            (0.        PSI)

              FUEL TO CLAD GAP CONDUCTANCE            2.1431E+03 W/M2-DEG.C     (  377.4 BTU/HR-FT2-DEG.F)

                   COMPONENT DUE TO SOLID-SOLID CONTACT        0.          W/M2-DEG.C    (    0.0 BTU/HR-FT2-DEG.F)
                   COMPONENT DUE TO CONDUCTION THRU THE GAS    1.3519E+03 W/M2-DEG.C    (  238.1 BTU/HR-FT2-DEG.F)
                   COMPONENT DUE TO RADIANT HEAT TRANSFER      1.7446E+02 W/M2-DEG.C    (   30.7 BTU/HR-FT2-DEG.F)

              GAS RELEASE FRACTION DURING CURRENT TIME STEP          .5163
              INTERNAL GAS PRESSURE                                9.9669E+04 PA          (  569.13 PSI)

              AVERAGE GAS COMPOSITION                              LOCAL GAS COMPOSITION

                        .085554  MOLE FRACTION HELIUM                        .085554  MOLE FRACTION HELIUM
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0.000000  MOLE FRACTION ARGON                  0.000000  MOLE FRACTION ARGON
0.000000  MOLE FRACTION HYDROGEN               0.000000  MOLE FRACTION HYDROGEN
0.000000  MOLE FRACTION NITROGEN               0.000000  MOLE FRACTION NITROGEN
0.000000  MOLE FRACTION CARBON MONOXIDE        0.000000  MOLE FRACTION CARBON MONOXIDE
 .111179  MOLE FRACTION KRYPTON                 .111179  MOLE FRACTION KRYPTON
 .803266  MOLE FRACTION XENON                   .803266  MOLE FRACTION XENON
----------                                     ----------
2.7504E-05 (ROD AVERAGE) KG-MOLE               1.2659E-07 (LOCAL) KG-MOLE

THERMAL CONDUCTIVITY OF FILL GAS     2.5046E-02 W/M-DEG.C       (1.4471E-02 BTU/HR-FT-DEG.F)
TEMPERATURE JUMP DISTANCE            1.0281E-07 METERS          (4.0476E-06 INCH)

NOMINAL HEAT CAPACITY                    3.0011E+07   J/KG-DEG.C     (7.1679E+03 BTU/LB-DEG.F)
STORED ENERGY AT TBAR               EBAR=6.2116E+05   J/KG           (2.6705E+02 BTU/LB)
VOLUME AVERAGE STORED ENERGY           E=6.8197E+05   J/KG           (2.9319E+02 BTU/LB)
STORED ENERGY PER UNIT LENGTH        EPL=5.4480E+05   J/M            (2.3422E+02 BTU/FOOT)
```

CASE = 6 AXIAL SUMMARY

TIME AT POWER IN DAYS 300.0

GAPCON-THERMAL-2 SAMPLE PROBLEM

AXIAL DISTANCE (METERS)	HEAT RATING (W/M)	CLAD SURFACE HEAT FLUX (W/M2)	CENTER LINE TEMP. (DEG.C)	AVERAGE VOL. FUEL TEMP. (DEG.C)	GAP CONDUCTANCE (W/M2-DEG.C)	RADIAL HOT GAP (METERS)	GAS RELEASE FRACTION	MOLE FRACTION HELIUM
1.829E-01	2.836E+04	3.643E+05	1.688E+03	1.424E+03	4.927E+02	8.785E-05	9.696E-02	8.552E-02
5.486E-01	4.546E+04	8.950E+05	2.560E+03	1.930E+03	1.126E+03	3.008E-05	6.732E-01	8.552E-02
9.144E-01	5.273E+04	1.124E+06	2.736E+03	1.967E+03	1.657E+03	1.775E-05	5.409E-01	8.552E-02
1.280E+00	5.531E+04	1.218E+06	2.790E+03	1.966E+03	1.969E+03	1.427E-05	5.244E-01	8.552E-02
1.646E+00	5.577E+04	1.238E+06	2.773E+03	1.931E+03	2.145E+03	1.860E-05	5.153E-01	8.552E-02
2.012E+00	5.577E+04	1.238E+06	2.775E+03	1.933E+03	2.143E+03	1.842E-05	5.163E-01	8.552E-02
2.377E+00	5.531E+04	1.238E+06	2.774E+03	1.933E+03	2.148E+03	1.851E-05	5.163E-01	8.552E-02
2.743E+00	5.367E+04	1.217E+06	2.790E+03	1.966E+03	1.982E+03	1.392E-05	5.249E-01	8.552E-02
3.109E+00	4.453E+04	1.165E+06	2.772E+03	1.981E+03	1.773E+03	1.649E-05	5.555E-01	8.552E-02
3.475E+00	2.695E+04	8.117E+05	2.475E+03	1.895E+03	9.976E+02	3.615E-05	5.531E-01	8.552E-02

TOTAL PIN CONDITIONS

VOLUME AVERAGED TEMPERATURE (DEG.C)	INTERNAL GAS PRESSURE (PA)	FISSION GAS RELEASE FRACTION
.1893E+04	.9971E+05	.5408E+00

TO CONVERT FROM	TO THE FOLLOWING	MULTIPLY BY
W/M2	BTU/HR-FT2	0.3172E+00
W/M	KW/FT	3.0480E-04
W/M2-DEG.C	BTU/HR-FT2-DEG.F	0.1761E+00
PA	PSI	5.7100E-03

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CASE  7     AXIAL SEGMENT  6  OF 10

    GAPCON-THERMAL-2    SAMPLE PROBLEM

      LINEAR HEAT RATING (AVG)          4.2651E+04 W/M     ( 13.00 KW/FT)
                         (PEAK)         4.2651E+04 W/M     ( 13.00 KW/FT)
     TIME IN-REACTOR               3.1104E+07 SEC.    ( 360.0 DAYS)
     BURNUP                        1.1199E+12 J/KGM  ( 12961.8 MWD/MTM)

          AVERAGE FLUX IN FUEL                  2.9913E+09 N/M2-S          (2.9913E+13 N/CM2-SEC.)
          CLAD OD SURFACE HEAT FLUX             9.4701E+05 W/M2            (3.0040E+05 BTU/HR-FT2)
          FUEL SURFACE HEAT FLUX                1.0947E+06 W/M2            (3.4726E+05 BTU/HR-FT2)
          COOLANT TEMERATURE                       285.21 DEG.C            (     545.38 DEG.F)
          FILM COEFFICIENT                      1.4196E+05 W/M2-DEG.C      (2.5000E+04 BTU/HR-FT2-DEG.F)
          CLAD THERMAL CONDUCTIVITY             1.5927E+01 W/M-DEG.C       (9.2027E+00 BTU/HR-FT-DEG.F)
          CLAD OD TEMPERATURE                       291.9 DEG.C            (      557.4 DEG.F)
          CLAD ID TEMPERATURE                       352.2 DEG.C            (      665.9 DEG.F)
          FUEL SURFACE TEMPERATURE                 1250.3 DEG.C            (     2282.6 DEG F)

              RADIUS          TEMPERATURE            RADIUS          TEMPERATURE         PERCENT OF
             (METERS)           (DEG C)             (INCHES)          (DEG F)           FUEL RADIUS

             .005578             1518.               .2196             2764.              90.00
             .004959             1766.               .1952             3210.              80.00
             .004339             1982.               .1708             3600.              70.00
             .003719             2164.               .1464             3927.              60.00
             .003099             2311.               .1220             4191.              50.00
             .002479             2425.               .0976             4397.              40.00
             .001859             2511.               .0732             4551.              30.00
             .001240             2570.               .0488             4658.              20.00
             .000620             2605.               .0244             4720.              10.00
            0.000000             2616.              0.0000             4741.               0.00

          MELT TEMPERATURE                       2790.  DEG.C      (  5054. DEG.F)
          MELT RADIUS                          0.00000 METERS      (  0.00 PERCENT OF FUEL RADIUS)

          VOLUME AVERAGE FUEL TEMPERATURE      1955.5 DEG.C      (     3551.8 DEG.F)

          CHANGE IN FUEL RADIUS DUE TO THERMAL EXPANSION       1.4040E-04  METERS         (   .005528 INCH)
          CHANGE IN FUEL RADIUS DUE TO RELOCATION              0.          METERS         (  0.000000 INCH)
          CHANGE IN FUEL RADIUS DUE TO DENSIFICATION           0.          METERS         (  0.000000 INCH)
          CHANGE IN FUEL RADIUS DUE TO SWELLING                0.          METERS         (  0.000000 INCH)
          TOTAL CHANGE IN FUEL RADIUS                          1.4040E-04  METERS         (   .005528 INCH)
          CHANGE IN CLAD RADIUS DUE TO THERMAL EXPANSION       1.2937E-05  METERS         (   .000509 INCH)
          CHANGE IN CLAD RADIUS DUE TO CREEP                   0.          METERS         (  0.000000 INCH)
          CHANGE IN CLAD RADIUS DUE TO  PRESSURE               0.          METERS         (  0.000000 INCH)
          TOTAL CHANGE IN CLAD RADIUS                          1.2937E-05  METERS         (   .000509 INCH)
          HOT GAP (RADIAL)                                     2.4934E-05  METERS         (   .000982 INCH)
          FUEL-CLAD INTERFACIAL PRESSURE                       0.          PA             (0.         PSI)

          FUEL TO CLAD GAP CONDUCTANCE          1.2172E+03 W/M2-DEG.C     ( 214.4 BTU/HR-FT2-DEG.F)

               COMPONENT DUE TO SOLID-SOLID CONTACT          0.          W/M2-DEG.C    (    0.0 BTU/HR-FT2-DEG.F)
               COMPONENT DUE TO CONDUCTION THRU THE GAS      9.8031E+02  W/M2-DEG.C    (  172.6 BTU/HR-FT2-DEG.F)
               COMPONENT DUE TO RADIANT HEAT TRANSFER        2.4307E+02  W/M2-DEG.C    (   42.8 BTU/HR-FT2-DEG.F)

          GAS RELEASE FRACTION DURING CURRENT TIME STEP          .6402
          INTERNAL GAS PRESSURE                                1.2112E+05 PA          ( 691.62 PSI)

          AVERAGE GAS COMPOSITION                              LOCAL GAS COMPOSITION

                    .070222  MOLE FRACTION HELIUM                        .070222  MOLE FRACTION HELIUM
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   0.000000  MOLE FRACTION ARGON                              0.000000  MOLE FRACTION ARGON
   0.000000  MOLE FRACTION HYDROGEN                           0.000000  MOLE FRACTION HYDROGEN
   0.000000  MOLE FRACTION NITROGEN                           0.000000  MOLE FRACTION NITROGEN
   0.000000  MOLE FRACTION CARBON MONOXIDE                    0.000000  MOLE FRACTION CARBON MONOXIDE
    .113017  MOLE FRACTION KRYPTON                             .113017  MOLE FRACTION KRYPTON
    .816762  MOLE FRACTION XENON                               .816762  MOLE FRACTION XENON
 ----------                                                ----------
 3.3509E-05 (ROD AVERAGE) KG-MOLE                          1.8907E-07 (LOCAL) KG-MOLE

THERMAL CONDUCTIVITY OF FILL GAS     2.4535E-02 W/M-DEG.C        (1.4176E-02 BTU/HR-FT-DEG.F)
TEMPERATURE JUMP DISTANCE            9.3357E-08 METERS           (3.6755E-06 INCH)

NOMINAL HEAT CAPACITY                    3.0369E+07   J/KG-DEG.C     (7.2535E+03 BTU/LB-DEG.F)
STORED ENERGY AT TBAR                EBAR=6.3054E+05   J/KG          (2.7108E+02 BTU/LB)
VOLUME AVERAGE STORED ENERGY            E=6.7881E+05   J/KG          (2.9183E+02 BTU/LB)
STORED ENERGY PER UNIT LENGTH         EPL=5.4227E+05   J/M           (2.3313E+02 BTU/FOOT)
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CASE = 7 AXIAL SUMMARY

TIME AT POWER IN DAYS 360.0

GAPCON-THERMAL-2 SAMPLE PROBLEM

AXIAL DISTANCE (METERS)	HEAT RATING (W/M)	CLAD SURFACE HEAT FLUX (W/M2)	CENTER LINE TEMP. (DEG.C)	AVERAGE VOL. FUEL TEMP. (DEG.C)	GAP CONDUCTANCE (W/M2-DEG.C)	RADIAL HOT GAP (METERS)	GAS RELEASE FRACTION	MOLE FRACTION HELIUM
1.829E-01	2.168E+04	2.786E+05	1.478E+03	1.283E+03	4.081E+02	9.837E-05	5.292E-02	6.351E-02
5.486E-01	3.477E+04	6.845E+05	2.329E+03	1.831E+03	8.021E+02	4.558E-05	6.057E-01	6.351E-02
9.144E-01	4.032E+04	8.595E+05	2.532E+03	1.924E+03	1.058E+03	3.045E-05	6.367E-01	6.351E-02
1.280E+00	4.229E+04	9.311E+05	2.597E+03	1.945E+03	1.191E+03	2.588E-05	6.368E-01	6.351E-02
1.646E+00	4.265E+04	9.470E+05	2.615E+03	1.954E+03	1.217E+03	2.502E-05	6.395E-01	6.351E-02
2.012E+00	4.265E+04	9.470E+05	2.616E+03	1.955E+03	1.217E+03	2.493E-05	6.402E-01	6.351E-02
2.377E+00	4.229E+04	9.470E+05	2.617E+03	1.957E+03	1.217E+03	2.485E-05	6.409E-01	6.351E-02
2.743E+00	4.104E+04	9.311E+05	2.600E+03	1.949E+03	1.192E+03	2.567E-05	6.390E-01	6.351E-02
3.109E+00	3.405E+04	8.913E+05	2.572E+03	1.946E+03	1.109E+03	2.867E-05	6.444E-01	6.351E-02
3.475E+00	2.061E+04	6.208E+05	2.230E+03	1.774E+03	7.377E+02	5.276E-05	5.712E-01	6.351E-02

TOTAL PIN CONDITIONS

VOLUME AVERAGED TEMPERATURE (DEG.C)	INTERNAL GAS PRESSURE (PA)	FISSION GAS RELEASE FRACTION
.1852E+04	.1339E+06	.6055E+00

TO CONVERT FROM	TO THE FOLLOWING	MULTIPLY BY
W/M2	BTU/HR-FT2	0.3172E+00
W/M	KW/FT	3.0480E-04
W/M2-DEG.C	BTU/HR-FT2-DEG.F	0.1761E+00
PA	PSI	5.7100E-03

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