JASON: A REACTOR CELL CODE
IN FORTRAN II OR IV

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IN FORTRAN II OR IV

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ABSTRACT

JASON is a derivative of the lattice physics code IDIOT, altered to furnish input data required by the ALTHAEA burnup code. It calculates the thermal neutron flux fine structure with the P3 approximation to the Boltzmann transport equation for a system of concentric cylinders limited to 16 regions.

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INTRODUCTION

A need has existed for a lattice physics code that would communicate directly with the ALTHAEA⁽¹⁾ burnup code, thus completing a chain of codes that leads from a specific fuel cell to fuel costs, under varied enrichments, fueling schemes and changing economic climates. At the present time the ALTHAEA burnup code is machine linked with the QUICK⁽²⁾ economics code which in turn is machine linked to the PUV⁽³⁾ plutonium value code. A link has now been established between a code called JASON and ALTHAEA.

JASON calculates the lattice physics parameters for a unit lattice cell of specified geometry and composition and translates these parameters into the input data necessary for communication with ALTHAEA. The two codes are linked by means of magnetic tape.*

In addition to the normal tabular results of JASON calculations which are printed from the A3 of the 7090, another tape, either A5 or B0 yields the necessary data change card information for the CASE GENERATOR or SUPERCASE GENERATOR versions of ALTHAEA respectively.

METHODS OF CALCULATION

Physics Parameters

The JASON code is a modification of the lattice physics code IDIOT reported in HW-63411.⁽⁴⁾ The new version uses the same physics model and methods of calculation. It calculates the lattice parameters for a unit lattice cell of specified geometry and composition. In addition, these parameters are translated into the input parameters necessary for communication with the ALTHAEA burnup code.

*The code presently exists in both a Fortran IV version for the UNIVAC 1108 EXEC II System and a Fortran II version for the IBM 7090, in which terminology this report is written. Variations to the 1108 are indicated in footnotes. The linking on the 1108 is normally by drum scratch files.

The lattice parameter calculations are written out to Tape Unit A3* and are similar to those previously made by the IDIOT code. The Tape Unit A3 output of JASON also contains information of engineering interest and the ALTHAEA parameters that are normally written to Tape Unit A5.**

The A5 output of JASON yields the necessary change cards in the correct format for the CASE GENERATOR version of ALTHAEA. Each JASON case*** normally yields cards to make a complete new ALTHAEA case. When using one-dimensional ALTHAEA it yields cards to make a complete new region for ALTHAEA, thus minimizing preparation of input data to the ALTHAEA code.

The program calculates the thermal neutron flux fine structure with a P3 approximation to the Boltzmann transport equation. The solution to the transport equation is for concentric cylindrical geometry; therefore, when cluster fuel elements are used, they are transformed internally to an equivalent fuel assembly of cylindrical geometry. Detailed information on the physics calculation is given in the document HW-63411 and will not be repeated here. Normal operating constants used in the physics calculation are presented in Appendix A.

Description of Calculated Results

The JASON code calculates the total surface area of fuel and the outside surface of the fuel cylinder in square feet per axial foot of unit lattice cell. The moderator volume, fuel volume, and cell volume are calculated in cubic feet per axial foot of cell. The weight of fuel and the volume and the weight of the moderator are given in pounds per axial foot of cell.

*Tape Unit A3 on the 7090 is equivalent to the printer on the 1108.

**Tape Unit A5 is used only when communicating with ALTHAEA CASE GENERATOR. When communicating with ALTHAEA SUPERCASE GENERATOR any other available tape can be used. On the 1108, scratch drum files are normally used in communicating with either of the above case generators.

***When a curve fit is desired for flux depression for ALTHAEA the second case of each pair of JASON cases applies in this statement.

Each ALTHAEA parameter must be calculated in a manner compatible with its definition as it already exists in the ALTHAEA code. The method of calculating each input parameter for ALTHAEA is shown in Appendix B. The names and brief descriptions of the ALTHAEA input parameters, calculated by JASON, are given below.

PERFIS: The volume expressed as an atom fraction of the total nuclei averaged fissile nuclide content of the fuel regions of a cell.

FCONST: The coefficient of the linear term in the flux depression equation for ALTHAEA.

FEXP: The coefficient of the exponential term in the flux depression equation for ALTHAEA.

IE: The ALTHAEA sequence number for the isotope upon which epsilon is based.

PWI: The specific power to be used in the zero-dimensional mode of ALTHAEA; or in the one-dimensional mode, the initial flux guess for ALTHAEA.

SPEC: The slowing down power per unit of fuel volume (SDPV) when zero-dimensional ALTHAEA is used; or the initial r guess for one-dimensional ALTHAEA.

SNF: The total nonfuel macroscopic absorption cross section of the JASON cell divided by the fuel volume.

F: The thermal utilization of fuel and target regions.

SCA: The epithermal effective macroscopic potential scattering cross section to be used in ALTHAEA for the NR1A correction to resonance integrals.

BMULT: The average reactivity at which the ALTHAEA calculation will be terminated.

E: Epsilon, as calculated for the JASON cell based on the fast effect of the isotope specified above as IE.

TOT: The total nuclei/cm³ of fuel and target averaged over the entire JASON cell.

TEM: The physical temperature of the nonfuels, volume averaged over all nonfuel regions and expressed in degrees centigrade.

TEMF: The average temperature of the fuel regions averaged over all fuel regions in the JASON cell, expressed in degrees centigrade.

DENS: The density of the fuel averaged over all fuel regions of JASON and expressed in grams/cm³.

IDENT: The identification number used in JASON to be passed on to ALTHAEA.

M/F: The moderator-to-fuel volume ratio as determined from the JASON cell.

Isotope concentrations are in nuclei per barn centimeter for each specified isotope.

The above set of parameters is passed on to the ALTHAEA CASE GENERATOR for the zero-dimensional ALTHAEA cases. If the one-dimensional mode of ALTHAEA is being used, additional input is required from JASON. These parameters, also communicated via the A5 scratch tape are:

SS1: The macroscopic transport cross section for the epithermal group determined from a volume weighted average, including all regions of the JASON cell.

SS2: The macroscopic transport cross section for the thermal group as determined from a flux and volume weighted average over all regions of the JASON cell.

XISS: The macroscopic XI-sigma scatter for the epithermal group determined from a volume weighted average over all regions of the JASON cell.

VR: The volume fraction of the JASON cell that contains fuel and/or target material.

BUCK: The transverse buckling to be used in ALTHAEA is the input buckling to JASON. BUCK is calculated either from the "height"

(Field 12 of the N card) and volume (Field 10 of the A card) input to JASON, or from the "height" and reactor volume determined from values indicated on the M and N cards.

PWMX: The maximum watts/cubic centimeter of fuel allowed, as determined from the indicated heat transfer rate on the M card and the heat transfer surface area.

The preceding parameters are calculated within JASON (see Appendix B for equations) and written out on both Tape Unit A3 (normal print-out) and Tape Unit A5. The A5 information is arranged so that it may be punched directly onto cards or printed if desired. Proper selection of the control integers for JASON and ALTHAEA will make it possible to utilize all of the preceding information desired for a case.

The table of neutron leakage as a function of heat transfer rate for reactors of five different sizes will be found in the A3 output if engineering output is requested (input variable K10). The specific power corresponding to each given heat transfer rate is also listed. A table of the geometrical buckling is used to calculate leakage. This table of leakage is printed out immediately below the table of buckling. Also printed are the bare reactor diameter (in centimeters) and the tons of fuel in the core required for each power level and heat transfer rate specified. Proper setting of control integers in JASON will cause it to pass on PWI and BMULT to ALTHAEA for a known heat transfer rate and total reactor power.

The power per foot of fuel element is calculated by assuming that the heat transfer rate is the same for any fuel surface of the reactor core, and using the known amount of fuel surface per foot of cell. Since for a given geometry and fuel composition, the ratio of tons of fuel per foot of cell is known, it is possible to find the average specific power, i. e., the megawatts thermal per ton of fuel.

Based on the specific power of any selected reactor power, calculations of the following are made in succession:

1. The corresponding weight of fuel in tons
2. The total length of unit fuel cells corresponding to this weight

3. The total volume required, including the moderator volume
4. The reactor diameter for an equivalent cylindrical reactor composed of JASON cells.

Any ratio of height-to-diameter may be specified as input to the code.

The geometrical buckling is calculated according to the equation

$$B_g^2 = \left(\frac{j_0}{R^1} \right)^2 + \left(\frac{\pi}{H^1} \right)^2 \quad (1)$$

where

j_0 = 2.405 = the first root of the Bessel Function $j_0(r)$

R^1 = $R + 2M$

H^1 = $H + 4M$

M = THE MIGRATION LENGTH FOR THE LATTICE CELL

R = BARE REACTOR RADIUS

H = BARE REACTOR HEIGHT

The leakage and buckling calculations are rule-of-thumb methods and are meant only to serve as guide lines in the survey calculations where great quantities of data must be handled. (See Appendix C for sample runs.)

OPERATING INSTRUCTIONS

Input data cards are arranged in alphabetical order according to the character in Column 74.

An example for a one ring cluster fuel assembly is as follows:

A, B, C₁, D₁, C₂, D₂, E, F, G, H, J, K, L, M, N,
next case.

NOTE: The last card of the last case must always be followed by a card having 9999 in Columns 1 to 4. If JASON is part of a set of chained programs the next link number to be called must be in columns 5 to 8 of this card. The B card is required for cluster fuel assemblies only and is optional. D, E, or F cards are used only if stored parameters are not to be utilized.

J and K cards are used only if the fuel regions contain plutonium. The K card may be omitted if stored plutonium cross sections are used.

All cases will use at least the underlined cards A, C₁, C₂, G, H, L, M, N. There must be one C card for each region of the cell.

DATA PREPARATION

A Card: Control Information

Format (I4, I2, 6I2, F9.5, E13.5, F9.5, F7.4, F3.1, I4, 3I2, I1)

Field No.	Column	Variable	Definition
1	1-4	KASENO	Case number
2	7-8	N	Number of regions in unit lattice cell
3	10	K1	0 if stored fast parameters are to be utilized 1 if fast parameters are to be given*
4	12	K2	0 if $\nu(28) = 2.62$ 1 if $\nu(28) = 2.845$
5	14	K3	0 for unirradiated metal 1 for irradiated metal, utilization of stored cross sections (see J card) 2 for irradiated metal, cross sections to be given (see J card and K card)
6	16	K4	0 if stored ages are to be utilized 1 if ages are to be given (see F card)
7	18	K5	0 if noncluster fuel element 1 if fuel element is a cluster (see B card)
8	20	IFTIN	1 normal amount of information on output record 2 maximum amount of information on output record
9	21-29	ECCOR	Ratio of bare slug length to canned fuel length
10	30-42	BUCK	Geometrical buckling if positive Core volume if negative (used with HEIGHT, see N Card, to calculate geometric buckling for a cylindrical reactor)
11	43-51	STRCOR	Streaming correction $(1 + \phi Q_r/\lambda)$
12	52-58	DIH	Graphite dih value

*The fast parameters that are to be given are punched on an E card (E in Column 74).

Field No.	Column	Variable	Definition	
13	59-61	DEL	0.0	For air atmosphere
			1.0	For air free atmosphere
			2.0	For alternate short method of calculating ϵ and τ (Light water lattices only)
			3.0	Set ϵ and $p = 1$; age is calculated the same as for 2.0
			4.0	Set ϵ and $p = 1$; age is calculated by conventional method (0.0 or 1.0)
14	62-65	J6	0	For normal operation; calculates heat transfer surfaces determined by IHTS (see C card)
			1	If heat transfer surfaces are to be given (see L card)
15	66-67	K6	0	For normal JASON operation and advancement to ALTHAEA CASE GENERATOR for each case via Tape Unit A5
			1-4	For communicating with SUPERCASE via Tape Unit B0
			5	For communicating with ALTHAEA CASE GENERATOR via Tape Unit A5 for the second of each pair of JASON cases. Flux depression coefficients are fitted to the pair of cases.
			10	For communicating with ALTHAEA SUPERCASE GENERATOR via Tape Unit B0
16	68-69	K7	0	For U-235 and/or plutonium in U-238
			1	For U-233 and/or plutonium in Th-232
			2	For U-235 and/or plutonium in Th-232
			3	For U-233 and/or plutonium in U-238
17	70-71	K9	± 1	If SNF = f in ALTHAEA
			± 2	If SNF = Nonfuel absorption in ALTHAEA
			± 3	If SNF = Nonfuel absorptions and ZONED SPECTRUM mode is used in ALTHAEA
(+ if normal output; - if debug information is desired)				

<u>Field No.</u>	<u>Column</u>	<u>Variable</u>	<u>Definition</u>	
18	72	K10	0	If normal operation (metric tons)
			1	If additional engineering information is desired (metric tons)
			2	For maximum output includes TELLUS (metric tons)
			3	Same as 2 (U.S. tons)
	74		A	BY DEFINITION (NOT READ)
	77-80		1	Card sequence number (NOT READ)

B Card: Cluster Fuel Element (This card is used only when K5 = 1 on A card.)

The information on the B card physically describes the cluster fuel element. The limitations on the cluster are:

1. The rods of any given ring must be of equal size.
2. Up to two rings of rods may surround the central rod.
3. Every rod in a ring must be equidistant from the center of the cluster assembly.

The regions of the effective cylinder defined by the cluster are described fully on C cards with the exception of the radius of each region; these radii are computed within the program.⁽¹⁾ Therefore, Field Number 6 of the C card may be ignored for all regions defining the effective cylindrical fuel assembly.

Card B has the following format: (8F7.4, 2F5.1, 7X, A1)

Field No.	Column	Variable	Definition
1	1-7	AI(1)	Bare radius of central rod (cm)*
2	8-14	AI(2)	Bare radius of rods in first ring (cm)
3	15-21	AI(3)	Bare radius of rods in second ring (cm)**
4	22-28	BI(1)	Canned radius of central rod (cm)*
5	29-35	BI(2)	Canned radius of rods in first ring (cm)
6	36-42	BI(3)	Canned radius of rods in second ring (cm)**
7	43-49	CI(1)	Distance from center of cluster to center of rods in first ring (cm)
8	50-56	CI(2)	Distance from center of cluster to center of rods in second ring (cm)**
9	57-61	S	Number of rods in first ring
10	62-66	Q	Number of rods in second ring
	74		B by definition
	77-80		Card sequence number (not read)

* 0.0 is punched in these columns if there is not a central rod in the cluster.

** If only one ring of rods (the central rod is not counted as a ring) makes up the cluster these columns are left blank.

C Card: Region Information

Each case requires one card of the following format for each region in the unit lattice cell: (2X, I2, 2F5.1, F9.3, F8.3, F10.5, F10.3, F7.3, F7.1, I2, 6X, A1)

Field No.	Columns	Variable	Definition
1	3-4	K	Region number (innermost region denoted by 1)
2	5-9	C(K)	0.0 if built-in cross sections are to be utilized 1.0 if cross sections are to be given in this region*
3	10-14	U(K)	0.0 if non-H ₂ O, D ₂ O or graphite region 1.0 if H ₂ O, D ₂ O or graphite region
4	15-23	A(K)	Atomic mass number of material in region**
5	24-31	D(K)	Density of region (g/cm ³)
6	32-41	R(K)	Outside radius of region (cm)
7	42-51	T(K)	Physical temperature of region (°K)
8	52-58	E(K)	0.0 if nonfuel region Enrichment if fuel region (wt% U-235 or U-233, see K7 on A)
9	59-65	POINTS(K)	Number of thermal flux points in flux traverse for this region if a table of flux versus radius is desired
	66-67	IHTS(K)	= 0 Nonheat transfer surface ≠ 0 Region number corresponding to this heat transfer surface
	74		C by definition
	77-80		Card sequence number (NCT READ)

* Each D card must immediately follow the C card of the region to which its cross sections are to be assigned.

** The following atomic mass numbers must be used:

Voids	=	0.0	Stainless steel	=	60.0
H ₂ O	=	1.0	Zirconium	=	90.0
D ₂ O	=	2.0	Thulium oxide	=	169.0
Organic	=	3.0	Bismuth	=	209.0
Lithium	=	6.0	Neptunium	=	237.0
Graphite	=	12.0	Uranium	=	238.0
Sodium	=	23.0	Uranium carbide	=	250.0
Magnesium	=	24.0	Plutonium-aluminum	=	260.0
BeO	=	25.0	Uranium oxide	=	270.0
Aluminum	=	27.0			

D Card: Cross Section Values (Used only when C(K) = 1.0 on C card)

If one wishes to use a particular set of cross section values for a region or regions other than those stored in the program, a 1.0 is punched in Field Number 2 on the corresponding C card(s). This C card is then immediately followed by a D card having the desired set of cross sections for that region. The D cards have the following format: (6E12.5, 1X, A1).

Field No.	Column	Variable	Definition
1	1-12	DSCT(K)	Scattering cross section for thermal group (cm ²)
2	13-24	DRSCT(K)	Scattering cross section for epithermal group (cm ²)
3	25-26	DABS1(K)	2200 m/s absorption cross section for region (2200 m/s cross section for U-238 if fuel region) (cm ²)
4	27-48	DABS2(K)	2200 m/s absorption cross section for U-235 if fuel region (cm ²). Blank if nonfuel region.
5	49-60	FIS1(K)	Fission cross section for U-238 if fuel region (cm ²). Blank if nonfuel region.
6	61-72	FIS2(K)	2200 m/s fission cross section for U-235 if fuel region (cm ²). Blank if nonfuel region.
	74		D by definition
	77-80		Card sequence number (NOT READ)

E Card: Fast Effect Parameters (Used only when K1 = 1 on the A card.)

If one wishes to use a set of fast parameters other than those stored in the program a 1 is punched in Field Number 3, K1, of the A card and the desired parameters are punched on an E card having the following format: (5E10.3, 3E6.3, 5X, A1)

Field No.	Column	Variable	Definition
1	1-10	DST1	Total fast neutron cross section for H ₂ O (cm ²)
2	11-20	DST2	Total fast neutron cross section for D ₂ O (cm ²)
3	21-30	DSE28	Elastic scattering cross section for U-238 (cm ²)
4	31-40	DSF28	Fission cross section for U-238 (cm ²)
5	41-50	DST28	Total cross section for U-238 (cm ²)
6	51-56	DNU28	$\nu(28)$
7	57-62	DNU25	$\nu(25)$
8	63-68	DALPHA	Ratio of capture-to-fission probability for U-238
	74		E by definition
	77-80		Card sequence number

F Card: Ages (Used only when K4 = 1 on the A card)

To use ages other than those stored in the program a 1 is punched in Field Number 6 of the A card and the desired ages are then punched on an F card having the following format: (8F8.3, 9X, A1)

Field No.	Column	Variable	Definition
1	1-8	DTG1	Age in 1.6 g/cm ³ graphite (g/cm ³)
2	9-16	DTG2	Age in 1.6 g/cm ³ graphite after inelastic collision (cm ²)
3	17-24	DTW1	Age in 1.0 g/cm ³ H ₂ O (g/cm ³)
4	25-32	DTW2	Age in 1.0 g/cm ³ H ₂ O after inelastic collision (cm ²)
5	33-40	DTD1	Age in 1.1 g/cm ³ D ₂ O (g/cm ³)
6	41-48	DTD2	Age in 1.1 g/cm ³ D ₂ O after inelastic collision (cm ²)
7	49-56	DTB1	Age in 3.025 g/cm ³ BeO (g/cm ³)
8	57-64	DTB2	Age in 3.025 g/cm ³ BeO after inelastic collision (cm ²)
	74		F by definition
	77-80		Card sequence number

G Card: Descriptive Information

Format (10A6, 2I5, 3X, A1)

<u>Field No.</u>	<u>Column</u>	<u>Variable</u>	<u>Definition</u>
	2-60		For descriptive information or report titles
1	61-65	K11	Number of ALTHAEA change cards to read from A2 and write to A5
2	66-70	K12	Not used
	74		G by definition
	77-80		Card sequence number

H Card: Descriptive Information

Format (10A6), 2I5, 3X, A1)

<u>Field No.</u>	<u>Column</u>	<u>Variable</u>	<u>Definition</u>
	2-60		For descriptive information or report titles
1	61-65	KDIL	The kind of diluent used in reduced density cases as determined from the following table: 1 - Zirconium 2 - Aluminum 3 - Beryllium 4 - Zirconium oxide 5 - Beryllium oxide
2	66-70	IPER	Volume percent of fuel in a reduced density case
	74		H by definition
	77-80		Card sequence number

J Card: Plutonium Isotopes (Used only when K3 = 1, 2 on the A card)

The number of grams plutonium per ton of fuel for irradiated fuel is punched on J cards, one for each fuel region. The J cards have the following format: (I2, 5E10.4, 21X, A1).

<u>Field No.</u>	<u>Column</u>	<u>Variable</u>	<u>Definition</u>
1	1-2	K	Region number
2	3-12	PERFIS	Percent fissile plutonium in region
3	13-22	G49(K)	Grams/ton Pu-239
4	23-32	G40(K)	Grams/ton Pu-240
5	33-42	G41(K)	Grams/ton Pu-241
6	43-52	G42(K)	Grams/ton Pu-242
	74		J by definition
	77-80		Card sequence number

K Card: Cross Sections for Plutonium Isotopes (Used only when K3 = 2 on the A Card)

To use cross sections other than those stored in the code for plutonium isotopes a 2 is punched in Field Number 5 of the A card and the desired cross sections are punched on a K card having the following format: (6E12. 5, 1X, A1)

Field No.	Column	Variable	Definition
1	1-12	BAB49	2200 m/s absorption cross section of Pu-239 (cm ²)
2	13-24	BAB40	2200 m/s absorption cross section of Pu-240 (cm ²)
3	25-36	BAB41	2200 m/s absorption cross section of Pu-241 (cm ²)
4	37-48	BAB42	2200 m/s absorption cross section of Pu-242 (cm ²)
5	49-60	BFI49	2200 m/s fission cross section of Pu-239 (cm ²)
6	61-72	BFI41	2200 m/s fission cross section of Pu-241 (cm ²)
	74		K by definition
	77-80		Card sequence number

L Card: Heat Transfer Surface Areas of Fuel Regions

Format (4(I2, F8. 4), E10. 4, 3I3, 14X, A1)

Field No.	Column	Variable	Definition
1	1-2	KFUEL(1)	Region number of first fuel region of interest
2	3-10	HETRS(1)	Heat transfer surface area of the first fuel region (ft ² /ft)
3	11-12	KFUEL(2)	Region number of second fuel region of interest
4	13-20	HETRS(2)	Heat transfer surface area of the second fuel region (ft ² /ft)
5	21-22	KFUEL(3)	Region number of third fuel region of interest
6	23-30	HETRS(3)	Heat transfer surface area of the third fuel region (ft ² /ft)
7	31-32	KFUEL(4)	Region number of fourth fuel region of interest
8	33-40	HETRS(4)	Heat transfer surface area of the fourth fuel region (ft ² /ft)
9	41-50	URA26	U-236/U-238 atom ratio if positive U-236/U-235 atom ratio if negative
10	51-53	LOSREG	Number of outside regions to be dropped in calculating ALTHAEA input parameters
11	54-56	JPHI	0 if flux depression is to be calculated based on both fuels and targets - 1 if flux depression is to be based on targets only + 1 if flux depression is to be based on fuels only
12	57-59	MELALT	0 when followed by 0-dimensional ALTHAEA 1 when followed by 1-dimensional ALTHAEA
	74		L by definition
	77-80		Card sequence number

M Card: Fuel surface heat transfer rates for engineering tables from
TELLUS

Format (6(I1, F9.2), F10.2, 3X, A1)

Field No.	Columns	Variable	Definition
1	1	ISP(1)	0 don't use HTR(1) to calculate specific power 1 use HTR(1) to calculate specific power
2	2-10	HTR(1)	An interesting heat transfer rate (Btu/ft ² hr)
3	11	ISP(2)	0 don't use HTR(2) to calculate specific power 1 use HTR(2) to calculate specific power
4	12-20	HTR(2)	An interesting heat transfer rate (Btu/ft ² hr)
5	21	ISP(3)	0 don't use HTR(3) to calculate specific power 1 use HTR(3) to calculate specific power
6	22-30	HTR(3)	An interesting heat transfer rate (Btu/ft ² hr)
7	31	ISP(4)	0 don't use HTR(4) to calculate specific power 1 use HTR(4) to calculate specific power
8	32-40	HTR(4)	An interesting heat transfer rate (Btu/ft ² hr)
9	41	ISP(5)	0 don't use HTR(5) to calculate specific power 1 use HTR(5) to calculate specific power
10	42-50	HTR(5)	An interesting heat transfer rate (Btu/ft ² hr)
11	51	ISP(6)	0 don't use HTR(6) to calculate specific power 1 use HTR(6) to calculate specific power
12	52-60	HTR(6)	An interesting heat transfer rate (Btu/ft ² hr)
13	61-70	A7	A number that when its absolute value is multiplied by FEXP will yield FCONST for the flux depression equation for ALTHAEA. This number has no effect when FCONST and FEXP are obtained as a fit from two JASON passes (i. e. K6 ≠ 0).
	74		M by definition
	77-80		Card sequence number

N Card: Reactor power card for engineering output tables

Format (5 (I1, F9.2), F8.3, 2F7.4)

Field No.	Columns	Variable	Description
1	1	LSP(1)	0 no effect 1 pass 1.0 + leakage, calculated at RPM(1) and the HTR(I) specified on N card to ALTHAEA as BMULT
2	2-10	RPM(1)	An interesting reactor power (MW_{th})
3	11	LSP(2)	0 no effect 1 pass 1.0 + leakage, calculated at RPM(2) and the HTR(I) specified on N card to ALTHAEA as BMULT
4	12-20	RPM(2)	An interesting reactor power (MW_{th})
5	21	LSP(3)	0 no effect 1 pass 1.0 + leakage, calculated at RPM(3) and the HTR(I) specified on N card to ALTHAEA as BMULT
6	22-30	RPM(3)	An interesting reactor power
7	31	LSP(4)	0 no effect 1 pass 1.0 + leakage, calculated at RPM(4) and the HTR(I) specified on N card to ALTHAEA as BMULT
8	32-40	RPM(4)	An interesting reactor power
9	41	LSP(5)	0 no effect 1 pass 1.0 + leakage, calculated at RPM(5) and the HTR(I) specified on N card to ALTHAEA as BMULT
10	42-50	RPM(5)	An interesting reactor power
11	51-58	SPOWER	Specific power (MW/ton) to pass on to ALTHAEA if not calculated from M card
12	59-65	HEIGHT	Ratio of bare core height to bare core diameter
13	66-72	ADDER	A quantity to add to 1.0 + leakage to calculate BMULT for ALTHAEA
	74		N by definition
	77-80		Card sequence number

Tape Units

The tape units used are as follows:

Input Data	Tape Unit #A2
Record Report	Tape Unit #A3
TELLUS Output	Tape Unit #A5
ALTHAEA Input Cards	Tape Unit #A5

The automatic coding system MONITOR must be utilized in the operation of the code on the 7090.

Since A5 is a special tape a label for it must always be supplied for use by the data processing group unless the tape isn't to be saved or printed.

Code Developments

In the near future a number of developments may take place in the JASON code. Among these are plans:

- 1) To expand the maximum number of regions available from the present 16
- 2) To allow more materials to be included in a given region
- 3) To give the code a broad four-group structure
- 4) To change the code from the present one neutron energy group P3 structure into a four-group structure.

REFERENCES

1. E. T. Merrill. ALTHAEA. Part I. A One-Dimensional Two-Group Diffusion Code with an Effective Four-Group Burnup, BNWL-462, (In press).
2. E. A. Eschbach, D. E. Deonigi, and S. Goldsmith. QUICK - A Simplified Fuel Cost Code, HW-71812, January 2, 1962.
3. E. A. Eschbach, M. F. Kanninen, and S. Goldsmith. PUVE - A Computer Code for Calculating Plutonium Value, HW-71811, December 1, 1961.
4. C. R. Richey. IDIOT - A Lattice Parameter Code for the IBM-709, HW-63411, January 7, 1960.

APPENDIX A

STORED DATA1. Cross Section Data

The cross section data used in the code are given in the table below. However, the code has been written such that the cross sections for any particular region or regions may be replaced with those of one's own choice. This procedure will be discussed in the operating instructions. The atomic mass numbers given in the table must be used in identifying the desired material.

TABLE OF CROSS SECTIONS
(Units in Barns)

Material	Atomic Mass Number	Absolute* Cross Section	Fission* Cross Section	Scattering Thermal	Cross Section Epithermal
Void	0.0	0.0	0.0	0.0	0.0
H ₂ O	1.0	0.644	0.0	---**	42.636
D ₂ O	2.0	0.92x10 ⁻³	0.0	---**	9.29
Graphite	12.0	3.74x10 ⁻³ ***	0.0	5.4	4.8
Aluminum	27.0	0.23	0.0	1.4	1.4
Stainless Steel	60.0	2.65	0.0	9.32	9.32
Zirconium	90.0	0.209	0.0	8.0	8.0
UO ₂	270.0	----	---	16.7	16.7
U _{metal}	238.0	----	---	8.3	8.3
U-235	----	693.52	582.78	---	---
U-238	----	2.71	0.0	---	---
Pu-239	----	1031.1	747.73	---	---
Pu-240	----	300.0	0.0	---	---
Pu-241	----	1397.4	1015.22	---	---
Pu-242	----	30.0	0.0	---	---

*2200 m/s values

**The scattering cross sections for H₂O and D₂O in the thermal region are:
(Footnotes continued on following page)

$$\begin{array}{ll}
 \sigma_S = [36.022 + 9.3126 (8.61 \times 10^{-5} T)^{-1/2}] \text{ barns} & T \leq 533 \text{ }^\circ\text{K} \\
 \sigma_S = [34.1912 + 9.7048 (8.61 \times 10^{-5} T)^{-1/2}] \text{ barns} & T > 533 \text{ }^\circ\text{K}
 \end{array} \left. \vphantom{\begin{array}{l} \sigma_S \\ \sigma_S \end{array}} \right\} \text{H}_2\text{O}$$

$$\sigma_S = [9.603 + 0.6922 (8.61 \times 10^{-5} T)^{-1/2}] \text{ barns} \quad \text{D}_2\text{O}$$

***For +1 dih graphite in air atmosphere. The dih value is part of the input data and the 2200 m/s cross section has been defined.

$$\sigma_g = 4.47 - 0.733 \text{ dih} - 1.466 \delta \left(\frac{1}{\rho_g} - \frac{1}{2.25} \right)$$

where

$$\begin{array}{ll}
 \rho_g & = \text{density of graphite} \\
 \delta & = 1 \text{ if air free atmosphere} \\
 \delta & = 0 \text{ if air atmosphere}
 \end{array}$$

2. Nu

The values of ν , the average number of neutrons released per fission, are given below

<u>Isotope</u>	<u>ν</u>
U-235	2.47
Pu-239	2.905
Pu-241	3.06

3. Fast Fission Parameters

The fast fission parameters stored in the code are given in the following table:

FAST FISSION PARAMETERS

<u>Symbol</u>	<u>Value</u>
σ_t^w	10 barns
σ_t^D	10 barns
σ_t^u	7.3 barns
σ_e^u	4.17 barns
σ_f^u	0.307 barns
$\alpha(28)$	0.190
$\nu(28)$	2.62 or 2.845*
$\nu(25)$	2.47

*The user has the choice of two values for $\nu(28)$; see the operating instructions.

4. Ages

The following ages (to 16 kT₀) have been utilized in the code. The τ' are the ages in the respective material after suffering an inelastic collision in the uranium fuel.

<u>Material</u>	<u>Symbol</u>	<u>Age (cm²)</u>
Graphite	τ_g	348.0
Graphite	τ'_g	215.0
H ₂ O	τ_w	30.1
H ₂ O	τ'_w	18.6
D ₂ O	τ_D	118.9
D ₂ O	τ'_D	73.5

APPENDIX B

The following equations show the methods used in JASON to calculate input parameters for ALTHAEA. Let L be the total number of regions (N) minus the number of fringe regions ($LOSREG$) to be omitted. Let $\delta = 0$ for nonfuel and nontarget regions, and let $\delta = 1$ for fuel and target regions. Then the ALTHAEA parameters are calculated as follows:

$$PERFIS^* = \frac{\sum_{k=1}^L \left(\sum_{i=1}^F N_i^f \right)_k V_k \delta_k}{\sum_{k=1}^L \left(\sum_{i=1}^F N_i \right)_k V_k \delta_k}$$

Where

N_i^f = nuclear density of fissile isotope i in region k
in nuclei/barn cm

V_k = volume of region k in cm^3

N_i = nuclear density of target or fuel isotope i in region k
in nuclei/barn cm

F = number of fuel or target isotopes in region k .

*The PERFIS calculated here, actually an atom fraction, is different from and should not be confused with the PERFIS required for the J cards.

FCONST, FEXP normally are determined from the equation form:

$$FD = FCONST \Sigma_a + e^{-FEXP \Sigma_a}$$

Where

$$FD = \frac{\sum_{k=1}^L \phi_k \delta_k}{\sum_{k=1}^L \phi_k}$$

$$\Sigma_a = \frac{\sum_{k=1}^L \left[\phi V \sum_{i=1}^F (\sigma_{a_i} N_i) \right]_k \delta_k}{\sum_{k=1}^L (\phi V)_k \delta_k}$$

- ϕ_k = thermal flux in region k
 V_k = volume of region k
 $(\sigma_{a_i})_k$ = microscopic Westcott absorption cross section for isotope i in region k
 $(N_i)_k$ = nuclei per cm³ of isotope i in region k
 F = number of different isotopes in region k.

Since two unknowns are sought (FCONST and FEXP) two flux depression points are required (two JASON cases) at different Σ_a 's (enrichments) for each set of values. If K6 = 0 on the A card, the constants are determined as follows:

$$FEXP = \frac{\ln FD}{\Sigma_a}$$

$$FCONST = |A7| * FEXP$$

Where

A7 = an input item and Σ_a and FD take on their previously defined meanings

PWI in the zero dimensional mode is the specific power and is either passed on to ALTHAEA from the input SPOWER or is calculated from the heat transfer surface areas (calculated, or input on L card), the heat transfer rate indicated on the M card and the fuel density averaged over the fuel regions.

PWI in the one dimensional mode is set to 1.0×10^{-11} as an initial flux guess for ALTHAEA.

SPEC is determined for zero dimensional cases as follows:

$$SPEC = \dot{SDPV} = \frac{\sum_{k=1}^L (\xi \sigma_s^e NV)_k}{\sum_{k=1}^L V_k \phi_k}$$

Where

ξ_k = average logarithmic energy decrement of the material in region k

- $(\sigma_s^e)_k$ = microscopic epithermal scattering cross section of the material in region k
 N_k = nuclei per cm^3 of material in region k
 V_k = volume of region k.

When operating in the one-dimensional mode

$$\text{SPEC} = R = \frac{\sum_{k=1}^L r_k V_k}{\sum_{k=1}^L V_k}$$

where

- r_k = epithermal ratio for region k
 V_k = volume of region k

SNF is determined as follows:

$$\text{SNF} = \frac{\sum_{k=1}^L (\phi V \sigma_a N)_k (1 - \delta_k)}{\left[\frac{\sum_{k=1}^L (\phi V)_k}{\sum_{k=1}^L V_k} \right] \left[\sum_{k=1}^L V_k \delta_k \right] \left[\frac{\pi * 293.16}{4 * \frac{\sum_{k=1}^L (\sigma_s^{\text{th}} \text{NVT})_k (1 - \delta_k)}{\sum_{k=1}^L (\sigma_s^{\text{th}} \text{NV})_k (1 - \delta_k)}} \right]^{1/2}}$$

Where the variables are the same as previously noted, and

- $(\sigma_a)_k$ = Maxwellian microscopic absorption cross section in region k
 $(\sigma_s^{\text{th}})_k$ = microscopic scattering cross section for the thermal group in region k

F equals the thermal utilization and is obtained by summing the F_k [C. R. Richey⁽⁴⁾] for each fuel and target region.

$$F = \sum_{k=1}^L f_k \delta_k$$

SCA is a form of the Bell correction and is determined as follows:

$$SCA = \frac{\sum_{k=1}^L (\sigma_s^{th} NV)_k \delta_k}{\sum_{k=1}^L V_k \delta_k} + \frac{\left(\frac{S_{eff}}{4 \sum_{k=1}^L V_k \delta_k} \right) \left\{ \frac{\sum_{k=1}^L [(\sigma_s^e NV)_k (1 - \delta_k)]}{\sum_{k=1}^L \frac{V_k}{V} \delta_k} \right\}}{\left\{ \left(\frac{S_{eff}}{4 \sum_{k=1}^L V_k \delta_k} \right) + \left[\frac{\sum_{k=1}^L [(\sigma_s^e NV)_k (1 - \delta_k)]}{\sum_{k=1}^L \frac{V_k}{V} \delta_k} \right] \right\}}$$

Where $(\sigma_s)_k$, N_k , V_k , δ_k , and ξ_k have the same meanings as defined previously.

S_{eff} is defined in Reference 4, page 10.

BMULT is the average reactivity at which ALTHAEA is to stop burning, and is determined as follows:

$$\begin{aligned} &1.0 + \text{ADDER} + \text{leakage} && \text{(when MELALT} = 0) \\ &- (1.0 + \text{ADDER}) && \text{(when MELALT} > 0) \end{aligned}$$

Where

ADDER is an input in Field 13 of the N card.

MELALT is an input in Field 12 of the L card.

Leakage is obtained from the table of leakage as a function of reactor power and heat transfer rate.

E is the fast effect, and if DEL (see A card) is 0.0 or 1.0, is calculated for systems containing U-238 as described in Reference 4, HW-63411, page 6.

When DEL is 3.0, epsilon is calculated using the following alternate semi-empirical method found to give fair results for light water moderated lattices (infinite arrays):

$$E^{28} = \epsilon_H + \frac{P_c \frac{\bar{\sigma}_f}{\bar{\sigma}_t}}{1 - P_c \left[\frac{v^{28} \bar{\sigma}_f}{\bar{\sigma}_t} + \frac{\bar{\sigma}_e}{\bar{\sigma}_t} \right]} \left[1 - \left(1 - \frac{\alpha}{\bar{\sigma}_f} \right) \epsilon_H \right]$$

Where

$$\epsilon_H = 1 + \frac{\alpha}{4.46 \frac{N_W}{N_{28}} + 2.326}$$

and

$$\alpha = (v^{28} - 1) \sigma_f^{28} - \sigma_c^{28}$$

The notation used has been that defined in HW-63411 (Reference 4).

If thorium-232 is used as the fertile material the above calculation is carried out, but with thorium concentrations substituted for that of U-238; then

$$E^{232} = 1 + \frac{E^{28} - 1}{4}$$

since the epsilon for thorium is known to be about one-fourth that of U-238.

TOT is the average fuel and target nuclei per barn centimeter and is calculated as follows:

$$TOT = \frac{\sum_{k=1}^L \left(\sum_{i=1}^F N_i \right)_k V_k}{\sum_{k=1}^L V_k \delta_k}$$

where the variables have their previously defined meaning.

TEM is the average moderator temperature in °C and is calculated as follows:

$$\text{TEM} = \frac{\sum_{k=1}^L (\sigma_k^{\text{th}} N_k V_k T_k) \delta_k^{\text{m}}}{\sum_{k=1}^L (\sigma_k^{\text{th}} N_k V_k) \delta_k^{\text{m}}} - 273.16 \text{ } ^\circ\text{K}$$

Where

T_k = physical temperature of region k expressed in degrees Kelvin

$\delta_k^{\text{m}} \equiv 0$ for nonmoderator regions
 $\equiv 1$ for moderator regions.

All other symbols have been previously defined.

TEMF is the average fuel temperature in $^\circ\text{C}$ and defined as follows:

$$\text{TEMF} = \frac{\sum_{k=1}^L T_k \delta_k}{\sum_{k=1}^L \delta_k} - 273.16 \text{ } ^\circ\text{K}$$

where T_k and δ_k have been previously defined.

DENS is the average fuel metal density and is calculated as follows:

$$\text{DENS} = \frac{\sum_{k=1}^L \left(\rho_k * \frac{238}{A_k} \right) V_k \delta_k}{\sum_{k=1}^L V_k \delta_k}$$

Where

A_k = input atomic mass to nearest whole number in region k,

ρ_k = input fuel density in g/cm^3 in region k,

and V_k and δ_k have been previously defined.

M/F is the moderator-to-fuel volume ratio and is calculated as follows:

$$M/F = \frac{\sum_{k=1}^L V_k \delta_k^m}{\sum_{k=1}^L V_k \delta_k}$$

Isotopic concentrations for ALTHAEA are calculated as follows:

$$(1) \quad (N_i)_k = \frac{\rho_k \times 0.6025 \times 10^{24}}{A_k} \frac{E_k}{100} \frac{238}{235}$$

where $i = \text{U-235, U-233}$

$$(2) \quad = \frac{\rho_k \times 0.6025 \times 10^{24}}{A_k} \frac{\text{PERFIS}_k}{100} \frac{G(i)_k}{G(49)_k + G(41)_k} \frac{238}{A_i}$$

where $i = \text{Pu-239, Pu-240, Pu-241, Pu-242}$

$A_i = 239, 240, 241, 242$

$$(3) \quad = \frac{\rho_k \times 0.6025 \times 10^{24}}{A_k} \frac{100 - E_k - \text{PERFIS}_k \left[\frac{G(49)_k + G(40)_k + G(41)_k + G(42)_k}{G(49)_k + G(41)_k} \right]}{100}$$

where $i = \text{U-238, Th-232}$

$A_k = 238, 270 \text{ or } 250 \text{ for Equations 1, 2, 3.}$

$$(4) \quad = \frac{\rho_k \times 0.6025 \times 10^{24}}{27} \frac{\text{PERFIS}_k}{100} \frac{G(i)_k}{G(49)_k + G(41)_k} \frac{27}{238} \frac{238}{A_i}$$

where $i = \text{Pu-239, Pu-240, Pu-241, Pu-242}$

$A_i = 239, 240, 241, 242$

$$(5) \quad (N_i)_k = \frac{\rho_k \times 0.6025 \times 10^{24}}{27} \left[100 - \left\{ E_k - \text{PERFIS}_k \frac{27}{238} \left[\frac{G(49)_k + G(40)_k + G(41)_k + G(42)_k}{G(49)_k + G(41)_k} \right] \right\} \frac{238}{27} \right] \frac{1}{100}$$

where i = aluminum isotopic concentration

$A_k = 260$ for Equations 4, 5.

$$(6) \quad = \frac{\rho_k * 0.6025 \times 10^{24}}{A_k}$$

where i = $\text{Tm}_2^{169}\text{O}_3$, Bi^{209} , Np^{237} or Li^6

$A_k = 169, 209, 237$ or 6 for Equation 6.

SS1 is the epithermal transport cross section and is calculated as follows:

$$\text{SS1} = \frac{\sum_{k=1}^L \left[\left(N \sigma_s^e \right)_k V_k \left(1 - \frac{2}{3 A_k} \right) \right]}{\sum_{k=1}^L V_k}$$

SS2 is the thermal transport cross section and is calculated as follows:

$$\text{SS2} = \frac{\sum_{k=1}^L \left[\left(N \sigma_s^{\text{th}} \right)_k \left(1 - \frac{2}{3 A_k} \right) V_k \phi_k^{\text{th}} \right]}{\sum_{k=1}^L V_k \phi_k^{\text{th}}}$$

XISS is the average effective scattering cross section and is calculated as follows:

$$\text{XISS} = \sum_{k=1}^L \xi_k \left(\sigma_s^{\text{th}} \right)_k N_k \frac{V_k}{\pi R_L^2}$$

where R_L is the outside radius of the cell.

VR is the fuel and target volume fraction and is calculated as follows:

$$VR = \sum_{k=1}^L \frac{V_k \delta_k}{\pi R_L^2}$$

BUCK is the transverse buckling and is calculated as follows:

$$BUCK = \frac{\pi}{H_1}^2$$

where

$$H_1 = H + 4M$$

M = migration length for the lattice cell.

H = the bare reactor height determined from "HEIGHT" and volume where the volume is either an input (-"BUCK") or is calculated from the average fuel density, the specific power and the fuel volume fraction. The specific power is either input or is calculated from the indicated heat transfer rate and the calculated or input heat transfer surface area.

APPENDIX C

SAMPLE RUNS

JASON CASE NUMBER 1001

1000 MWE PWR WESTINGHOUSE REACTOR
BURLINGTON SITE - 3090 MWT, 93. T.D.

INPUT CONTROL DATA

IN	K1	K2	K3	K4	K5	IFTIN	ECCOR		BUCK	STRCOR	DIH	DEL				
4	-0	-0	-0	-0	-0	1	1.0000+00		-9.7260+06	1.0000+00	1.0000+00	2.0000+00				
JG	K6	K7	K9	K10	K11	K12	KDIL	IPER	URA26	LOSREG	JPHI	MELALT	A7	SPOWER	HEIGHT	ADDER
-0	-0	-0	2	1	-0	-0	-0	-0	-0.000	-0	-0	1	2.00	-0.00	1.077	-0.0000

INPUT REGION INFORMATION

REGION NUMBER	RADIUS CM.	RADIUS INCHES	MATERIAL	DENSITY GM/CC	TEMP DEG C	TEMP DEG F	VOLUME FRACTION	THICKNESS REG-INCH	NUCLEI PER BARN CM
1	.46596	.18345	UO2	10.190	704.440	1299.992	.30349	.18345	2.27388-02
2	.51422	.20245	ZIRC	6.400	332.220	629.996	.06612	.01900	4.19721-02
3	.54455	.21439	ST STL	7.900	303.060	577.508	.04489	.01194	7.30152-02
4	.84582	.33300	H2O	.710	303.060	577.508	.58550	.11861	2.37140-02

IF ARRAY IS TRIANGULAR, PITCH = .6342 INCHES
IF ARRAY IS SQUARE, PITCH = .5902 INCHES

JASON-P3 OUTPUT REGION INFORMATION

REGION NUMBER	AVERAGE FLUX	THERMAL UTILIZATION	HEAT TRAN UTILIZATN	LOG ENRGY DECREMENT	SIGMA A	SIGMA S	XI SIGMA S	EPITHERMAL RATIO	NEUTRON TEMP
1	.88678	.84896	1.000	.03600	2.39965-01	.37974	.01367	.16082	576.759
2	.92817	.00488	.000	.02180	5.14569-03	.33578	.00732	.15357	576.227
3	.93954	.07303	.000	.03530	1.37965-01	.68050	.02402	.15161	576.220
4	1.00000	.07313	.000	.94800	9.95078-03	1.84404	.95849	.14198	576.220

REGION NUMBER	THERMAL SCAT X-SEC	EPITHERMAL SCAT X-SEC	REGION CROSS SECTIONS IN BARNS				MAXWLL AVGD ABS X-SEC	WESCOTT ABS X-SEC	WESCOTT FIS X-SEC
			2200 M/S ABS X-SEC	2200 M/S ABS X-SEC	2200 M/S FIS X-SEC				
				FISSILE MAT	FISSILE MAT				
1	1.67000+01	1.67000+01	2.71000+00	6.78000+02	5.79000+02	1.05531+01	1.74979+01	1.21266+01	
2	8.00000+00	8.00000+00	1.94000-01	0.00000	0.00000	1.22598-01	2.38791-01	0.00000	
3	9.32000+00	9.32000+00	2.99000+00	0.00000	0.00000	1.88954+00	2.99000+00	0.00000	
4	7.77615+01	4.26360+01	6.64000-01	0.00000	0.00000	4.19616-01	6.64000-01	0.00000	

ETA	EPSILON	RES. ESCAPE	THERM UTILIZE	CELL FOUR FACTORS CONVERS K RATIO INFINITY		AGE	DIFF AREA	MIGRATION AREA	MATERIAL BUCKLING
1.71150	1.03947	.73439	.84896	.74607	1.10937	62.0686	5.0693	67.1379	1.54625-03

ISOTOPE CONCENTRATIONS (NUCLEI/BARN CM)

U235	U238
4.99731-04	2.22454-02

ZERO DIMENSIONAL ALTHAEA INPUT PARAMETERS								
PERFIS	SDPV MELEAGER	SNF	SCA	FUEL DENS OF METAL	F	DELTA	TOT	MELEAGER TEMP
.02197	1.86800	.06546	1.09444	8.98230	.84294	1.06816	2.27451-02	303.220
FLUX DEPRESSION	FCONST	FEXP	SP POWER MW/TONNE	FUEL TEMP	TONNES OF FUEL IN CORE			
1.08051	.64526	.32263	70.805	704.44	2.92258+01			

ONE DIMENSIONAL ALTHAEA PARAMETERS								CELL AVE R	FUEL+TARGET	VERT BUCK	BAPE HEIGHT
SS1	SS2	SS3	SS4	XISS1	XISS2	XISS3	S13	SPEC	VOL FRACT-VR	BUCK	HQFT
.23370	.49726	.50740	.80491	.283457	.555575	.566914	.97967	.14198	.30349	1.2969-04	2.4309+02

CORE DESIGN INFORMATION FOR CYLINDRICAL CORE WITH L/D RATIO = 1.07700

CLAD SURFACE OF FUEL REGIONS	MODERATOR VOLUME	OUT SIDE SURFACE CYLINDER	CELL INFORMATION (PER FOOT OF CELL)				MODERATOR WEIGHT	FUEL VOLUME	CLADDING VOLUME
			CELL VOLUME	VOL MOD PER VOL FUEL	FUEL WEIGHT				
.09605 SQ FT/FT	.00142 CU FT/FT	.17436 SQ FT/FT	.00242 CU FT/FT	1.92925	.46706 LBS/FT	.06278 LBS/FT	.00073 CU FT/FT	.00027 CU FT/FT	

LEAKAGE						SPECIFIC POWER IN MEGAWATTS PER TONNE
NEUTRON LEAKAGE AS A FUNCTION OF POWER AND HEAT TRANSFER RATE						
REACTOR POWER MEGAWATTS THERMAL						
	* 3500.	3090.	2500.	2000.	1500.	
***** 1000 BTU/HR SQ FT *						
100.	* .0085657	.0092536	.0105406	.0120943	.0144102	13.284
196.	* .0129730	.0139946	.0159039	.0181905	.0215860	26.077
300.	* .0167712	.0180724	.0205052	.0233953	.0270787	39.853
400.	* .0199193	.0214474	.0242991	.0276787	.0326721	53.137
500.	* .0227326	.0244601	.0276787	.0314853	.0370951	66.421
533.	* .0236042	.0253926	.0287235	.0326605	.0384576	70.805

GEOMETRICAL BUCKLING					
REACTOR POWER MEGAWATTS THERMAL					
	* 3500.	3090.	2500.	2000.	1500.
***** 1000 BTU/HR SQ FT *					
100.	* 1.2014-04	1.3847-04	1.5793-04	1.8124-04	2.1021-04
196.	* 1.9450-04	2.0993-04	2.3887-04	2.7345-04	3.2506-04
300.	* 2.5193-04	2.7166-04	3.0861-04	3.5263-04	4.1811-04
400.	* 2.9970-04	3.2295-04	3.6642-04	4.1811-04	4.9482-04
500.	* 3.4253-04	3.6888-04	4.1811-04	4.7655-04	5.6309-04
533.	* 3.5582-04	3.8313-04	4.3413-04	4.9464-04	5.8419-04

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		BARE REACTOR DIAMETER IN CM				
		REACTOR POWER MEGAWATTS THERMAL				
		3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	465.26	446.34	415.90	386.09	350.78
196.	*	371.59	356.47	332.16	308.35	280.16
300.	*	322.60	309.47	288.37	267.70	243.22
400.	*	293.10	281.17	262.00	243.22	220.98
500.	*	272.09	261.02	243.22	225.79	205.14
533.	*	266.35	255.52	238.09	221.03	200.82

		TONNES OF FUEL IN CORE				
		REACTOR POWER MEGAWATTS THERMAL				
		3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	263.4706	232.6069	188.1933	150.5546	112.9160
196.	*	134.2183	118.4956	95.8702	76.6962	57.5221
300.	*	87.8235	77.5356	62.7311	50.1849	37.6387
400.	*	65.8677	58.1517	47.0483	37.6387	28.2290
500.	*	52.6941	46.5214	37.6387	30.1109	22.5832
533.	*	49.4316	43.6411	35.3083	28.2466	21.1850

JASON CASE NUMBER 1002

1000 MWE PWR WESTINGHOUSE REACTOR
 DUPLINGTON SITE - 3090 MWT, 93. T.D.

INPUT CONTROL DATA

N	K1	K2	K3	K4	K5	IFTIM	ECCOR	BUCK	STRCOR	DIH	DEL					
4	-0	-0	-0	-0	-0	1	1.0000+00	-9.7260+06	1.0000+00	1.0000+00	2.0000+00					
J6	K6	K7	K9	K10	K11	K12	KDIL	IPER	URA26	LOSREG	JPHI	MELALT	A7	SPOWER	HEIGHT	ADDER
-0	-0	-0	2	1	-0	-0	-0	-0	-0.000	-0	-0	2	2.00	-0.00	1.077	-0.0000

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BNWL-482

INPUT REGION INFORMATION

REGION NUMBER	RADIUS CM.	RADIUS INCHES	MATERIAL	DENSITY GM/CC	TEMP DEG C	TEMP DEG F	VOLUME FRACTION	THICKNESS REG-INCH	NUCLEI PEP BARN CM
1	.46596	.18345	UO2	10.190	704.440	1299.992	.30349	.18345	2.27388-02
2	.51422	.20245	ZIRC	6.400	332.220	629.996	.06612	.01900	4.19721-02
3	.54455	.21439	ST STL	7.900	303.060	577.508	.04489	.01194	7.30152-02
4	.84582	.33300	H2O	.710	303.060	577.508	.58550	.11861	2.37140-02

IF ARRAY IS TRIANGULAR, PITCH = .6342 INCHES
IF ARRAY IS SQUARE, PITCH = .5902 INCHES

JASON-P3 OUTPUT REGION INFORMATION

REGION NUMBER	AVERAGE FLUX	THERMAL UTILIZATION	HEAT TRAN UTILIZATH	LOG ENRGY DECREMENT	SIGMA A	SIGMA S	XI SIGMA S	EPITHERMAL RATIO	NEUTRON TEMP
1	.88293	.85356	1.000	.03600	2.49226-01	.37974	.01367	.16646	576.759
2	.92591	.00475	.000	.02180	5.14569-03	.33578	.00732	.15862	576.227
3	.93765	.07073	.000	.03530	1.37965-01	.68050	.02402	.15652	576.220
4	1.00000	.07096	.000	.94800	9.95079-03	1.84404	.95849	.14625	576.220

REGION NUMBER	REGION CROSS SECTIONS IN BARNS							
	THERMAL	EPITHERMAL	2200 M/S	2200 M/S	2200 M/S	MAXWLL AVGD	WESCOTT	WESCOTT
	SCAT X-SEC	SCAT X-SEC	ABS X-SEC	ABS X-SEC	FIS X-SEC	ABS X-SEC	ABS X-SEC	FIS X-SEC
1	1.67000+01	1.67000+01	2.71000+00	6.78000+02	5.79000+02	1.09604+01	1.82081+01	1.26917+01
2	8.00000+00	8.00000+00	1.94000-01	0.00000	0.00000	1.22598-01	2.40263-01	0.00000
3	9.32000+00	9.32000+00	2.99000+00	0.00000	0.00000	1.88954+00	2.99000+00	0.00000
4	7.77615+01	4.26360+01	6.64000-01	0.00000	0.00000	4.19616-01	6.64000-01	0.00000

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BNWL-482

ETA	EPSILON	RES.	THERM	CELL FOUR FACTORS		AGE	DIFF	MIGRATION	MATERIAL
		ESCAPE	UTILIZE	CONVERS	K		AREA	AREA	PUCKLING
1.72167	1.03947	.73440	.85356	RATIO	INFINITY	62.0686	4.9146	66.9833	1.71651-03
				.73692	1.12183				

ISOTOPE CONCENTRATIONS (NUCLEI/BARN CM)

U235	U238
5.22760-04	2.22226-02

ZERO DIMENSIONAL ALTHAEA INPUT PARAMETERS								
PERFIS	SDPV	SNF	SCA	FUEL DENS	F	DELTA	TOT	MELEAGER
	MELEAGER			OF METAL				TEMP
.02298	1.86800	.06550	1.09444	8.98230	.84743	1.06818	2.27454-02	303.220

FLUX	FCONST	FEXP	SP POWER	FUEL	TONNES OF FUEL
DEPRESSION			MW/TONNE	TEMP	IN CORE
1.08364	.64447	.32223	70.805	704.44	2.92258+01

ONE DIMENSIONAL ALTHAEA PARAMETERS

SS1	SS2	SS3	SS4	XISS1	XISS2	XISS3	S13	CELL AVE R	FUEL+TARGET	VERT BUCK	BARE HEIGHT
.25370	.49726	.50740	.80552	.283457	.555575	.566914	1.74854	SPEC	VOL FRACT-VR	BUCK	HORT
								.14625	.30349	1.2973-04	2.4309+02

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CORE DESIGN INFORMATION FOR CYLINDRICAL CORE WITH L/D RATIO = 1.07700

CLAD SURFACE OF FUEL REGIONS	CELL INFORMATION (PER FOOT OF CELL)							
	MODERATOR	OUT SIDE	CELL	VOL MOD	FUEL	MODERATOR	FUEL	CLADDING
	VOLUME	SURFACE	VOLUME	PER	WEIGHT	WEIGHT	VOLUME	VOLUME
		CYLINDER		VOL FUEL				
.09605	.00142	.17436	.00242	1.92925	.46706	.06278	.00073	.00027
SQ FT/FT	CU FT/FT	SQ FT/FT	CU FT/FT		LBS/FT	LBS/FT	CU FT/FT	CU FT/FT

BNWL-482

LEAKAGE						
NEUTRON LEAKAGE AS A FUNCTION OF POWER AND HEAT TRANSFER RATE						
		REACTOR POWER MEGAWATTS THERMAL				
	*	3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	.0085474	.0092336	.0105242	.0120687	.0143800
196.	*	.0129457	.0139652	.0158758	.0181530	.0215419
300.	*	.0167363	.0180351	.0204632	.0233478	.0276233
400.	*	.0198784	.0214036	.0242499	.0276233	.0326077
500.	*	.0226865	.0244107	.0276233	.0314230	.0370228
533.	*	.0235564	.0253414	.0286661	.0325960	.0383831

SPECIFIC
POWER IN
MEGAWATTS
PER TONNE

13.284

26.077

39.853

53.137

66.421

70.805

GEOMETRICAL BUCKLING						
REACTOR POWER MEGAWATTS THERMAL						
	*	3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	1.2816-04	1.3850-04	1.5795-04	1.8128-04	2.1625-04
196.	*	1.9454-04	2.0997-04	2.3892-04	2.7351-04	3.2514-04
300.	*	2.5198-04	2.7172-04	3.0868-04	3.5272-04	4.1823-04
400.	*	2.9977-04	3.2302-04	3.6652-04	4.1823-04	4.9496-04
500.	*	3.4261-04	3.6898-04	4.1823-04	4.7669-04	5.6327-04
533.	*	3.5591-04	3.8323-04	4.3425-04	4.9478-04	5.8437-04

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BNWL-482

 1000 BTU/HR SQ FT *

		BARE REACTOR DIAMETER IN CM				
		REACTOR POWER MEGAWATTS THERMAL				
	*	3500.	3090.	2500.	2000.	1500.

100.	*	465.26	446.34	415.90	386.09	350.78
196.	*	371.59	356.47	332.16	308.35	280.16
300.	*	322.60	309.47	288.37	267.70	243.22
400.	*	293.10	281.17	262.00	243.22	220.98
500.	*	272.09	261.02	243.22	225.79	205.14
533.	*	266.35	255.52	238.09	221.03	200.82

 1000 BTU/HR SQ FT *

		TONNES OF FUEL IN CORE				
		REACTOR POWER MEGAWATTS THERMAL				
	*	3500.	3090.	2500.	2000.	1500.

100.	*	263.4706	232.6069	188.1933	150.5546	112.9160
196.	*	134.2183	118.4956	95.8702	76.6962	57.5221
300.	*	87.8235	77.5356	62.7311	50.1849	37.6387
400.	*	65.8677	58.1517	47.0483	37.6387	28.2290
500.	*	52.6941	46.5214	37.6387	30.1109	22.5832
533.	*	49.4316	43.6411	35.3083	28.2466	21.1850

JASON CASE NUMBER 1011

1000 MWE PWR WESTINGHOUSE REACTOR
BURLINGTON SITE - 3090 NWT, 93, T.O.

INPUT CONTROL DATA

N	K1	K2	K3	K4	K5	IFTIN	ECCOR	BUCK	STRCOR	DIH	DEL					
4	-0	-0	-0	-0	-0	1	1.0000+00	-9.7260+06	1.0000+00	1.0000+00	2.0000+00					
J6	K6	K7	K9	K10	K11	K12	KDIL	IPER	URA26	LOSREG	JPHI	MELALT	A7	SPOWER	HEIGHT	ADDER
-0	-0	-0	2	1	-0	-0	-0	-0	-0.000	-0	-0	11	2.00	-0.00	1.077	-0.0000

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BNWL-482

INPUT REGION INFORMATION									
REGION NUMBER	RADIUS CM.	RADIUS INCHES	MATERIAL	DENSITY GM/CC	TEMP DEG C	TEMP DEG F	VOLUME FRACTION	THICKNESS REG-INCH	NUCLEI PEP BARN CM
1	.40596	.18345	UO2	10.190	704.440	1299.992	.30349	.18345	2.27388-02
2	.51422	.20245	ZIRC	6.400	332.220	629.996	.06612	.01900	4.19721-02
3	.54455	.21439	ST STL	7.900	303.060	577.508	.04489	.01194	7.30152-02
4	.84582	.33300	H2O	.710	303.060	577.508	.58550	.11861	2.37140-02

IF ARRAY IS TRIANGULAR, PITCH = .6342 INCHES
 IF ARRAY IS SQUARE, PITCH = .5902 INCHES

JASON-P3 OUTPUT REGION INFORMATION									
REGION NUMBER	AVERAGE FLUX	THERMAL UTILIZATION	HEAT TRAN UTILIZATN	LOG ENRGY DECREMENT	SIGMA A	SIGMA S	XI SIGMA S	EPITHERMAL RATIO	NEUTRON TEMP
1	.86772	.86932	1.000	.03600	2.86270-01	.37974	.01367	.18923	576.759
2	.91708	.00432	.000	.02180	5.14569-03	.33578	.00732	.17876	576.227
3	.93028	.06282	.000	.03530	1.37965-01	.68050	.02402	.17606	576.220
4	1.00000	.06354	.000	.94800	9.95078-03	1.84404	.95849	.16307	576.220

REGION CROSS SECTIONS IN BARNS								
REGION NUMBER	THERMAL SCAT X-SEC	EPITHERMAL SCAT X-SEC	2200 M/S ABS X-SEC	2200 M/S ABS X-SEC	2200 M/S FIS X-SEC	MAXWLL AVGD ABS X-SEC	WESCOTT ABS X-SEC	WESCOTT FIS X-SEC
1	1.67000+01	1.67000+01	2.71000+00	6.78000+02	5.79000+02	1.25895+01	2.10758+01	1.49575+01
2	8.00000+00	8.00000+00	1.94000-01	0.00000	0.00000	1.22598-01	2.46138-01	0.00000
3	9.32000+00	9.32000+00	2.99000+00	0.00000	0.00000	1.88954+00	2.99000+00	0.00000
4	7.77615+01	4.26360+01	6.64000-01	0.00000	0.00000	4.19616-01	6.64000-01	0.00000

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BNWL-482

ETA	EPSILON	RES. ESCAPE	THERM UTILIZE	CELL FOUR FACTORS CONVERS RATIO	K INFINITY	AGE	DIFF AREA	MIGRATION AREA	MATERIAL PUCKLING
1.75296	1.03947	.73440	.86932	.70667	1.16331	62.0686	4.3842	66.4528	2.27675-03

ISOTOPE CONCENTRATIONS (NUCLEI/BARN CM)

U235 6.14876-04	U238 2.21317-02
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PERFIS	SDPV MELEAGER	SNF	SCA	FUEL DENS OF METAL	F	DELTA	TOT	MELEAGER TEMP
.02703	1.86800	.06567	1.09444	8.98230	.86285	1.06818	2.27465-02	303.220

FLUX DEPRESSION	FCONST	FEXP	SP POWER MW/TONNE	FUEL TEMP	TONNES OF FUEL IN CORE
1.09625	.64190	.32095	70.805	704.44	2.92258+01

ONE DIMENSIONAL ALTHAEA PARAMETERS

SS1	SS2	SS3	SS4	XISS1	XISS2	XISS3	S13	CELL AVE R SPEC	FUEL+TARGET VOL FRACT-VR	VERT BUCK BUCK	BAPE HEIGHT HOPT
.25370	.49726	.50740	.80793	.283457	.555575	.566914	2.35198	.16307	.30349	1.2985-04	2.4309+02

CORE DESIGN INFORMATION FOR CYLINDRICAL CORE WITH L/D RATIO = 1.07700

CLAD SURFACE OF FUEL REGIONS	MODERATOR VOLUME	OUT SIDE SURFACE CYLINDER	CELL VOLUME	CELL INFORMATION (PER FOOT OF CELL) VOL MOD PER VOL FUEL	FUEL WEIGHT	MODERATOR WEIGHT	FUEL VOLUME	CLADDING VOLUME
.09605 SQ FT/FT	.00142 CU FT/FT	.17436 SQ FT/FT	.00242 CU FT/FT	1.92925	.46706 LBS/FT	.06278 LBS/FT	.00073 CU FT/FT	.00027 CU FT/FT

LEAKAGE						SPECIFIC POWER IN MEGAWATTS PER TONNE	
NEUTRON LEAKAGE AS A FUNCTION OF POWER AND HEAT TRANSFER RATE							
		3500.	3090.	2500.	2000.		1500.

1000 BTU/HR SQ FT *							
100.	*	.0084843	.0091659	.0104472	.0119810	.0142765	13.284
196.	*	.0128519	.0138645	.0157621	.0180241	.0213907	26.077
300.	*	.0166169	.0179070	.0203190	.0231848	.0274330	39.853
400.	*	.0197380	.0212533	.0240811	.0274330	.0323863	53.137
500.	*	.0225278	.0242408	.0274330	.0312089	.0367745	66.421
533.	*	.0233920	.0251656	.0284693	.0323747	.0381267	70.805

GEOMETRICAL BUCKLING						
REACTOR POWER MEGAWATTS THERMAL						
		3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	1.2822-04	1.3857-04	1.5804-04	1.8139-04	2.1639-04
196.	*	1.9466-04	2.1010-04	2.3909-04	2.7372-04	3.2540-04
300.	*	2.5217-04	2.7192-04	3.0893-04	3.5302-04	4.1861-04
400.	*	3.0001-04	3.2329-04	3.6683-04	4.1861-04	4.9546-04
500.	*	3.4290-04	3.6930-04	4.1861-04	4.7716-04	5.6387-04
533.	*	3.5621-04	3.8357-04	4.3466-04	4.9528-04	5.8501-04

		BARE REACTOR DIAMETER IN CM				
		REACTOR POWER MEGAWATTS THERMAL				
		3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	465.26	446.34	415.90	386.09	350.78
196.	*	371.59	356.47	332.16	308.35	280.16
300.	*	322.60	309.47	288.37	267.70	243.22
400.	*	293.10	281.17	262.00	243.22	220.98
500.	*	272.09	261.02	243.22	225.79	205.14
533.	*	266.35	255.52	238.09	221.03	200.82

		TONNES OF FUEL IN CORE				
		REACTOR POWER MEGAWATTS THERMAL				
		3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	263.4706	232.6069	188.1933	150.5546	112.9160
196.	*	134.2183	118.4956	95.8702	76.6962	57.5221
300.	*	87.8235	77.5356	62.7311	50.1849	37.6387
400.	*	65.8677	58.1517	47.0483	37.6387	28.2290
500.	*	52.6941	46.5214	37.6387	30.1109	22.5832
533.	*	49.4316	43.6411	35.3083	28.2466	21.1850

JASON CASE NUMBER 1016

1000 MWE PWR WESTINGHOUSE REACTOR
BURLINGTON SITE - 3090 MWT, 93, T.D.

INPUT CONTROL DATA

IN	K1	K2	K3	K4	K5	IFTIN	ECCOR	BUCK	STRCOR	DIH	DEL						
4	-0	-0	-0	-0	-0	1	1.0000+00	-9.7260+06	1.0000+00	1.0000+00	2.0000+00						
J6	K6	K7	K9	K10	K11	K12	KDIL	IPER	URA26	LOSREG	JPHI	MELALT	A7	SPOWER	HEIGHT	ADDER	
-0	-0	-0	2	1	20	-0	-0	-0	-0.000	-0	-0	16	2.00	-0.00	1.077	-0.0000	

EPI THERMAL IN REGION 1 IS EITHER NEGATIVE OR GREATER THAN .85- EPI THERMAL RATIO SET EQUAL TO .85
 EPI THERMAL IN REGION 2 IS EITHER NEGATIVE OR GREATER THAN .85- EPI THERMAL RATIO SET EQUAL TO .85
 EPI THERMAL IN REGION 3 IS EITHER NEGATIVE OR GREATER THAN .85- EPI THERMAL RATIO SET EQUAL TO .85
 EPI THERMAL IN REGION 4 IS EITHER NEGATIVE OR GREATER THAN .85- EPI THERMAL RATIO SET EQUAL TO .85

INPUT REGION INFORMATION

REGION NUMBER	RADIUS CM.	RADIUS INCHES	MATERIAL	DENSITY GM/CC	TEMP DEG C	TEMP DEG F	VOLUME FRACTION	THICKNESS REG-INCH	NUCLEI PEP BARN CM
1	.10000	.03937	ST STL	7.900	303.060	577.508	.01398	.03937	7.30152-02
2	.60000	.23622	H2O	.710	303.060	577.508	.48923	.19685	2.37140-02
3	.70390	.27713	ST STL	7.900	303.060	577.508	.18937	.04091	7.30152-02
4	.84582	.33300	H2O	.710	303.060	577.508	.30743	.05587	2.37140-02

IF ARRAY IS TRIANGULAR, PITCH = .6342 INCHES
 IF ARRAY IS SQUARE, PITCH = .5902 INCHES

JASON-P3 OUTPUT

REGION INFORMATION									
REGION NUMBER	AVERAGE FLUX	THERMAL UTILIZATION	HEAT TRAN UTILIZATN	LOG ENRGY DECREMENT	SIGMA A	SIGMA S	XI SIGMA S	EPITHERMAL RATIO	NEUTRON TEMP
1	1.00959	.05407	.000	.03530	1.37965-01	.68050	.02402	.85000	576.220
2	1.00899	.13642	.000	.94800	9.95078-03	1.84404	.95849	.85000	576.220
3	.99855	.72455	.000	.03530	1.37965-01	.68050	.02402	.85000	576.220
4	1.00000	.08496	.000	.94800	9.95078-03	1.84404	.95849	.85000	576.220

REGION CROSS SECTIONS IN BARNS									
REGION NUMBER	THERMAL SCAT X-SEC	EPITHERMAL SCAT X-SEC	2200 M/S ARS X-SEC	2200 M/S ABS X-SEC	2200 M/S FIS X-SEC	MAXWLL AVGD ARS X-SEC	WESCOTT ARS X-SEC	WESCOTT FIS X-SEC	
				FISSILE MAT	FISSILE MAT				
1	9.32000+00	9.32000+00	2.99000+00	0.00000	0.00000	1.88954+00	2.99000+00	0.00000	
2	7.77615+01	4.26360+01	6.64000-01	0.00000	0.00000	4.19616-01	6.64000-01	0.00000	
3	9.32000+00	9.32000+00	2.99000+00	0.00000	0.00000	1.88954+00	2.99000+00	0.00000	
4	7.77615+01	4.26360+01	6.64000-01	0.00000	0.00000	4.19616-01	6.64000-01	0.00000	

ETA	EPSILON	RES. ESCAPE	THERM UTILIZE	CELL FOUR FACTORS CONVERS K INFINITY		AGE	DIFF AREA	MIGRATION AREA	MATERIAL BUCKLING
.00000	1.00000	1.00000	.00000	.00000	.00000	59.7103	9.3761	69.0864	-1.74011-01

ISOTOPE CONCENTRATIONS (NUCLEI/BARN CM)

PERFIS	SDPV MELEAGER	SNF	SCA	ZERO DIMENSIONAL ALTHAEA INPUT PARAMETERS FUFL DENS F DELTA			TOT	MELEAGER TEMP
.00000	.00000	.05672	.00000	.00000	.00000	1.00000	0.00000	303.220
FLUX DEPRESSION	FCONST	FEXP	SP POWER MW/TONNE	FUEL TEMP	TONNES OF FUEL IN CORE			
.00000	.00000	.00000	.000	.00	0.00000			

ONE DIMENSIONAL ALTHAEA PARAMETERS

SS1	SS2	SS3	SS4	XISS1	XISS2	XISS3	S13	CELL AVE K SPEC	FUEL+TARGET VOL FRACT-VR	VERT BUCK BUCK	BARE HEIGHT HORT
.29966	.58773	.59972	.98146	.384237	.753104	.768474	2.34510	.85000	.50000	0.0000	0.0000

CORE DESIGN INFORMATION FOR CYLINDRICAL CORE WITH L/D RATIO = 1.07700

CLAD SURFACE OF FUEL REGIONS SQ FT/FT	MODERATOR VOLUME CU FT/FT	OUT SIDE SURFACE CYLINDER SQ FT/FT	CELL INFORMATION (PER FOOT OF CELL)			MODERATOR WEIGHT LBS/FT	FUEL VOLUME CU FT/FT	CLADDING VOLUME CU FT/FT
			CELL VOLUME CU FT/FT	VOL MOD PER VOL FUEL	FUEL WEIGHT LBS/FT			
.00000	.00193	.17436	.00242	.00000	.00000	.08543	.00000	.00049

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LEAKAGE						
NEUTRON LEAKAGE AS A FUNCTION OF POWER AND HEAT TRANSFER RATE						
		REACTOR POWER MEGAWATTS THERMAL				
	*	3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	.8690877	.8690877	.8690877	.8690877	.8690877
196.	*	.8690877	.8690877	.8690877	.8690877	.8690877
300.	*	.8690877	.8690877	.8690877	.8690877	.8690877
400.	*	.8690877	.8690877	.8690877	.8690877	.8690877
500.	*	.8690877	.8690877	.8690877	.8690877	.8690877
533.	*	.8690877	.8690877	.8690877	.8690877	.8690877

SPECIFIC
POWER IN
MEGAWATTS
PER TONNE

GEOMETRICAL BUCKLING						
REACTOR POWER MEGAWATTS THERMAL						
	*	3500.	3090.	2500.	2000.	1500.

1000 BTU/HR SQ FT *						
100.	*	2.9911-02	2.9911-02	2.9911-02	2.9911-02	2.9911-02
196.	*	2.9911-02	2.9911-02	2.9911-02	2.9911-02	2.9911-02
300.	*	2.9911-02	2.9911-02	2.9911-02	2.9911-02	2.9911-02
400.	*	2.9911-02	2.9911-02	2.9911-02	2.9911-02	2.9911-02
500.	*	2.9911-02	2.9911-02	2.9911-02	2.9911-02	2.9911-02
533.	*	2.9911-02	2.9911-02	2.9911-02	2.9911-02	2.9911-02

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 1000 BTU/HR SQ FT *

		BARE REACTOR DIAMETER IN CM				
		REACTOR POWER MEGAWATTS THERMAL				
		3500.	3090.	2500.	2000.	1500.

100.	*	.00	.00	.00	.00	.00
196.	*	.00	.00	.00	.00	.00
300.	*	.00	.00	.00	.00	.00
400.	*	.00	.00	.00	.00	.00
500.	*	.00	.00	.00	.00	.00
533.	*	.00	.00	.00	.00	.00

 1000 BTU/HR SQ FT *

		TONNES OF FUEL IN CORE				
		REACTOR POWER MEGAWATTS THERMAL				
		3500.	3090.	2500.	2000.	1500.

100.	*	.0000	.0000	.0000	.0000	.0000
196.	*	.0000	.0000	.0000	.0000	.0000
300.	*	.0000	.0000	.0000	.0000	.0000
400.	*	.0000	.0000	.0000	.0000	.0000
500.	*	.0000	.0000	.0000	.0000	.0000
533.	*	.0000	.0000	.0000	.0000	.0000

END OF REPORT

TOTAL COMPUTATION TIME 5.255 SECONDS OR .08758 MINUTES.

5 1 1 9 -0 -0 -0 -0 -0 -0.0000 -0.0000 -0.0000

NEXT LINK = 7

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