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照射履歴に従った燃料ペレット－被覆管ギャップ熱伝達解析プログラムFREG－3の入力手引

1976年10月

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照射履歴に従った燃料ペレット－被覆管ギャップ熱伝達解析プログラムFREG－3の入力手引

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（1976年9月20日受理）

この報告書は，プログラムFREG－3のプログラム概要と使用手引である。FREG－3を使用する場合に必要な入力の書式および出力形式について説明している。

FREG－3は，燃料棒内の温度分布およびそれに基づく蓄積熱量の計算を行う。この計算は，通常運転状態下の温度分布の安全性評価を行うものであるが，燃料棒の照射履歴に従って温度分布を求めることができる。プログラムに必要な物性値およびモデルは，組込みあるいは入力形式のオプションになっており，これらオプションはkey wordによって切換が可能になっている。オプションの選択によって，安全性評価用ばかりでなく最良推定値用プログラムとしても使用できると考える。

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JAERI-M 6742

User's guide for FREG-3: A computer program to analyze pellet-cladding gap conductance in accordance with fuel-rod irradiation history

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(Received September 20, 1976)

The present report describes user's manual for program FREG-3, and provides a general description of the program and instructions of input/output.

FREG-3 estimates the temperature distribution in a fuel rod and the stored energy based on the distribution. The temperature distribution is calculated in accordance with fuel-rod irradiation history.

Mechanical properties and models in handling specific problems, such as densification and relocation, are optional in the program. The options are to be given by key word. If appropriate options are selected, the program is used not only as a safety evaluation code, but also as a best evaluation code.

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1. はじめに

この報告書は，プログラムFREG−3の使用手引である。FREG−3の計算方法の詳細については，別の報告書にまとめることを予定しているので[6]，この報告書ではFREG−3を使用する場合に必要な入力の書式および出力型式等について説明する。

FREG−3は燃料棒内の温度分布およびそれに基づく蓄積熱量の計算を行う。この計算は，通常運転状態下の温度分布を求めるものであるが，燃料棒の照射履歴（出力，冷却水温度と冷却水圧力の変化）に従って温度分布を求めることができる。

燃料棒の安全性を評価する場合，燃料ペレットの最高温度および燃料棒に蓄えられる蓄積熱量（stored energy）が問題となる。

燃料ペレット温度が，ペレットの溶融温度（UO_2の場合約2800℃）以上になると，ペレットの相変化に伴う体積の膨張および温度上昇に伴う核分裂生成ガスの放出による燃料棒内圧の上昇のため燃料被覆管の破損が考えられる。このため，安全性上，燃料ペレットの最高温度が，ペレットの溶融温度以下になるよう燃料棒は設計，使用される。

LOCA（Loss of Coolant Accident：冷却材喪失事故）状態において，燃料棒からの熱除去能力が極端に低下する。核分裂生成物の崩壊熱およびLOCA直前に蓄えられていたペレットの蓄積熱量のため，被覆管の温度は上昇する。軽水炉に使用されるジルコニウム合金被覆管は，冷却材喪失事故時に，著しく変化して燃料棒がくずれ落ちるとかあるいは燃料棒内の内圧上昇によって被覆管が著しくふくれる等の現象を提すると考えられる。この現象は緊急炉心冷却系（ECCS）から供給される冷却水の流れを防げる，すなわちcoolable geometry（炉心の冷却可能な形状）の確保を困難にするおそれがある。

coolable geometryが保持できるか否かは，ECCSの性能によって支配される。しかし，事故発生直前における燃料棒の運転状態，とりわけ燃料棒内の温度分布（燃料棒内蓄積エネルギ）と燃料棒内ガス圧力は，事故の初期条件を与える重要な事項である。

事故後の被覆管温度上昇に寄与する被覆管表面熱伝達，崩壊熱と事故直前の温度分布等のうち燃料棒に関して，われわれが何らかの形である程度コントロールしうるものは蓄積熱量のみである。すなわち，ギャップ寸法の選択，出力の変更等によって蓄積熱量をコントロールすることが可能である。

したがって，燃料棒使用の安全性上ペレットの最高温度ならびに蓄積熱量を，出来る限り正確に評価することが望まれる。この最高温度および蓄積熱量の評価には，燃料棒内の温度分布の解析が必要不可欠である。さらに温度分布を決定する最大の要因は，ペレット表面と被覆管内面間のギャップ熱伝達である。温度分布を評価するということは，いかにギャップ熱伝達率を求めるかという作業にかゝっていると云って過言ではない。

ギャップ熱伝達係数の評価を含めて，燃料棒内の温度分布を評価する目的の計算機用プログラムが種々開発されきた。特に，UO_2ペレットの温度上昇の安全性評価プログラムとして，GAPCON[1]，GAPCON−THERMAL−1[2]，GAPCON−THERMAL−2[3),4]が公開されている。

プログラムGAPCON，GAPCON−THERMAL−1は，燃料棒の一定出力下での燃焼度の増加による温度分布の変化しか計算できない。GAPCON−THERMAL−2は，出力の変化に

ついて照射履歴が追えるようになっているが，その他のパラメータ（冷却水圧力，温度）は一定値で変化させることができない。また，単位にインチ系，メートル系が混存したり，BWR燃料棒の計算を行うと最高温度が著しく高くなり非現実的過ぎる等の点がある。

プログラムFREG−3は，GAPCON−THERMAL−1を改造，修正したものである。主たる改造は，時間（あるいは燃焼度）に従う出力，冷却水温度，冷却水圧力の変化すなわち燃料棒の照射履歴に伴う燃料棒内温度分布を計算できるようにしたことである。また，主な修正は，単位系の整理，BWR燃料棒の計算を行っても妥当な結果がえられるようにしたことである。さらに，燃料ペレット，被覆管の物性値の計算式の追加，スウェリング，ギャップに対するペレットクラックの効果，焼しまり等のモデルが追加されている。これらの計算式，モデルはすべてオプション形式となっていて，key wordにより使用者が選択できる。これらオプションを適切に選択することによって，FREG−3は安全性評価用としてばかりでなく，最良推定用プログラムとしても使用できると考える。

FREG−3は，一定出力のもとで燃焼度増加の温度分布を計算するGAPCON−THERMAL−1を照射履歴に追従して計算するようにしたため，計算上かなり無理な点が生じた。そのような点（出力の半径と軸方向分布，プレナム温度等）については，照射履歴に追従して変更が可能なようにオプションを追加した。また，長期間の照射によって変化すると考えられるパラメータ，例えば半径と軸方向の出力分布等を照射履歴に従って変更できるようになっている。

2. プログラム概要

FREG-3は，燃料棒のペレットスタックに相当する部分を軸方向に被覆管を含め最大２０等分割，ペレット半径を５０等分割して計算を進める。被覆管は，軸方向に上記の通り２０等分割であるが，半径方向には１領域と考える。さらに，これら分割された領域の上部にプレナムがあると考えている。

温度分布を求めるにさいし，軸方向に分割された領域（FREG-3ではこの領域をセグメントと称する）では，軸方向の熱流を無視した定常熱伝導方程式が成立すると仮定する。

燃料棒内の温度を計算する場合，重要なkey parameterはギャップ熱伝達率である。FREG-3のギャップ熱伝達評価の基本式は，修正されたLoss and Stoute[5]の実験式である。Loss and Stouteのギャップ熱伝達率は，接触による熱伝達，ギャップに含まれるガスの熱伝導に基づく熱伝達および輻射による熱伝達から成ると考える。FREG-3は，ガスの熱伝導による熱伝達の評価に力点をおいている。そのため，ギャップに含まれるガスの種類と組成，ギャップ寸法の評価を行う。ガスの種類は，初期封入ガス，製造時にペレットに残留したガスおよび核分裂生成ガスを考慮する。特に，核分裂生成ガスは，Kr，Xeの各同位元素についてchainを考えてその生成量を近似計算で求めている。次に，ガスの組成が計算され混合ガスの熱伝導率が求められる。

一方，ギャップ熱伝達に影響を与えるギャップ寸法については，被覆管内径の変化とペレット外径の変化が考慮される。被覆管内径の変化には，内外圧力による弾性歪，クリープ歪および熱歪を考えている。ペレットの外径の変化には，熱歪およびスウェリングによる歪を考える外，ペレット焼しまり，クラックおよびその再配置をモデル化してギャップ寸法の算出に取入れている。しかし，これらによる変位および歪は，温度計算の目的のためにモデル化されて取入れているもので，これでえられた被覆管応力等については，なお検討を要する点が残っている。FREG-3の計算結果を使用する場合，上記の如き事項を充分念頭に入れて評価されることを希望する。

プログラム全体の流れをFig－1に示す。また，FREG-3に含まれている各Subroutineおよびfunctionの処理内容の概略をTable－1に示す。なおFREG-3のプログラムリストをAppendix－Aに収録しているので参照されたい。

プログラムの流れはFig－1に示す通りである。ギャップ熱伝達係数は，図中の番号１６～２８の個所で計算される。この部分がプログラムの主要部分である。通常初期値を１０００Btu／hr・ft^2・F（0.567w／cm^2℃）に設定し，一旦温度分布が求められる（19），この温度分布に基き，ギャップ寸法およびギャップ熱伝達に影響する諸現象（熱膨張，ＦＰガス放出量等：21～２５）を計算し，ギャップ寸法等を評価する。このギャップ寸法，ガスの熱伝達率等を使ってギャップ熱伝達率の再評価が行なわれる（26）。これと仮定値の比較を行う（27）。この計算を収斂するまでくりかえす。

軸方向セグメントの温度計算が終了したら，燃料ペレットスタック全長についての体積平均温度を計算し，これが収斂していれば次のステップに移る。収斂していなければ，これはＦＰガスの放出量の評価が正しくないので，（22）で計算された放出量を各セグメントについて積

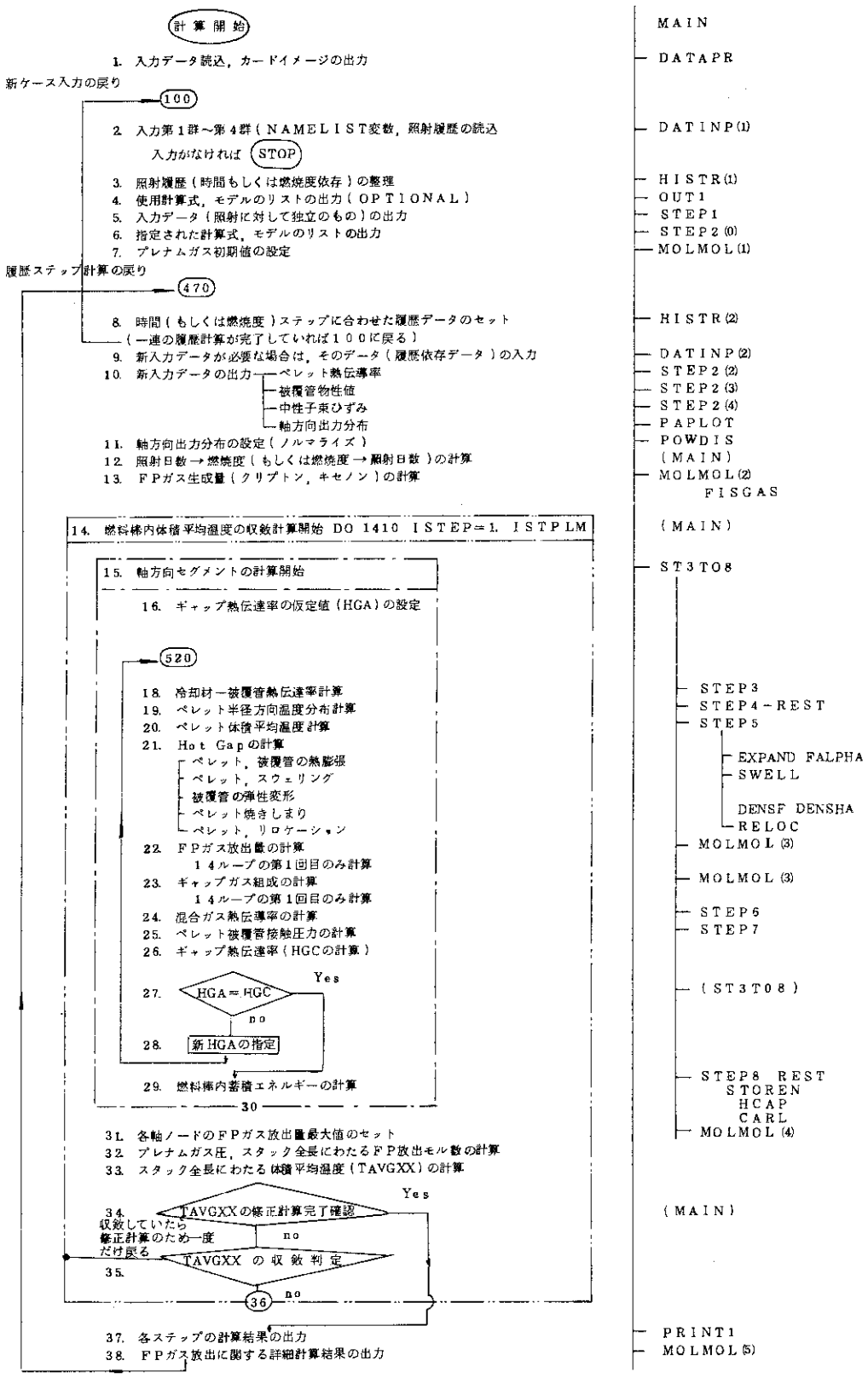


Fig.－1　FREG－3 計算流れ図

Table−1 FREG−3に含まれる subroutine およびその処理概要

MAIN	プログラム全体を制御する。
CARL	蓄積エネルギーの計算
CHECK(KS)	KS＝1,2 入力データ相互間の一貫性を調べる。
CREEP	被覆管クリープ変形量計算。
	KS＝1 F.P.ガスのRadio−Activityを計算する為の初期値セット
	KS＝2 Radio−Activityを計算する
DATAPR	入力カードの80カラム・イメージをプリントする。
DATA1	計算に必要な定数及び熱的，機械的物性値を設定する。
DATINP(KS)	KS＝1 タイトル，運転履歴に依存しない入力値及び運転履歴データの入力。必要ならばその単位変換をする。
	KS＝2 運転履歴に依存するデータを必要に応じ入力する。
DENSF	ペレット Densification 量計算。
DENSHA	HALDEN Densification Model。
DENSGT	GAPCON−THERMAL−2 Densification. Model.
DEPRES	ペレット内熱中性子束歪をベッセル I_0 近似により算出。
ERROR	直線内挿の際，表からはずれたパラメータが与えられたときの警告。
EXPAND	ペレット熱膨張モデル。
FALPHA	ペレット熱膨張係数計算式。
FCOND	ペレット熱伝導率計算式。
FISGAS	K_r，X_e について核分裂・崩壊Chain計算を行ない原子数を求める。
FYIELD	被覆管温度依存Yield Stressを計算する。
GAPRO	繰返し収斂計算中のGap Conductance収斂状況をLine Printerでグラフ化する。打切り回数を越え未収束の場合，必ずプリントされる。
HCAP	UO_2 の比熱計算（温度依存）
HEAD	アウト・プットの各頁のタイトルなどをプリントする。
HISTR(KS)	KS＝1 入力で与えられた運転履歴データを調べ，妥当な出力変動で計算が行なえるように（定常条件），履歴を再分割する。
	KS＝2 時間ステップが変る度に，必要なパラメータを再設定する。
HICLM	液体金属−被覆管 熱伝達係数計算。
HTCW	Dittus−Boelterの式による熱伝達係数計算。
HYOSHI	出力用紙の表紙を作る。
MOLMOL(KS)	KS＝1 初期プレナム・ガスのモル数を計算
	KS＝2 各軸方向セグメント毎のF.P.ガス生成量を計算。 照射量の積算。
	KS＝3 各軸方向セグメント毎のガス放出率を体積平均温度を用いて表より求め，ガスモル分率計算。

	KS＝4　燃料棒平均温度を求める繰返し計算中の最も妥当なガス・モル分率を求める。
	KS＝5　次のタイム・ステップのF.P.ガス計算初期値セット，軸方向Elongationによるプレナム圧力計算。
MOLMO4	改良ガス放出モデル（プレナム温度計算を詳細に行なう）
OUT1	このプログラムに用意されている計算式，モデルの一覧表をプリントする。
PAPLOT	入力された軸方向出力分布をライン・プリンターによって図示する。
POWDIS	入力された軸方向出力分布を規格化し，他に入力された平均又はピーク出力に合せる。
PRINT1	計算結果の出力（詳細）
PRINT2	計算結果の出力（簡略）
PROF	半径方向温度分布をライン・プリンタ・によって図示する。
RELOC	ペレット Relocation Model。
STEP0	計算を行なった日付，時刻をシステムより得る。
STEP1	計算の初期値を決め，選ばれたオプションに従い入力値をプリントする。
STEP2(KS)	KS＝0　主にギャップ・ガスに関する初期状態を決め，他にモデルに関するオプションをプリントする。
	KS＝1　使用していない。
	KS＝2　ペレット熱伝導率の表を変更の指示のある度に出力。
	KS＝3　被覆管物性値の表を　〃
	KS＝4　ペレット内中性子束歪の表を　〃
STEP3	冷却材ー被覆管熱伝達係数の計算及び被覆管内温度分布，ペレット外表面温度計算。
STEP4	ペレット内温度分布，中心孔径（再組織化）の計算
STEP5 (STEP5A)	被覆管の弾性変形，熱変形，クリープ変化量，ペレットの熱膨張，Swelling，Densification，Relocationを計算，ホット・ギャップの計算。
STEP6	ギャップ中のガス伝導率計算。
STEP7 (STEP7A)	ギャップ・コンダクタンスの計算。もし接触していれば，その接触圧力の計算。
STEP8	蓄積エネルギー，燃料棒体積平均温度の計算。
ST3TO8(KS)	KS＝1.2　各軸方向セグメント毎のr方向一次元温度分布，及びギャップ・コンダクタンスを繰返し収斂法により求める。
STOREN	蓄積エネルギー計算。
SWELL (SWELLA)	Revised Gap Clouser Model.
TEPP	2－Array間の直線内挿。
TERP	複数個Array間の直線内挿。

算した量を新たなguessとしてくりかえし計算を行う。

FREG−3は，現在GAPCON−THERMAL−1と同様各セグメントの体積平均温度によってFPガスの放出量を定めている。一方，ギャップ熱伝達がギャップにおけるガスの組成によって変動するので，上記の収斂計算を必要とする。

1〜9までは主として入力に関する部分であり，37，38は出力に関する部分である。

Fig−1には，左側の計算処理を行っているsubroutine名を右側に示している。

FREG−3の入力は，ノートル系とインチ系の両方が使用できる。これは，3.2節で述べるkey word KUNITで切換え使用が可能である。ただし，プログラム内の諸計算は，メートル系に統一されている。

3. 入 力 手 引

FREG−3の入力データは，カード入力形式で，その第1枚目のカードは，タイトルカードである。FREG−3は連続計算が可能で，入力カードでタイトルカードから次のタイトルカードまでの計算を"ケース"と呼ぶ。1計算ケースの中で照射履歴に従って時間あるいは燃焼度を計算に適するように分割した分割点を"ステップ"と云う。ステップは，入力された照射履歴の最初の点を第1ステップとしたシリーズナンバーになる。

3.1 入力データの構成

FREG−3の入力データは次の8群で構成される。入力データカードの順序もここで記述する順序に従う。Fig−2にデータ構成および順序を示すので，以下の説明に参照されたい。入力データには最初に読み込まれて初期値の設定に使われるものと計算の進行に伴って読まれ使用されるものとがある。

また，FREG−3の入力データをまとめるときのデータシートをTable−2に示す。このシートは入力計画を作成する場合便利なはずである。

1) TITLE and END card（第1群入力）

このカードは，各計算ケースの入力カード群の最初に必要なTITLEカードである。すべての入力カード群の最後に特定のシグナルをパンチしたカードを付けるとEND cardになる。

このカードは，1枚のカードであり，20A4のFORMAT形式で読まれる。TITLEカードとして使用する場合は，1〜80コラム内に任意の文字をパンチしてよい。ただし，次に述べるENDカードになるシグナルを入れてはならない。TITLEカードの内容は，出力の各頁の第1行に印刷される。

ENDカードとして使用するときのシグナルは，

i) コラム1〜4に"STOP"

ii) ブランクカード

の2種がある。FREG−3の入力カードは第1群のTITLEカードから始り第8群で終るいくつかの計算ケースの入力カード群と最後のENDカードによって構成される。

2) MAIN NAMELIST DATA card（第2群入力）

b$INPUT……$で区切られているNAMELIST形式の入力cardである。入力内容については，3.2節参照のこと。ここで入力されるデータがFREG−3の主要入力データである。

3) HISTORY DATA card（第3群入力）

計算する燃料棒の照射履歴のdataを入力する。照射履歴は，出力，冷却水温度，冷却水圧力の変動のある時点における時間（または燃焼度）を入力する。ただし，1ステップ以上50ステップまでにしなければならない。入力型式は7F10.1，5I2のFormat形式である。この入力の中の5I2は5)〜8)群の入力群を制御するsignalの入力である。詳しくは，3.3節参照のこと。このHistory dataの最後にはデータ終了を表すカードを入れなければならない。この終了シグナルは−1.0でコラム1〜10にパンチする。

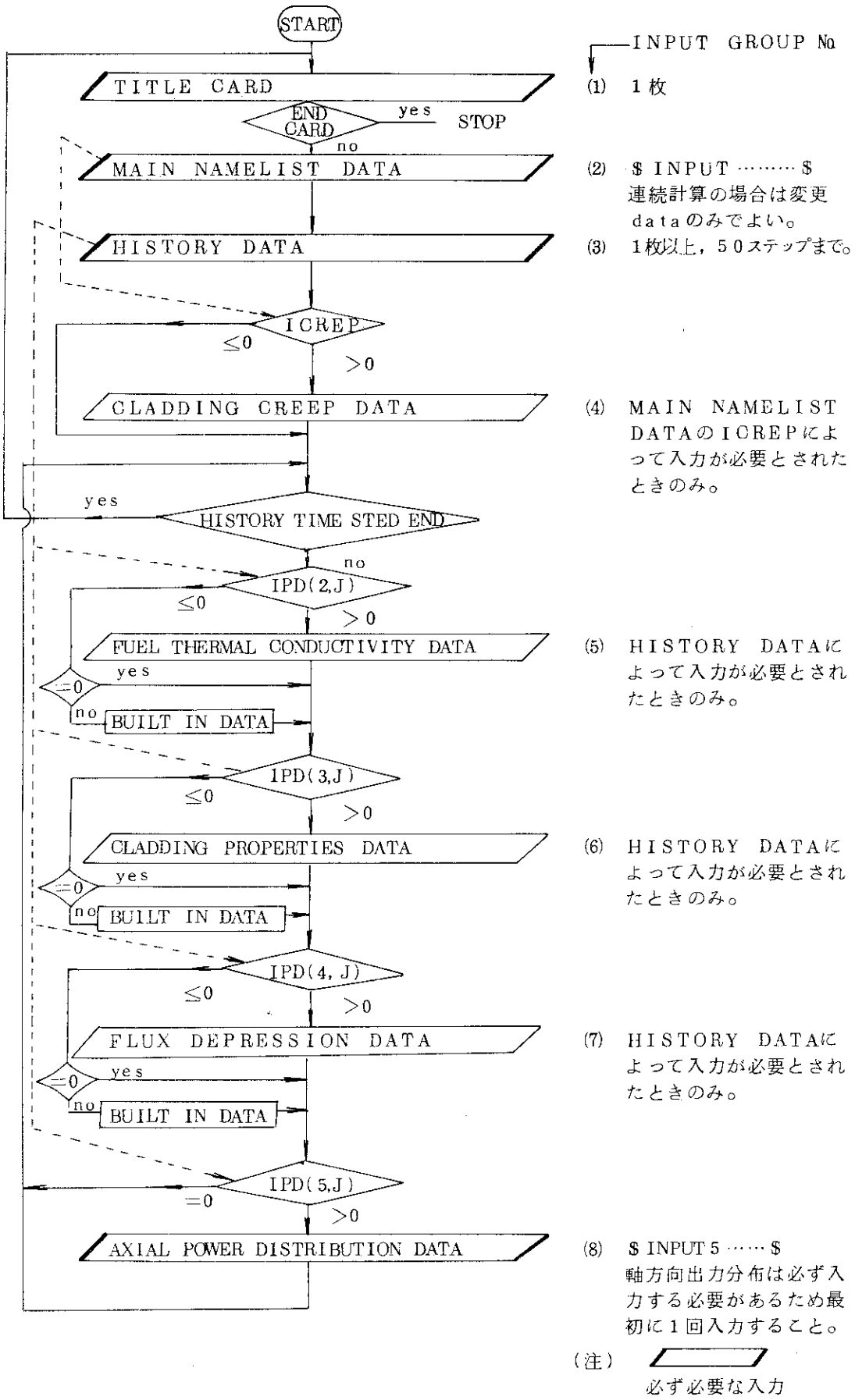


Fig.-2 FREG-3入力DATAの構成および順序

Table-2 FREG 3 INPUT DATA SHEET

(2) MAIN NAMELIST DATA /INPUT/

No.	FORTRAN NAME	CASE [ ]	CASE [ ]	CASE [ ]
1	FRPUO2			
2	FR35			
3	FR40			
4	FR41			
5	FRDEN			
6	FRSIN			
7	DFS			
8	DCI			
9	DCO			
10	LFUEL			
11	DSINZ			
12	DVOIDZ			
13	LVOIDZ			
14	VPLENZ			
15	ATMOS			
16	TM			
17	ROUF			
18	ROUC			
19	SIGHF			
20	DE			
21	V			
22	DTEMP			
23	SINTEM			
24	DDISH			
25	HDISH			
26	FRACHE			
27	FRACAR			
28	FRACH			
29	FRACN			
30	FRACKR			
31	FRACXE			
32	S			
33	XX			
34	NOH			
35				
36				
37				
38				
39				
40	IFLUX			
41	KOOL			
42	NPOW			
43	IPEAK			
44	ICDF			
45	ICREP			
46	IYIELD			
47	NEXP			
48	MEXP			
49	ISWELL			
50	MREST			
51	MDEN			
52	MRELOC			
53	LCREP			
54	IIPROF			
55	MCONV			
56	MREV1			
57	IOUT1			
58	NUCLEI			
59	ISPA			
60	NAMSP			
61	NHIST			
62	KUNIT			

(1) TITLE CARD

CASE [ ]	
CASE [ ]	
CASE [ ]	

(3) HISTORY DATA

STEP	項目 カラム	時間又は燃焼度	線出力密度	冷却材入口温度	冷却材圧力	補助データ (1)	補助データ (2)	補助データ (3)	ICD 1	2	3	4	5
		1 5 10	15 20	25 30	35 40	45 50	55 60	65 70	72	74	76	78	80
CASE [ ]	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												

CASE [ ]	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	

CASE [ ]	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	

NOTE

INPUT CONTROL DATA (ICD)
ICD(1)=TEMPERATURE PROFILE PRINT OUT
ICD(2)=PELLET THERMAL CONDUCTIVITY
ICD(3)=CLADDING PROPERTY
ICD(4)=RADIAL FLUX DEPRESSION
ICD(5)=AXIAL POWER DISTRIBUTION

		NAMSP	内容
CASE [ ]	補助データ(1)		
	補助データ(2)		
	補助データ(3)		

CASE [ ]	補助データ(1)		
	補助データ(2)		
	補助データ(3)		

CASE [ ]	補助データ(1)		
	補助データ(2)		
	補助データ(3)		

(5),(6),(7),(8) SUB NAMELIST DATA

CASE	STEP	NAMELIST名	FORTRAN名	1 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80

NAMELIST名 ： FORTRAN名

ICD(2)	INPUT2	CF1= 温度， CF2= 熱伝導率， CF3= 内側酸化膜の熱伝導率．
ICD(3)	INPUT3	AA1= 温度， AA2= 熱伝導率， AA3= 耐力， AA4= ヤング率， AA5= ポアソン比， AA6= 熱膨張係数， AA7= マイヤー硬度
ICD(4)	INPUT4	RV1= 半径， RV2= DEPRESSION．
ICD(5)	INPUT5	POWER= 軸方向出力分布．

(4) 被覆管 クリープ データ

		時間 (hr)	変位量 in cm
CASE [ ]	1		
	2		
	3		
	4		
	5		
	6		

CASE [ ]	1		
	2		
	3		
	4		
	5		
	6		

CASE [ ]	1		
	2		
	3		
	4		
	5		
	6		

4) CLADDING CREEP DATA card（第4群入力）

第2群のNAMELIST DATA中のOPTION signal，key word ICREPによって必要（ICREP＜0）とされるときのみ，入力される。入力データは，時間に対する被覆管外直径変位値で，F10.0，E10.0のFornat形式で読込まれ，20対まで許される。詳しくは3.6節参照のこと。このデータカード枚数は，key word ICREPと一致しなければならない。

5) FUEL THERMAL CONDUCTIVITY DATA card（第5群入力）

第3群のHISTORY DATAで入力を必要とされたときに読込まれる。入力型式は$INPUT2……$のNAMELIST形式で，30対まで許される。詳しくは3.4節参照のこと。

6) CLADDING PROPERTIES DATA card（第6群入力）

第3群のHISTORY DATAで入力を必要とされたときに読込まれる。入力型式は，$INPUT3……$のNAMELISTで，30対まで許される。詳しくは，3.4節参照のこと。

7) FLUX DEPRESSION DATA card（第7群入力）

このデータは，燃料ペレットの半径方向熱中性子束分布である。第3群のHISTORY DATAで入力を必要とされたときに読込まれる。入力は，$INPUT4……$のNAMELIST形式で，20対まで許される。詳しくは，3.4節参照のこと。

8) AXIAL POWER DISTRIBUTION DATA card（第8群入力）

燃料の軸方向出力分布を与えるデータで，第2群入力のNPOW＋1個のデータが必要である。照射履歴に従ってこの分布を変更することも可能である。そのかわり，最初のステップには必ず入力されねばならない。DATAは，$INPUT5……$のNAMELIST形式で入力される。詳しくは，3.4節参照のこと。

3.2 主入力データ

FREG-3の主な入力変数は，第2群の入力によって与えられる。この入力は，NAMELIST形式である。

もし，連続的に数ケースの計算を実行する場合，第2のケースからは，この入力群中の変更のあるデータのみを与えればよい。ただし，この場合，第2のケース以後のデータの単位系は，原則として最初に与えた単位系のkey word KUNITで決定される。

第2群の入力変数のFORTRAN SYMBOL NAMEとその定義をTable-3に示す。

3.3 照射履歴データの入力

3.3.1 まえおき

FREG-3は，時間（または燃焼度）に依存した照射履歴のパラメータを入力しなければならない。この照射履歴に関するデータは，第3群として入力される。この節において照射履歴データの入力法を説明する。このデータは，最大50ステップまで与えることが許される。

計算の1ステップに関する情報は1枚のカードに納められる。

1枚のカード上のデータ構成，形式をFig-3に示す。この節の説明にさいし，図中に示す

Table－3 Fortran symbol name and definition for 2nd input group

番号	FORTRAN NAME	単位 cm－kg系	単位 Ft－ℓb系	説明	SAMPLE DATA
1	FRPUO2			重量比 PuO_2／(PuO_2 ＋UO_2)	
2	FR35			重量比 U^{235}／(U^{235}＋U^{238})	0.0254
3	FR40			重量比 Pu^{240}／(Total Pu)	
4	FR41			重量比 Pu^{241}／(Total Pu)	
5	FRDEN			ペレット密度／理論密度	0.935
6	FRSIN			組織変化した燃料の密度／理論密度	
7	DFS (S)	CM	INCH	ペレット直径	0.365
8	DCI	CM	INCH	被覆管内径	0.3735
9	DCO	CM	INCH	被覆管外径	0.422
10	LFUEL	CM	INCH	燃料柱長さ	132.0
11	DSINZ	CM	INCH	組織変化している部分の外直径	
12	DVOIDZ	CM	INCH	ペレットの初期中心孔径	
13	LVOIDZ	CM	INCH	ペレットの初期中心孔長さ（燃料棒全体）	
14	VPLENZ	CM^3	$INCH^3$	プレナム体積	0.5
15	ATMOS	ATMOS-PHERES	ATMOS-PHERES	初期封入ガス圧	20
16	TM	℃	℃	ペレット融点	2790.
17	ROUF (S)	CM	INCH	ペレット表面粗さ（算術平均値）	0.00004
18	ROUC (S)	CM	INCH	被覆管内表面粗さ（算術平均値）	0.00002
19	SIGHF (S)	$\frac{Watt}{CM^2-°C}$	$\frac{BTU}{HR-FT^2-°F}$	冷却材－被覆管熱伝達係数 ＞0　SIGHFの値を熱伝達係数とする。 ＝0　冷却材をナトリウムとして熱伝達係数を計算する。 冷却材を水としてDITTUS-BEOLTERの式で計算する。 ＝－2　冷却材を水としてJENS-LOTTESの式で計算する。 ＝－3　飽和温度を境として－1，－2の双方を用いる。	
20	DE	CM	INCH	冷却材流路の相当直径 （SIGHF＝－1，－3のときのみ）	
21	V	$\frac{M}{SEC}$	$\frac{FT}{SEC}$	冷却材速度（　〃　）	
22	DTEMP (S)	℃	℃	炉心を通過する冷却材の軸方向温度差 (T_{OUTLET}－T_{INLET})	100.

番号	FORTRAN NAME	単位 cm-kg系	単位 Ft-ℓb系	説明	SAMPLE DATA
23	SINTEM	℃	℉	ペレット焼結温度（MDEN=1 のときのみ入力）	
24	DDISH	CM	INCH	ペレット・ディッシュの外直径	
25	HDISH	CM	INCH	〃 深さ	
26	FRACHE			初期封入ガスの組成 ヘリウム／初期封入ガス	
27	FRACAR			〃 アルゴン／ 〃	
28	FRACH			〃 水素／ 〃	
29	FRACN			〃 窒素／ 〃	
30	FRACKR			〃 クリプトン／ 〃	
31	FRACXE			〃 キセノン／ 〃	
32	S	$\frac{CC}{gr(FUEL)}$	$\frac{CC}{gr(FUEL)}$	燃料に吸着されているガスの量（H_2，N_2 のみ）	
33	XX			吸着ガスの組成 H_2／（H_2+N_2）	
34	NOH			吸着ガス中の水素の挙動を指定するシグナル （注）原プログラム（GAPCON-THERMAL-1）内では常にNOH=1とする。すなわち水素は被覆管と反応，又は被覆管よりもれ出てしまい，混合ガスの組成とはならないとしている。このため，この入力変数は無意味となっている。	
35					
36					
37					
38					
39					
40	IFLUX			=0 高速中性子照射 >0 熱中性子照射	1
41	KOOL			1以上の整数値を指定すると冷却材の温度を被覆管内面温度とする。冷却材－被覆管熱伝達係数，被覆管温度計算は行なわない。	
42	NPOW			計算を行なう燃料柱セグメント数（最大20等分割）	10
43	IPEAK			与えられた線出力密度（履歴data参照）が平均出力かピーク出力かを指定するシグナル。 >0 平均出力を入力 ≦0 ピーク出力を入力	0

番号	FORTRAN NAME	単位 cm-kg系	単位 Ft-ℓb系	説明	SAMPLE DATA
44	ICDF			内外圧力の差による被覆管の弾性変形を考慮するシグナル ＜0　被覆管の弾性変形が考慮される。 ≧0　考慮されない。 (注)　ICREP＞0のとき，この弾性変形も考慮して，DATAが作られているならば≧0としなければならない。	
45	ICREP			被覆管クリープ変形を計算するOPTION ＞0　時間対クリープ変形による半径（内半径の変位（CM OR／INCH））の表をICREP枚入力する。（最大20） ＝0　クリープしない。 ＝-2　ATR設計使用の式 ＝-3　Pressure tube設計の式 ＝-4　プログラムFIGRO使用の式 ＝-5　新ATR設計使用のモデル	
46	IYIELD			被覆管耐力の計算を指定するシグナル ＝0　プログラムGAPCON-THERMAL-1に用意された値を用いる。	
47	NEXP			ペレットの線熱膨張係数の計算式を指定するシグナル。 ＝0　熱膨張は考慮しない。 ＝1　ROTH & HALEMANの式を用いる。（GAPCON） ＝2　CONWAY FINCEL & HAINの式を用いる。（GAPCON-THERMAL-1）	
48	MEXP			ペレットの熱膨張による変位量を計算するMODELを指定するシグナル。 ＝1　HALF CRACK MODEL（GAPCON-THERMAL-1 MODEL） ＝2　PLASTIC MODEL（面積バランス） ＝3　2領域モデル（BRITTLE MODEL ＋ PLASTIC MODEL）	
49	ISWELL			ペレットのSWELLING量を計算するMODELを指定する。 ＝0　SWELLINGを考慮しない。	

番号	FORTRAN NAME	単位 cm+kg系	単位 Ft-ℓb系	説明	SAMPLE DATA
				=1 GEITHOFF, et.al. MODEL (GAPCON ORIGINAL)を用いる。 =2 REVISED GAP CLOSURE MODEL (GAPCON-THERMAL-1に追加されたMODEL)を用いる。	
50	MREST			ペレットの再組織化による計算を行なうシグナル =0 再組織化を行なわない。 ≧0 再組織化を考慮し，寸法変化を計算して次のTime-Stepの初期値とする。	
51	MDEN			ペレットのDENSIFICATIONによる変位を計算するシグナル =0 DENSIFICATIONは行なわない。 =1* HALDEN DENSIFICATION MODELを用いる。 =2* GAPCON-THERMAL-2のMODELを用いる。	
52	MRELOC			ペレットのRELOCATIONによる変位を計算するシグナル =0 RELOCATIONは行なわない。 =1 GAPCON-THERMAL-2使用モデルを用いる。	
53	LCREP			ペレットのクリープ変形を計算するシグナル。 =0 クリープ変形しない。 (現プログラムでは，ペレットのクリープは考慮していない。将来，追加の予定)	
54	IIPROF			燃料温度分布をPRINTするシグナル。 =0 プリントしない。 =1 詳細温度分布をプリントする。 =2 詳細温度分布とライン・プリンタによる温度分布の図をプリントする。	
55	MCONV			GAP-CONDUCTANCEの収束繰返し計算の方法を指示する。 =0 プログラムGAPCON-THERMAL-1と同じであるが，収斂加速因子，及び体積平均温度収斂繰返し計算の回数によって	

番号	FORTRAN NAME	単位 cm-kg系	単位 Ft-ℓb系	説明	SAMPLE DATA
				の予測値の設定に改良がなされている。 ＝1　NEWTON-RAPHSON法によって収斂させる。	
56	MREV1			GAP-CONDUCTANCEの計算法についての指示 ≧0　プログラムGAPCON-THERMAL-1と同じ。 ＝1　ROSS & STOUTEの式において，ギャップ幅が支配的因子となるが，このギャップ幅を原プログラムより厳密に扱ったMODEL（特に接触後のギャップ幅）を用いる。 ＝-1　RESAR-41の式を使用する。	
57	IOUT1			プログラムに用意されたオプションの一覧表をプリント・アウトするシグナル。 ＝0　プリント・アウトしない。 ＝1　プリント・アウトする。	
58	NOCLEI			FISSION PRODUCT（ガス）のRADIO-ACTIVITYを計算しプリント・アウトするシグナル。 ＝0　計算しない。 ＝1　計算する。	
59	ISPA			運転履歴に依存させて，変化させたい入力パラメータ（本表中に(S)で示した入力変数のみ有効，詳細は以後に述べる）の数を示す。 最大1 caseにつき3個。	
60	NAMSP			ISPAによって指定された変化させたい入力変数名を指示する。変数名はコード化された番号によって与えなければならない。 ISPA＝0のときこの入力は無効となる。	
61	NHIST			運転履歴の独立変数を指定する。 ＝0　時間（DAY） ＝1　燃焼度（MWD／MTM）	
62	KUNIT			入力データの単位系を指示する。 ＝0　FT-LB-BTUを主とした単位系 ＝1　CM-KG-KCAL　〃	

番号	FORTRAN NAME	単位		説明	SANPLE DATA
		cm－kg系	Ft－ℓb系		
				ここで選ばれた単位系は以後に行なわれる入力についても，ほぼ共通している。以後の各入力dataの単位は各々の項で参照されたい。	

① 時間または燃焼度	② 線出力密度	③ 冷却材入口温度	④ 冷却材圧力	⑤ ＜補	⑥ 助	⑦ DATA＞	⑧ 入力コントロールデータ（IPD）
	kW／ft	°F	psi				
	W／cm	°C	kg／cm²				

notes：1. 単位の上段はKUNIT＝0のときの単位，下段はKUNIT＝1のときの単位

2. FORMAT（7E10.0，5I2）

Fig.－3 Constitution of irradiation history data card

指示番号①，②～⑧を使用する。

以下，入力カードの①，②～⑧の順に従って説明する。⑤，⑥，⑦の補助データの使用法については別途3.5節に詳述する。

照射履歴データ入力の最後には，コラム1～10に－1.0をパンチしたカードを追加しなければならない。これが照射履歴データ入力の終了シグナルになる。

3.3.2 照射履歴データ

① 独立変数：時間または燃焼度

照射履歴の最も基本となる変数で，時間または燃焼度である。入力は第1ステップを基準とした積算値で与える。時間で指定するか燃焼度で指定するかは，第2群入力のオプション選択のkey word NHISTによって決定される。すなわち，NHIST＝0ならば時間（単位day），NHIST＝1ならば燃焼度（単位MWd／MTM）である。

Fig－3の②～⑧のデータは，この独立変数に対応した値が入力されねばならない。

時間を独立変数として選んだ場合，100日を越える時間間隔（△T）が履歴として与えられると，プログラムは自動的にその時間間隔を等分割して履歴を作成する。その分割数は，1＋△T（日）／100（日）の整数値とし，もし△T／100が整数値ならば，その数に置きかえる。また，分割が行なわれた場合，②～⑦のパラメータは，①によって直線内挿した値とする。

燃焼度が独立変数として選ばれた場合には，上記のような分割は行なわない。

② 線出力密度

第2群入力で入力されたIPEAKによって選択された燃料棒平均出力，あるいはピーク出力を与える。すなわち，IPEAK＞0ならば平均出力，IPEAK≦0ならばピーク出力を与えねばならない。これは，もし平均出力で与えたければIPEAK＞0，ピーク出力で与えたければIPEAK≦0にするということである。

出力変化（△P）が100w／cmを越えて与えられた場合には，時間間隔が1＋△P（w／cm）／100（w／cm）で与えられる整数値個に等分割され，自動的に履歴データを作成する。計算は，①，②によって作成された履歴に従って行なわれる。入力した点については必ず計算される（Fig−4参照）。入力データは最大50ステップまで計算されるが，分割された場合，最大100ステップまで許される。

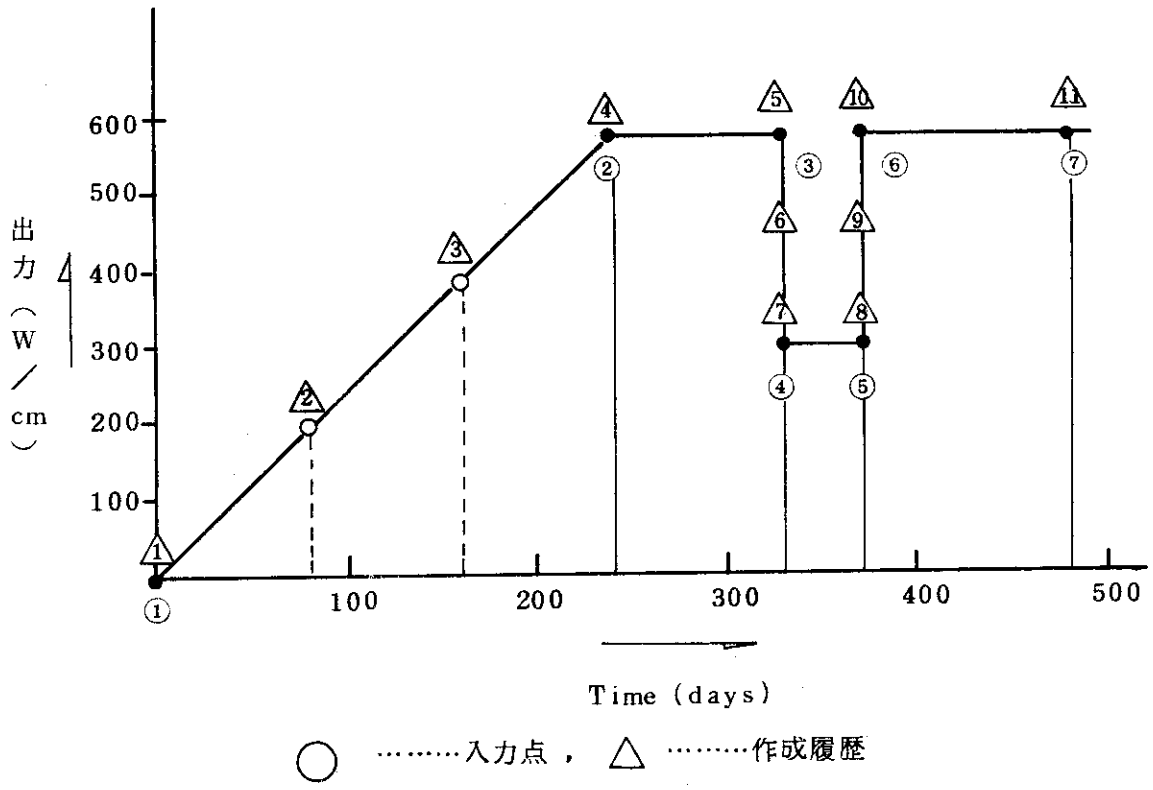


Fig − 4　時間による履歴の作成例

なお，時間および線出力密度の増加が大きく，両方共に分割が必要とされた場合，必要とされる分割数の大きい方に従って分割され，履歴データが作成される。

③ 冷却材入口温度

冷却材の軸方向温度分布は，この値を基準として計算される。すなわち，冷却材軸方向温度分布は，第2群の入力DTEMP（冷却材出口温度と入口温度の差）および後述の軸方向出力分布により計算される。入力値の単位は℉または℃である。この単位は，第2群入力のkey word KUNITによって℉から℃へあるいは℃から℉に変換される。

④ 冷却材圧力

FREG−3では冷却材圧力の軸方向分布を考えない。常時，その履歴ステップ内では一定とする。入力値の単位はpsiまたはkg／cm^{2}である。この単位は第2群入力のkey word

KUNITによってpsiからkg／cm²へあるいはkg／cm²からpsiに変換される。

⑤～⑦　補助データ

②～④以外に履歴をもつデータを選び変化させたい場合に使用する。選べるパラメータ，およびその使用方法は3.5節「補助照射履歴データ」を参照されたい。

⑧　入力コントロールデータ

履歴データ中に5個のコントローラが用意されている。このコントローラは，各履歴ステップ毎に変更することが可能である。シンボル名はIPD(I，J)である(I：コントローラの種類，J：計算ステップNo.)。

1) 温度分布プリントアウトコントローラ，IPD(1，J)

このコントローラは，第1番目のコントローラで，この値を変えることにより次のような温度分布の出力を行う。

0：軸方向各sectionの半径方向温度分布はプリントされない。

1：軸方向各sectionの半径方向温度分布を詳細にプリントアウトする。

2：上記1のプリントアウトの外，ラインプリンタによる温度分布図を出力する。

＜0　1ステップの計算結果を2ページに要約してプリントする。

2) 燃料熱伝導率コントローラ，IPD(2，J)

このコントローラは，第2番目のコントローラで，この値を変えることにより，照射履歴に従って燃料熱伝導率の算出式を切換えることが可能である。このコントローラの値によって次のようなことが実行できる。

＝0　：　前ステップと同じ表または計算式を用いる。そのため計算の第1ステップで，0を指定してはならない。

＝N　：　温度に対する熱伝導率の表を入力しなければならない。入力はN一対のデータで，3.4節に述べる方法によって入力されなければならない。N≦30である。

＝－N：　プログラムに組込まれた計算式が使用される。組込み計算式は次の通りである。

＝－2：WARD Design equation

＝－3：Godfrey equation

＝－4：Lyons equation

3) 被覆管熱的，機械的物性値のコントローラ，IPD(3，J)

このコントローラは第3番目の制御数で，この値によって，被覆管に関する熱的,機械的物性値が選択される。

＝0　：　前ステップで使用されたと同じ値(表)が用いられる。そのため，計算の第1ステップでは0を指定することは許されない。

＝N　：　温度に対する各パラメータの表を入力する。入力はN一対のデータで，3.4節に述べる方法によって入力されなければならない。

N≦30である。

＝－N：　プログラムに組込まれている表を用いる。

＝－2：被覆管をジルカロイ－2として，組込みの表を用いる。

＝－4：被覆管をジルカロイ－4として，組込みの表を用いる。

＝－9：被覆管をステンレス鋼として，組込みの表を用いる。

上記各物性値の組込みの値は，Table－4，5，6に示す通りである。なお，ジルカロイ－4のデータはGAPCON－THERMAL－2から採用したもので，未検討なままである。使用にさいしては変更の必要があろう。

4）燃料ペレット内半径方向熱中性子束分布のコントローラ，IPD(4，J)

このコントローラは第4番目の制御数で，この値によって燃料ペレット内半径方向熱中性子束分布が決定される。

＝0　：　前ステップと同じ表を用いる。または，熱中性子束のdepressionを考慮せずフラットと考える。

＝N　：　直径対熱中性子束の相対値の表を入力する。入力はN対のデータである。この入力は3.4節に述べる方法によって入力されねばならない。N≦20である。

＝－1：　プログラムに組込まれた値が使用される。それは，副プログラムDEPRESによって計算される。

5）軸方向出力分布のコントローラ，IPD(5，J)

このコントローラは，第5番目の制御数で，この値によって燃料棒の軸方向の出力分布が決定される。

＝0　：　前ステップと同じ分布が用いられる。そのため，第1ステップにおいて0を指定することは許されない。

＝1　：　新しい出力分布が入力される。この入力は3.4節に述べる入力法によって入力されねばならない。計算の第1ケース第1ステップは必ず1とし，入力カードが用意されねばならない。

3.4　照射履歴に伴って変更しうる物性値，モデル

前節の入力コントローラによって必要とされるとき，各履歴ステップに応じ，読みこまれる。これらのデータとして，1）燃料ペレット熱伝導率，2）被覆管の熱的・機械的物性値，3）燃料ペレット内半径方向熱中性子分布，4）軸方向出力分布がある。

これらのデータは，コントロールデータ（3.3節に述べたコントローラ）によって指定された時のみ，付加すればよく，常に入力しなければならないものではない。ただし，計算の第1ステップで4)に述べる軸方向出力分布は計算条件として，必ず入力しなければならない。

1）燃料熱伝導率

第2番目のコントローラがNのとき（IPD(2，J)＝N）だけ必要になる。入力は，NAMELIST法である。NAMELIST名はINPUT2で，入力に必要なFORTRAN名等をTable－7に示す。ここで入力する温度・熱伝導率は表に示す単位で入力されねばならない。第2群中で入力された単位切換key word KUNITによる変換は行なわれない。コントローラを負にする（プログラム組込みの熱伝導率を使用）場合を除くと，計算の第1ステップでは，このデータを必ず与えなければならない。

2）被覆管の熱的・機械的物性値

このデータは，被覆管に関する熱的・機械的物性値で照射履歴と共に読み込まれる第3番目

Table－4　２０％冷間加工３１６ステンレス鋼の物性値

温　度 (℃)	熱伝導率 (w/cm/℃)	降伏強さ (kg/cm^2)	ヤング率 (kg/cm^2)	ポアソン比	線熱膨張係数 (cm/cm/℃)	Meyer硬さ (kg/cm^2)
25	0.145	6350	1972000	0.267	16.45E-6	19200
50	0.148	6150	1968000	0.268	16.60E-6	18400
75	0.152	6000	1960000	0.270	16.75E-6	17800
100	0.155	5850	1945000	0.272	16.87E-6	17500
125	0.159	5730	1925000	0.274	17.00E-6	17200
150	0.162	5650	1910000	0.276	17.12E-6	17000
175	0.166	5590	1890000	0.278	17.23E-6	1680
200	0.169	5540	1872000	0.280	17.32E-6	16600
225	0.173	5500	1850000	0.282	17.42E-6	16480
250	0.176	5450	1835000	0.283	17.48E-6	16350
275	0.180	5400	1815000	0.285	17.55E-6	16220
300	0.183	5350	1795000	0.287	17.65E-6	16100
325	0.187	5320	1785000	0.288	17.73E-6	16000
350	0.190	5300	1755000	0.290	17.84E-6	15900
375	0.194	5280	1735000	0.292	17.94E-6	15850
400	0.197	5260	1715000	0.294	18.05E-6	15820
425	0.201	5230	1695000	0.297	18.14E-6	15760
450	0.204	5210	1680000	0.299	18.22E-6	15680
475	0.208	5200	1650000	0.301	18.32E-6	15550
500	0.211	5120	1625000	0.302	18.40E-6	15390
525	0.215	5020	1600000	0.304	18.50E-6	15180
550	0.218	4900	1575000	0.306	18.56E-6	14850
575	0.221	4750	1550000	0.308	18.65E-6	14400
600	0.225	4600	1525000	0.309	18.71E-6	13750
625	0.229	4250	1490000	0.311	18.85E-6	12850
650	0.232	3900	1454000	0.313	18.89E-6	11650

Table－5　ジルカロイ－2の物性値

温　度 (℃)	熱伝導率 (w/cm/℃)	降伏強さ (kg/cm^2)	ヤング率 (kg/cm^2)	ポアソン比	線熱膨張係数 (cm/cm/℃)	Meyer硬さ (kg/cm^2)
25	0.126	3150	972000	0.370	5.83E-6	9470
100	0.134	2450	914000	0.400	6.25E-6	7360
200	0.145	1670	850000	0.446	6.66E-6	5030
300	0.156	1110	780000	0.492	6.97E-6	3340
400	0.170	850	710000	0.492	7.18E-6	2560
500	0.184	700	640000	0.492	7.34E-6	2110

Table－6　ジルカロイ－4の物性値

温　度 (℃)	熱伝導率 (w/cm/℃)	降伏強さ (kg/cm^2)	ヤング率 (kg/cm^2)	ポアソン比	線熱膨張係数 (cm/cm/℃)	Meyer硬さ (kg/cm^2)
25	0.129	3150	972000	0.370	5.83E-6	9470
100	0.136	2450	914000	0.400	6.25E-6	7360
200	0.143	2450	914000	0.400	6.25E-6	7360
300	0.152	2450	914000	0.400	6.25E-6	7360
400	0.164	2450	914000	0.400	6.25E-6	7360
500	0.180	2450	914000	0.400	6.25E-6	7360

Table－7　燃料ペレット熱伝導率入力について
（NAMELIST名，INPUT2）

	FORTRAN変数名	単　位
温　度	CF1	℃
熱伝導率	CF2	W/cm-℃
熱伝導率（再結晶化後）	CF3	W/cm-℃

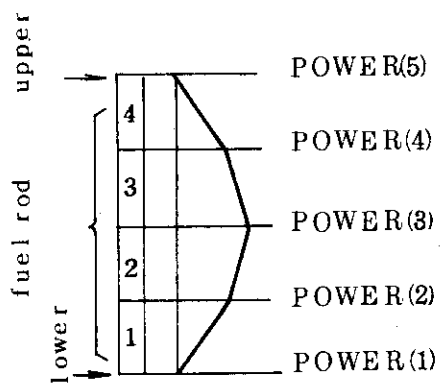
のコントローラがNのとき（IPD(3,J)=N）のみ必要となる。入力はNAMELIST法で，NAMELIST名は，INPUT 3である。入力に必要なFORTRAN変数名等をTable－8に示す。これらの入力値は表に示されるように第2群で入力された単位変換のkey word KUNITの値に従った単位系で入力されねばならない。

3）燃料ペレット内熱中性子束分布

このデータは，燃料ペレット内熱中性子束分布に関するもので，照射履歴と共に読み込まれた第4番目のコントローラがNのとき（IPD(4,J)=N）のみ必要とされる。入力は，NAMELIST方式で，NAMELIST名INPUT4である。入力に必要なFORTRAN変数名等をTable－9に示す。入力値のうち，直径の単位は，単位変換key word KUNITの値に応じた単位で入力されねばならない。

4）軸方向出力分布

このデータは，燃料棒の軸方向出力分布を定めるもので，照射履歴と共に読み込まれた第5番目のコントローラが0でないとき（IPD(5,J)≠0）のみ必要になる。入力はNAMELIST方式で，NAMELIST名INPUT 5である。入力データは，第2群入力のNPOWで与えられた数より1多く必要である。燃料棒の最下部の出力分布をPOWER(1)とし順次上方にNPOW＋1までの出力分布を入力する。入力値は，線出力密度そのものの値でも相対値でもよい。この出力分布は，第2群の入力で与えられたIPEAK（軸方向出力分布に対して，履歴データ中の線出力密度が平均値であるかピーク値であるかを指定する）との関係を考慮して入力しなければならない。なお，計算対象となるaxial segmentの相対出力は，そのsegmentの上下端の分布の平均値（POWER(I)＋POWER(I+1)／2で与えられる。この出力分布の入力例をFig－5に示す。なお，このデータは，計算の第1ステップでは必ず与えねばならない。



NPOW(axial segment number)=4

Expample of imput card

b $ INPUT(1)=0.01, 0.7, 1.0, 0.7, 0.01 $

Fig.－5 Input example of fuel rod axial power distribution (under NPOW=4 and IPEAK=0 condition)

Table－8　被覆管熱的・機械的物性値の入力について
（NAMELIST名，INPUT3）

	FORTRAN 変数名	単位 KUNIT=0	単位 KUNIT=1
温度	AA1	℉	℃
熱伝導率	AA2	BTU／hr-ft-℉	W／cm-℃
耐力	AA3	psi	kg／cm^2
ヤング率	AA4	psi	kg／cm^2
ポアソン比	AA5	－	－
線熱膨張係数	AA6	1／℉	1／℃
メイヤー硬度	AA7	kg／cm^2	kg／cm^2

Table－9　燃料ペレット内径方向熱中性子束分布の入力について

	FORTRAN 変数名	単位 KUNIT=0	単位 KUNIT=1
直径	RV1	in	cm
熱中性子束相対値	RV2	－	－

3.5　補助照射履歴データ

先に3.3節でふれたように，FREG－3は照射履歴のパラメータとして，線出力密度，冷却材入口温度，冷却材圧力の3つを用意している。さらにこれらに加えて例えばプレナム内温度等のパラメータを照射履歴に依存させて変化させたいような場合，ここで述べる入力によって処理することができる。

3.5.1　照射履歴に依存して変化させることができるパラメータ

照射履歴と共に入力し，照射履歴に応じて変えることができるパラメータは，以下の通りである。

1）プレナム内温度

FREG－3は通常プレナム内温度を，冷却材出口温度に10°Fを加えた温度にとっている。この一定値である10°Fをここで述べる方法によって照射履歴に応じた値に変化させることができる。

2）冷却材出口温度

第2群の入力の中のDTEMP（冷却材出口と入口の温度差）を照射履歴と共に変化させる。

3）再組織化するときのペレット密度

第2群入力のうちFRSIN（ペレットが再組織化するときのペレット密度）

4）ペレット外表面粗さ

第2群入力のペレット外表面粗さ，ROUF

5）被覆管内表面粗さ

第2群入力の被覆管内表面粗さ，ROUC

6）冷却材－被覆管熱伝達係数

冷却材－被覆管表面熱伝達係数を固定値とするが，照射履歴に従って変化させる。

3.5.2　使用法

このデータを使用して計算したいとき，その使用法は以下の通りである。

1）照射履歴に依存して変化させたいパラメータを決定する。ただし，選べるパラメータの種類の個数は，最大3個までである。これを決定したら，第2群の入力のISPAにその個数を入力する。

2）決定したパラメータが何であるかを指定する。そのために，第2群入力のNAMSPにパラメータのコード番号を入力する。NAMSPの値によって選定されるパラメータをTable－10に示す。

Table－10　照射履歴データに追加しうるパラメータ

NAMSP	Explanation	unit
1	冷却材出口温度とプレナム内温度の温度差	℃
2	冷却材出口－入口温度差	℃
3	再組織化するときのペレット密度	fraction
4	ペレット外表面粗さ	cm
5	被覆管内表面粗さ	cm
6	冷却材－被覆管熱伝達係数 （固定値であるが時間依存）	W/cm^2-℃

3）選定したパラメータの照射履歴による変化値を第3群入力カードの41～70コラムに入力する。

3.5.3　使用入力例

プレナム温度と被覆管表面熱伝達係数を履歴性をもつデータに切換えることを考える。

1）第2群入力のISPA，NAMSPに，次のように数値を入れる。

ISPA＝2（パラメータがプレナム温度と熱伝達係数の2個である）

NAMSP(1)＝1，NAMSP(2)＝6（Table－10を参照すれば，プレナム温度のコード番号は1，熱伝達係数は6である）

2）第2群の照射履歴カードの41～50コラムにプレナム温度と冷却材温度の温度差を，51～60コラムに熱伝達係を入力する（Fig－6参照）。この場合，パラメータは2個であるから61～70コラムはブランクである。

card column	1 10	11	41 50	51 60	61 70	71
1	0.0		0.0	1.134	b	
2	10.0		5.0	1.134	r a	
3	100.0		5.0	1.134	n	
4	200.		100.	0.057	k	
5	300.		100.	0.057		
6	500.		100.	0.057		

history data

coolant／clad heat transfer coefficient

Temperature difference between plenum and coolant

Fig－6 Example using history－depended parameter on irradiation history card (3rd input group)

3.5.4 使用上の注意

1) 照射履歴データについて説明したように，100日あるいは100w／cmをこえるような時間，出力変化の入力は，プログラム内で自動的に小分割が行なわれる。そのような場合には，ここで与えられたパラメータも，時間に対して直線内挿の値が用いられる。

2) このパラメータの単位は，第2群入力中のKUNITの値のいかんにかかわらず，Table－10に記載された単位で入力されねばならない。

3) ここで述べたオプションの各パラメータは，プログラム内で使用されている変数を直接置き換えるようにプログラムされている。すなわち，NAMSP＝2, 3, 4, 5によって与えられる値は，第2群入力中のデータ，DTEMP，FRSIN，ROUF，ROUCを置き換える。

このために，連続したケースの計算を行うときには，新しいケースの最初の入力にさいしそれぞれの値を再設定しなければならない。もしこれを行なわないと，前ケースの最終値が，次ケースの初期値として計算される。

4) NAMSP(I)＝6（冷却材－被覆管表面熱伝達係数を変化させる）のとき，これによって与えられる数値は，第2群入力中のSIGHFに置き換る。そのため，正数値ならば，その値を熱伝達係数とし，0または負の数値の場合は，SIGHFについて説明したオプションと同性値のものとして取扱かわれる。

5) NAMSP(I)＝1（冷却材出口温度とプレナム内平均温度の温度差）のとき，これによって与えられる数値は，プログラム内で変数の置き換えをしない。したがって，計算ケースが変っても，第2群入力で再設定する等の必要はない。

6) ISPA＝0と与えたときには，たとえ照射履歴カード中に，この節で説明した追加データがパンチされていたとしても（コラム41～70），すべて無視される。

7) ISPAに与えた数とNAMSPに与えた数が一致しない場合，追加の履歴データの個数はいずれか小さい方の数と解釈する。

例えば，ISPA＝3，NAMSP(1)＝1あるいはISPA＝1，NAMSP(1)＝1，NAMSP(2)＝2のとき，いずれもISPA＝1，NAMSP(1)＝1と解釈し，照射履歴入力カードのコラム41～50に与えられた数値のみしか用いられない。

3.6 被覆管クリープダウンデータの入力

FREG-3の計算に，被覆管クリープダウン量を取入れたいとき，入力データとして時間対変化量の表を入力して計算を遂行することができる。

まず，第2群入力中のICREPの値として，次に述べるデータカードの枚数（正整数）を入力する。

計算に使用するクリープダウン量データは，入力の第4群として入力される。入力形式はFig-7に示す通りである。

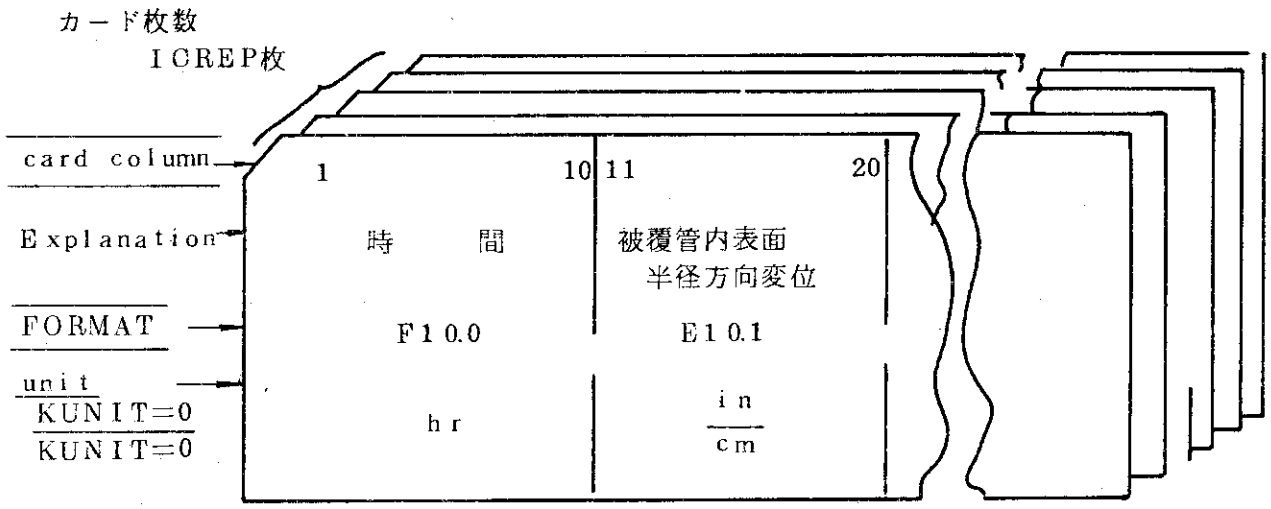


Fig-7 Input card FORMAT of cladding creep down data

クリープダウン量は，履歴データによって与えられる照射時間について上記入力値から，直線内挿によってえられる。このえられた被覆管変位量は，被覆管の全変位量に加算される。したがって，クリープダウン変位量の符号は，負となるので，マイナス(−)を入れて入力されねばならない。入力の照射時間の単位はhrであり，第2枚目よりの時間は第1枚目の時間を基準とした積算時間である。ここで入力された時間の単位はhr，照射履歴の時間の単位はdayであるが，プログラム内で単位変換が行なわれる。

4. 入出力について

FREG−3のサンプル入出力をAppendix−Bに示す。このサンプル計算に使用した入力データは，111ページにカードイメージのまま示されているので，入力データとして示すことを省略する。

4.1 入力データ

1）表 紙

AppendixBのとびらの下方の出力は出力の表紙である。

2）入力データ

111ページ上段は入力カードイメージのままプリントしたものである。

3）111ページ下段は照射履歴を整理したものである。この履歴は計算に使用する履歴で，入力履歴そのままではない。入力履歴点は，TIME STEP Noの次に＊＊で示される。＊＊のない履歴点は3.3節に述べた計算に使用する分割内挿履歴点である。

4）使用オプション

112から113ページ上段は第2群入力でIOUT=1のとき出力される。FREG−3に用意されている計算モデルと計算式の総括表である。この計算で使用するモデルおよび計算式については，各タイトルの最後にkey word name=Iで示される。例えば，最後のFuel CreepはLCREP=0であるから，下方の説明でこの計算に燃料クリープは考慮していないことを示している。

なお，各タイトル下方のオプションの説明の左側に＊で示したものがある。例えば fuel thermal expansion equationではNEXP=2に＊が付されている。この＊はFREG−3のテスト計算結果から，妥当と考えられる計算結果を与えるモデル，計算式を示す。

5）主入力データ

113ページ下段に示される値は，主として第2群で入力されたデータを示す。右側にFORTRAN symbol name，場合によってその値を示す。

ペレット直径等については，メートル系とインチ系の両者が併記されている。FREG−3のプログラム中では，原則としてメートル系で計算している。そのため，インチ系で入力された場合，入力データはメートル系に換算された後再度インチ系に変換されるので，入力値と若干ずれを生じることがある。これら単位系の変換は，第2群入力のKUNITでコントロールされている。KUNIT＝0ならばインチ系入力，KUNIT＝1ならばメートル系入力である。ただし，KUNIT＝1の方は，プログラム内のDATA statementにより設定されているので，特に指定する必要はないが，インチ系入力ではKUNIT＝0を第2群入力で必ず指定しなければならない。

6）物性値，計算使用値

114ページは，この計算に使用される1）燃料ペレットの熱伝導率，2）被覆管の物性値，3）燃料ペレット内半径方向熱中性子束分布相対値（depression factor）を示している。

7）軸方向出力分布

114ページの最下部は，この計算に使用する軸方向出力分布相対値を示す。右側にラインプリンターによる分布図を描いている。これは入力値のcheckに便利なはずである。

4.2 計算結果の出力

115ページ以後は，FREG−3の計算結果の出力である。115から121は，計算の第2ステップの計算結果を示している。これら出力値の説明をTable B−1に示す。Table B−1の左方の数字（1）～（84）は，115から122ページ中に書き込まれた数字にそれぞれ対応する。

117ページ下段は，3.3.2節の⑧で説明したコントローラIPD(I，J)=1としたときの出力である。

122ページは，計算の第3ステップの計算結果を3.3.2節の⑧で説明したコントローラIPD(I，J)<0として，計算結果の要約を出力したものである。

118ページと119ページ上段のランプリンタによる温度分布図は，3.3.2節の⑧で説明したコントローラIPD(I，J)=2としたとき出力される。このSample problemのステップ2ではIPD(I，J)=1なので本来ならば出力されないが参考のため収録した。それぞれ第1セグメント（最下部），第5セグメント（中央部），第10セグメント（最上部）の温度分布を示す。118～119ページのそれぞれの図の右下方にプリントされているギャップコンダクタンスと115ページのギャップコンダクタンスは多少のちがいが生じる。これは，118～119ページでプリントしているギャップコンダクタンスの値は，収斂する1ステップ前の値であるからである。正しく収斂した値は115ページに記載されている。

謝　　辞

この入力手引をまとめるに当り，森島淳好氏（燃料安全第一研究室室長）から多くの教示をえた。また，図，表の整理については梅原啓子嬢を煩わした。記して謝意を表す。

参 考 文 献

1) G. R. Horn and F. E. Panisko, User's Guide for GAPCON : A Computer Program to Predict Fuel-to-Cladding Heat Transfer Coefficients in Oxide Fuel Pins, HEDL-TME 72-128, September 1972.

2) C. R. Hann, C. E. Beyer and L. J. Parchen, GAPCON-THERMAL-1 : A Computer Program for Calculating the Gap Conductance in Oxide Fuel Pins, BNWL-1778 September 1973

3) C. E. Beyer, C. R. Hann, D. D. Lanning, F. E. Panisko and L. J. Parchen, GAPOON-THERMAL-2, A Computer Program for Calculating the Thermal Behavior of an Oxide Fuel Rod, BNWL-1898, November 1975.

4) C. E. Beyer, C.R.Hann, D.D.Lanning, F.E.Panisko and L.J.Parchen, Users Guide for GAPCON-THERMAL-2 : A Computer Program for Calculating the THERMAL BEHAVIOR of an Oxide Fuel Rod, BNWL-1897, November 1975.

5) A. M. Ross and R. L. Stoute, Heat Transfer Coefficients Between UO_2 and Zirealoy-2, CRFD-1075 or AECL-1552, June 1962.

6) Y. Harayama, et al, to be published.

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3) C. E. Beyer, C. R. Hann, D. D. Lanning, F. E. Panisko and L. J. Parchen, GAPOON-THERMAL-2, A Computer Program for Calculating the Thermal Behavior of an Oxide Fuel Rod, BNWL-1898, November 1975.

4) C. E. Beyer, C.R.Hann, D.D.Lanning, F.E.Panisko and L.J.Parchen. Users Guide for GAPCON-THERMAL-2 : A Computer Program for Calculating the THERMAL BEHAVIOR of an Oxide Fuel Rod, BNWL-1897, November 1975.

5) A. M. Ross and R. L. Stoute, Heat Transfer Coefficients Between UO_2 and Zirealoy-2, CRFD-1075 or AECL-1552, June 1962.

6) Y. Harayama, et al, to be published.

Appendix A

LISTING OF FREG-3

* SOURCE STATEMENT *

```
      C                                                                 MAIN0010
      C        FREG-3   MAIN PROGRAMME                                  MAIN0020
      C                                                                 MAIN0030
      C                                                                 MAIN0040
      C                                                                 MAIN0050
 1          REAL  MUF,MOL,MOLEFR,MOLFR                                 MAIN0060
      C     **************                                             MAIN0070
 2          COMMON /HIS  / BASE(100),HIS(7,100),MODE(5,100)            MAIN0080
 3          COMMON /BURN  / BURN(20),BUOLD(20)                         MAIN0090
 4          COMMON /IXIR  / IX,IR,IIH,MAXTEP                           MAIN0100
      C     **************                                             MAIN0110
 5          COMMON /POWRAY/ PAVRG,FUELL,FL,PO*ER(21),A(21),NPOW,PTOT,LPMAX,  MAIN0120
           1                PKPOWR,IPEAK,DELP,PMAX                    MAIN0130
 6          COMMON /BRNRAY/ VOLCC,A1Z,A7Z,A8Z,A9Z,A10Z                 MAIN0140
 7          COMMON /MOLM9 / TAVGXX(20)                                 MAIN0150
 8          COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                      MAIN0160
 9          COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR           MAIN0170
10          COMMON /COM 10/ VVOIDZ,FRUO2,TPLENA,NPOW1                  MAIN0180
11          COMMON /COM 20/ RHO,RHOS,FRUU,FRPUPU                       MAIN0190
12          COMMON /COM 8M/ ISTOP,ICASE                                MAIN0200
13          COMMON /COM 91/ SEC                                        MAIN0210
14          COMMON /COM123/ IOUT1,IIPROF                               MAIN0220
15          COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCT,  MAIN0230
           1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V,  MAIN0240
           2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,    MAIN0250
           3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH, MAIN0260
           4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACAE,HGACEL,    MAIN0270
           5                DTEMP,ITOT,HG ,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELL MAIN0280
           6                ,NEXP,MEXP,NHIST                           MAIN0290
16          COMMON /FINVT / FNVT(20),TNVT(20)                          MAIN0300
17          COMMON /CONVER/ NONCON                                     MAIN0310
18          COMMON /HISTMA/ APOWER                                     MAIN0320
19          COMMON /NUCLEI/ NUCLEI,A(40,23)                            MAIN0330
20          COMMON /DIAL  / FPDIAL                                     MAIN0340
21          DATA ISTPLM,IR / 5,5 /                                     MAIN0350
      C                                                                 MAIN0360
      C     DATE AND TIME CALL ........................... STEP0       MAIN0370
22                                                  CALL STEP0         MAIN0380
23          CALL HYOSHI                                                MAIN0390
      C                                                                 MAIN0400
      C     CARD IMAGE DATA PRINT AND REWIND ............. DATAPR      MAIN0410
24                                                  CALL DATAPR        MAIN0420
      C     INITIALIZE AND THE BEGIN CALCULATIONS.                     MAIN0430
      C                                                                 MAIN0440
25    100 CONTINUE                                                     MAIN0450
      C     ITOT IS ITERATION TOTAL COUNTER.  SEE PRINT1               MAIN0460
26          KOUNT = ICASE = ITOT = 0                                   MAIN0470
27          TDAYS=TOTLDY=0.0                                           MAIN0480
28          TOTBUR = 0.0                                               MAIN0490
29          DO 110 I@=1,20                                             MAIN0500
      C     FAST FLUENCE(FNVT),THERMAL FLUENCE(TNVT) ZERO SET          MAIN0510
30          BUOLD(I@) = 0.0                                            MAIN0520
31    110 BURN(I@)=FNVT(I@)=TNVT(I@)=0.0                               MAIN0530
      C DATA INPUT (HISTORY INDEPENDENT DATA)                           MAIN0540
32                                                  CALL DATINP(1)     MAIN0550
      C HISTORY-INDEPENDENT INPUT DATA CHECK              ...CHECK(1)   MAIN0560
      C                                                   ...CHECK      MAIN0570
      C IF THERE IS NO CARD FOR INPUT DATA, STOP THE CALCULATION        MAIN0580
      C     DATE AND TIME CALL                                ...STEP0  MAIN0590
```


* SOURCE STATEMENT (FTMAIN)*

```
      C HISTORY STEP ARRANGEMENT ........................ HISTR(1,NEXT)  MAIN0600
33                                                  CALL HISTR(1,NEXT) MAIN0610
34          IF(IOUT1.EQ.1)                          CALL OUT1          MAIN0620
      C HISTORY INDEPENDENT-INPUT-DATA PRINT OUT ......... STEP1        MAIN0630
35                                                  CALL STEP1         MAIN0640
      C OPTIONAL SIGNAL INPUT ARRANGE AND PRINT OUT ....... STEP2(0)    MAIN0650
36                                                  CALL STEP2(0)      MAIN0660
      C SET UP PLENUM MOLE CONTENT ...................... MOLMOL(1)     MAIN0670
37                                                  CALL MOLMOL(1)     MAIN0680
      C SET UP DECAY CONSTANT OF SPECIFIED ISOTOPES                     MAIN0690
38                                      IF(NUCLEI.GE.1) CALL CURIE(1)  MAIN0700
      C                                                                 MAIN0710
      C     HISTORY DATA SET   IIH IS HISTORY-STEP-COUNTER              MAIN0720
      C                                                                 MAIN0730
39    470 CONTINUE                                                     MAIN0740
40                                                  CALL TIME(KTIME)   MAIN0750
      C HISTORY DATA SETTING AT EACH TIME (BURNUP) STEP ... HISTR(2,NEXT) MAIN0760
41                                                  CALL HISTR(2,NEXT) MAIN0770
42          IF(NEXT.EQ.4HNEXT) GO TO 100                               MAIN0780
      C DATA INPUT (HISTORY AND HISTORY DEPENDENT DATA).... DATINP(2)   MAIN0790
43                                                  CALL DATINP(2)     MAIN0800
      C                                                   ...DEPRES( , , ) MAIN0810
      C HISTORY-DEPENDENT INPUT DATA CHECK                ...CHECK(2)   MAIN0820
44          IF(IIH.EQ.1.OR.MODE(1,IIH).NE.0)            CALL STEP2(1)  MAIN0830
      C FUEL THERMAL CONDUCTIVITY PRINT ................ STEP(2)        MAIN0840
45          IF(IIH.EQ.1.OR.MODE(2,IIH).NE.0)            CALL STEP2(2)  MAIN0850
      C                                                   ...FCOND      MAIN0860
      C CLADDING MECHANICAL PROPERTIES PRINT ............ STEP2(3)      MAIN0870
46          IF(IIH.EQ.1.OR.MODE(3,IIH).NE.0)            CALL STEP2(3)  MAIN0880
      C CLADDING-YIELD-STRENGTH FOR FILL UP TABLE         ...FYIELD( , ) MAIN0890
      C RADIAL FLUX DEPRESSION PRINT .................... STEP2(4)      MAIN0900
47          IF(IIH.EQ.1.OR.MODE(4,IIH).GT.0)            CALL STEP2(4)  MAIN0910
      C AXIAL POWER DISTRIBUTION PRINT .................. PAPLOT  ( , , ) MAIN0920
48          IF(IIH.EQ.1.OR.MODE(5,IIH).GT.0)            CALL PAPLOT(NPOW,NEWK, MAIN0930
           1                                                NEWCL,NEWFLX) MAIN0940
      C FP GAS RELEASE RATE MODIFIED  (FPDIAL)                          MAIN0950
49          IF(FPDIAL.NE.1.0 .AND. IIH.EQ.1)            CALL STEP2(5)  MAIN0960
      C     AXIAL POWER DISTRIBUTION CALC..................... POWDIS  MAIN0970
50                                                  CALL POWDIS        MAIN0980
      C           TDAYS = DELTA TIME (TIME STEP)                        MAIN0990
51          WTONFT=RHO*VOLCC/1.E6                                      MAIN1000
52          WTM=WTONFT*(FRUU*FRUO2+FRPUPU*FRPUO2)                      MAIN1010
53          FACT = 1.                                                  MAIN1020
54          IF(NHIST.EQ.0) GO TO 200                                   MAIN1030
55          IF(PAVRG.GT.0.0) GO TO 201                                 MAIN1040
56          TDAYS=0.0                                                  MAIN1050
57          GO TO 202                                                  MAIN1060
58    201 CONTINUE                                                     MAIN1070
59          TDAYS=BURNUP*WTM/(PAVRG/1.E6)                              MAIN1080
60    202 CONTINUE                                                     MAIN1090
61          TOTLDY=TOTLDY+TDAYS                                        MAIN1100
62          GO TO 204                                                  MAIN1110
63    200 CONTINUE                                                     MAIN1120
64    203 PP=PAVRG                                                     MAIN1130
65          IF(IPEAK.LE.0) PP=PKPOWR                                   MAIN1140
66          IF(PP.LE.0.0) GO TO 204                                    MAIN1150
67          FACT = APOWER/PP                                           MAIN1160
68    204 CONTINUE                                                     MAIN1170
      C                                                                 MAIN1180
```

```
* SOURCE STATEMENT (FTMAIN )*
      DO 480 IPOW=1,NPOW                                                MAIN1190
      P=(POWER(IPOW)+POWER(IPOW+1))*0.5                                 MAIN1200
      P=P*FACT                                                          MAIN1210
      BURN(IPOW)=BURN(IPOW)+P*1.0E-6*TDAYS/WTM                          MAIN1220
  480 CONTINUE                                                          MAIN1230
      IF(NHIST.EQ.0) TOTBUR=TOTBUR+PAVRG*FACT*1.E-6*TDAYS/WTM           MAIN1240
                                                  CALL MOLMOL(2)        MAIN1250
C FISSION GAS GENERATION KRYPTON AND XENON                ...FISGAS( , , ) MAIN1260
C                                                                       MAIN1270
C     BEGIN AXIAL CALCULATIONS                                          MAIN1280
C                                                                       MAIN1290
      ISTOP=ISTPLM                                                      MAIN1300
                                                  CALL ST3T08(1)        MAIN1310
C                                                                       MAIN1320
C                                                                       MAIN1330
      DELTV1=DELTV2*1.0                                                 MAIN1340
C                                                                       MAIN1350
      DO 1410 ISTEP=1,ISTPLM                                            MAIN1360
      MAXTEP = ISTEP                                                    MAIN1370
      NONCON=1                                                          MAIN1380
C                                                                       MAIN1390
C     AXIAL NODE GAP CONDUCTANCE ITERATION........... ST3T08(2)         MAIN1400
                                                  CALL ST3T08(2)        MAIN1410
C COOLANT-CLADDING HEAT TRANSFER, HEAT FLUX,CLAD TEMP ...STEP3          MAIN1420
C                                                          ...HTC*      MAIN1430
C                                                          ...HTCLM     MAIN1440
C FUEL TEMP,DISTRIBUTION,RESTRUCTURING TEMPERATURE     ...STEP4         MAIN1450
C FUEL THERMAL CONDUCTIVITY                                ...FCOND     MAIN1460
C HOT GAP CALCULATION (MREV1=0)                        ...STEP5         MAIN1470
C                     (MREV1=1)                        ..(STEP5A)       MAIN1480
C FUEL THERMAL EXPANSION                                   ...EXPAND    MAIN1490
C                                                             ...FALPHA MAIN1500
C FUEL DENSIFICATION                                       ...DENSF     MAIN1510
C FUEL DENSIFICATION  (HALDEN)                                ...DENSHA MAIN1520
C FUEL DENSIFICATION  (GAPCON THERMAL-2)                      DENSGA   MAIN1530
C CLADDING CREEP                                           ...CREEP     MAIN1540
C FUEL SWELLING       (MREV1=0)                            ...SWELL     MAIN1550
C                     (MREV1=1)                            ..(SWELLA)   MAIN1560
C FUEL RELOCATION     (GAPCON THERMAL-2)                      RELOC     MAIN1570
C FISSION GAS RELEASE AT THIS TIME STEP                ...MOLMOL(3)     MAIN1580
C                                                          ...TEPP( , ) MAIN1590
C THERMAL CONDUCTIVITY OF GAS MIXTURE                  ...STEP6         MAIN1600
C GAP CONDUCTANCE                                      ...STEP7         MAIN1610
C CLADDING YIELD STRENGTH                                  ...FYIELD( , ) MAIN1620
C FUEL THERMAL CONDUCTIVITY                                ...FCOND     MAIN1630
C                                                      ...STEP8         MAIN1640
C DATE AND TIME CALL                                       ...STEPO     MAIN1650
C STORED ENERGY (UNIT CONVERSION)                          ...STOREN    MAIN1660
C FUEL HEAT CAPACITY VS TEMPERATURE                           ...HCAP   MAIN1670
C                                                                ...TEPP MAIN1680
C STORED ENERGY                                               ...CARL   MAIN1690
C GAP CONDUCTANCE CONVERGENCE TRACE AND PRINT              ...GAPRO     MAIN1700
C FUEL TEMPERATURE PROFILE                                 ...PROF      MAIN1710
C FISSION GAS RELEASE MAXIMUM VALUE SETTING            ...MOLMOL(4)     MAIN1720
C                                                          ...TEPP( , ) MAIN1730
C                                                                       MAIN1740
      DELTXX=TAVGXX(ISTEP+1)-TAVGXX(ISTEP)                              MAIN1750
C                                                                       MAIN1760
      DELTV1=ABS(DELTXX)/TAVGXX(ISTEP+1)                                MAIN1770
```



```
* SOURCE STATEMENT (FTMAIN )*
      IF(DELTV1.LE.0.005) ISTOP = ISTEP                                 MAIN1780
      IF(DELTV1.LE.0.005.AND.DELTV2.LE.0.005.AND.ISTEP.GT.2             MAIN1790
     *    .AND.NONCON.EQ.0 ) GO TO 1420                                 MAIN1800
C                                                                       MAIN1810
C----- NONCON = 0 SET IN SUB. ST3T08 (ST. NO. 10) + 3 LINE              MAIN1820
      DELTV3 = DELTV2                                                   MAIN1830
      DELTV2=DELTV1                                                     MAIN1840
 1410 CONTINUE                                                          MAIN1850
      ISTEP = ISTPLM                                                    MAIN1860
      PRINT 701,IIH,DELTV3,NONCON                                       MAIN1870
C                                                                       MAIN1880
  701 FORMAT(// 1X,130(1H*),/ 10X,33HNO CONVERGENCE IN AXIAL ITERATION  MAIN1890
     1    /5X,10HCASE NO.   ,I2,3X,30HRELATIVE ERROR (PRIVIOUS STEP) ,  MAIN1900
     * F7.5,3X,30HGAP CONDUCTANCE ITERATION FLAG  ,I2,12H (=0,NORMAL)   MAIN1910
     2  / 1X,130(1H*)   )                                              MAIN1920
C                                                                       MAIN1930
C     VOLUMETRIC AVERAGE TEMPERATURE CONVERGENCE END    DO 1410       MAIN1940
C                                                                       MAIN1950
 1420 CONTINUE                                                          MAIN1960
      ISTOP=ISTEP                                                       MAIN1970
                                                  CALL TIME(LTIME)      MAIN1980
      SEC = FLOAT(LTIME-KTIME)/1000.                                    MAIN1990
C                                                                       MAIN2000
C*************************** NEW OUTPUT ROUTINE CALL ******74/08/29    MAIN2010
C                                                                       MAIN2020
      IF(MODE(1,IIH) . LT . 0) 10,15                                    MAIN2030
   15 CONTINUE                                                          MAIN2040
      CALL PRINT1                                                       MAIN2050
C                                                         ...HEAD(1)    MAIN2060
C                                                         ...HEAD(-1)   MAIN2070
      GO TO 20                                                          MAIN2080
   10 CONTINUE                                                          MAIN2090
      CALL PRINT2                                                       MAIN2100
   20 CONTINUE                                                          MAIN2110
C     FISSION GAS MAXIMUM RELEASE CALCULATION........ MOLMOL(5)         MAIN2120
                                                  CALL MOLMOL(5)        MAIN2130
C     FISSION GAS RADIO-ACTIVITY AMOUNTS CALCULATION                    MAIN2140
                                        IF(NUCLEI.GE.1) CALL CURIE(2)   MAIN2150
C                                                                       MAIN2160
      DO 30 IQ = 1,NPOW                                                 MAIN2170
      RUOLD(IQ)=BURN(IQ)                                                MAIN2180
   30 CONTINUE                                                          MAIN2190
C                                                                       MAIN2200
      GO TO 470                                                         MAIN2210
C                                                                       MAIN2220
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 MAIN2230
C*********************************************************************MAIN2240
      END                                                               MAIN2250
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP0                                                  STP00010
C                                                                       STP00020
C     THIS SUBROUTINE IS CALLED FROM MAIN                               STP00030
C                                                                       STP00040
      COMMON /HIZUKE/ K1,K2,K3,K4,K5,K6                                 STP00050
      CALL DATE(K1,K2)                                                  STP00060
      CALL TIME(KKK)                                                    STP00070
      K3 = KKK/3600000                                                  STP00080
      K4 = MOD(KKK,3600000)/60000                                       STP00090
      K5 = MOD(KKK,60000)/1000                                          STP00100
      K6 = MOD(KKK,1000)                                                STP00110
      RETURN                                                            STP00120
C*********************************************************************STP00130
      END                                                               STP00140
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP1                                                  STP10010
C                                                                       STP10020
C     THIS SUBROUTINE IS CALLED FROM MAIN                               STP10030
C                                                                       STP10040
      REAL  MUF,MOL,MOLEFR,MOLFR,LFUEL,KB,LVOIDZ                        STP10050
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  STP10060
     1                PKPOWR,IPEAK,DELP,PMAX                            STP10070
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                  STP10080
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) STP10090
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  STP10100
      COMMON /COM 10/ VVOIDZ,FRUO2,TPLENA,NPOW1                         STP10110
      COMMON /COM 12/ DENSIT,FR38,FR39                                  STP10120
      COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                            STP10130
      COMMON /COM 15/ NCR,GAP                                           STP10140
      COMMON /COM 21/ N,NN,NNN,NF                                       STP10150
      COMMON /COM 90/ VOLGAS,W,HGC                                      STP10160
      COMMON /COM157/ RCI,RCO                                           STP10170
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI,  STP10180
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, STP10190
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   STP10200
     3                NCLAD,NCON,NFLX,KUOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,STP10210
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   STP10220
     5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELLSTP10230
     6                ,NEXP,MEXP,NHIST                                  STP10240
      COMMON /HIZUKE/ K1,K2,K3,K4,K5,K6                                 STP10250
      COMMON /D15    / MDEN,MRELOC, SINTEM                              STP10260
      COMMON /DIMEN1/ DVOIDX(20),DVOIDH(20),DFSX(20),DCIX(20),DCOX(20), STP10270
     1                VVOIDX(20),VVOIDH(20),TSINX(20),RSINX(20)         STP10280
     2               ,ZLENGT(5,20),VOIDL(20)                            STP10290
      COMMON /INPUT A/ MREST,LCREP,DDISH,HDISH                          STP10300
      COMMON /HIS  / BASE(100),HIS(7,100),MODE(5,100)                   STP10310
      COMMON /DIAL / FPDIAL                                             STP10320
      COMMON /HIST1/ NNHIST,MAXTEP                                      STP10330
      COMMON / PLOT / IPLOT                                             STP10340
C                                                                       STP10350
C                                                                       STP10360
C     INITIALIZE AND BEGIN EXECUTION.                                   STP10370
C                                                                       STP10380
      FNPOW=NPOW                                                        STP10390
      FL = FUELL / FNPOW                                                STP10400
      FR38=1.-FR35                                                      STP10410
      RSINZ=DSINZ/2.                                                    STP10420
      RVOIDZ=DVOIDZ/2.                                                  STP10430
      VVOIDZ=PI*RVOIDZ**2*VOIDZL/FNPOW                                  STP10440
C..... WE ASSUMED THE INITIAL CENTRAL HOLE PENETRATE FROM BOTTOM TO TOP STP10450
C     ,THEN RECALCULATE CENTRAL HOLE DIAMETER (CORRECT INPUT DIAMETER)  STP10460
      RVOIDD=SQRT(VVOIDZ/(PI*FL))                                       STP10470
      DVOIDD=RVOIDD*2.                                                  STP10480
      IF(RVOIDD.GT.0.0) VOIDZL=FUELL                                    STP10490
C                                                                       STP10500
      FRUO2=1.-FRPUO2                                                   STP10510
      DENSIT=FRPUO2*11.46+FRUO2*10.97                                   STP10520
      FR39=1.-FR40-FR41                                                 STP10530
      IF(FRPUO2.LE.1.E-10) FR39=0.                                      STP10540
      GAP=DCI-DFS                                                       STP10550
      RFS=DFS/2.                                                        STP10560
      RCI=DCI/2.                                                        STP10570
      RCO=DCO/2.                                                        STP10580
      VOLGAS=PI/4.*(DCI**2-DFS**2)*FL+VVOIDZ                            STP10590
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* SOURCE STATEMENT (STEP1)*

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C----- INITIALIZE COLD DIMENSION SET                                   STP10600
      DO 11 I=1,NPOW                                                    STP10610
      DVOIDX(I)=DVOIDH(I)=DVOIDD                                        STP10620
      VVOIDX(I)=VVOIDH(I)=VVOIDZ                                        STP10630
      DFSX(I)  =DFS                                                     STP10640
      DCIX(I)  =DCI                                                     STP10650
      DCOX(I)  =DCO                                                     STP10660
C                                                                       STP10670
      RSINX(I)=RSINZ                                                    STP10680
      VOIDL(I)=FL                                                       STP10690
      IF(RVOIDZ.LE.0.0) VOIDL(I)=0.0                                    STP10700
   11 CONTINUE                                                          STP10710
C                                                                       STP10720
      WRITE(6, 501) TITLE,K1,K2,K3,K4                                   STP10730
      WRITE(6, 502)                                                     STP10740
      WRITE(6, 503) FRPUO2,FR39,FR40,FR41,FRUO2,FR35,FR38               STP10750
      DUM1 = DFS / 2.54                                                 STP10760
      DUM2 = DSINZ / 2.54                                               STP10770
      DUM3 = DVOIDZ / 2.54                                              STP10780
      WRITE(6, 504) FRDEN,FRDEN,FRSIN,FRSIN,DFS,DUM1,DSINZ,DUM2,        STP10790
     *              DVOIDZ,DUM3                                         STP10800
      DUM1 = GAP / 2.54                                                 STP10810
      DUM2 = DCI / 2.54                                                 STP10820
      DUM3 = DCO / 2.54                                                 STP10830
      DUM4 = FUELL / 2.54                                               STP10840
      DUM5 = VOIDZL / 2.54                                              STP10850
      DUM6=DDISH/2.54                                                   STP10860
      DUM7 = HDISH / 2.54                                               STP10870
      WRITE(6, 505) DDISH,DUM6,HDISH,DUM7                               STP10880
      WRITE(6, 506) GAP,DUM1,DCI,DUM2,DCO,DUM3,FUELL,DUM4,VOIDZL,DUM5,  STP10890
     *              S,S,XX,XX                                           STP10900
      DUM1 = VPLENZ / ( 2.54**3 )                                       STP10910
      DUM3 = DTEMP * 1.8                                                STP10920
      DUM4 = DE / 2.54                                                  STP10930
      DUM5 = V / .3048                                                  STP10940
      DUM7 = ROUF / 2.54                                                STP10950
      DUM8 = ROUC / 2.54                                                STP10960
      WRITE(6, 510) VPLENZ,DUM1,DTEMP,DUM3,DE,DUM4,V,DUM5,              STP10970
     *                                      ROUF,DUM7,ROUC,DUM8         STP10980
      DUM1 = 1.8*TM + 32.0                                              STP10990
      WRITE(6, 514) TM,DUM1                                             STP11000
      WRITE(6, 513) ATMOS,ATMOS                                         STP11010
      WRITE(6,520) FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE              STP11020
      IF(SIGHF) 180,190,200                                             STP11030
  180 IF(SIGHF.EQ.-1.) WRITE(6,581) SIGHF                               STP11040
      IF(SIGHF.EQ.-2.) WRITE(6,582) SIGHF                               STP11050
      IF(SIGHF.EQ.-3.) WRITE(6,583) SIGHF                               STP11060
      IF(SIGHF.EQ.-4.) PRINT 584, SIGHF                                 STP11070
      GO TO 210                                                         STP11080
  190 WRITE(6,580) SIGHF                                                STP11090
      GO TO 210                                                         STP11100
  200 DUM1 = SIGHF * 30.48 ** 2 * 3600. / 1.8 / 1055.                   STP11110
      WRITE(6,589) SIGHF,DUM1                                           STP11120
  210 CONTINUE                                                          STP11130
      IF(IFLUX) 220,220,230                                             STP11140
  220 WRITE(6,590) IFLUX                                                STP11150
      GO TO 240                                                         STP11160
  230 WRITE(6,591) IFLUX                                                STP11170
  240 CONTINUE                                                          STP11180
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* SOURCE STATEMENT (STEP1   )*

      C                                                                 STP11190
      C     FUEL THERMAL EXPANSION COEFFICIENT OPTION PRINT             STP11200
      C                                                                 STP11210
 94         IF(NEXP.GT.0) WRITE(6,633) NEXP                             STP11220
      C                                                                 STP11230
      C                                                                 STP11240
 95         IF(KOOL.GT.0) WRITE(6,639) KOOL                             STP11250
 96         WRITE(6,640) NPOW                                           STP11260
 97         IF(MDEN.GT.0) WRITE(6,641) MDEN                             STP11270
 98         IF(MDEN.EQ.1) WRITE(6,645)  SINTEM                          STP11280
 99         IF(MRELOC.EQ.1) WRITE(6,651) MRELOC                         STP11290
100         IF(FRSIN.GT.FRDEN) MREST = 1                                STP11300
101         IF(MREST.EQ.0) WRITE(6,655) MREST                           STP11310
102         IF(MREST.EQ.1) WRITE(6,656) MREST                           STP11320
      C                                                                 STP11330
103         IF(IPLOT.LE.0) RETURN                                       STP11340
      C                                                                 STP11350
104         KPOW=NPOW/2.0+0.5001                                        STP11360
105         IF(KPOW.LE.0) KPOW=1                                        STP11370
106         WRITE(8)    (TITLE(I),I=1,20),KPOW,NPOW,MAXTEP              STP11380
107         WRITE(8)  FRPUO2,FR39,FR40,FR41,FRUO2,FR35,FR38,FRDEN,FRSIN, STP11390
          A           DFS,DSINZ,DDISH,HDISH,GAP,DCI,DCO,FUELL,          STP11400
          B           VOIDZL,S,XX,VPLENZ,DTEMP,DE,V,ROUF,ROUC,          STP11410
          C           TM,ATMOS,FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE ,STP11420
          D           SIGHF,MODE(2,1),MODE(3,1),MODE(4,1),IFLUX,IPEAK,  STP11430
          E           ICREP ,ICDF ,ISWELL ,NEXP ,MEXP ,MDEN ,           STP11440
          F           MRELOC ,MPEST                                     STP11450
108        RETURN                                                       STP11460
      C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 STP11470
109   501 FORMAT(1H1/ 20A4,10X,2A4,I5,3H HR,I3,7H MINUTE                ) STP11480
110   502 FORMAT(//58X,18(1H*) / 58X,    18H*  INPUT VALUES  * /        STP11490
          1  58X,18(1H*)  /  7X,126(1H*)                                STP11500
          1 / 7X, 1H*,124X, 1H*                                       ) STP11510
111   503 FORMAT( 7X,1H*,9X, 16HFUEL COMPOSITION, 99X,1H*/ 7X,8H*   ( 1) , STP11520
          A F11.4,    24H   WEIGHT FRACTION PUO2     ,62X,               STP11530
          B 21HFRPUO2                 *                   / 7X,8H*      , STP11540
          C F11.4,    24H   WEIGHT FRACTION PU239    ,62X,               STP11550
          D 21HFR39=1.-FR40-FR41      *                   / 7X,8H*   ( 2) , STP11560
          E F11.4,    24H   WEIGHT FRACTION PU240    ,62X,               STP11570
          F 21HFR40                   *                   / 7X,8H*   ( 3) , STP11580
          G F11.4,    24H   WEIGHT FRACTION PU241    ,62X,               STP11590
          H 21HFR41                   *                   / 7X,8H*      , STP11600
          I F11.4,    24H   WEIGHT FRACTION UO2      ,62X,               STP11610
          J 21HFRUO2=1.-FRPUO2        *                   / 7X,8H*   ( 4) , STP11620
          K F11.4,    24H   WEIGHT FRACTION U235     ,62X,               STP11630
          L 21HFR35                   *                   / 7X,8H*      , STP11640
          M F11.4,    24H   WEIGHT FRACTION U238     ,62X,               STP11650
          N 21HFR38=1.-FR35           *                               ) STP11660
112   504 FORMAT( 7X,                                                   STP11670
          A 47H*   ( 5)  FUEL DENSITY                        ,F14.5,4H(FRA, STP11680
          B 10HCTION TD) ,F13.5,38H(FRACTION TD)     FRDEN          */7X,STP11690
          C 47H*   ( 6)  RESTRUCTURED FUEL DENSITY           ,F14.5,4H(FRA, STP11700
          D 10HCTION TD) ,F13.5,38H(FRACTION TD)     FRSIN          */7X,STP11710
          E 47H*   ( 7)  PELLET DIAMETER                     ,F14.5,4H( CM, STP11720
          F 10H )        ,F13.5,38H(INCHES)          DFS            */7X,STP11730
          G 47H*   ( 8)  INITIAL RESTRUCTURED FUEL DIAMETER  ,F14.5,4H( CM  STP11740
          H 10H )        ,F13.5,38H(INCHES)          DSINZ          */7X,STP11750
          I 47H*   ( 9)  INITIAL CENTER HOLE DIAMETER        ,F14.5,4H( CM  STP11760
          J 10H )        ,F13.5,38H(INCHES)          DVOIDZ           * ) STP11770
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* SOURCE STATEMENT (STEP1   )*

113   505 FORMAT( 7X,                                                   STP11780
          1 47H*   (  )  PELLET DISH DIAMETER                 ,F14.5,4H( CM, STP11790
          2 10H )        ,F13.5,38H(INCHES)          DDISH          */7X,STP11800
          3 47H*   (  )  PELLET DISH DEPTH                    ,F14.5,4H( CM, STP11810
          4 10H )        ,F13.5,38H(INCHES)          HDISH            * ) STP11820
114   506 FORMAT( 7X,                                                   STP11830
          A 47H*         PELLET-TO-CLAD DIAMETRAL GAP         ,F14.5,4H( CM  STP11840
          B 10H )        ,F13.5,38H(INCHES)          GAP=DCI-DFS    */7X,STP11850
          C 47H*   (10)  CLAD INSIDE DIAMETER                 ,F14.5,4H( CM  STP11860
          D 10H )        ,F13.5,38H(INCHES)          DCI            */7X,STP11870
          E 47H*   (11)  CLAD OUTSIDE DIAMETER                ,F14.5,4H( CM  STP11880
          F 10H )        ,F13.5,38H(INCHES)          DCO            */7X,STP11890
          G 47H*   (12)  FUEL LENGTH                          ,F14.5,4H( CM  STP11900
          H 10H )        ,F13.5,38H(INCHES)          LFUEL(REAL)    */7X,STP11910
          I 47H*   (13)  INITIAL CENTER VOID LENGTH           ,F14.5,4H( CM, STP11920
          J 10H )        ,F13.5,38H(INCHES)          LVOIDZ(REAL)   */7X,STP11930
          K 47H*   (14)  SORBED GAS CONTENT                   ,F14.5,4H(CC/, STP11940
          L 10HGRAM)     ,F13.5,38H(CC/GRAM)         S              */7X,STP11950
          M 47H*   (15)  FRACTION OF SORBED GAS WHICH IS H2   ,F14.5,4H    , STP11960
          N 10H          ,F13.5,38H                  XX               * ) STP11970
115   510 FORMAT( 7X,                                                   STP11980
          A 47H*   (16)  PLENUM VOLUME                        ,F14.5,4H(CU.  STP11990
          B 10H CM)      ,F13.5,38H(CU. IN.)         VPLENZ         */7X,STP12000
          * 48H*   (17)  AXIAL TEMPERATURE GRADIENT ACROSS COREF13.5,4H(DEG, STP12010
          * 10H C)       ,F13.5,38H(DEG F)           DTEMP          */7X,STP12020
          E 47H*   (18)  COOLANT PASSAGE EQUIVALENT DIAMETER  ,F14.5,4H( CM, STP12030
          F 10H  )       ,F13.5,38H(INCHES)          DE             */7X,STP12040
          G 47H*   (20)  COOLANT VELOCITY                     ,F14.5,4H(M/S, STP12050
          H 10HEC)       ,F13.5,38H(FT/SEC)          V              */7X,STP12060
          M 47H*   (23)  FUEL SURFACE ROUGHNESS, ARITH. MEAN  ,E14.5,4H( CM, STP12070
          N 10H )        ,E13.5,38H(INCHES)          ROUF           */7X,STP12080
          O 47H*   (24)  CLAD ID SURFACE ROUGHNESS ARITH. MEAN,E14.5,4H( CM, STP12090
          P 10H )        ,E13.5,38H(INCHES)          ROUC             * ) STP12100
116   513 FORMAT( 7X,                                                   STP12110
          A 47H*   (36)  FILL GAS PRESSURE                    ,F14.5,4H(ATM, STP12120
          B 10HOSPHERES) ,F13.5,38H(ATMOSPHERES)     ATMOS            * ) STP12130
117   514 FORMAT( 7X,                                                   STP12140
          A 47H*   (35)  MELTING TEMPERATURE OF THE FUEL      ,F14.5,4H(DEG  STP12150
          B 10H C)       ,F13.5,38H(DEG F)           TM               * ) STP12160
      C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 STP12170
118   520 FORMAT( 7X,                                                   STP12180
          A 30H*         FILL GAS COMPOSITION, 95X,                 1H*/7X,STP12190
          B 10H*   (37)  ,F8.4, 30H   MOLE FRACTION HELIUM       ,57X,  STP12200
          C 21HFRACHE                 *  /7X,                           STP12210
          D 10H*   (38)  ,F8.4, 30H   MOLE FRACTION ARGON        ,57X,  STP12220
          E 21HFRACAR                 *  /7X,                           STP12230
          F 10H*   (39)  ,F8.4, 30H   MOLE FRACTION HYDROGEN     ,57X,  STP12240
          G 21HFRACH                  *  /7X,                           STP12250
          H 10H*   (40)  ,F8.4, 30H   MOLE FRACTION NITROGEN     ,57X,  STP12260
          I 21HFRACN                  *  /7X,                           STP12270
          J 10H*   (41)  ,F8.4, 30H   MOLE FRACTION KRYPTON      ,57X,  STP12280
          K 21HFRACKR                 *  /7X,                           STP12290
          L 10H*   (42)  ,F8.4, 30H   MOLE FRACTION XENON        ,57X,  STP12300
          M 21HFRACXE                 *                               ) STP12310
119   525 FORMAT( 7X,1H*,124X,1H* )                                     STP12320
      C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 STP12330
120   580 FORMAT( 7X,                                                   STP12340
          A 27H*   (43)  COOLANT IS SODIUM,78X, 7HSIGHF =, F8.2,    5X, 1H*) STP12350
121   581 FORMAT( 7X,                                                   STP12360
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* SOURCE STATEMENT (STEP1   )*
                 A 53H*   (43)  COOLANT IS *ATER  (DITTUS-BOELTER EQUATION), 52X,   STP12370
                 B                                     7HSIGHF =, F8.2,    5X, 1H*) STP12380
      122     582 FORMAT( 7X,                                                       STP12390
                 A 52H*   (43)  COOLANT IS WATER  (JENS LOTTES EQUATION)    , 53X,   STP12400
                 B                                     7HSIGHF =, F8.2,    5X, 1H*) STP12410
      123     583 FORMAT( 7X,                                                       STP12420
                 A 60H*   (  )  COOLANT IS *ATER  (SUBCOOL=DITTUS BOELTER, SATURAT  STP12430
                 B 14HE=JENS LOTTES),                 31X,7HSIGHF =, F8.2,    5X, 1H*) STP12440
      124     584 FORMAT( 7X,                                                       STP12450
                 A 52H*   (43)  COOLANT IS *ATER  (TOM,S CORRELATION)       ,53X,   STP12460
                 B                                   7HSIGHF = ,F8.2,   5X,1H*)      STP12470
      125     589 FORMAT( 7X,                                                       STP12480
                 A 52H*   (43)  COOLANT NOT SPECIFIED,FILM COEFFICIENT IS  ,F12.2,  STP12490
                 B  9H(W/CM2-C), F14.2,14H(BTU/HR-FT2-F),4X,5HSIGHF,15X,1H*       ) STP12500
      126     590 FORMAT( 7X,                                                       STP12510
                 A 34H*   (44)  FAST FLUX IRRADIATION   ,71X, 7HIFLUX =,I3,10X,1H*) STP12520
      127     591 FORMAT( 7X,                                                       STP12530
                 A 34H*   (44)  THERMAL FLUX IRRADIATION,71X, 7HIFLUX =,I3,10X,1H*) STP12540
      128     633 FORMAT( 7X,                                                       STP12550
                 1 80H*   (45)  FUEL THERMAL EXPANSION IS TAKEN INTO ACCOUNT.       STP12560
                 2                    ,25X,7HNEXP  =,I3,10X,1H*                   ) STP12570
      129     639 FORMAT( 7X,                                                       STP12580
                 A 60H*   (46)  IF(KOOL.GT.0) THE COOLANT TEMPERATURE IS THE SAME , STP12590
                 B 52HTEMPERATURE OF THE CLADDING ID.                KOOL  =,I3,    STP12600
                 C                                                        10X,1H*) STP12610
      130     640 FORMAT( 7X,                                                       STP12620
                 A 84H*   (55)  NUMBER OF AXIAL SEGMENTS  (LIMIT OF 20)             STP12630
                 B                    ,21X, 7HNPO*  =,I3,10X,1H*                 ) STP12640
      131     641 FORMAT( 7X,                                                       STP12650
                 1 80H*   (  )  FUEL DENSIFICATION IS TAKEN INTO ACCOUNT.           STP12660
                 2                    ,25X,   7HMDEN  =,  I3, 10X,1H*            ) STP12670
      132     645 FORMAT(7X,                                                        STP12680
                 1 60H*   (  )  FABRICATE SINTERING TEMPERATURE  (DEG C)            ,STP12690
                 2 45X,7HSINTEM=,F6.1,7X,1H*)                                       STP12700
      133     651 FORMAT( 7X,                                                       STP12710
                 1 80H*   (  )  FUEL RELOCATION MODEL IS USED.                      STP12720
                 2                    ,25X, 7HMRELOC= , I3, 10X,1H*              ) STP12730
      134     655 FORMAT( 7X,                                                       STP12740
                 1 80H*   (  )  RESTRUCTURING CALCULATION IS NOT PERFORMED          STP12750
                 2                    ,25X,7HMREST = , I3, 10X,1H*               ) STP12760
      135     656 FORMAT( 7X,                                                       STP12770
                 1 80H*   (  )  RESTRUCTURING CALCULATION IS PERFORMED              STP12780
                 2                    ,25X,7HMREST = , I3, 10X,1H*               ) STP12790
            C    *    1    *    2    *    3    *    4    *    5    *    6    *    7 STP12800
            C*****************************************************************STP12810
      136         END                                                               STP12820
```

* SOURCE STATEMENT *

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      SUBROUTINE STEP2(KS)                                              STP20010
C                                                                       STP20020
C     THIS SUBROUTINE IS CALLED FROM MAIN                               STP20030
C                                                                       STP20040
      REAL  MUF,MOL,MOLEFR,MOLFR                                        STP20050
      COMMON /IYIELD/ IYIELD                                            STP20060
         COMMON /MCONV / MCONV                                          STP20070
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  STP20080
     1                PKPOWR,IPEAK,DELP,PMAX                            STP20090
      COMMON /BRNRAY/ VOLCC,A1Z,A7Z,A8Z,A9Z,A10Z                        STP20100
      COMMON /DATA 1/ ZR(7,6),ZR4(7,6),ST(7,26),TABLE(2, 80)            STP20110
      COMMON /DATA 4/ PI,CCPRIN3,SECDAY,AVOGAD,RR,CONEN                 STP20120
      COMMON /DATA 6/ NZR2,NZR4,NST                                     STP20130
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) STP20140
      COMMON /COM 12/ DENSIT,FR38,FR39                                  STP20150
      COMMON /COM 14/ KCON                                              STP20160
      COMMON /COM 20/ RHO,RHOS,FRUU,FRPUPU                              STP20170
      COMMON /COM 21/ N,NN,NNN,NF                                       STP20180
      COMMON /COM025/ VOLUME                                            STP20190
      COMMON /COM 90/ VOLGAS,W,HGC                                      STP20200
      COMMON /COM128/ IOUT1,IIPROF                                      STP20210
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI,  STP20220
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, STP20230
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   STP20240
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,STP20250
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   STP20260
     5                DTEMP,ZCLAD,HG,PEAKAVG,MINI,ICDF,ISTOR,ICREP,ISWELLSTP20270
     6                ,NEXP,MEXP,NHIST                                  STP20280
      COMMON /INPUT A/ MREST,LCREP,DDISM,HDISH                          STP20290
      COMMON /POWREF/ POWREF(21)                                        STP20300
      COMMON/DATA 3/ VOLAT(29),FISGR(29)                                STP20310
      COMMON/DIAL/FRDIAL                                                STP20320
      COMMON /NUCLEI/ NUCLEI,A(40,23)                                   STP20330
      DIMENSION YCF(3, 30),RVINCH(20)                                   STP20340
      IF(KS.GT.0) GO TO 10000                                           STP20350
      RHO=DENSIT*FRDEN                                                  STP20360
      RHOS=DENSIT*FRSIN                                                 STP20370
      VOLUME=PI/4.*(DFS**2-DVOIDZ**2)                                   STP20380
      VOLCC=VOLUME                                                      STP20390
      M=RHO*VOLCC                                                       STP20400
      GRPUCC=FRPUO2*RHO                                                 STP20410
      GRUCC=RHO-GRPUCC                                                  STP20420
      UATWT=235.*FR35+238.*FR38                                         STP20430
      FRUU=UATWT/(UATWT+32.)                                            STP20440
      PUATWT=239.*FR39+240.*FR40+241.*FR41                              STP20450
      FRPUPU=PUATWT/(PUATWT+32.0)                                       STP20460
      A1Z=FR38*FRUU*AVOGAD/238.*VOLCC*GRUCC                             STP20470
      A7Z=FR39*FRPUPU*AVOGAD/239.*VOLCC*GRPUCC                          STP20480
      A8Z=FR40*FRPUPU*AVOGAD/240.*VOLCC*GRPUCC                          STP20490
      A9Z=FR41*FRPUPU*AVOGAD/241.*VOLCC*GRPUCC                          STP20500
      A10Z=FR35*FRUU*AVOGAD/235.*VOLCC*GRUCC                            STP20510
      A1=A1Z                                                            STP20520
      A7=A7Z                                                            STP20530
      A8 =A8Z                                                           STP20540
      A9 =A9Z                                                           STP20550
      A10=A10Z                                                          STP20560
      IF(NOH) 3,3,2                                                     STP20570
    2 WRITE(6,601) NOH                                                  STP20580
      GO TO 4                                                           STP20590
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* SOURCE STATEMENT (STEP2)*

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    3 WRITE(6,602) NOH                                                  STP20600
    4 CONTINUE                                                          STP20610
C                                                                       STP20620
C     CLADDING CREEP OPTION PRINT                                       STP20630
C                                                                       STP20640
      IF(ICREP.LT.0) WRITE(6,611) ICREP                                 STP20650
      IF(ICREP.GT.0) WRITE(6,617) ICREP                                 STP20660
      IF(LCREP.EQ.1) WRITE(6,821) LCREP                                 STP20670
C                                                                       STP20680
C     CLADDING ELASTIC DEFORMATION OPTION PRINT                         STP20690
C                                                                       STP20700
      IF(ICDF.LT.0) WRITE(6,621) ICDF                                   STP20710
C                                                                       STP20720
C     FUEL SWELLING OPTION PRINT                                        STP20730
C                                                                       STP20740
      IF(ISWELL.EQ.1) WRITE(6,632) ISWELL                               STP20750
      IF(ISWELL.EQ.2) WRITE(6,633) ISWELL                               STP20760
C                                                                       STP20770
C     STORED ENERGY OPTION PRINT                                        STP20780
C                                                                       STP20790
      IF(ISTOR) 73,71,71                                                STP20800
   71 WRITE(6,641) ISTOR                                                STP20810
      GO TO 74                                                          STP20820
   73 WRITE(6,643) ISTOR                                                STP20830
   74 CONTINUE                                                          STP20840
C                                                                       STP20850
C     PEAK OR AVERAGE SELECT OPTION PRINT                               STP20860
C                                                                       STP20870
      IF(IPEAK) 81,81,82                                                STP20880
   81 WRITE(6,651) IPEAK                                                STP20890
      GO TO 83                                                          STP20900
   82 WRITE(6,653) IPEAK                                                STP20910
   83 CONTINUE                                                          STP20920
      IF(IOUT1) 84,84,86                                                STP20930
   84 WRITE(6,661) IOUT1                                                STP20940
      GO TO 86                                                          STP20950
   86 CONTINUE                                                          STP20960
      IF(IIPROF.EQ.1) WRITE(6,680) IIPROF                               STP20970
C                                                                       STP20980
      IF(MEXP.GT.0) WRITE(6,691) MEXP                                   STP20990
C                                                                       STP21000
      IF(MCONV.EQ.0) WRITE(6,701) MCONV                                 STP21010
      IF(MCONV.EQ.1) WRITE(6,702) MCONV                                 STP21020
C                                                                       STP21030
C     CLADDING YIELD STRENGTH OPTION PRINT                              STP21040
C                                                                       STP21050
      IF(IYIELD.EQ.0) WRITE(6,710) IYIELD                               STP21060
C                                                                       STP21070
      IF(NHIST.EQ.0) WRITE(6,720) NHIST                                 STP21080
      IF(NHIST.EQ.1) WRITE(6,721) NHIST                                 STP21090
      IF(NUCLEI.EQ.1) WRITE(6,725) NUCLEI                               STP21100
      WRITE(6,902)                                                      STP21110
      RETURN                                                            STP21120
C     ================================================================STP21130
C                                                                       STP21140
10000 CONTINUE                                                          STP21150
      GO TO (1111,2222,3333,4444,5555,6666,7777), KS                    STP21160
 1111 CONTINUE                                                          STP21170
      RETURN                                                            STP21180
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* SOURCE STATEMENT (STEP2   )*

      C=====================================================================STP21190
 86    2222 CONTINUE                                                        STP21200
      C                                                                     STP21210
      C     THERMAL CONDUCTIVITY OF FUEL PRINT                              STP21220
      C                                                                     STP21230
 87         IF(NEWK.GT.0) WRITE(6,903)                                      STP21240
 88         IF(NCON) 200,205,210                                            STP21250
 89     200 KCON = NCON * (-1)                                              STP21260
 90         IF(KCON.EQ.2) WRITE(6,732) NCON                                 STP21270
 91         IF(KCON.EQ.2.AND.FRDEN.LT..95) KCON = 1                         STP21280
 92         IF(KCON.EQ.3) WRITE(6,733) NCON                                 STP21290
 93         IF(KCON.EQ.4) WRITE(6,734) NCON                                 STP21300
 94         IF(KCON.EQ.5) WRITE(6,735) NCON                                 STP21310
 95         GO TO 220                                                       STP21320
 96     205 WRITE(6,1001) NCON                                              STP21330
 97         STOP                                                            STP21340
 98     210 KCON = -1                                                       STP21350
 99         WRITE(6,736) NCON                                               STP21360
100         GO TO 220                                                       STP21370
101     220 WRITE(6,900)                                                    STP21380
102         IF(NCON) 230,230,260                                            STP21390
103     230 GO TO (231,231,260,260,260,260       ),KCON                     STP21400
104     231 DO 250 J=1,11                                                   STP21410
105         TEMP=300.+FLOAT(J-1)                                            STP21420
106         CF(1,J)=TEMP                                                    STP21430
107         CF(3,J) = FCOND(FRSIN,TEMP+273.,KCON)                           STP21440
108         IF(FRDEN.GE..95) GO TO 232                                      STP21450
109         CF(2,J) = FCOND(FRDEN,TEMP+273.,KCON)                           STP21460
110         GO TO 250                                                       STP21470
111     232 CF(2,J) = FCOND(FRDEN,TEMP+273.,KCON)                           STP21480
112     250 CONTINUE                                                        STP21490
113         NN = 11                                                         STP21500
114         GO TO 290                                                       STP21510
115     260 DO 270 J=1,11                                                   STP21520
116         TEMP=300.+FLOAT(J-1)                                            STP21530
117         CF(1,J)=(TEMP)                                                  STP21540
118         CF(2,J) = FCOND(FRDEN,TEMP+273.,KCON)                           STP21550
119         CF(3,J) = FCOND(FRSIN,TEMP+273.,KCON)                           STP21560
120     270 CONTINUE                                                        STP21570
121         NNN=11                                                          STP21580
122         GO TO 290                                                       STP21590
123     280 NNN = NCON                                                      STP21600
124     290 DO 295 J = 1,NNN                                                STP21610
125         YCF(1,J) = CF(1,J) * 1.8 + 32.                                  STP21620
126         YCF(2,J) = CF(2,J)*57.8                                         STP21630
127         YCF(3,J) = CF(3,J)*57.8                                         STP21640
128     295 CONTINUE                                                        STP21650
129         WRITE(6,740) (((CF(I,J),YCF(I,J),I=1,3),J=1,NNN)                STP21660
130         WRITE(6,900)                                                    STP21670
131         WRITE(6,902)                                                    STP21680
132         RETURN                                                          STP21690
      C=====================================================================STP21700
133    3333 CONTINUE                                                        STP21710
      C                                                                     STP21720
      C     CLADDING PROPERTIES PRINT                                       STP21730
      C                                                                     STP21740
134         IF(NEWK.GT.0) GO TO 300                                         STP21750
135         WRITE(6,903)                                                    STP21760
136     300 CONTINUE                                                        STP21770
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* SOURCE STATEMENT (STEP2   )*

137         WRITE(6,900)                                                    STP21780
138         IF(NCLAD.GE.1) WRITE(6,751) NCLAD                               STP21790
139         IF(NCLAD.EQ.-2) WRITE(6,752) NCLAD                              STP21800
140         IF(NCLAD.EQ.-4) WRITE(6,754) NCLAD                              STP21810
141         IF(NCLAD.EQ.-9) WRITE(6,759) NCLAD                              STP21820
142         IF(NCLAD.NE.-2) GO TO 320                                       STP21830
143         NN = NZR2                                                       STP21840
144         DO 310 I=1,7                                                    STP21850
145         DO 310 J=1,NZR2                                                 STP21860
146     310 AA(I,J) = ZR(I,J)                                               STP21870
147         GO TO 370                                                       STP21880
148     320 IF(NCLAD.NE.-4) GO TO 340                                       STP21890
149         NN = NZR4                                                       STP21900
150         DO 330 I=1,7                                                    STP21910
151         DO 330 J=1,NZR4                                                 STP21920
152     330 AA(I,J) = ZR4(I,J)                                              STP21930
153         GO TO 370                                                       STP21940
154     340 IF(NCLAD.NE.-9) GO TO 360                                       STP21950
155         NN = NST                                                        STP21960
156         DO 350 I=1,7                                                    STP21970
157         DO 350 J=1,NST                                                  STP21980
158     350 AA(I,J) = ST(I,J)                                               STP21990
159         GO TO 370                                                       STP22000
160     360 CONTINUE                                                        STP22010
      C                                                                     STP22020
      C     CLADDING MATERIAL SPECIFICATION ERROR PRINT                     STP22030
      C                                                                     STP22040
161         WRITE(6,760) NCLAD                                              STP22050
162         STOP                                                            STP22060
163     370 CONTINUE                                                        STP22070
164         IF(NCLAD.GE.1) NN=NCLAD                                         STP22080
165         WRITE(6,770) IYIELD                                             STP22090
166         WRITE(6,900)                                                    STP22100
167         WRITE(6,781)                                                    STP22110
168         WRITE(6,900)                                                    STP22120
169         DO 380 J=1,NN                                                   STP22130
170     380 WRITE(6,790) (AA(I,J),I=1,7)                                    STP22140
171         WRITE(6,902)                                                    STP22150
172         RETURN                                                          STP22160
173    4444 CONTINUE                                                        STP22170
      C=====================================================================STP22180
      C                                                                     STP22190
      C     FLUX DEPRESSION PRINT                                           STP22200
      C                                                                     STP22210
174         IF(NEWK.GT.0.OR.NEWCL.GT.0) GO TO 400                           STP22220
175         WRITE(6,903)                                                    STP22230
176     400 CONTINUE                                                        STP22240
177         WRITE(6,900)                                                    STP22250
178         DO 410 J=1,NF                                                   STP22260
179     410 RVINCH(J) = RV(1,J) / 2.54                                      STP22270
180         WRITE(6,900)                                                    STP22280
181         WRITE(6,810) NFLX,(RV(1,J),RVINCH(J),RV(2,J),J=1,NF)            STP22290
182         WRITE(6,902)                                                    STP22300
183         RETURN                                                          STP22310
184    5555 CONTINUE                                                        STP22320
      C                                                                     STP22330
      C     CORRECTED F.P. GAS RELEASE RATE PRINT OUT                       STP22340
      C                                                                     STP22350
185         IF(FPDIAL.LE.0.0) PRINT 907,FPDIAL                              STP22360
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* SOURCE STATEMENT (STEP2   )*

      PRINT 903                                                         STP22370
      DO 510 I = 1 , 29                                                 STP22380
      FISGR(I)=FISGR(I)*FPDIAL                                          STP22390
      IF(FISGR(I).GE.1.0) FISGR(I) = 1.                                 STP22400
  510 CONTINUE                                                          STP22410
      PRINT 901                                                         STP22420
      PRINT 904,FPDIAL                                                  STP22430
      PRINT 905                                                         STP22440
      DO 515 I = 1 , 29                                                 STP22450
      PRINT 906,VOLAT(I),FISGR(I)                                       STP22460
  515 CONTINUE                                                          STP22470
      PRINT 902                                                         STP22480
      RETURN                                                            STP22490
 6666 CONTINUE                                                          STP22500
 7777 CONTINUE                                                          STP22510
      RETURN                                                            STP22520
C     *    1    *    2    *    3    *    4    *    5    *    6    *    7 STP22530
  601 FORMAT( 7X,                                                       STP22540
     A 84H*   (57)  THE HYDROGEN IS ASSUMED TO REACT WITH THE CLADDING  STP22550
     B                    ,21X, 7HNOM   =,I3,10X,1H*                  ) STP22560
  602 FORMAT( 7X,                                                       STP22570
     A 84H*   (57)  HYDROGEN IS ASSUMED TO REMAIN IN FUEL PIN           STP22580
     B                    ,21X, 7HNOM   =,I3,10X,1H*                  ) STP22590
  621 FORMAT( 7X,                                                       STP22600
     A105H*   (60)  ELASTIC CLAD DEFLECTION TAKEN INTO ACCOUNT.         STP22610
     B                                        ,7HICOF  =,I3,10X,1H*)    STP22620
  632 FORMAT( 7X,                                                       STP22630
     A105H*   ( )  GEITHOFF, ET AL, MODEL IS USED.                      STP22640
     B                                        ,7HISWELL=,I3,10X,1H*)    STP22650
  633 FORMAT( 7X,                                                       STP22660
     A105H*   ( )  REVISED GAP CLOSURE MODEL IS USED.                   STP22670
     B                                        ,7HISWELL=,I3,10X,1H*)    STP22680
  641 FORMAT( 7X,                                                       STP22690
     A105H*   (62)  STORED ENERGY CALCULATION IS NOT PERFORMED.         STP22700
     B                                        ,7HISTOR =,I3,10X,1H*)    STP22710
  643 FORMAT( 7X,                                                       STP22720
     A105H*   (62)  STORED ENERGY CALCULATION IS PERFORMED.             STP22730
     B                                        ,7HISTOR =,I3,10X,1H*)    STP22740
  651 FORMAT( 7X,                                                       STP22750
     A105H*   (63)  A PEAK POWER NEEDS TO BE INPUT.                     STP22760
     B                                        ,7HIPEAK =,I3,10X,1H*)    STP22770
  653 FORMAT( 7X,                                                       STP22780
     A105H*   (63)  AN AVERAGE POWER NEEDS TO BE INPUT.                 STP22790
     B                                        ,7HIPEAK =,I3,10X,1H*)    STP22800
  611 FORMAT( 7X,                                                       STP22810
     A 95H*   ( )  CLADDING CREEP VALUES DETERMINED FROM                STP22820
     2                                   ,10X,7HICREP =,I3,10X,1H*)     STP22830
  617 FORMAT( 7X,                                                       STP22840
     A105H*   (59)  A TABLE OF TIME VERSUS CLADDING CREEP DOWN VALUES MUSTP22850
     BST BE USED. ICREP=THE NUMBER OF CARDS.      ,7HICREP =,I3,10X,1H*) STP22860
  661 FORMAT( 7X,                                                       STP22870
     A  80H*   (64)  OPTIONAL EQUATION LIST DID NOT PRINT               STP22880
     B                    ,25X,7HIOUT1 = ,I3, 10X, 1H* )                STP22890
  662 FORMAT( 7X,                                                       STP22900
     A  80H*   (64)  OPTIONAL EQUATION LIST IS PRINTED                  STP22910
     B                    ,25X,7HIOUT1 = ,I3, 10X, 1H* )                STP22920
  663 FORMAT( 7X,                                                       STP22930
     A  80H*   (65)  RADIUS TEMPERATURE PROFILE IN FUEL PIN IS PRINTED  STP22940
     B                    ,25X,7HIIPROF= , I3,10X, 1H* )                STP22950
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* SOURCE STATEMENT (STEP2   )*

  691 FORMAT( 7X,                                                       STP22960
     A 80H*   ( )  FUEL THERMAL EXPANSION IS TAKEN INTO ACCOUNT.      , STP22970
     B                                   45X ,7HMEXP  =,I3,10X,1H*)     STP22980
  701 FORMAT( 7X,                                                       STP22990
     1 80H*   (67)  GAPCON-THERMAL-1 ORIGINAL CONVERGENCE METHOD IS USEDSTP23000
     2                         ,25X,7HMCONV = , I3, 10X,1H*           ) STP23010
  702 FORMAT( 7X,                                                       STP23020
     1 80H*   (68)  NEWTON RAPHSON METHOD IS USED                       STP23030
     2                         ,25X,7HMCONV = , I3, 10X,1H*           ) STP23040
  710 FORMAT( 7X,                                                       STP23050
     A105H*   ( )  YIELD STRENGTH IS USED FROM TABLE DATA WHICH IS ASSISTP23060
     BGNED BY NCLAD                                   ,7HIYIELD=,I3,10X,1H*) STP23070
  720 FORMAT( 7X,                                                       STP23080
     1 35H*   ( )  TIME DEPENDENT HISTORY   ,70X,7HNHIST =,I3,10X,1H*) STP23090
  721 FORMAT( 7X,                                                       STP23100
     1 35H*   ( )  BURNUP DEPENDENT HISTORY ,70X,7HNHIST =,I3,10X,1H*) STP23110
  725 FORMAT( 7X,                                                       STP23120
     1 42H*   ( )  FISSION PRODUCTS YIELD PRINT OUT,63X,7HNUCLE1=,      STP23130
     2                                                 I3,10X,1H*)      STP23140
  732 FORMAT( 7X,                                                       STP23150
     A 84H*   (48)  FUEL THERMAL CONDUCTIVITY VALUES DETERMINED FROM WARSTP23160
     BD DESIGN EQUATIONS    ,21X, 7H(NCON)=, I3,10X,1H*                ) STP23170
  733 FORMAT( 7X                                                        STP23180
     A 84H*   (48)  FUEL THERMAL CONDUCTIVITY VALUES DETERMINED FROM DATSTP23190
     BA OF GODFREY, ET AL   ,21X, 7H(NCON)=, I3,10X,1H*                ) STP23200
  734 FORMAT( 7X                                                        STP23210
     A 84H*   (48)  FUEL THERMAL CONDUCTIVITY VALUES DETERMINED FROM DATSTP23220
     BA OF LYONS  , ET AL   ,21X, 7H(NCON)=, I3,10X,1H*                ) STP23230
  735 FORMAT( 7X                                                        STP23240
     A 84H*   (48)  FUEL THERMAL CONDUCTIVITY VALUES DETERMINED FROM RESSTP23250
     2AK-41 EQUATION        ,21X, 7H(NCON)=, I3,10X,1H*                ) STP23260
  736 FORMAT( 7X,                                                       STP23270
     A 84H*   (48)  FUEL THERMAL CONDUCTIVITY VALUES WERE INPUTTED      STP23280
     B                    ,21X, 7H(NCON)=, I3,10X,1H*                  ) STP23290
  740 FORMAT( 7X,1H*,17X,'TEMPERATURE',46X,'THERMAL CONDUCTIVITY',30X    STP23300
     1      ,1H* /7X,1H*,124X,1H* / 7X,1H*,54X,'UNRESTRUCTURED FUEL'    STP23310
     2       ,21X,'RESTRUCTURED FUEL',13X,1H* / 7X,1H*,7X,29(1H-),14X   STP23320
     3       ,28(1H-),10X,28(1H-), 8X,1H*/ 7X,1H*,10X,'(DEG C)',8X      STP23330
     4       ,'(DEG F)',18X,' (WATT/CM-C)   (BTU/HR-FT-F)',10X          STP23340
     5       ,' (WATT/CM-C)   (BTU/HR-FT-F)', 8X,1H*/ 7X,1H*,124X,1H* / STP23350
     6       (7X,1H*,7X,F10.0,4X,F10.0,18X,F10.3,5X,F10.3,13X,F10.3     STP23360
     7       , 5X,F10.3,12X,1H*)                                        ) STP23370
  751 FORMAT( 7X,                                                       STP23380
     A 84H*   (50)  CLADDING NOT SPECIFIED, PROPERTIES WERE INPUTTED    STP23390
     B                    ,21X,8H(NCLAD)=, I3, 9X,1H*                  ) STP23400
  752 FORMAT( 7X,                                                       STP23410
     A 34H*   (51)  CLADDING IS ZIRCALOY-2  ,71X,8H(NCLAD)=,I3, 9X,1H*) STP23420
  754 FORMAT( 7X,                                                       STP23430
     A 34H*   (51)  CLADDING IS ZIRCALOY-4  ,71X,8H(NCLAD)=,I3, 9X,1H*) STP23440
  759 FORMAT( 7X,                                                       STP23450
     A 41H*   (50)  CLADDING IS 316 STAINLESS STEEL,64X,                STP23460
     B 8H(NCLAD)=, I3, 9X,1H*                                           ) STP23470
  760 FORMAT(5X, 36HCLADDING MATERIAL SPEC. ERROR NCLAD=,  I3 ,         STP23480
     1 10H  STEP2                                                       ) STP23490
  770 FORMAT( 7X, 1H*, 104X                    ,8H IYIELD=,I3, 9X,1H* )STP23500
  781 FORMAT( 7X, 1H*,10X, 40HTEMPERATURE      THERMAL          YIELD   STP23510
     A       ,7X,50HYOUNGS        POISSONS       THERMAL        MAYE,   STP23520
     B  1HR ,16X, 1H* /7X, 1H*,24X,  30HCONDUCTIVITY      STRENGTH     STP23530
     C       , 3X,50HMODULUS        RATIO        EXPANSION       HARDN  STP23540
```

```
* SOURCE STATEMENT (STEP2   )*
                 D  3HESS,14X,1H* /7X, 1H*,87X,   6HCOEFF. , 31X,            1H*/7X,STP23550
                 E  1H*, 12X,50H(DEG C)        (*/CM/C)        (KG/CM2)       (KG/CM  STP23560
                 F  2H2),24X,21H( /C)        (KG/CM2) , 15X,1H*                  ) STP23570
 236     790 FORMAT( 7X,1H*,F20.1,F14.5,F15.1,E17.5,F13.3,E17.5,F13.1,15X,1H*) STP23580
 237     810 FORMAT(7X,                                                          STP23590
                 1 70H*   (54)  FLUX DEPRESSION VALUES USED                      STP23600
                 2                        ,35X,7H(NFLX)=, I3,10X,1H*  /          STP23610
                 3       2(7X,1H*,124X,1H* /) 7X,1H*,27X,'DIAMETER',36X,'FLUX RATIO' STP23620
                 4  ,43X,1H* / 7X,1H*,21X,'( CM )',9X,'(INCH)',82X,1H* /         STP23630
                 5       , 7X,1H*,124X,1H* / (7X,1H*,17X,F10.4,5X,F10.4,27X,F10.4 STP23640
                 6  ,45X, 1H*    )                                               ) STP23650
 238     820 FORMAT( 7X,                                                         STP23660
                 1 84H*   (  )  FUEL NOT CREEP                                   STP23670
                 2                        ,21X, 7HLCREP =,I3,10X,1H*             ) STP23680
 239     821 FORMAT( 7X,                                                         STP23690
                 1 84H*   (  )  FUEL CREEP                                       STP23700
                 2                        ,21X, 7HLCREP =,I3,10X,1H*             ) STP23710
 240     900 FORMAT( 7X,1H*,124X,1H* )                                           STP23720
 241     901 FORMAT(7X,1H*,124X,1H* / 7X,1H*,124X,1H* )                          STP23730
 242     902 FORMAT(  7X,1H*,124X,1H* /   7X,126(1H*)                            ) STP23740
 243     903 FORMAT(1H1 / 7X,126(1H*), / 7X,1H*,124X,1H* )                       STP23750
 244     904 FORMAT( 7X,                                                         STP23760
                 1 84H*   (  )  F.P. GAS RELEASE RATE CONTROL DIAL               STP23770
                 2                        ,21X, 7HFPDIAL=,F5.3,8X,1H* /          STP23780
                 3  7X,1H*,124X,1H* )                                            STP23790
 245     905 FORMAT(7X,1H*,10X,40HVOLUME AVG. TEMP.(C)      RELEASE RATE         STP23800
                 1       74X,1H* / 7X,1H*,124X,1H* )                             STP23810
 246     906 FORMAT(7X,1H*,20X,F10.2,5X,F12.6,77X,1H* )                          STP23820
 247     907 FORMAT(// 10(1H*), ' CAUTION FPDIAL NEGATIVE  FPDIAL=',F3.1, /)     STP23830
                                                                                 STP23840
         C
 248    1001 FORMAT(5X, 47HFUEL THERMAL CONDUCTIVITY SPEC. NO ERROR NCON= ,I3,   STP23850
                 1 10H  STEP2                                                    ) STP23860
         C   *    1    *    2    *    3    *    4    *    5    *    6    *    7  STP23870
         C*****************************************************************STP23880
 249             END                                                             STP23890
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP3                                                  STP30010
C     THIS SUBROUTINE IS CALLED FROM ST3TO8                             STP30020
C                                                                       STP30030
      REAL  MUF,MOL,MOLEFR,MOLFR                                        STP30040
      COMMON /COM39 / HFLUX(20)                                         STP30050
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                  STP30060
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) STP30070
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             STP30080
      COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP                  STP30090
      COMMON /COM 08/ II,JCASE,TCOOLF,XMOTOT                            STP30100
      COMMON /COM 21/ K,NN,NNN,NF                                       STP30110
      COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TH,THR                    STP30120
      COMMON /COM 38/ QOVRAB,QOVRAC,QOVRAS,HF                           STP30130
      COMMON /COM357/ TAVGC                                             STP30140
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPU02,FR35,FR40,FR41,DFS,DCI,  STP30150
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, STP30160
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   STP30170
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,STP30180
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   STP30190
     5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICOF,ISTOR,ICREP,ISWELLSTP30200
     6                ,NEXP,MEXP,NHIST                                  STP30210
      COMMON /COM3P/ TSAT                                               STP30220
C     ******************************************************************STP30230
      QOVRAC=P       /(PI*(DCO+2,*DELRCO))                              STP30240
      HFLUX(IPOW)=QOVRAC                                                STP30250
      QOVRAI=P       /(PI*(DCI+2,*DELRC))                               STP30260
      QOVRAS=P       /(PI*(DFS+2,*DELR))                                STP30270
      IF(KOOL.GT.0) GO TO 680                                           STP30280
      IF(SIGHF) 590,600,610                                             STP30290
  590 CONTINUE                                                          STP30300
C                                                                       STP30310
C     CLADDING-TO-COOLANT HEAT TRANSFER COEFFICIENT OF WATER            STP30320
C                                                                       STP30330
C     KDJ=1 ..DITTUS BOELTER,         KDJ=2 ..JENS LOTTES               STP30340
C     KDJ=3 SUBCOOL...DITTUS-BOELTER , BOILING...JENS-LOTTES            STP30350
      KDJ=-1*IFIX(SIGHF)                                                STP30360
C     ************************    CALL HTCW    ************************STP30370
      CALL HTCW(KDJ,TCOOL,QOVRAC,V,DE,HF,TCO,EXTP,TSAT)                 STP30380
      GO TO 630                                                         STP30390
C     ************************    CALL HTCLM    ***********************STP30400
  600 CALL HTCLM (HF,TCOOL,DE,V)                                        STP30410
      GO TO 620                                                         STP30420
  610 HF=SIGHF                                                          STP30430
  620 CONTINUE                                                          STP30440
C     *************                                        HHHHHHHHHHH  STP30450
      IF(HF.LE.0.0) TCO = TCOOL                                         STP30460
      IF(HF.LE.0.0) GO TO 630                                           STP30470
C     *************                                        HHHHHHHHHHH  STP30480
      TCO=TCOOL+QOVRAC/HF                                               STP30490
  630 CONTINUE                                                          STP30500
      TAVGC=TCO+20.                                                     STP30510
      QOVRAA=(QOVRAC+QOVRAI)/2.                                         STP30520
      IITRY=1                                                           STP30530
  640 CONTINUE                                                          STP30540
      IN1 = 7                                                           STP30550
      IN2 = 30                                                          STP30560
      TCC = TERP(TAVGC,AA,2,NN,IN1,IN2,IN3,31)                          STP30570
      IITRY=IITRY+1                                                     STP30580
      DELTC=QOVRAA*(DCO+2,*DELRCO-DCI-2,*DELRC)/(2,0*TCC)               STP30590
```


* SOURCE STATEMENT (STEP3)*

```
      TCI=TCO+DELTC                                                     STP30600
      TAVGC1=(TCO+TCI)/2.                                               STP30610
      DEL=ABS(TAVGC1-TAVGC)                                             STP30620
      IF(DEL-0.55) 670,670,650                                          STP30630
  650 TAVGC=TAVGC1                                                      STP30640
      IF(IITRY-50) 640,640,660                                          STP30650
  660 WRITE(6,1470)                                                     STP30660
  670 CONTINUE                                                          STP30670
      GO TO 690                                                         STP30680
  680 TCI=TCOOL                                                         STP30690
      TAVGC=TCI-20.                                                     STP30700
      QOVRAA=(QOVRAC+QOVRAI)/2.                                         STP30710
      IITRY=0                                                           STP30720
      IN1=7                                                             STP30730
      IN2=30                                                            STP30740
  682 CONTINUE                                                          STP30750
      IITRY=IITRY+1                                                     STP30760
      TCC=TERP(TAVGC,AA,2,NN,IN1,IN2,IN3,32)                            STP30770
      DELTC=QOVRAA*(DCO+2,*DELRCO-DCI-2,*DELRC)/(2,0*TCC)               STP30780
      TCO=TCI-DELTC                                                     STP30790
      TAVGC1=(TCO+TCI)/2.                                               STP30800
      DEL=ABS(TAVGC-TAVGC1)                                             STP30810
      IF(DEL-0.55) 688,688,684                                          STP30820
  684 TAVGC=TAVGC1                                                      STP30830
      IF(IITRY-50) 682,682,686                                          STP30840
  686 WRITE(6,1470)                                                     STP30850
  688 CONTINUE                                                          STP30860
      HF=0.0                                                            STP30870
  690 CONTINUE                                                          STP30880
      QOVRAG=(QOVRAS+QOVRAI)/2.                                         STP30890
C                                                                       STP30900
C     SET UP SYSTEM OF N NODES OF EQUAL THICKNESS, RADII IN FEET        STP30910
C                                                                       STP30920
      TFS=TCI+QOVRAG/HG                                                 STP30930
      RETURN                                                            STP30940
 1470 FORMAT(10X,'NO CONVERGENCE IN TCC     STEP3'                    ) STP30950
C*********************************************************************STP30960
      END                                                               STP30970
```

* SOURCE STATEMENT *

```
 1        SUBROUTINE STEP4                                                STP40010
C                                                                        STP40020
C        THIS SUBROUTINE IS CALLED FROM ST3TO8                           STP40030
C                                                                        STP40040
 2        REAL  MUF,MOL,MOLEFR,MOLFR                                      STP40050
 3        COMMON /POWRAY/ PAVRG,FUELL,FL,PO*ER(21),AI(21),NPOW,PTOT,LPMAX, STP40060
         1               PKPOWR,IPEAK,DELP,PMAX                           STP40070
 4        COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                STP40080
 5        COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) STP40090
 6        COMMON /COM  1/ TT( 51),TSR( 51),QIN(51),Q(51),TS(51),CLCRP(2,20) STP40100
 7        COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                           STP40110
 8        COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP                STP40120
 9        COMMON /COM 04/ RSINF,QQS,QQU,QTOT                              STP40130
10        COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                STP40140
11        COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                          STP40150
12        COMMON /COM 14/ KCON                                            STP40160
13        COMMON /COM 21/ N,NN,NNN,NF                                     STP40170
14        COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TH,THR                  STP40180
15        COMMON /COM49P/ DC(20,51),IPROF                                 STP40190
16        COMMON /COM048/ DSIN,RSIN,TSIN,TSINC,DVOID,RVOID,T              STP40200
17        COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI, STP40210
         1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, STP40220
         2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,  STP40230
         3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,STP40240
         4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,  STP40250
         5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELLSTP40260
         6                ,NEXP,MEXP,NHIST                                STP40270
14        COMMON /RESTRU/ ISINT,RVOIDX,VVOIDC,VLENGT                      STP40280
19        COMMON /INPUT A/ MREST,LCREP,DDISH,HDISH                        STP40290
C                                                                        STP40300
20        N=50                                                            STP40310
21        DR=(RFS+DELR-RVOID)/FLOAT(N)                                    STP40320
22        RO=(RFS+DELR)                                                   STP40330
23        DO 700 I=1,N                                                    STP40340
C                                                                        STP40350
24        R=RO-DR*(I-1)                                                   STP40360
25        DD =(2.*R-DR)                                                   STP40370
26        IN1 = 2                                                         STP40380
27        IN2 = 20                                                        STP40390
28        DDD=RFS/RO*DD                                                   STP40400
29        RATIO = TERP(DDD,RV,2,NF,IN1,IN2,IN3,41)                        STP40410
30        RDR=R-DR                                                        STP40420
31        IF(RDR.GE.RSIN ) Q(I)=PI*(R**2-RDR**2)*RATIO*QQU                STP40430
32        IF(RDR.LT.RSIN .AND.R.GT.RSIN ) Q(I)=((R**2-RSIN **2)*QQU+(RSIN **STP40440
         *2-RDR**2)*QES)*PI*RATIO                                         STP40450
33        IF(RDR.LT.RSIN .AND.R.LE.RSIN ) Q(I)=PI*(R**2-RDR**2)*RATIO*QQS STP40460
34    700 CONTINUE                                                        STP40470
C                                                                        STP40480
C        CORRECT FOR ACCUMULATION OF ERROR IN HEAT GENERATION            STP40490
C                                                                        STP40500
35        SUMQ=0.                                                         STP40510
36        DO 710 I=1,N                                                    STP40520
37    710 SUMQ=SUMQ+Q(I)                                                  STP40530
C                                                                        STP40540
38        IF(SUMQ.LE.0.0) CORR = 1.0                                      STP40550
39        IF(SUMQ.LE.0.0) GO TO 715                                       STP40560
C        *************                                                   STP40570
40        CORR=QTOT/SUMQ                                                  STP40580
41    715 CONTINUE                                                        STP40590
```


* SOURCE STATEMENT (STEP4)*

```
42        DO 720 I=1,N                                                    STP40600
43    720 Q(I)=CORR*Q(I)                                                  STP40610
44        ACC=1.                                                          STP40620
45        QIN(1)=QTOT-Q(1)                                                STP40630
46        DO 730 I=2,N                                                    STP40640
47    730 QIN(I)=QIN(I-1)-Q(I)                                            STP40650
48        IME=0                                                           STP40660
49        DO 860 I=1,N                                                    STP40670
50        R=(RFS+DELR)-     DR*FLOAT(I-1)                                 STP40680
51        RDR=R-DR                                                        STP40690
52        IF(I.GT.1) GO TO 740                                            STP40700
53        TAV=TFS                                                         STP40710
54        TZ=TFS                                                          STP40720
55        GO TO 750                                                       STP40730
56    740 TAV=TT(I-1)                                                     STP40740
57        TZ=TT(I-1)                                                      STP40750
58    750 CONTINUE                                                        STP40760
59        DEN=FRDEN                                                       STP40770
60        IF(R.LE.RSIN ) DEN=FRSIN                                        STP40780
61    760 TAVK = TAV + 273.                                               STP40790
62        IF(NCON) 770,780,800                                            STP40800
63    770 C = FCOND(DEN,TAVK,KCON)                                        STP40810
64        GO TO 810                                                       STP40820
65    780 WRITE(6,1910) NCON                                              STP40830
66        STOP                                                            STP40840
67    800 KK=2                                                            STP40850
68        IF(R.LE.RSIN ) KK=3                                             STP40860
69        IN1 = 3                                                         STP40870
70        IN2 = 30                                                        STP40880
71        C = TERP(TAV,CF,KK,NNN,IN1,IN2,IN3,42)                          STP40890
72    810 CONTINUE                                                        STP40900
73        IF(RDR.LT.1.E-20) GO TO 820                                     STP40910
C        *************                                                   STP40920
74        IF(Q(I).LE.0.0) GO TO 820                                       STP40930
C        *************                                                   STP40940
75        TERM=(RDR**2/(R**2-RDR**2)-QIN(I)/Q(I))*ALOG(R/RDR)             STP40950
76        GO TO 830                                                       STP40960
C            Q(I)  =  HEAT RATE IN I RING                                STP40970
C            QIN(I) = TOTAL HEAT RATE UNTIL INNER RING (I-1)             STP40980
C            R  = OUTER RADIUS OF I RING                                 STP40990
C            RDR = INNER RADIUS OF RING I                                STP41000
77    820 TERM=0.                                                         STP41010
78    830 TT(I)=TZ+Q(I)/(2.*PI*C)*(.5-TERM)                               STP41020
79        TAV1=(TZ+TT(I))/2.                                              STP41030
80        TTAV=TAV                                                        STP41040
81        DIFF=ABS(TAV-TAV1)                                              STP41050
82        IF(DIFF-ACC) 860,860,840                                        STP41060
83    840 TAV=TAV1                                                        STP41070
84        IME=IME+1                                                       STP41080
85        IF(IME-10) 760,850,850                                          STP41090
86    850 WRITE(6,1920) TTAV,TAV1                                         STP41100
87    860 IME=0                                                           STP41110
C        DC(1,IPOW,1) = RFS + DELR                                       STP41120
88        DO 870 I=1,N                                                    STP41130
89        TS(I)=(RFS+DELR)-(RFS+DELR-RVOID)*FLOAT(I)/FLOAT(N)             STP41140
C        DC(I,IPOW,1+1) = TS(I)                                          STP41150
90    870 CONTINUE                                                        STP41160
91        BB(3,1) = TFS                                                   STP41170
92        BB(4,1) = RFS                                                   STP41180
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* SOURCE STATEMENT (STEP4   )*
      IN1 = 2                                                           STP41190
      IN2 = 20                                                          STP41200
      DDD = RFS * 2.0                                                   STP41210
      BB(5,1) = TERP(DDD,RV,  2,NF,IN1,IN2,IN3,43)                      STP41220
      DC(  IPOW,1) = TFS                                                STP41230
C     RV(1,I),RV(2,I) ARE DIAMETER AND DEPRESSION FACTOR RESPECTIVELY   STP41240
C     RV IS SETTED IN SUBROUTINE STEP2                                  STP41250
      DO 880 I=1,N                                                      STP41260
      DC(  IPOW,I+1) = TT(I)                                            STP41270
      BB(3,I+1) = BB(1,I) = TT(I)                                       STP41280
      BB(4,I+1) = BB(2,I) = TS(I)                                       STP41290
  880 CONTINUE                                                          STP41300
      IN1 = 2                                                           STP41310
      IN2 = 20                                                          STP41320
      DDD = TS(I) * 2.0                                                 STP41330
      BB(5,I+1) = TERP(DDD,RV,  2,NF,IN1,IN2,IN3,44)                    STP41340
C           ........... MREST RESTRUCTURE OPTION  ( NOW IGNORE )        STP41350
C                                                                       STP41360
C     IF(MREST.LE.0) GO TO 900                                          STP41370
      IF(FRDEN.GE.FRSIN) FRSIN=FRDEN                                    STP41380
      TSINC=1.E20                                                       STP41390
C     **********                                                        STP41400
      IF(TOTLDY.LE.0.0) GO TO 890                                       STP41410
C                                                                       STP41420
C     ISINT IS THE SIGN OF RESTRUCTURING BIGIN                          STP41430
      ISINT=1                                                           STP41440
      VOIDZL=FUELL                                                      STP41450
C                                                                       STP41460
C     RESTRUCTURING TEMPERATURE        REFER D-936                      STP41470
C                                                                       STP41480
      RETEM=.00001367*ALOG10(24.*TOTLDY ) +.000480                      STP41490
      TSINC=1./RETEM-273.                                               STP41500
  890 CONTINUE                                                          STP41510
      TSIN = TSINC                                                      STP41520
      IN3 = 6                                                           STP41530
      IN2 = N + 1                                                       STP41540
      RSIN = TERP(TSIN,BB,2,N,IN1,IN2,IN3,45)                           STP41550
      IF(RSIN.LE.RSINZ) RSIN=RSINZ                                      STP41560
      DSIN=2.*RSIN                                                      STP41570
C*****************************************************                  STP41580
      FACT = 0.0                                                        STP41590
      IF(FRSIN.LE.0.0) GO TO 5                                          STP41600
      FACT = (FRSIN-FRDEN) / FRSIN                                      STP41610
    5 CONTINUE                                                          STP41620
      SQRV  = RVOIDZ**2 + FACT*(RSIN**2 - RSINZ**2)                     STP41630
      RVOID = SQRT(SQRV)                                                STP41640
C*****************************************                              STP41650
      RVOID=SQRT((RSIN**2)*(FRSIN-FRDEN)/FRSIN+(RVOIDZ**2)*FRDEN/FRSIN) STP41660
      IF(RVOID.LE.RVOIDZ) RVOID=RVOIDZ                                  STP41670
      DVOID=2.*RVOID                                                    STP41680
      ELTC=FL-VOIDZL/FNPOW                                              STP41690
      VTC=PI*ELTC*RVOIDZ**2                                             STP41700
      VVOID=(PI*FL*RVOID**2-VTC)                                        STP41710
  900 CONTINUE                                                          STP41720
      RETURN                                                            STP41730
 1920 FORMAT('0 NOCONVERGENCE IN TEMP CALC AFTER 10 ITERATIONS, ASSUMED STP41740
     1TEMP =',F7.2,'  ,CALCULATED TEMP =',F7.2//)                       STP41750
 1910 FORMAT(3X,26HNCON SPEC NO. ERROR  NCON=,I3,8H   STEP4 )           STP41760
C*****************************************************************     STP41770
```



```
* SOURCE STATEMENT (STEP4   )*
      END                                                               STP41780
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP5                                                  STP50010
C                                                                       STP50020
C     THIS SUBROUTINE IS CALLED FROM ST3TO8                             STP50030
C                                                                       STP50040
      REAL  MUF,MOL,MOLEFR,MOLFR                                        STP50050
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  STP50060
     1                PKPOWR,IPEAK,DELP,PMAX                            STP50070
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                  STP50080
      COMMON /DATA 5/ SDOT,SDOTT,EF,MUF,EPSIF,EPSIC                     STP50090
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) STP50100
      COMMON /COM  1/ TT( 51),TSR( 51),WIN(51),Q(51),TS(51),CLCRP(2,20) STP50110
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             STP50120
      COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP                  STP50130
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  STP50140
      COMMON /COM 5J/ DELRCC,DELRDE,DELRRE,TSHOUL                       STP50150
      COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                            STP50160
      COMMON /COM 15/ NCR,GAP                                           STP50170
      COMMON /COM 21/ N,NN,NNN,NF                                       STP50180
      COMMON /COM025/ VOLUME                                            STP50190
      COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TH,THR                    STP50200
      COMMON /COM048/ DSIN,RSIN,TSIN,TSINC,DVOID,RVOID,T                STP50210
      COMMON /COM 56/ VOLGP,VOLGAP                                      STP50220
      COMMON /COM 57/ VRUF,ALPHAC,PRESCN                                STP50230
      COMMON /COM 8G/ GG(20,100)                                        STP50240
      COMMON /COM157/ RCI,RCO                                           STP50250
      COMMON /COM357/ TAVGC                                             STP50260
      COMMON /COM568/ DELRB,DELRP,DELRCI,DELRT,TAVGF,VAVGT              STP50270
      COMMON /D15   / MDEN,MRELOC, SINTEM                               STP50280
      COMMON /MOL579/ PRESTO(20)                                        STP50290
      COMMON /ML5938/ TBAR(20)                                          STP50300
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI,  STP50310
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, STP50320
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   STP50330
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,STP50340
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   STP50350
     5                DTEMP,ZCLAD,HG,PERAVG,MINI,ICOF,ISTOR,ICREP,ISWELLSTP50360
     6                ,NEXP,MEXP,NHIST                                  STP50370
      COMMON /BURN / BURN(20),BOOLD(20)                                 STP50380
      COMMON /COM M50/ R1700,R1500,R1350                                STP50390
      COMMON /COM M5/ STREST                                            STP50400
      COMMON /BRNGAS/ AKR(20),AXE(20),PHI(20),ENXE(20),ENKR(20)         STP50410
      COMMON /ELONG/ PLENGT(5)                                          STP50420
      COMMON /INPUT A/ MREST,LCREP,DDISH,HDISH                          STP50430
      COMMON /ST5DEN / DLPLD,DENSL                                      STP50440
      COMMON /COM8M/ ISTOP,ICASE                                        STP50450
      COMMON /RELO1/ RGAPC(20),RFSO(20),DELEXP(20)                      STP50460
C                                                                       STP50470
      DIMENSION       DELCT(50),DELL(50)                                STP50480
      DATA SC1,SC2 /1.E-4,1.15E-4/                                      STP50490
C          SC1,SC2 ARE STRESS COEFFICIENT IN CLADDING CREEP CALCULATION STP50500
C                                                                       STP50510
      BU    =BURN(IPOW)                                                 STP50520
      DO 100 I=1,20                                                     STP50530
  100 GG(I,ITER) = 0.0                                                  STP50540
C                                                                       STP50550
C     VOLUME AVERAGE THE TEMPERATURE.                                   STP50560
C                                                                       STP50570
      TSR(N+1)=RVOID                                                    STP50580
      DO 910 I=1,N                                                      STP50590
```


* SOURCE STATEMENT (STEP5)*

```
      BI=1                                                              STP50600
  910 TSR(1)=(RFS+DELR)-(((RFS+DELR)-RVOID)/FLOAT(N))*(BI-1.0)          STP50610
      VAFR=(TSR(1)**2-TSR(2)**2)*PI*((TFS+TT(1))*.5)                    STP50620
      DO 920 I=2,N                                                      STP50630
      VAFR=VAFR+(TSR(I)**2-TSR(I+1)**2)*PI*((TT(I)+TT(I-1))*.5)         STP50640
  920 CONTINUE                                                          STP50650
      VAVGT=VAFR/(((RFS+DELR)**2-RVOID**2)*PI)                          STP50660
      IF(KOUNT.EQ.0) TBAR(IPOW)=VAVGT                                   STP50670
C                                                                       STP50680
C     CALCULATE RADIUS AVERAGED FUEL TEMPERATURE                        STP50690
C                                                                       STP50700
      TEMP=0.                                                           STP50710
      DO 930 I=1,N                                                      STP50720
      TEMP=TEMP+BR(1,I)*(RFS+DELR-RVOID)/FLOAT(N)                       STP50730
  930 CONTINUE                                                          STP50740
      TAVGF=TEMP/(RFS+DELR-RVOID)                                       STP50750
      RD=(RFS-RVOIDZ)/FLOAT(N)                                          STP50760
      IF(NEXP.LE.0) GO TO 936                                           STP50770
C                                                                       STP50780
C     ******************  FUEL THERMAL EXPANSION  ******************STP50790
      CALL EXPAND  (RFS,RD,T1,TFS,FRPUO2,DELRT,DELCT,DELL,L,NEXP,MEXP,  STP50800
     1              RVOID )                                             STP50810
C                                                                       STP50820
  936 CONTINUE                                                          STP50830
C                                                                       STP50840
      GG(10,ITER) = DELRT                                               STP50850
C     ******************                                                STP50860
C                                                                       STP50870
      DELRDE=0.0                                                        STP50880
      DENSL=0.0                                                         STP50890
      IF(MDEN.LE.0) GO TO 931                                           STP50900
      TSIN=SINTEM                                                       STP50910
C                                                                       STP50920
C     ******************* FUEL DENSIFICATION ************************STP50930
      CALL DENSF(FRDEN,BU,TSIN,RFS,DELRDE,MDEN,DFS)                     STP50940
C     ***************************************************************STP50950
C                                                                       STP50960
      DENSL=DLPLD                                                       STP50970
  931 CONTINUE                                                          STP50980
C                                                                       STP50990
      T1300 = 1300.                                                     STP51000
      IN1 = 6                                                           STP51010
      IN2 = N + 1                                                       STP51020
      R1300 = TERP(T1300,BB,2,N,IN1,IN2,IN3,52)                         STP51030
      R1700 = TERP(1700.,BB,2,N,IN1,IN2,IN3,53)                         STP51040
      IF(KOUNT.GT.0) R1700=RSIN                                         STP51050
      R1500 = TERP(1500.,BB,2,N,IN1,IN2,IN3,54)                         STP51060
      R1350 = TERP(1350.,BB,2,N,IN1,IN2,IN3,55)                         STP51070
      VH=PI*R1700**2                                                    STP51080
      VL=PI*(RFS**2-R1350**2,)                                          STP51090
      VC=PI*(R1350**2-R1700**2)                                         STP51100
      GG(20,ITER) = 4H NO                                               STP51110
      IF(ISWELL.LE.0) GO TO 940                                         STP51120
C     ISWELL = 0  ;  NOT INTO ACCOUNT FUEL SWELLING                     STP51130
      GG(20,ITER) = 4HOLD                                               STP51140
C                                                                       STP51150
C     ******************* OLD SWELLING MODEL ************************STP51160
      DELVB=(SDOT*VOLUME*FRDEN+SDOTT*VC)*BU    /1.E4-(1.-FRDEN)*(.8*VH+.STP51170
     15*VC+.3*VL)                                                       STP51180
```

```
* SOURCE STATEMENT (STEP5   )*

      IF(DELVB) 940,940,950                                             STP51190
  940 DELVB=0.                                                          STP51200
  950 CONTINUE                                                          STP51210
      DELRB=DELVB/(3.*PI*RFS)                                           STP51220
C     ******************************************************************STP51230
C                                                                       STP51240
      GG(11,ITER) = DELRB                                               STP51250
      TAVGC=(TCI+TCO)/2.                                                STP51260
C                                                                       STP51270
C     CLADDING THERMAL EXPANSION    AA(6,J)                             STP51280
C                                                                       STP51290
      IN1 = 7                                                           STP51300
      IN2 = 30                                                          STP51310
      ALPHAC = TERP(TAVGC,AA,6,NN,IN1,IN2,IN3,56)                       STP51320
      DELRC=RCI*ALPHAC*(TAVGC-25.)                                      STP51330
      DELRCI=DELRC                                                      STP51340
      DELRCO=RCO*ALPHAC*(TAVGC-25.)                                     STP51350
      DELRCC=0.                                                         STP51360
      PRESI=ATMOS*14.696*(((TCI+TFS)/2.)+273.)/298.                     STP51370
       IF(ISTEP.EQ.1.AND.ITER.EQ.1) PRESTO(1)=PRESI                     STP51380
      PRESCN=2.0*(EXTP*(RCO+DELRCO)**2-PRESTO(ISTEP)*(RCI+DELRC)**2)    STP51390
C                                                                       STP51400
C     CLADDING CREEP                                                    STP51410
C                                                                       STP51420
      IF(ICREP.LE.0) GO TO 960                                          STP51430
      IN1 = 2                                                           STP51440
      IN2 = 20                                                          STP51450
      DELRCC = TERP(TOTLDY,CLCRP,2,NCR,IN1,IN2,IN3,57)                  STP51460
  960 CONTINUE                                                          STP51470
      IF(ICREP.GE.0) GO TO 962                                          STP51480
C                                                                       STP51490
C     ****************** CLADDING CREEP ****************************** STP51500
      ICR=-1*ICREP                                                      STP51510
      CALL CREEP(TOTLDY*24.,PHI(IPOW),STRESS ,TAVGC,EXTP,PRESTO(ISTEP), STP51520
     1           DCO,DCI,SC1,SC2,EPST,DEPS,ICR  )                       STP51530
      DELRCC=RCI*EPST                                                   STP51540
C     ******************************************************************STP51550
C                                                                       STP51560
      DELRC=DELRC-DELRCC                                                STP51570
      DELRCO=DELRCO-DELRCC                                              STP51580
      DELRP=0.                                                          STP51590
      PRESCN=0.                                                         STP51600
      GO TO 970                                                         STP51610
  962 CONTINUE                                                          STP51620
      IF(ICDF.GT.0.0) GO TO 970                                         STP51630
C                                                                       STP51640
C     CLADDING ELASTIC DEFORMATION                                      STP51650
C                                                                       STP51660
      IN1 = 7                                                           STP51670
      IN2 = 30                                                          STP51680
      EC = TERP(TAVGC,AA,4,NN,IN1,IN2,IN3,58)                           STP51690
      CMU = TERP(TAVGC,AA,5,NN,IN1,IN2,IN3,59)                          STP51700
      DELRP=(RCI+DELRC)/(EC*((RCO+DELRCO)**2-(RCI+DELRC)**2))*((PRESTO(ISTP51710
     1STEP)*(RCI+DELRC)**2-EXTP*(RCO+DELRCO)**2)*(1.-CMU)+(PRESTO(ISTEP)STP51720
     2-EXTP)*((RCO+DELRCO)**2)*(1.+CMU))                                STP51730
      DELRC=DELRC+DELRP                                                 STP51740
      DELRCO=DELRCO+DELRP                                               STP51750
      PRESCN=0.                                                         STP51760
  970 CONTINUE                                                          STP51770
```



```
* SOURCE STATEMENT (STEP5   )*

      DELR=DELRT+DELRB+DELRDE                                           STP51780
      TH=GAP/2.+DELRC-DELR                                              STP51790
      GG(15,ITER) = TH                                                  STP51800
      THXX = TH - 1.98*(ROUF + ROUC)                                    STP51810
      GG(12,ITER) = THXX                                                STP51820
      DELRBH=0.0                                                        STP51830
      DELRBR=0.0                                                        STP51840
      IF(ISWELL-1) 2000,1000,980                                        STP51850
  980 CONTINUE                                                          STP51860
      IF(THXX.LE.0.0) GO TO 1000                                        STP51870
C                                                                       STP51880
C     FUEL SWELLING                                                     STP51890
C     ISWELL = 0    SWELLING IS NOT TAKEN INTO ACCOUNT                  STP51900
C     ISWELL = 1    GEITHOF, ET AL. MODEL     (OLD SWELLING MODEL)      STP51910
C     ISWELL = 2    REVISED GAP CLOSURE MODEL (NEW SWELLING MODEL)      STP51920
C     ****************** NEW SWELLING MODEL ************************** STP51930
      GG(20,ITER) = 4HNE*                                               STP51940
      CALL SWELL (R1300,R1500,R1700,RFS,RVOID,PI,BU     ,TH,GAP,DELRT,DELSTP51950
     1RC,DELRBH,ROUF,ROUC,THREF,DELRBR,DELRDE )                         STP51960
      GG(13,ITER) = DELRBH                                              STP51970
      GG(16,ITER) = TH                                                  STP51980
C     ******************************************************************STP51990
C                                                                       STP52000
C     IF(TH.GT.0) GO TO 990                                             STP52010
      IF(TH.GT.(1.98*(ROUF+ROUC) + 1.0E-6))  GO TO 990                  STP52020
      TH=1.98*(ROUF+ROUC)+1.0E-6                                        STP52030
      GG(17,ITER) = TH                                                  STP52040
  990 CONTINUE                                                          STP52050
      IF(DELRB.LT.DELRBH.AND.TH.GT.0) DELRB=DELRBH                      STP52060
      GG(14,ITER) = DELRB                                               STP52070
 1000 CONTINUE                                                          STP52080
      DELRRE=0.0                                                        STP52090
      IF(MRELOC.LE.0) GO TO 1100                                        STP52100
C     --------- GAP WAS CLOSED , THXX.LE.0.0                            STP52110
      IF(THXX.LE.0.0) GO TO 1100                                        STP52120
C                                                                       STP52130
      PPPPP=(POWER(IPOW)+POWER(IPOW+1))/2.0                             STP52140
C                                                                       STP52150
C     ******************** FUEL RELOCATION MODEL ********************* STP52160
      CALL RELOC(DELRRE,DFS,GAP,PPPPP,IPOW,NPOW,MRELOC)                 STP52170
C     ******************************************************************STP52180
C                                                                       STP52190
      IF(DELRRE) 1120,1120,1130                                         STP52200
 1120 DELRRE=0.0                                                        STP52210
      GO TO 1100                                                        STP52220
 1130 CONTINUE                                                          STP52230
      IF(THXX-DELRRE) 1110,1110,1100                                    STP52240
C          IF GAP WAS STICKED DUE TO RELOCATION , CORRECT GAP *IDTH     STP52250
 1110 THDUM=1.98*(ROUF+ROUC)+1.E-6                                      STP52260
      DELRRE=GAP/2. + DELRC - DELR - THDUM                              STP52270
 1100 CONTINUE                                                          STP52280
C                                                                       STP52290
      DELR=DELRT+DELRB+DELRDE+DELRRE                                    STP52300
      TH=GAP/2. + DELRC - DELR                                          STP52310
C                                                                       STP52320
      THK=TH-1.98*(ROUF+ROUC)                                           STP52330
      VOLGAP=PI/4.*((DCI+2.*DELRC)**2-(DFS+2.*DELR)**2)*FL              STP52340
      CRUF=1.980*(ROUF+ROUC)                                            STP52350
      VRUF=PI*DFS*CRUF*FL                                               STP52360
```

```
* SOURCE STATEMENT (STEP5    )*
165         IF(VOLGAP.LE.VRUF) VOLGAP=VRUF                                  STP52370
166         VOLGP=VOLGAP+VVOID                                              STP52380
167         VCOLD=PI*((RFS+   DELR)**2-R1350**2)                            STP52390
168         VCOOL=PI*(R1350**2-R1700**2)                                    STP52400
169         VHOT=PI*(R1700**2-RVOID**2)                                     STP52410
170         RDISH = DDISH/2.                                                STP52420
171         TSHOUL=TEPP(RDISH,TT,TS,N)                                      STP52430
172         PLENGT(1)=FL                                                    STP52440
173         PLENGT(2)=FL*(1.+FALPHA(TSHOUL,NEXP)*(TSHOUL-25.) )             STP52450
174         PLENGT(3)=FL*(1.+FALPHA(TT(N),NEXP)*(TT(N)-25.) )               STP52460
175         PLENGT(4)=PLENGT(2)-PLENGT(1)                                   STP52470
176         PLENGT(5)=PLENGT(3)-PLENGT(1)                                   STP52480
      C                                                                     STP52490
      C---------- TH IS HOT GAP AT THIS STEP  ,CALCULATE COLD GAPC(IPOW)    STP52500
      C     COLD GAP DEFINE AT ROOM TEMPERATURE (25. DEG C)                 STP52510
      C                                                                     STP52520
177         XDELR = 0.0                                                     STP52530
178         DO 10 I=1,N                                                     STP52540
179         T1 = BB(3,I)                                                    STP52550
180         T2 = BB(3,I+1)                                                  STP52560
181         T3 = (T1+T2)/2.0                                                STP52570
182         ALP = FALPHA(T3,NEXP)                                           STP52580
183         RINGR = BB(4,I) - BB(4,I+1)                                     STP52590
184         DELRIN =RINGR*ALP*(25.-T3)                                      STP52600
185         XDELR = XDELR + DELRIN                                          STP52610
186      10 CONTINUE                                                        STP52620
187         DELEXP(IPOW) = XDELR                                            STP52630
188         RGAPC(IPOW) = TH-XDELR                                          STP52640
189         RFSO(IPOW) = (RFS+DELR) + XDELR                                 STP52650
190         RETURN                                                          STP52660
      C*************************                                            STP52670
191         END                                                             STP52680
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP5A                                                 ST5A0010
C                                                                       ST5A0020
C     THIS SUBROUTINE IS CALLED FROM ST3TOB                             ST5A0030
C                                                                       ST5A0040
      REAL  MUF,MOL,MOLEFR,MOLFR                                        ST5A0050
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  ST5A0060
     1                PKPOWR,IPEAK,DELP,PMAX                            ST5A0070
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RK,CONEN                  ST5A0080
      COMMON /DATA 5/ SDOT,SDOTT,EF,MUF,EPSIF,EPSIC                     ST5A0090
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) ST5A0100
      COMMON /COM  1/ TT( 51),TSR( 51),WIN(51),Q(51),TS(51),CLCRP(2,20) ST5A0110
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             ST5A0120
      COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP                  ST5A0130
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  ST5A0140
      COMMON /COM 30/ DELRCC,DELRDE,DELRNE,TSHOUL                       ST5A0150
      COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                            ST5A0160
      COMMON /COM 15/ NCR,GAP                                           ST5A0170
      COMMON /COM 21/ N,NN,NNN,NF                                       ST5A0180
      COMMON /COM025/ VOLUME                                            ST5A0190
      COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TH,THR                    ST5A0200
      COMMON /COM048/ DSIN,RSIN,TSIN,TSINC,DVOID,RVOID,T                ST5A0210
      COMMON /COM 56/ VOLGP,VOLGAP                                      ST5A0220
      COMMON /COM 57/ VRUF,ALPHAC,PRESCN                                ST5A0230
      COMMON /COM 8G/ GG(20,100)                                        ST5A0240
      COMMON /COM157/ RCI,RCO                                           ST5A0250
      COMMON /COM357/ TAVGC                                             ST5A0260
      COMMON /COM568/ DELRB,DELRP,DELRCI,DELRT,TAVGF,VAVGT              ST5A0270
      COMMON /D15   / MDEN,MRELUC, SINTEM                               ST5A0280
      COMMON /MOL579/ PRESTO(20)                                        ST5A0290
      COMMON /MOL5938/ TBAR(20)                                         ST5A0300
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRP002,FR35,FR40,FR41,DFS,DCI,  ST5A0310
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, ST5A0320
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   ST5A0330
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,ST5A0340
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   ST5A0350
     5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELLST5A0360
     6                ,NEXP,MEXP,NHIST                                  ST5A0370
      COMMON /BURN / BURN(20),BUOLD(20)                                 ST5A0380
      COMMON /COM M50/ R1700,R1500,R1350                                ST5A0390
      COMMON /COM M5/ STRFSI                                            ST5A0400
      COMMON /BRNGAS/ AKR(20),AXE(20),PHI(20),ENXE(20),ENKR(20)         ST5A0410
      COMMON /ELONG/ PLENGT(5)                                          ST5A0420
      COMMON /INPUT A/ MRESI,LCREP,UDISH,HDISH                          ST5A0430
      COMMON /COSATA/ RESGAP,PCONT                                      ST5A0440
      COMMON /STSDEN / DLPLD,DENSL                                      ST5A0450
      COMMON /COM8M/ ISTOP,ICASE                                        ST5A0460
      COMMON /GRADE/ IGRADE,MOTGP,RINT                                  ST5A0470
C                                                                       ST5A0480
      DIMENSION DELCT(50),DELL(50)                                      ST5A0490
      DATA SC1,SC2 /1.E-4,1.15E-4/                                      ST5A0500
C          SC1,SC2 ARE STRESS COEFFICIENT IN CLADDING CREEP CALCULATION ST5A0510
C                                                                       ST5A0520
      BO    =BURN(IPOW)                                                 ST5A0530
      DO 100 I=1,20                                                     ST5A0540
  100 GG(I,ITER) = 0.0                                                  ST5A0550
C                                                                       ST5A0560
C     FUEL VOLUME AVERAGED TEMPERATURE            VAVGT(DEG-C)          ST5A0570
C                                                                       ST5A0580
      TSR(N+1)=RVOID                                                    ST5A0590
```


* SOURCE STATEMENT (STEP5A)*

```
      DO 910 I=1,N                                                      ST5A0600
      BI=I                                                              ST5A0610
  910 TSR(I)=(RFS+DELR)-(((RFS+DELR)-RVOID)/FLOAT(N))*(BI-1.0)          ST5A0620
      VAFR=(TSR(1)**2-TSR(2)**2)*PI*((TFS+TT(1))*.5)                    ST5A0630
      DO 920 I=2,N                                                      ST5A0640
      VAFR=VAFR+(TSR(I)**2-TSR(I+1)**2)*PI*((TT(I)+TT(I-1))*.5)         ST5A0650
  920 CONTINUE                                                          ST5A0660
      VAVGT=VAFR/(((RFS+DELR)**2-RVOID**2)*PI)                          ST5A0670
      IF(KOUNT.EQ.0) TBAR(IPOW)=VAVGT                                   ST5A0680
C                                                                       ST5A0690
C     FUEL RADIUS AVERAGED TEMPERATURE            TAVGF(DEG-C)          ST5A0700
C                                                                       ST5A0710
      TEMP=0.                                                           ST5A0720
      DO 930 I=1,N                                                      ST5A0730
  930 TEMP = TEMP + (BB(3,I) + BB(3,I+1)) / 2.0                         ST5A0740
      TAVGF = TEMP / FLOAT(N)                                           ST5A0750
C                                                                       ST5A0760
C     CLADDING THERMAL EXPANSION        AA(6,J),DELRC,GAP1              ST5A0770
C                                                                       ST5A0780
      IN1 = 7                                                           ST5A0790
      IN2 = 30                                                          ST5A0800
      ALPHAC = TERP(TAVGC,AA,6,NN,IN1,IN2,IN3,56)                       ST5A0810
      DELRC=RCI*ALPHAC*(TAVGC-25.)                                      ST5A0820
      DELRCI=DELRC                                                      ST5A0830
      DELRCO=RCO*ALPHAC*(TAVGC-25.)                                     ST5A0840
      PRESI=ATMOS*14.696*(((TCI+TFS)/2.)+273.)/298.                     ST5A0850
       IF(ISTEP.EQ.1.AND.ITER.EQ.1) PRESTO(1)=PRESI                     ST5A0860
      PRESCN=2.0*(EXTP*(RCO+DELRCO)**2-PRESTO(ISTEP)*(RCI+DELRC)**2)    ST5A0870
      GAPORI = GAP/2.0                                                  ST5A0880
      GAP1 = GAPORI + DELRC                                             ST5A0890
C                                                                       ST5A0900
C     CLADDING ELASTIC DEFORMATION   AA(4,J),AA(5,J),DELRP,GAP2         ST5A0910
C                                                                       ST5A0920
      DELRP = 0.0                                                       ST5A0930
      IF(ICDF.EQ.0.OR.ICREP.GT.0) GO TO 970                             ST5A0940
      IN1 = 7                                                           ST5A0950
      IN2 = 30                                                          ST5A0960
      EC = TERP(TAVGC,AA,4,NN,IN1,IN2,IN3,58)                           ST5A0970
      CMU = TERP(TAVGC,AA,5,NN,IN1,IN2,IN3,59)                          ST5A0980
      DELRP=(RCI+DELRC)/(EC*((RCO+DELRCO)**2-(RCI+DELRC)**2))*((PRESTO(ISTA0990
     1STEP)*(RCI+DELRC)**2-EXTP*(RCO+DELRCO)**2)*(1.-CMU)+(PRESTO(ISTEP)ST5A1000
     2-EXTP)*((RCO+DELRCO)**2)*(1.+CMU))                                ST5A1010
      DELRC=DELRC+DELRP                                                 ST5A1020
      DELRCO=DELRCO+DELRP                                               ST5A1030
      PRESCN=0.                                                         ST5A1040
  970 CONTINUE                                                          ST5A1050
      GAP2 = GAP1 + DELRP                                               ST5A1060
C                                                                       ST5A1070
C     CLADDING CREEP                              CLCRP,DELRCC,GAP3     ST5A1080
C                                                                       ST5A1090
      DELRCC = 0.0                                                      ST5A1100
      IF(ICREP.EQ.0) GO TO 962                                          ST5A1110
      IF(ICREP.LT.0) GO TO 960                                          ST5A1120
      IN1 = 2                                                           ST5A1130
      IN2 = 20                                                          ST5A1140
      DELRCC = TERP(TOTLDY,CLCRP,2,NCR,IN1,IN2,IN3,57)                  ST5A1150
      GO TO 961                                                         ST5A1160
  960 CONTINUE                                                          ST5A1170
      ICR=-1*ICREP                                                      ST5A1180
```

```
* SOURCE STATEMENT (STEP5A  )*
                 89        CALL CREEP(TOTLDY*24.,PHI(IPOW),STREST,TAVGC,EATP,PRESTO(ISTEP),  ST5A1190
                          1          DCO,DCI,SC1,SC2,EPST,DEPS,ICK  )                        ST5A1200
                 90        DELRCC = (-1)*RCI*EPST                                             ST5A1210
                 91    961 DELRC  = DELRC  + DELRCC                                            ST5A1220
                 92        DELRCO = DELRCO + DELRCC                                           ST5A1230
                 93    962 CONTINUE                                                           ST5A1240
                 94        GAP3 = GAP2 + DELRCC                                               ST5A1250
                       C                                                                      ST5A1260
                       C   FUEL DENSIFICATION                          MDEN,DELRDE            ST5A1270
                       C                                                                      ST5A1280
                 95        DELRDE=0.0                                                         ST5A1290
                 96        DENSL=0.0                                                          ST5A1300
                 97        IF(MDEN.LE.0) GO TO 931                                            ST5A1310
                 98        TSIN=SINTEM                                                        ST5A1320
                 99        CALL DENSF(FRDEN,BU,TSIN,RFS,DELRDE,MDEN,DFS)                      ST5A1330
                100        DENSL=DLRLD                                                        ST5A1340
                101    931 CONTINUE                                                           ST5A1350
                102        GAP9 = GAP3 - DELRDE                                               ST5A1360
                103        RLIMIT = RFS + GAP9 + DELRDE                                       ST5A1370
                       C                                                                      ST5A1380
                104        RESGAP = 2.0*(ROUF + ROUC) + 1.E-5                                 ST5A1390
                       C                                                                      ST5A1400
                105        IGOOLD = IGRADE                                                    ST5A1410
                106        IN1 = N                                                            ST5A1420
                107        IN2 = N + 1                                                        ST5A1430
                108        R1300 = TERP(1300.,BB,2,N,IN1,IN2,IN3,52)                          ST5A1440
                109        R1350 = TERP(1350.,BB,2,N,IN1,IN2,IN3,53)                          ST5A1450
                110        R1500 = TERP(1500.,BB,2,N,IN1,IN2,IN3,54)                          ST5A1460
                111        R1700 = TERP(1700.,BB,2,N,IN1,IN2,IN3,55)                          ST5A1470
                112        IF(MREST.GT.0) R1700 = RSIN                                        ST5A1480
                113        GG(20,ITER) = 4HNO                                                 ST5A1490
                       C                                                                      ST5A1500
                       C   MOST CONSERVATIVE FUEL SWELLING                                    ST5A1510
                       C                                                                      ST5A1520
                114        RSWEL = DELRB = 0.0                                                ST5A1530
                115        IF(ISWELL.EQ.0) GO TO 510                                          ST5A1540
                116        GG(20,ITER) = 4HOLD                                                ST5A1550
                117        CALL       SWELLA(  1    ,R1300,R1350,R1500,R1700,RFS,RVOID,PI,BU,  ST5A1560
                          1                 SDOT,SDOTT,VOLUME,FRDEN,DELVB,DELRB)              ST5A1570
                118        IF(DELRB.LT.0.0) DELRB = 0.0                                       ST5A1580
                119        RSWEL = DELRB                                                      ST5A1590
                120    510 CONTINUE                                                           ST5A1600
                       C                                                                      ST5A1610
                       C   CONSERVATIVE FUEL THERMAL EXPANSION                                ST5A1620
                       C                                                                      ST5A1630
                121        RALPHA = DELRT = 0.0                                               ST5A1640
                122        RD = (RFS - RVOID ) / FLOAT(N)                                     ST5A1650
                123        IF(NEXP.EQ.0) GO TO 520                                            ST5A1660
                124        CALL EXPAND  (RFS,RD,TT,TFS,FRPUO2,DELRT,DELCT,DELL,L,NEXP,Z ,     ST5A1670
                          1                RVOID )                                             ST5A1680
                125        RALPHA = DELRT                                                     ST5A1690
                126    520 CONTINUE                                                           ST5A1700
                127        DELRSM = RSWEL + RALPHA                                            ST5A1710
                       C                                                                      ST5A1720
                128        ROLD = RFS + DELRDE + DELRT + DELRB                                ST5A1730
                       C                                                                      ST5A1740
                129        IF(DELRSM.LE.GAP9) GO TO 530                                       ST5A1750
                130        IGRADE = 1                                                         ST5A1760
                131        RINT = DELRSM - GAP9                                               ST5A1770
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* SOURCE STATEMENT (STEP5A  )*
                       C   RINT IS POSITIVE                                                   ST5A1780
                132        DELRRE=0.0                                                         ST5A1790
                133        GO TO 900                                                          ST5A1800
                134    530 CONTINUE                                                           ST5A1810
                       C                                                                      ST5A1820
                       C   FUEL THERMAL EXPANSION AS SPECIFIED NEXP AND MEXP                  ST5A1830
                       C                                                                      ST5A1840
                135        RALPHA = DELRT = 0.0                                               ST5A1850
                136        IF(NEXP.EQ.0) GO TO 540                                            ST5A1860
                137        CALL EXPAND  (RFS,RD,TT,TFS,FRPUO2,DELRT,DELCT,DELL,L,NEXP,MEXP,   ST5A1870
                          1                RVOID )                                             ST5A1880
                138        RALPHA = DELRT                                                     ST5A1890
                139    540 CONTINUE                                                           ST5A1900
                140        DELRSM = RSWEL + RALPHA                                            ST5A1910
                141        IF(DELRSM.LE.GAP9) GO TO 570                                       ST5A1920
                142        IGRADE = 2                                                         ST5A1930
                143        RINT = DELRSM - GAP9                                               ST5A1940
                144        DELRRE=0.0                                                         ST5A1950
                145        GO TO 900                                                          ST5A1960
                146    570 CONTINUE                                                           ST5A1970
                       C                                                                      ST5A1980
                       C   FUEL SWELLING CALCULATION AS SPECIFIED ISWELL                      ST5A1990
                       C                                                                      ST5A2000
                147        RSWEL = DELRB = 0.0                                                ST5A2010
                148        IF(ISWELL.EQ.0) GO TO 580                                          ST5A2020
                149        IF(ISWELL.EQ.2) GG(20,ITER) = 4HNEW                                ST5A2030
                150        CALL       SWELLA(ISWELL,R1300,R1350,R1500,R1700,RFS,RVOID,PI,BU,  ST5A2040
                          1                 SDOT,SDOTT,VOLUME,FRDEN,DELVB,DELRB)              ST5A2050
                151        IF(DELRB.LT.0.0) DELRB = 0.0                                       ST5A2060
                152        RSWEL = DELRB                                                      ST5A2070
                153    580 CONTINUE                                                           ST5A2080
                154        DELRSM = RSWEL + RALPHA                                            ST5A2090
                155        IF(DELRSM.LE.GAP9) GO TO 590                                       ST5A2100
                156        IGRADE = 3                                                         ST5A2110
                157        DELRSM = GAP9                                                      ST5A2120
                158        DELRB = GAP9-RALPHA                                                ST5A2130
                159        RINT = 0.0                                                         ST5A2140
                160        PCONT = 0.0                                                        ST5A2150
                161        DELRRE=0.0                                                         ST5A2160
                162        GO TO 800                                                          ST5A2170
                163    590 CONTINUE                                                           ST5A2180
                       C                                                                      ST5A2190
                       C   FUEL RELOCATION                             MRELOC,RRELOC          ST5A2200
                       C                                                                      ST5A2210
                164        RRELOC = DELRRE = 0.0                                              ST5A2220
                165        IF(MRELOC.EQ.0) GO TO 600                                          ST5A2230
                166        PPPPP = (POWER(IPOW)+POWER(IPOW+1)) / 2.                           ST5A2240
                167        CALL RELOC(DELRRE,DFS,GAP,PPPPP,IPOW,NPOW,MRELOC)                  ST5A2250
                168        IF(DELRRE.LT.0.0) DELRRE = 0.0                                     ST5A2260
                169        RRELOC = DELRRE                                                    ST5A2270
                170    600 CONTINUE                                                           ST5A2280
                171        DELRSM = RSWEL + RALPHA + RRELOC                                   ST5A2290
                172        IF(DELRSM.LE.GAP9) GO TO 610                                       ST5A2300
                173        IGRADE = 4                                                         ST5A2310
                174        RINT = DELRSM - GAP9                                               ST5A2320
                175        PCONT=0.0                                                          ST5A2330
                176        GO TO 900                                                          ST5A2340
                177    610 CONTINUE                                                           ST5A2350
                178        IGRADE = 5                                                         ST5A2360
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* SOURCE STATEMENT (STEP5A  )*

      DELRSM = DELRT + DELRB + DELRRE                                   ST5A2370
      HOTGP = GAP9 - DELRSM + RESGAP                                    ST5A2380
      RINT = 0.0                                                        ST5A2390
      PCONT=0.0                                                         ST5A2400
      GO TO 900                                                         ST5A2410
  800 CONTINUE                                                          ST5A2420
C                                                                       ST5A2430
C     CONTACT PRESSURE ASSUMPTION ( PCONT ) IN KG/CM2                   ST5A2440
C                                                                       ST5A2450
C     CONTACT        CONTACT                                            ST5A2460
C     GRADE          PRESSURE                                           ST5A2470
C     (IGRADE)       (ASSUMED)                                          ST5A2480
C                    (KG/CM2)                                           ST5A2490
C                                                                       ST5A2500
C  A  1 HARD1        PFACE(CALCULATED IN STEP7)                         ST5A2510
C  B  2 HARD2        170.(MAX)   76. + 94*COEF                          ST5A2520
C  C  3 SOFT           0.                          ONLY SWELLING        ST5A2530
C  D  4 SOFT           0.                          SWELLING + RELOCATION ST5A2540
C  E  5 OPEN           0.                                               ST5A2550
C                                                                       ST5A2560
C     DEFINE RINTMX                                                     ST5A2570
C                                                                       ST5A2580
      RINTMX = (RFS + DELRDE + DELRSM ) * RLIMIT / ROLD                 ST5A2590
     *       - (RFS + DELRDE + GAP9)                                    ST5A2600
      COEF   = RINT / RINTMX                                            ST5A2610
      IF(COEF.LT..0.OR.COEF.GT.1.) WRITE(6,2020) COEF,IGRADE            ST5A2620
      IF(COEF.LT..0.OR.COEF.GT.1.) STOP                                 ST5A2630
      IF(IGRADE.EQ.2) PCONT =170. * COEF                                ST5A2640
      IF(IGRADE.EQ.3) PCONT = 76. * COEF                                ST5A2650
      IF(ITER.GT.1.AND.IGOOLD.EQ.4.AND.IGRADE.EQ.2) PCONT = 170.*COEF   ST5A2660
  900 CONTINUE                                                          ST5A2670
      GG(18,ITER) = RINT                                                ST5A2680
      GG(19,ITER) = IGRADE                                              ST5A2690
C                                                                       ST5A2700
C     DELR CALCULATION                                                  ST5A2710
C                                                                       ST5A2720
      DELR = DELRSM + DELRDE                                            ST5A2730
      TH = HOTGP                                                        ST5A2740
      VCOLD  = PI*((RFS + DELR)**2 - R1350**2)                          ST5A2750
      VCOOL  = PI*(R1350**2 - R1700**2)                                 ST5A2760
      VHOT   = PI*(R1700**2 - RVOID**2)                                 ST5A2770
      RDISH = DDISH/2.                                                  ST5A2780
      TSHOUL=TEMP(RDISH,TT,TS,N)                                        ST5A2790
      PLENGT(1)=FL                                                      ST5A2800
      PLENGT(2)=FL*(1.+FALPHA(TSHOUL,NEXP)*(TSHOUL-25.) )               ST5A2810
      PLENGT(3)=FL*(1.+FALPHA(TT(N),NEXP)*(TT(N)-25.) )                 ST5A2820
      PLENGT(4)=PLENGT(2)-PLENGT(1)                                     ST5A2830
      PLENGT(5)=PLENGT(3)-PLENGT(1)                                     ST5A2840
      RETURN                                                            ST5A2850
C    *    1    *    2    *    3    *    4    *    5    *    6    *    7 ST5A2860
 2000 FORMAT( 7X, 'MEAP SPEC ERROR   MEXP=',  I5 , 5X,  7H STEP5A,    ) ST5A2870
 2010 FORMAT( 7X, 11HPRINT ERROR, 4X, 6H IGRADE=, I3, 4X, 7H PRINT=,    ST5A2880
     1,F12.5, 5X, 7H STEP5A                                            ) ST5A2890
 2020 FORMAT( 7X, 'COEF ERROR   COEF=',F12.5,5X,'IGRADE=',I5,5X,'STEP5A'ST5A2900
     *                                                                 ) ST5A2910
      END                                                               ST5A2920
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP6                                                  STP60010
C                                                                       STP60020
C     THIS SUBROUTINE IS CALLED FROM ST3TO8                             STP60030
C                                                                       STP60040
      REAL  MUF,MOL,MOLEFR,MOLFR                                        STP60050
      COMMON /DATA 1/ ZR(7,6),ZR4(7,6),ST(7,26),TABLE(2, 80)            STP60060
      COMMON /DATA 2/ EKLJ(6),GMWT(6),SIGLJ(6)                          STP60070
      COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TH,THR                    STP60080
      COMMON /COM678/ TOTMOL,ABTGAS,VISMIX,GK,GASKON                    STP60090
      COMMON /COM600/ TGAS,TOCI,HGOLD                                   STP60100
      COMMON /MOL678/ MOLEFR(6)                                         STP60110
      DIMENSION       PHICAP(6,6),CSUBP(6),VISCOS(6),OMEGA(6),CON(10)   STP60120
      TGAS=(TCI+TFS)/2.                                                 STP60130
      ABTGAS=(TGAS)+273.                                                STP60140
C                                                                       STP60150
C     CALCULATE THERMAL CONDUCTIVITY ANS VISCOSITY OF THE GAS           STP60160
C                                                                       STP60170
      DO 1040 I=1,6                                                     STP60180
      TKE=ABTGAS/EKLJ(I)                                                STP60190
      IN1 = 2                                                           STP60200
      IN2 = 80                                                          STP60210
      OMEGA(I) = TERP(TKE,TABLE,2,80,IN1,IN2,IN3,61)                    STP60220
 1040 CONTINUE                                                          STP60230
      DO 1050 I=1,6                                                     STP60240
      VISCOS(I)=2.67E-5*SQRT(ABTGAS*GMWT(I))/(OMEGA(I)*SIGLJ(I)**2)     STP60250
 1050 CONTINUE                                                          STP60260
      DO 1060 I=1,6                                                     STP60270
      DO 1060 J=1,6                                                     STP60280
      PHICAP(I,J)=1./SQRT(8.)/(SQRT(1.+GMWT(I)/GMWT(J)))*(1.+SQRT(VISCOSSTP60290
     1(I)/VISCOS(J))*((GMWT(J)/GMWT(I))**.25))**2                       STP60300
 1060 CONTINUE                                                          STP60310
      DO 1070 I=1,6                                                     STP60320
      IF(I.EQ.3) GO TO 1070                                             STP60330
      IF(I.EQ.4) GO TO 1070                                             STP60340
      CON(I)=1.9891E-4*(SQRT(ABTGAS/GMWT(I)))/(SIGLJ(I)**2*OMEGA(I))   STP60350
 1070 CONTINUE                                                          STP60360
      CSUBP(3)=6.947-0.20E-3*ABTGAS+4.608E-7*ABTGAS**2                  STP60370
      CSUBP(4)=6.524+1.25E-3*ABTGAS-1.E-9*ABTGAS**2                     STP60380
      DO 1080 I=3,4                                                     STP60390
      CON(I)=(CSUBP(I)+1.25*1.987)*VISCOS(I)/GMWT(I)                    STP60400
 1080 CONTINUE                                                          STP60410
      GASKON=0.                                                         STP60420
      VISMIX=0.                                                         STP60430
      DO 1100 I=1,6                                                     STP60440
      DENOM=0.                                                          STP60450
      DO 1090 J=1,6                                                     STP60460
      DENOM=DENOM+MOLEFR(J)*PHICAP(I,J)                                 STP60470
 1090 CONTINUE                                                          STP60480
      GASKON=GASKON+MOLEFR(I)*CON(I)/DENOM                              STP60490
      VISMIX=VISMIX+MOLEFR(I)*VISCOS(I)/DENOM                           STP60500
 1100 CONTINUE                                                          STP60510
      GK = GASKON * 4.1858                                              STP60520
      RETURN                                                            STP60530
C***********************                                                STP60540
      END                                                               STP60550
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP7                                                  STP70010
C                                                                       STP70020
C     THIS SUBROUTINE IS CALLED FROM STSTOR                             STP70030
C                                                                       STP70040
      REAL  MUF,MOL,MOLEFR,MOLFR                                        STP70050
      COMMON /FTNVT / FNVT(20),TNVT(20)                                 STP70060
      COMMON /IYIELD/ IYIELD                                            STP70070
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  STP70080
     1                PKPOWR,IPEAK,DELP,PMAX                            STP70090
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                  STP70100
      COMMON /DATA 5/ SDOT,SDOT1,EF,MUF,EPSIF,EPSIC                     STP70110
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) STP70120
      COMMON /COM  1/ TT( 51),TSR( 51),QIN(51),Q(51),TS(51),CLCRP(2,20) STP70130
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             STP70140
      COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STF                  STP70150
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLOY,TOTBUR                  STP70160
      COMMON /COM 08/ II,JCASE,TCOOLF,AMOTOT                            STP70170
      COMMON /COM 13/ RFS,FNPOW,RSINZ,PVOIDZ                            STP70180
      COMMON /COM 14/ KCON                                              STP70190
      COMMON /COM 21/ N,NN,NNN,NF                                       STP70200
      COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TH,THR                    STP70210
      COMMON /COM 56/ VOLGP,VOLGAP                                      STP70220
      COMMON /COM 57/ VRUF,ALPHAC,PRESCN                                STP70230
      COMMON /COM78 / PFACE,VOLOVT,HSOLID,HGAS,HRAD,G1PG2,PRESX(20)     STP70240
      COMMON /COM 8G/ GG(20,100)                                        STP70250
      COMMON /COM 90/ VOLGAS,W,HGC                                      STP70260
      COMMON /COM157/ RCI,RCO                                           STP70270
      COMMON /COM357/ TAVGC                                             STP70280
      COMMON /COM678/ TOTMOL,ABTGAS,VISMIX,GK,GASKON                    STP70290
      COMMON /MOL579/ PRESTO(20)                                        STP70300
      COMMON /MOL678/ MOLEFR(6)                                         STP70310
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPU02,FR35,FR40,FR41,DFS,DCI,  STP70320
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, STP70330
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   STP70340
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,STP70350
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   STP70360
     5                DTEMP,ZCLAD,HG,PEKAVG,MIN1,ICDF,ISTOR,ICREP,ISWELLSTP70370
     6                ,NEXP,MEXP,NHIST                                  STP70380
      COMMON /COM M7/ STREST,CFLAG                                      STP70390
      COMMON /MREV1/  MREV1                                             STP70400
      DIMENSION ABCD(7)                                                 STP70410
      DATA ABCD / 1HA,1HB,1HC,1HD,1HE,1HF,1HG                           STP70420
C                                                                       STP70430
C     CALCULATE GAS PRESX(IPOW)SURE IN THE PIN                          STP70440
C                                                                       STP70450
      ABTCV=(TT(N))+273.                                                STP70460
      V2=VVOID                                                          STP70470
      V1=PI*((RCI+DELRC)**2-(RFS+DELR)**2)*FL                           STP70480
      IF(V1.LE.VOLGAP) V1=VOLGAP                                        STP70490
      VOLOVT=V1/ABTGAS+V2/ABTCV                                         STP70500
      PRESX(IPOW)=84.80804*TOTMOL/VOLOVT                                STP70510
      IF(ISTEP.EQ.1) PRESTO(1)=PRESX(IPOW)                              STP70520
      EMMIX=MOLEFR(1)*4.0+MOLEFR(2)*39.94+MOLEFR(3)*2.016+MOLEFR(4)*28.0STP70530
     12+MOLEFR(5)*83.80+MOLEFR(6)*131.3                                 STP70540
      ELL=VISMIX/PRESTO(ISTEP)*SQRT(ABTGAS/EMMIX)                       STP70550
      G1PG2 = 5.448 / 14.22 * ELL                                       STP70560
C CLAD STRESS   PRINT-OUT NO-TAMENI MAIKAI KEISAN-SURU YOONI SYUSEI 8/30STP70570
      IN1 = 7                                                           STP70580
      IN2 = 30                                                          STP70590
```


* SOURCE STATEMENT (STEP7)*

```
      EC = TERP(TAVGC,AA,4,NN,IN1,IN2,IN3,71)                           STP70600
      CMU = TERP(TAVGC,AA,5,NN,IN1,IN2,IN3,72)                          STP70610
      YDSTR = FYIELD(IYIELD,TAVGC,FNVT(IPOW))                           STP70620
      RCI=DCI/2.                                                        STP70630
      RCO=DCO/2.                                                        STP70640
      RS@RMC=(RCO+DELRCO)**2-(RCI+DELRC)**2                             STP70650
      RS@RPC=(RCO+DELRCO)**2+(RCI+DELRC)**2                             STP70660
      ALOGC=ALOG((RCO+DELRCO)/(RCI+DELRC))                              STP70670
      STREST=ALPHAC*EC*(TCI-TCO)/(2.*(1.-CMU)*ALOGC)*(1.-(2.*(RCO+DELRCOSTP70680
     1)**2/RS@RMC*ALOGC))                                               STP70690
      TR=TH-1.98*(ROUF+ROUC)                                            STP70700
      PFACE = 0.                                                        STP70710
      GG(18,ITER) = TR                                                  STP70720
      CFLAG=1H*                                                         STP70730
      IF(THR) 1120,1120,1110                                            STP70740
 1110 CONTINUE                                                          STP70750
      IF(MREV1.LT.0) GO TO 1112                                         STP70760
      HGAS = GK/(TH+G1PG2)                                              STP70770
      GO TO 1114                                                        STP70780
C     ...............  RESAR-41 GAP CONDUCTANCE                         STP70790
 1112 CONTINUE                                                          STP70800
      GKBTU = GK*57.79                                                  STP70810
      THFT = TH/2.54/12.                                                STP70820
      HGAS1 = 1500.*GKBTU + 4./(0.006 + 12.*THFT)                       STP70830
      HGAS2 = GKBTU / (THFT/2. + 14.4E-6)                               STP70840
      HGAS  = AMAX1(HGAS1,HGAS2)                                        STP70850
 1114 CONTINUE                                                          STP70860
C     ....................        HGAS = GK/(CEE*(ROUF+ROUC)+G1PG2)     STP70870
C                                                                       STP70880
      HSOLID=0.                                                         STP70890
      CFLAG=1H                                                          STP70900
      GO TO 1180                                                        STP70910
 1120 CONTINUE                                                          STP70920
      TR=ABS(THR)                                                       STP70930
      GG(19,ITER) = TR                                                  STP70940
      PFACE=(TR*EC/(RCI+DELRC)+PRESCN/RS@RMC)/(RS@RPC/RS@RMC+CMU+EC*(1.-STP70950
     1ALOGC)/EF)                                                        STP70960
      PRMAX=((YDSTR-STREST)*RS@RMC+PRESCN)/RS@RPC                       STP70970
      IF(PFACE.GT.PRMAX) PFACE=PRMAX                                    STP70980
      IF(PFACE.LT.0.0) PFACE=0.0                                        STP70990
      TFSK = TFS + 273.                                                 STP71000
      IF(NCON) 1160,1160,1130                                           STP71010
 1130 CONTINUE                                                          STP71020
      IN1 = 3                                                           STP71030
      IN2 = 30                                                          STP71040
      FK = TERP(TFS,CF,2,NCON,IN1,IN2,IN3,74)                           STP71050
      GO TO 1170                                                        STP71060
 1160 FK=FCOND(FRDEN,TFSK,KCON)                                         STP71070
 1170 CONTINUE                                                          STP71080
      IN1 = 7                                                           STP71090
      IN2 = 30                                                          STP71100
      CK = TERP(TCI,AA,2,NN,IN1,IN2,IN3,75)                             STP71110
      CKM = 2. * FK * CK / ( FK+CK )                                    STP71120
      CPFACE=PFACE                                                      STP71130
      CEE=1.980*EXP(-.00125*CPFACE)                                     STP71140
      GG(9,ITER) = CEE                                                  STP71150
      ROUGH=SQRT((ROUF**2+ROUC**2)/2.)                                  STP71160
      CROUGH=ROUGH                                                      STP71170
      RMEYER = TERP(TCI,AA,7,NN,IN1,IN2,IN3,76)                         STP71180
```

```
* SOURCE STATEMENT (STEP7   )*

 99          IF(IYIELD.GT.0) HMEYER = 2.8*YDSTR                          STP71190
100          CZZ=SQRT(CROUGH)                                            STP71200
101          AO=140.2*CZZ-.103                                           STP71210
102          HSOL=CKM*CPFACE/(AO*CZZ*HMEYER)                             STP71220
103          HSOLID=HSOL                                                 STP71230
104          HGAS = GK/(CEE*(ROUF+ROUC)+G1PG2)                           STP71240
105          IF(MREV1.GE.0) GO TO 1180                                   STP71250
106          GKBTU = GK * 57.79                                          STP71260
107          PPSI = PFACE * 14.22                                        STP71270
108          HGAS = 0.6 * PPSI * GKBTU/14.4E-6                           STP71280
       C     ......................                                      STP71290
       C                                                                 STP71300
109     1180 CONTINUE                                                    STP71310
110          TFSR=TFS +273.                                              STP71320
111          TCISR=TCI+273.                                              STP71330
112          AF=RFS+DELR                                                 STP71340
113          AC=RCI+DELRC                                                STP71350
114          HRAD=0.56687E-11/(1./EPSIF+AF/AC*(1./EPSIC-1.))*(TFSR**2+TCISR**2)STP71360
            *     *(TFSR+TCISR)                                          STP71370
115          HGC=HSOLID+HGAS+HRAD                                        STP71380
       C                                                                 STP71390
       C     ......................                                      STP71400
116          IF(MREV1.GE.0) GO TO 1190                                   STP71410
117          HGAS=HGAS/1763.0                                            STP71420
118          HGC =HGAS                                                   STP71430
119          HSOLID=HRAD=0.0                                             STP71440
120     1190 CONTINUE                                                    STP71450
       C                                                                 STP71460
       C     ......................                                      STP71470
121          GG(1,ITER) = ITER                                           STP71480
122          GG(2,ITER) = TT(N)                                          STP71490
123          GG(3,ITER) = HG                                             STP71500
124          GG(4,ITER) = HGC                                            STP71510
125          GG(5,ITER) = HSOLID                                         STP71520
126          GG(6,ITER) = HGAS                                           STP71530
127          GG(7,ITER) = HRAD                                           STP71540
128          RETURN                                                      STP71550
       C*****************************************************************STP71560
129          END                                                         STP71570
```

* SOURCE STATEMENT *

```
      SUBROUTINE STEP7A                                                 ST7A0010
C                                                                       ST7A0020
C     THIS SUBROUTINE IS CALLED FROM ST3T08                             ST7A0030
C                                                                       ST7A0040
      REAL MUF,MOL,MOLEFR,MOLFR                                         ST7A0050
      COMMON /IGRADE/ IGRADE,HOTGP,RINT                                 ST7A0060
      COMMON /MREV1 / MREV1                                             ST7A0070
      COMMON /FTNVT / FNVT(20),TNVT(20)                                 ST7A0080
      COMMON /IYIELD/ IYIELD                                            ST7A0090
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  ST7A0100
     1                PKPO*R,IPEAK,DELP,PMAX                            ST7A0110
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                  ST7A0120
      COMMON /DATA 5/ SDOT,SDOTT,EF,MUF,EPSIF,EPSIC                     ST7A0130
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) ST7A0140
      COMMON /COM  1/ TT( 51),TSR( 51),QIN(51),Q(51),TS(51),CLCRP(2,20) ST7A0150
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             ST7A0160
      COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP                  ST7A0170
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  ST7A0180
      COMMON /COM 08/ II,JCASE,TCOOLF,XMOTOT                            ST7A0190
      COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                            ST7A0200
      COMMON /COM 14/ KCON                                              ST7A0210
      COMMON /COM 21/ N,NN,NNN,NF                                       ST7A0220
      COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TH,THR                    ST7A0230
      COMMON /COM 56/ VOLGP,VOLGAP                                      ST7A0240
      COMMON /COM 57/ VRUF,ALPHAC,PRESCN                                ST7A0250
      COMMON /COM78 / PFACE,VOLOVT,HSOLID,HGAS,HRAD,G1PG2,PRESX(20)     ST7A0260
      COMMON /COM 8G/ GG(20,100)                                        ST7A0270
      COMMON /COM 90/ VOLGAS,W,MGC                                      ST7A0280
      COMMON /COM157/ RCI,RCO                                           ST7A0290
      COMMON /COM357/ TAVGC                                             ST7A0300
      COMMON /COM678/ TOTMOL,ABTGAS,VISMIX,GK,GASKON                    ST7A0310
      COMMON /MOL579/ PRESTO(20)                                        ST7A0320
      COMMON /MOL678/ MOLEFR(6)                                         ST7A0330
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPU02,FR35,FR40,FR41,DFS,DCI,  ST7A0340
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, ST7A0350
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,PBC,SIGMF,IFLUX,   ST7A0360
     3                NCLAD,NCON,NFLX,KOOL,NE*K,NE*CL,NE*FLX,VOIDZL,NOH,ST7A0370
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   ST7A0380
     5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICREP,IS*ELLST7A0390
     6                ,NEXP,MEXP,NHIST                                  ST7A0400
      COMMON /COM M7/ STHEST,CFLAG                                      ST7A0410
      COMMON /COM7A/ RESGAP,PCONT                                       ST7A0420
      COMMON /RELO1/ RGAPC(20),RFSO(20),DELEXP(20)                      ST7A0430
      DIMENSION ABCD(7)                                                 ST7A0440
      DATA ABCD / 1HA,1HB,1HC,1HD,1HE,1HF,1HG      /                    ST7A0450
C                                                                       ST7A0460
C     CALCULATE GAS PRESX(IPOW) PRESSURE IN THE PIN                     ST7A0470
C                                                                       ST7A0480
      IF(ITER.EQ.1.AND.IGRADE.NE.5)                                     ST7A0490
     1       VOLGAP=(RFS+DELR+RESGAP/2.)*RESGAP*PI*2.*FL                ST7A0500
      ABTCV=(TT(N))+273.                                                ST7A0510
      V2=VVOID                                                          ST7A0520
      V1=PI*((RCI+DELRC)**2-(RFS+DELR)**2)*FL                           ST7A0530
      IF(ITER.EQ.1.AND.IGRADE.NE.5)                                     ST7A0540
     1       VOLGAP=(RFS+DELR+RESGAP/2.)*RESGAP*PI*2.*FL                ST7A0550
      IF(ITER.EQ.1.AND.IGRADE.EQ.5)                                     ST7A0560
     1       VOLGAP=(RFS+DELR+HOTGP/2. )*HOTGP*PI*2.*FL                 ST7A0570
      IF(V1.LE.VOLGAP) V1=VOLGAP                                        ST7A0580
      VOLOVT=V1/ABTGAS+V2/ABTCV                                         ST7A0590
```


* SOURCE STATEMENT (STEP7A)*

```
      PRESX(IPOW)=84.80804*TOTMOL/VOLOVT                                ST7A0600
      IF(ISTEP.EQ.1) PRESTO(1)=PRESX(IPOW)                              ST7A0610
      EMMIX=MOLEFR(1)*4.0+MOLEFR(2)*39.94+MOLEFR(3)*2.016+MOLEFR(4)*28.0ST7A0620
     12+MOLEFR(5)*83.80+MOLEFR(6)*131.3                                 ST7A0630
      ELL=VISMIX/PRESTO(ISTEP)*SQRT(ABTGAS/EMMIX)                       ST7A0640
      G1PG2 = 5.448 / 14.22 * ELL                                       ST7A0650
C                                                                       ST7A0660
      IN1 = 7                                                           ST7A0670
      IN2 = 30                                                          ST7A0680
      EC = TERP(TAVGC,AA,4,NN,IN1,IN2,IN3,71)                           ST7A0690
      CMU = TERP(TAVGC,AA,5,NN,IN1,IN2,IN3,72)                          ST7A0700
      YDSTR = FYIELD(IYIELD,TAVGC,FNVT(IPOW))                           ST7A0710
      RCI=DCI/2.                                                        ST7A0720
      RCO=DCO/2.                                                        ST7A0730
      RSQRMC=(RCO+DELRCO)**2-(RCI+DELRC)**2                             ST7A0740
      RSQRPC=(RCO+DELRCO)**2+(RCI+DELRC)**2                             ST7A0750
      ALOGC=ALOG((RCO+DELRCO)/(RCI+DELRC))                              ST7A0760
      STREST=ALPHAC*EC*(TCI-TCO)/(2.*(1.-CMU)*ALOGC)*(1.-(2.*(RCO+DELRCOST7A0770
     1)**2/RSQRMC*ALOGC))                                               ST7A0780
C                                                                       ST7A0790
C     CONTACT PRESSURE CALCULATION                PFACE(KG/CM2)         ST7A0800
C                                                                       ST7A0810
      TH = RINT                                                         ST7A0820
      PFACE=(TH*EC/(RCI+DELRC)+PRESCN/RSQRMC)/(RSQRPC/RSQRMC+CMU+EC*(1.-ST7A0830
     1MUF)/EF)                                                          ST7A0840
      GG(16,ITER) = PFACE                                               ST7A0850
      IF(IGRADE.EQ.1) GO TO 1120                                        ST7A0860
      PFACE = PCONT                                                     ST7A0870
 1120 CONTINUE                                                          ST7A0880
      PRMAX=((YDSTR-STREST)*RSQRMC+PRESCN)/RSQRPC                       ST7A0890
      IF(PFACE.GT.PRMAX) PFACE=PRMAX                                    ST7A0900
      IF(PFACE.LT.0.0) PFACE=0.0                                        ST7A0910
      TFSK = TFS + 273.                                                 ST7A0920
      IF(NCON) 1160,1160,1130                                           ST7A0930
 1130 CONTINUE                                                          ST7A0940
      IN1 = 3                                                           ST7A0950
      IN2 = 30                                                          ST7A0960
      FK = TERP(TFS,CF,2,NCON,IN1,IN2,IN3,74)                           ST7A0970
      GO TO 1170                                                        ST7A0980
 1160 FK=FCOND(FRDEN,TFSK,KCON)                                         ST7A0990
 1170 CONTINUE                                                          ST7A1000
      IN1 = 7                                                           ST7A1010
      IN2 = 30                                                          ST7A1020
      CK = TERP(TCI,AA,2,NN,IN1,IN2,IN3,75)                             ST7A1030
      CKM = 2. * FK * CK / ( FK+CK )                                    ST7A1040
C                                                                       ST7A1050
C     HOT GAP CORRECTION FACTOR   (CEE)  CALCULATION                    ST7A1060
C                                                                       ST7A1070
      CEE = EXP(-.00125*PFACE)                                          ST7A1080
C                                                                       ST7A1090
C     HSOLID CALCULATION                  HSOLID(W/CM2.DEG-C)           ST7A1100
C                                                                       ST7A1110
      ROUGH=SQRT((ROUF**2+ROUC**2)/2.)                                  ST7A1120
      CROUGH=ROUGH                                                      ST7A1130
      HMEYER = TERP(TCI,AA,7,NN,IN1,IN2,IN3,76)                         ST7A1140
      IF(IYIELD.GT.0) HMEYER = 2.8*YDSTR                                ST7A1150
      CZZ=SQRT(CROUGH)                                                  ST7A1160
      AO=140.2*CZZ-.103                                                 ST7A1170
      HSOLID = CKM * PFACE/(AO*CZZ*HMEYER)                              ST7A1180
```

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* SOURCE STATEMENT (STEP/A  )*
                                                                        ST7A1190
      C                                                                 ST7A1200
      C     HOT GAP CALCULATION                    HOTGAP(CM)           ST7A1210
      C                                                                 ST7A1220
 90         IF(IGRADE.NE.5) HOTGP = CEE*RESGAP                         ST7A1230
 91         TH = HOTGP                                                 ST7A1240
 92         HOTGAP = HOTGP + GAPG2                                     ST7A1250
 93         VOLGAP=(RFS*DELR+HOTGP /2.) * HOTGP  * PI * 2. * FL        ST7A1260
 94         VOLGP= VOLGAP + VVOID                                      ST7A1270
      C                                                                 ST7A1280
      C     HGAS CALCULATION                   HGAS(W/CM2/DEG-C)        ST7A1290
      C                                                                 ST7A1300
 95         HGAS = BK/HOTGAP                                           ST7A1310
 96    1120 CONTINUE                                                   ST7A1320
 97         CFLAG = ABCD(IGRADE)                                       ST7A1330
      C                                                                 ST7A1340
      C     HRAD CALCULATION                       HRAD(W/CM2/DEG-C)   ST7A1350
      C                                                                 ST7A1360
 98         TCISK=TC1+273.                                             ST7A1370
 99         AF=RFS*DELR                                                ST7A1380
100         AC=RCI*DELRC                                               ST7A1390
101         HRAD=0.5668*E-11/(1./EPSIF+AF/AC*(1./EPSIC-1.))*(TFSK**2+TCISK**2)ST7A1400
           *      *(TFSK+TCISK)                                        ST7A1410
102         HGC=HSOLID+HGAS+HRAD                                       ST7A1420
103         GG(1,ITER) = ITER                                          ST7A1430
104         GG(2,ITER) = TT(N)                                         ST7A1440
105         GG(3,ITER) = HG                                            ST7A1450
106         GG(4,ITER) = HGC                                           ST7A1460
107         GG(5,ITER) = HSOLID                                        ST7A1470
108         GG(6,ITER) = HGAS                                          ST7A1480
109         GG(7,ITER) = HRAD                                          ST7A1490
110         GG(9,ITER) = CEE                                           ST7A1500
111         GG(17,ITER) = PFACE                                        ST7A1510
112         GG(18,ITER) = RINT                                         ST7A1520
      C                                                                 ST7A1530
      C --------- TH IS HOT GAP AT THIS STEP  , CALCULATE COLD GAP RGAPC(IPOW)ST7A1540
      C        COLD GAP DEFINE AT ROOM TEMPERATURE (25. DEG C)         ST7A1550
      C                                                                 ST7A1560
113         XDELR = 0.0                                                ST7A1570
114         DO 10 I=1,N                                                ST7A1580
115         T1= BB(3,I)                                                ST7A1590
116         T2 = BB(3,I+1)                                             ST7A1600
117         T3 = (T1+ T2)/2.                                           ST7A1610
118         ALP = FALPHA(T3,NEAP)                                      ST7A1620
119         RINGR = BB(4,I) - BB(4,I + 1)                              ST7A1630
120         DELRIN = RINGR*ALP*(25.-T3)                                ST7A1640
121         XDELR = XDELR + DELRIN                                     ST7A1650
122      10 CONTINUE                                                   ST7A1660
123         DELEXP(IPOW) = XDELR                                       ST7A1670
124         RGAPC(IPOW) = TH-XDELR                                     ST7A1680
125         RFSO(IPOW) = (RFS+DELR) + XDELR                            ST7A1690
126         RETURN                                                     ST7A1700
      C*****************************************************************ST7A1710
127         END
```

* SOURCE STATEMENT *

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      SUBROUTINE STEP8                                                  STP80010
C                                                                       STP80020
C     THIS SUBROUTINE IS CALLED FROM ST3TO8                             STP80030
C                                                                       STP80040
      REAL  MUF,MOL,MOLEFR,MOLFR                                        STP80050
      COMMON /MREV1 / MREV1                                             STP80060
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  STP80070
     1                PKPOWR,IPEAK,DELP,PMAX                            STP80080
      COMMON /BRNGAS/ AKR(20),AXE(20),PHI(20),ENXE(20),ENKR(20)         STP80090
      COMMON /BURN  / BURN(20),BUOLD(20)                                STP80100
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONER                  STP80110
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) STP80120
      COMMON /COM  1/ TT( 51),TSR( 51),WIN(51),Q(51),TS(51),CLCKP(2,20) STP80130
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             STP80140
      COMMON /COM 03/ TC,P,DELRCO,DELRC,DELR,TCOOL,STP                  STP80150
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  STP80160
      COMMON /COM 08/ II,JCASE,TCOOLF,XMOTOT                            STP80170
      COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                            STP80180
      COMMON /COM 20/ RHO,RHOS,FRUU,FRPUPU                              STP80190
      COMMON /COM 21/ N,NN,NNN,NF                                       STP80200
      COMMON /COM 35/ TBI,TBO,TCC,TCI,TCO,TFS,TM,THR                    STP80210
      COMMON /COM 38/ QOVRAB,QOVRAC,QOVRAS,HF                           STP80220
      COMMON /COM89 / HGX(20),HGAPX(20),TCLINE(20)                      STP80230
      COMMON /COM128/ IOUT1,IIPROF                                      STP80240
      COMMON /COM49P/ DC(20,51),IPROF                                   STP80250
      COMMON /COM76 / PFACE,VOLOVT,HSOLID,HGAS,HRAD,G1PG2,PRESX(20)     STP80260
      COMMON /COM048/ DSIN,RSIN,TSIN,TSINC,DVOID,RVOID,T                STP80270
      COMMON /COM568/ DELRB,DELRP,DELRCI,DELRT,TAVGF,VAVGT              STP80280
      COMMON /COM678/ TOTMOL,ABTGAS,VISMIX,GK,GASKON                    STP80290
      COMMON /MOL678/ MOLEFR(6)                                         STP80300
      COMMON /MC838 / VOLTX(20)                                         STP80310
      COMMON /COM M8/ NOCONV,HGNO,HGCNO,ISTPNO,IPOWNO,NPOWNO            STP80320
      COMMON /COM 8M/ ISTOP,ICASE                                       STP80330
      COMMON /HIZUKE/ K1,K2,K3,K4,K5,K6                                 STP80340
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPU02,FR35,FR40,FR41,DFS,DCI,  STP80350
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXIP,DE,V, STP80360
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   STP80370
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NGH STP80380
     4                FRACHE,FRACAR,FRACHG,FRACN,FRACKR,FRACXE,HGACEL,  STP80390
     5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELL STP80400
     6                ,NEXP,MEXP,NHIST                                  STP80410
      COMMON /PRINO2/ CP1(20)    ,CP2(20)    ,ST1(20)    ,ST2(20)       STP80420
     *                ST3(20)    ,ST4(20)    ,ST5(20)    ,ST6(20)       STP80430
      COMMON /RESTRU/ TSINT,RVOIDX,VVOIDC,VLENGT                        STP80440
      COMMON /DIMEN1/ DVOIDX(20),DVOIDH(20),DFSX(20),DCIX(20),DCOX(20), STP80450
     1                VVOIDX(20),VVOIDH(20),TSINX(20),RSINX(20)         STP80460
     2               ,ZLENGT(5,20),VOIDL(20)                            STP80470
      DATA CP1,CP2,ST1,ST2,ST3,ST4,ST5,ST6 / 160*0.0 /                  STP80480
      DATA TSINC/0.0/                                                   STP80490
C                                                                       STP80500
      IF(MREV1.EQ.0.AND.THR.GT.0.0) PFACE=0.                            STP80510
      VOLTX(IPOW)=VOLOVT                                                STP80520
      HGX(IPOW)=HG                                                      STP80530
      TCLINE(IPOW)=TT(N)                                                STP80540
      HGAPX(IPOW)=TH                                                    STP80550
C-----------------------------------------------  STORED ENERGY  --------STP80560
      CALL        STOREN(VAVGT,TSR,TFS,TT,N,PI,DFS,RHO,                 STP80570
     1 CPNOM,CPMIN,CPMAX,STORE,STOR,STORB,STOREB,STOREC,STOREF,CPNOMF)  STP80580
C                                                                       STP80590
```


* SOURCE STATEMENT (STEP8)*

```
      CP1(IPOW)      = CPNOM                                            STP80600
      CP2(IPOW)      = CPNOMF                                           STP80610
      ST1(IPOW)      = STOR                                             STP80620
      ST2(IPOW)      = STORB                                            STP80630
      ST3(IPOW)      = STORE                                            STP80640
      ST4(IPOW)      = STOREB                                           STP80650
      ST5(IPOW)      = STOREC                                           STP80660
      ST6(IPOW)      = STOREF                                           STP80670
C                                                                       STP80680
      IF(ISTEP.LT.ISTOP.OR.IIPROF.LE.0) GO TO 20000                     STP80690
      IPROF=0                                                           STP80700
      HGDUM=HG*1763.                                                    STP80710
C     ***********************   CALL PROF, GAPRO   ******************STP80720
      CALL PROF(TM,TCI,TCO,TCOOL,TH,HGDUM,JCASE,IPOW,NPOW,MINI,ISTEP,   STP80730
     *          LPMAX)                                                  STP80740
C     ***************************************************************STP80750
20000 CONTINUE                                                          STP80760
      IF(NOCONV.EQ.1) CALL GAPRO(ICASE,JCASE)                           STP80770
      IF(NOCONV.EQ.1) WRITE(6,1880) HGNO,HGCNO,ISTPNO,IPOWNO,NPOWNO     STP80780
      NOCONV = 0                                                        STP80790
C                                                                       STP80800
      RSIN=0.                                                           STP80810
      TSINC=0.0                                                         STP80820
      RKVOID=RVOID                                                      STP80830
      VTC=0.0                                                           STP80840
C                                                                       STP80850
      IF(T.LE..001.OR.FRDEN.EQ.FRSIN) GO TO 1350                        STP80860
      IF(FRDEN.GE.FRSIN) FRSIN=FRDEN                                    STP80870
C     **********                                                        STP80880
      RETEM=.00001367*ALOG10(24.*TOTLDY ) +.000480                      STP80890
      TSINC=1./RETEM-273.                                               STP80900
C     TSIN=1.8*TSINC+32.                                                STP80910
      TSIN = TSINC                                                      STP80920
 1340 CONTINUE                                                          STP80930
      IN1 =  6                                                          STP80940
      IN2 = 51                                                          STP80950
      RSIN = TERP(TSIN,BB,2,N,IN1,IN2,IN3,82)                           STP80960
      IF(RSIN.LE.RSINZ) RSIN = RSINZ                                    STP80970
      DSIN=2.*RSIN                                                      STP80980
C*************************************************                      STP80990
      FACT = 0.0                                                        STP81000
      IF(FRSIN.LE.0.0) GO TO 5                                          STP81010
      FACT = (FRSIN-FRDEN) / FRSIN                                      STP81020
    5 CONTINUE                                                          STP81030
      SQRV = RVOIDZ**2 + FACT*(RSIN**2 - RSINZ**2)                      STP81040
      RVOID = SQRT(SQRV)                                                STP81050
C*************************************************                      STP81060
      IF(RVOID.LE.RVOIDZ) RVOID = RVOIDZ                                STP81070
      DVOID=2.*RVOID                                                    STP81080
      ELTC=FL-VOIDZL/FNPOW                                              STP81090
      VTC=PI*ELTC*RVOIDZ**2                                             STP81100
      VVOID=(PI*FL*RVOID**2-VTC)                                        STP81110
 1350 CONTINUE                                                          STP81120
C                                                                       STP81130
C----- MODIFY HOT DIMENSION TO COLD STATE(VOID AND RESTRUCTURE RADIUS)  STP81140
C                                                                       STP81150
      TTT = TT(N)                                                       STP81160
      ALP=FALPHA(TTT,NEXP)                                              STP81170
C. ISINT IS ALWAYS SETTED TO 0 AT EACH AXIAL SECTION LOOP IN SUB. ST3TO8STP81180
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* SOURCE STATEMENT (STEPR    )*

      C       AND SET TO 1 IN SUB, STEP4 IF RESTRUCTURING OCCURED              STP81190
 88         IF(ISINT.EQ.0) ALP=0.0                                            STP81200
 89         IF(RVOID.EQ.RVOID2) ALP = 0.0                                     STP81210
 90         RVOIDX=RVOID/(1.+ALP*(TTT-25.))                                   STP81220
 91         VVOIDC=(PI*FL*RVOIDX**2-VTC)                                      STP81230
 92         IF(VVOIDC.LE.0.0) VVOIDC=0.0                                      STP81240
      C                                                                        STP81250
      C..... WE ASSUMED THE CENTRAL VOID ALWAYS FORMED UNIFORM DIAMETER FROM  STP81260
      C       BOTTOM TO TOP                                                    STP81270
      C                                                                        STP81280
 93         IF(RVOIDX.LE.1.E-10) GO TO 10                                     STP81290
 94         VLENGT=VVOIDC/(PI*RVOIDX**2)                                      STP81300
 95         GO TO 20                                                          STP81310
 96      10 CONTINUE                                                          STP81320
 97         VLENGT=0.0                                                        STP81330
 98      20 CONTINUE                                                          STP81340
      C                                                                        STP81350
      C       WHERE  RVOIDX IS THE RADIUS OF CENTRAL VOID AT ROOM TEMPERATURE  STP81360
      C              VVOIDC IS THE VOLUME OF CENTRAL VOID AT ROOM TEMPERATURE  STP81370
      C              VLENGT  IS THE LENGTH OF CENTRAL VOID EQUAL TO 1-SECTION  STP81380
      C                      LENGTH (=FL)                                      STP81390
      C                                                                        STP81400
 99         RETURN                                                            STP81410
      C   *    1    *    2    *    3    *    4    *    5    *    6    *    7   STP81420
100   1660 FORMAT( //, 2X, 'NON-CONVERGENCE IN HGC -- HG =', F9.6,'  HGC =',STP81430
     *F9.6, 2X, 'ISTEP =', I2, '  IPOW =', I2, ' OF ', I2                  )  STP81440
101    1770 FORMAT(1H ,24X,'RADIUS',10X,'TEMPERATURE',15X,'RADIUS',12X,'TEMPERSTP81450
     14TURE',10X,'PERCENT OF',/,24X,'(INCHES)',11X,'(DEG F)',18X,'(CM)',STP81460
     213X,'(DEG C)',12X,'FUEL RADIUS',//(24X,F6.4,9X,F10.0,17X,F8.4,13X,STP81470
     3 F8.0,10X,F10.2))                                                        STP81480
      C*****************************************************************STP81490
102         END                                                              STP81500
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* SOURCE STATEMENT *
 1        SUBROUTINE ST3T06(KS)                                          ST380010
C                                                                        ST380020
C       THIS SUBROUTINE IS CALLED FROM MAIN                              ST380030
C                                                                        ST380040
 2        REAL  MUF,MOL,MOLEFR,MOLFR                                     ST380050
 3        COMMON /ANKRXE/ ANKR,ANXE                                      ST380060
 4        COMMON /MEMO1 / MEMO1(20,5),HATA(20)                           ST380070
 5           COMMON /MCONV / MCONV                                       ST380080
 6        COMMON /MAIMOL/ TAVGX,VOLTXS                                   ST380090
 7        COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),A1(21),NPOW,PTOT,LPMAX,ST380100
         1                PKPOWR,IPEAK,DELP,PMAX                         ST380110
 8        COMMON /BRNGAS/ AKR(20),AXE(20),PHI(20),ENXE(20),ENKR(20)      ST380120
 9        COMMON /BRNRAY/ VOLCC,A1Z,A7Z,A8Z,A9Z,A10Z                     ST380130
10        COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN               ST380140
11        COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) ST380150
12        COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                          ST380160
13        COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP               ST380170
14        COMMON /COM 04/ RSINF,@0S,@0U,@TOT                             ST380180
15        COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR               ST380190
16        COMMON /COM 08/ II,JCASE,TCOOLF,AMOTOT                         ST380200
17        COMMON /COM 10/ VVOIDZ,FRUO2,TPLENA,NPOW1                      ST380210
18        COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                         ST380220
19        COMMON /COM 20/ RHO,RHOS,FRUU,FRPUPU                           ST380230
20        COMMON /COM 21/ N,NN,NNN,NF                                    ST380240
21        COMMON /COM046/ DSIN,RSIN,TSIN,TSINC,DVOID,RVOID,T             ST380250
22        COMMON /COM M8/ NOCONV,HGNO,HGCNO,ISTPNO,IPOWNO,NPOWNO         ST380260
23        COMMON /COM 86/ GG(20,100)                                     ST380270
24        COMMON /COM 8M/ ISTOP,ICASE                                    ST380280
25        COMMON /COM 90/ VOLGAS,W,HGC                                   ST380290
26        COMMON /ML838 / VOLTX(20)                                      ST380300
27        COMMON /ML5936/ TBAR(20)                                       ST380310
28        COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI, ST380320
         1                DCO,DVOIDZ,VPLENZ,ATMGS,S,XX,ROOF,ROUC,EXTP,DE,V, ST380330
         2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,STGHF,IFLUX,  ST380340
         3                NCLAD,NCON,NFLX,KGOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,ST380350
         4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACAE,HG4CEL,  ST380360
         5                DTEMP,ZCLAD,HG,PEAKVG,MINI,ICDF,ISTOR,ICREP,ISWELLST380370
         6                ,NEXF,MEXP,NHIST                                ST380380
29        COMMON /COM 35/ TBI,TBO,TCO,TCI,TCO,TFS,TM,THR                 ST380390
30        COMMON /COM 38/ @OVRAB,@OVRAC,@OVRAS,HF                        ST380400
31        COMMON /COM M7/ STRESI,CFLAG                                   ST380410
32        COMMON /COM 50/ DELRCC,DELRDE,DELRRE,TSHOUL                    ST380420
33        COMMON /COM M50/ R1700,R1500,R1350                             ST380430
34        COMMON /COM78 / PFACE,VOLOVT,HSOLID,HGAS,HRAD,G1PG2,PRESX(20)  ST380440
35        COMMON /COM157/ RCI,RCO                                        ST380450
36        COMMON /COM668/ DELRM,DELRP,DELRCI,DELRT,TAVGF,VAVGT           ST380460
37        COMMON /COM678/ TOTMOL,ABTGAS,VISMIX,GK,GASKON                 ST380470
38        COMMON /PRINO1/ TCOLT(20) ,HFILM(20) ,TCOCA(20) ,TCICA(20) ,   ST380480
         *     CCONB(20) ,TGAPC(20) ,HFLXFB(20),GCS(20)  ,GCG(20)   ,   ST380490
         *     GCP(20)   ,GCI(20)   ,TJUMP(20) ,DRTF(20)  ,DRSF(20)  ,   ST380500
         *     DRF(20)   ,DRTC(20)  ,DRPC(20)  ,DRCLD(20) ,TFSCA(20) ,   ST380510
         *     DRCC(20)  ,BR1(20)   ,BR2(20)   ,BR3(20)   ,BR4(20)   ,   ST380520
         *     RATF(20)  ,RATC(20)  ,CPRES(20) ,CSTRES(20),GASCC(20) ,   ST380530
         *     GASCB(20) ,ITER2(20)                                     ST380540
39        COMMON /PRINO3/ DKDF(20),DPRF(20),FCONT(20),TDISP(20)          ST380550
40        COMMON /RESTRO/ ISINT,RVOIDX,VVOIDC,VLENGT                     ST380560
41        COMMON /DIMEN1/ DVOIDX(20),DVOIDH(20),DFSX(20),DCIX(20),DCOX(20), ST380570
         1                VVOIDX(20),VVOIDH(20),ISINX(20),RSINX(20)      ST380580
         2               ,ZLENGT(5,20),VOIDL(20)                         ST380590
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* SOURCE STATEMENT (ST3T06 )*
42        COMMON /ELONG/ PLENGT(5)                                       ST380600
43        COMMON /CONVER/ NONCON                                         ST380610
44        COMMON /MREV1 / MREV1                                          ST380620
45        COMMON /NEWGAS/ MGAS                                           ST380630
46        COMMON /STODEN / DLPLD,DENSL                                   ST380640
47        COMMON / DIMEN2 / DENSFL(5,20)                                 ST380650
C*********                                                               ST380660
48        DIMENSION PREHG(20),HGAC(20)                                   ST380670
49        DATA PREHG / 20*0.5678 /                                       ST380680
C*********                                                               ST380690
50        GO TO (1111,2222                          )  ,KS               ST380700
51   1111 CONTINUE                                                       ST380710
52        DO 444 I=1,20                                                  ST380720
53        DO 443 J=1,5                                                   ST380730
54    443 MEMO1(I,J) = 0                                                 ST380740
55    444 HATA(I) = 4H                                                   ST380750
56        RETURN                                                         ST380760
C                                                                        ST380770
57   2222 CONTINUE                                                       ST380780
58        TAVGX=0.                                                       ST380790
59        VOLTXS=0.                                                      ST380800
60        DO 1370 IPOW=1,NPOW                                            ST380810
C                                                                        ST380820
C       CALCULATE THE POWER, TCOOL, THE NEW NUMBER OF XE AND KR          ST380830
C       ATOMS IN EACH SEGMENT.                                           ST380840
C                                                                        ST380850
61        DVOIDZ=DVOIDX(IPOW)                                            ST380860
62        DFS   =DFSX  (IPOW)                                            ST380870
63        DCI   =DCIX  (IPOW)                                            ST380880
64        DCO   =DCOX  (IPOW)                                            ST380890
65        VVOIDZ=VVOIDX(IPOW)                                            ST380900
66        RVOIDZ=DVOIDZ/2.                                               ST380910
67        RFS   =DFS/2.                                                  ST380920
68        RCI   =DCI/2.                                                  ST380930
69        RCO   =DCO/2.                                                  ST380940
70        ISINT =0                                                       ST380950
71        RSINZ = RSINX(IPOW)                                            ST380960
72        P=(POWER(IPOW)+POWER(IPOW+1))*0.5                              ST380970
73        TCOOL=TINLET+DTEMP*AI(IPOW)                                    ST380980
74        TCOOLF = TCOOL * 1.8 + 32.                                     ST380990
75        IF(RSINZ.GT.0.) GO TO 500                                      ST381000
76        WGT=RHO*(RFS**2-RVOIDZ**2)*PI                                  ST381010
77        WGTS=0.                                                        ST381020
78        GO TO 510                                                      ST381030
79    500 WGT=RHO*(RFS**2-RSINZ**2)*PI                                   ST381040
80        WGTS=RHOS*(RSINZ**2-RVOIDZ**2)*PI                              ST381050
81    510 WGTCM=WGT+WGTS                                                 ST381060
82        RSIN=RSINZ                                                     ST381070
83        DSIN=DSINZ                                                     ST381080
84        RVOID=RVOIDZ                                                   ST381090
85        DVOID=DVOIDZ                                                   ST381100
86        VVOID=VVOIDZ                                                   ST381110
87        @TOT = P                                                       ST381120
C       @GRAM IS IN  W/CM2/GRAM OF FUEL                                  ST381130
88        @GRAM=WTOT/WGTCM                                               ST381140
89        @@U=@GRAM*RHO                                                  ST381150
90        @W5=@GRAM*RHOS                                                 ST381160
C       INITIALIZE                                                       ST381170
91           NOCONV = 0                                                  ST381180
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* SOURCE STATEMENT (ST3T08  )*

 92          ITER = ITEE = 0                                                ST381190
 93       DELR = DELRC = DELRCO = DELTAO = DELHGO = 0.0                     ST381200
 94       HGACEL = 0.8                                                      ST381210
 95       IF(ISTEP.EQ.1) HGACEL=0.6                                         ST381220
 96       IF(ISTEP.EQ.2) HGACEL=0.5                                         ST381230
 97       IF(ISTEP.EQ.3) HGACEL=0.4                                         ST381240
 98       IF(ISTEP.EQ.4) HGACEL=0.3                                         ST381250
 99       IF(ISTEP.EQ.5) HGACEL=0.2                                         ST381260
100          IF(ISTEP.LE.3) GO TO 518                                       ST381270
101          IF(MEMO1(IPOW,ISTEP-1).LT.  8) GO TO 518                       ST381280
102          HGACEL = HGAC(IPOW)                                            ST381290
103          ITEE = MEMO1(IPOW,ISTEP-1)                                     ST381300
104   518    CONTINUE                                                       ST381310
105       IOSC = 0                                                          ST381320
106       HGOLD = 0.5678                                                    ST381330
107       OLDOLD = HGCOLD = 0.5678                                          ST381340
108       HG1=HG2=HGC1=HGC2=0.5678                                          ST381350
109       HGMAX = 10E+3                                                     ST381360
110       HGMIN = 0.0                                                       ST381370
C-----------------------                                                    ST381380
111       IF(ISTEP.LE.2) GO TO 550                                          ST381390
112       HG = PREHG(IPOW)                                                  ST381400
113   550 CONTINUE                                                          ST381410
CCCCCC    HG = INITIAL HG IS INPUTTED AT SUB. STEP1                         ST381420
C     GAP CONDUCTANCE ITERATION LOOP                                        ST381430
114   520 CONTINUE                                                          ST381440
115       ITER=ITER+1                                                       ST381450
116          ITEE = ITEE + 1                                                ST381460
C                                                                           ST381470
C                                                                           ST381480
C     STEP3 COOLANT-CLADDING HEAT TRANSFER, HEAT FLUX, CLADDING TEMP.       ST381490
C     STEP4 FUEL TEMPERATURE DISTRIBUTION, RESTRUCTURING TEMPERATURE        ST381500
C     STEP5 THERMAL EXPANSION, SWELLING, HOT GAP                            ST381510
C     MOLMOL(2) FISSION GAS RELEASE RATE                                    ST381520
C     STEP6 THERMAL CONDUCTIVITY OF GAS MIXTURE                             ST381530
C     STEP7 GAP CONDUCTANCE                                                 ST381540
C                                                                           ST381550
C                                                                           ST381560
117                                                CALL STEP3               ST381570
118                                                CALL STEP4               ST381580
119       IF(MREV1.LE.0)                           CALL STEP5               ST381590
120       IF(MREV1.EQ.1)                           CALL STEP5A              ST381600
121                                                CALL MOLMOL(3)           ST381610
122                                                CALL STEP6               ST381620
123       IF(MREV1.LE.0)                           CALL STEP7               ST381630
124       IF(MREV1.EQ.1)                           CALL STEP7A              ST381640
C                                                                           ST381650
C     BEGIN CONVERGENCE OF HG NOW.                                          ST381660
C                                                                           ST381670
125       IF(MCONV) 10,10,20                                                ST381680
126    10 DELTA=HGC-HG                                                      ST381690
127       DELHG=HG-HGOLD                                                    ST381700
128       HGOLD=HG                                                          ST381710
129       IF(ABS(DELTA/HG).LT.0.01.AND.ITER.GT.1) NONCON = 0                ST381720
130       IF(ABS(DELTA/HG).LT.0.01.AND.ITER.GT.1) GO TO 1230                ST381730
131       FAC1 = FAC2 = 1.0                                                 ST381740
132       IF(ISTEP.EQ.1.AND.ITER.GT.1) GO TO 1230                           ST381750
133       IF(ISTEP.EQ.2.AND.ITER.GT.5) GO TO 1230                           ST381760
134       IF(ISTEP.EQ.3.AND.ITER.GT.10) GO TO 1230                          ST381770
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* SOURCE STATEMENT (ST3T08  )*

135       IF(ITER.GT.45) GO TO 1220                                         ST381780
136       IF(ITER.LE.3) GO TO 1200                                          ST381790
137       IF(.NOT.(DEL2*DEL1.GT..0.AND.DEL1*DELTA.LT..0)) GO TO 1192        ST381800
138       IF(ABS((HG-HG1)/DELTA).LT.0.001) GO TO 1192                       ST381810
139       HGACEL = HGACEL * 0.5                                             ST381820
140       HG = ( HG+HG1) / 2.0                                              ST381830
141       GO TO 520                                                         ST381840
142  1192 CONTINUE                                                          ST381850
143       IF(DELTA*DELTAO.LT..0.AND.ABS(DELHG/DELHGO).GT.0.8)   FAC1=0.8    ST381860
144       IF(DELTA*DELTAO.GT..0.AND.ABS((HGCOLD-HGC)/HGC).LT.0.003) FAC1=1.2ST381870
145       HGACEL = HGACEL * FAC1                                            ST381880
146          IF(HGACEL.GT.0.6) HGACEL=0.6                                   ST381890
147       IF(ITEE.LE. 10.AND.                HGACEL.LT.0.1   ) HGACEL=0.1   ST381900
148       IF(ITEE.LE. 15.AND.ITEE.GT. 10.AND.HGACEL.LT.0.07  ) HGACEL=0.07  ST381910
149       IF(ITEE.LE. 20.AND.ITEE.GT. 15.AND.HGACEL.LT.0.05  ) HGACEL=0.05  ST381920
150       IF(ITEE.LE. 25.AND.ITEE.GT. 20.AND.HGACEL.LT.0.04  ) HGACEL=0.04  ST381930
151       IF(ITEE.LE. 30.AND.ITEE.GT. 25.AND.HGACEL.LT.0.03  ) HGACEL=0.03  ST381940
152       IF(ITEE.LE. 35.AND.ITEE.GT. 30.AND.HGACEL.LT.0.02  ) HGACEL=0.02  ST381950
153       IF(ITEE.LE. 40.AND.ITEE.GT. 35.AND.HGACEL.LT.0.01  ) HGACEL=0.01  ST381960
154       IF(HGACEL.LT.0.015) HGACEL = 0.015                                ST381970
155       IF(DELTA*DELTAO.LT..0.AND.ABS((OLDOLD-HGC)/HGC).LT.0.012) FAC2=.5 ST381980
156       HGACEL = HGACEL * FAC2                                            ST381990
157  1200 CONTINUE                                                          ST382000
158          HG2 = HG1                                                      ST382010
159          HG1 = HG                                                       ST382020
160       HG=HG+HGACEL*DELTA                                                ST382030
161       IF((HG+HGC).LT.,567.AND.ITEE.LE.5) HGACEL=0.5                     ST382040
162  1210 CONTINUE                                                          ST382050
163       DELTAO=DELTA                                                      ST382060
164       DELHGO=DELHG                                                      ST382070
165       OLDOLD = HGCOLD                                                   ST382080
166       HGCOLD = HGC                                                      ST382090
167              DEL2=DEL1                                                  ST382100
168       OLDOLD=HGC2=HGC1                                                  ST382110
169       DELTAO=DEL1=DELTA                                                 ST382120
170       HGCOLD=HGC1=HGC                                                   ST382130
171       GG(8,ITER) = HGACEL                                               ST382140
172       GO TO 520                                                         ST382150
173    20 HG2 = HG                                                          ST382160
174       DELTA2  = HGC - HG                                                ST382170
175       IF(DELTA2.LT.0.0.AND.HG.LT.HGMAX)  HGMAX = HG                     ST382180
176       IF(DELTA2.GT.0.0.AND.HG.GT.HGMIN)  HGMIN = HG                     ST382190
177       IF(HGMAX.LT.HGMIN)  GO TO 1213                                    ST382200
178  1212 IF(ITER.LE.1)  GO TO 1211                                         ST382210
179       HATA(IPOW)=1H                                                     ST382220
180       IF(ABS(DELTA2/HG2).LT.0.01) HATA(IPOW)=1HA                        ST382230
181       IF(ABS(DELTA2/HG2).LT.0.01)  GO TO 1230                           ST382240
182       IF(ABS((HG2-HG1)/HG1).LT.0.0002) HATA(IPOW)=1HB                   ST382250
183       IF(ABS((HG2-HG1)/HG1).LT.0.0002)  GO TO 1230                      ST382260
184       IF(ISTEP.EQ.1.AND.ITER.GT.1) GO TO 1230                           ST382270
185       IF(ITER.GT.45)  GO TO 1220                                        ST382280
186       HG = HG2 - DELTA2*(HG2-HG1)/(DELTA2-DELTA1)                       ST382290
187       IF(HG.GT.HGMAX)  HG = HGMAX                                       ST382300
188       IF(HG.LE.HGMIN)  HG = HGMIN                                       ST382310
189       DELTA1 = DELTA2                                                   ST382320
190       HG1 = HG2                                                         ST382330
191       IF(HG.EQ.HGMAX.AND.HG1.EQ.HGMIN)  HG = (HGMAX+HGMIN)/2.0          ST382340
192       IF(HG.EQ.HGMIN.AND.HG1.EQ.HGMAX)  HG = (HGMAX+HGMIN)/2.0          ST382350
193       GO TO 520                                                         ST382360
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 1211 CONTINUE                                                          ST382370
      DELTA1 = HGC- HG                                                  ST382380
      HG1 = HG                                                          ST382390
      HG = HGC                                                          ST382400
      IF(ABS(DELTA1).GT.0.8.AND.HG1.NE.0.568)  HG = 0.568               ST382410
      GO TO 520                                                         ST382420
 1213 HMX = HGMAX + HGMIN                                               ST382430
      HMN = 0.2*( HGMAX + HGMIN )                                       ST382440
      HGMAX = HMX                                                       ST382450
      HGMIN = HMN                                                       ST382460
      GO TO 1212                                                        ST382470
 1220 CONTINUE                                                          ST382480
C     NON-CONVENGENCE IN GAP CONDUCTANCE                                ST382490
      NOCONV = 1                                                        ST382500
      HGNO   = HG                                                       ST382510
      HGCNO  = HGC                                                      ST382520
      ISTPNO = ISTEP                                                    ST382530
      IPOWNO = IPOW                                                     ST382540
      NPOWNO = NPOW                                                     ST382550
      IF(ITER.GT.45) WRITE(6,3000)                                      ST382560
      NP1 = N + 1                                                       ST382570
      IF(ITER.GT.45) WRITE(6,3010) (BB(3,I),I=1,NP1)                    ST382580
 1230 CONTINUE                                                          ST382590
      IF(ITER.GE.50.AND.NOCONV.EQ.0) GO TO 1220                         ST382600
C-------------------------                                              ST382610
      PREHG(IPOW) = HG                                                  ST382620
         HGAC(IPOW) = HGACEL                                            ST382630
      MEMO1(IPOW,ISTEP) = ITER                                          ST382640
                                                   CALL STEP8           ST382650
C*****************  DONT RETURN TO GAP-CON ITERATION LOOP IN THIS VERSIONST382660
      TAVGX=TAVGX+TBAR(IPOW)                                            ST382670
      VOLTXS=VOLTXS+VOLTX(IPOW)                                         ST382680
C-----------------------------------------------------------------------ST382690
C**********  STORE THE NODAL INFORMATION FOR OUTPUT   74.8.26 **********ST382700
      IF(ISTEP.LT.ISTOP) GO TO 2001                                     ST382710
C                                                                       ST382720
      TCOLT(IPOW)    =TCOOL                                             ST382730
      HFILM(IPOW)    =HF                                                ST382740
      TCOCA(IPOW)    =TCO                                               ST382750
      TCICA(IPOW)    =TCI                                               ST382760
      CCONB(IPOW)    =TCC                                               ST382770
      TGAPC(IPOW)    =(TCI+TFS)/2.                                      ST382780
      HFLXPB(IPOW)   =GOVRAS                                            ST382790
      GCS(IPOW)      =HSOLID                                            ST382800
      GCG(IPOW)      =HGAS                                              ST382810
      GCR(IPOW)      =HRAD                                              ST382820
      GCT(IPOW)      =HGC                                               ST382830
      TJUMP(IPOW)    =G1PG2                                             ST382840
C                                                                       ST382850
      DRTF(IPOW)     =DELRT                                             ST382860
      DRSF(IPOW)     =DELRB                                             ST382870
      DRDF(IPOW)     =DELRDE                                            ST382880
      DRRF(IPOW)     =DELRRE                                            ST382890
      DRF(IPOW)      =DELR                                              ST382900
      DRTC(IPOW)     =DELRCI                                            ST382910
      DRPC(IPOW)     =DELRP                                             ST382920
      DRCLD(IPOW)    =DELRCI+DELRP+DELRCC                               ST382930
      TFSCA(IPOW)    =TFS                                               ST382940
      DRCC(IPOW)     =DELRCC                                            ST382950
```



```
      BR1(IPOW)      =RVOID                                             ST382960
      BR2(IPOW)      =R1700                                             ST382970
      BR3(IPOW)      =R1350                                             ST382980
      BR4(IPOW)      =RFS + DELR                                        ST382990
      RATF(IPOW)     =DELR/RFS *100.                                    ST383000
      RATC(IPOW)     =DELRCO/RCO *100.                                  ST383010
      CPRES(IPOW)    =PFACE                                             ST383020
      CSTRES(IPOW)   =STREST                                            ST383030
      GASCC(IPOW)    =GASKON                                            ST383040
      GASCB(IPOW)    =GK                                                ST383050
C                                                                       ST383060
      ITERZ(IPOW)    = ITER                                             ST383070
      FCONT(IPOW)    = CFLAG                                            ST383080
C                                                                       ST383090
      DVOIDX(IPOW)   =RVOIDX*2.                                         ST383100
      DVOIDH(IPOW)   =RVOID *2.                                         ST383110
      DFSX(IPOW)     =DFS                                               ST383120
      DCIX(IPOW)     =DCI                                               ST383130
      DCOX(IPOW)     =DCO                                               ST383140
      VVOIDX(IPOW)   =VVOIDC                                            ST383150
      VVOIDH(IPOW)   =VVOID                                             ST383160
      TSINX(IPOW)    =TSINC                                             ST383170
      RSINX(IPOW)    =RSIN                                              ST383180
      VOIDL(IPOW)    =VLENGT                                            ST383190
      TDISH(IPOW)    =TSHOUL                                            ST383200
C                                                                       ST383210
      DO 25 J=1,5                                                       ST383220
      ZLENGT(J,IPOW) = PLENGT(J)                                        ST383230
   25 CONTINUE                                                          ST383240
C                                                                       ST383250
      DENSFL(1,IPOW) = DENSL                                            ST383260
      DENSFL(2,IPOW) = - FL*DENSL                                       ST383270
      DENSFL(3,IPOW) = PLENGT(4) + DENSFL(2,IPOW)                       ST383280
      DENSFL(4,IPOW) = PLENGT(4)                                        ST383290
      DENSFL(5,IPOW)=0.0                                                ST383300
C                                                                       ST383310
 2001 CONTINUE                                                          ST383320
C                                                                       ST383330
C-----------------------------------------------------------------------ST383340
 1370 CONTINUE                                                          ST383350
      IF(MGAS.LE.0)                                CALL MOLMOL(4)       ST383360
            IF(MGAS.EQ.1)                          CALL MOLMO4          ST383370
      RETURN                                                            ST383380
C    *    1    *    2    *    3    *    4    *    5    *    6    *    7 ST383390
 3000 FORMAT(1H1, 7X, 18H FUEL TEMPERATURE ,80X,6HST3T08                ) ST383400
 3010 FORMAT(1H , 10X, 10F10.2                                          ) ST383410
      END                                                               ST383420
```

* SOURCE STATEMENT *

```
 1        SUBROUTINE CARL(TSS,TFS,TT,N,PI,DFS,STORE)                      CARL0010
    C                                                                     CARL0020
    C     THIS SUBROUTINE IS CALLED FROM STEP 8                           CARL0030
    C     REFER BNWL-1778,GAPCON THERMAL-1, PAGE 4-19                     CARL0040
    C     CALCULATING STORED ENERGY OF THE FUEL                           CARL0050
    C                                                                     CARL0060
 2        DIMENSION AREA(50),TVOL(50),HCAT(50)                            CARL0070
 3        DIMENSION TSS(50),TT(50)                                        CARL0080
 4        REAL K1,K2,K3                                                   CARL0090
 5        DO 10 I=1,N                                                     CARL0100
 6     10 AREA(I) = ((TSS(I)**2-TSS(I+1)**2)*PI)                          CARL0110
 7        TVOL(1) = ((TFS+TT(1)) * .5) + 273.                             CARL0120
 8        DO 20 I=2,N                                                     CARL0130
 9     20 TVOL(I) = ((TT(I)+TT(I-1)) * .5) + 273.                         CARL0140
10        TKEL = 535.285                                                  CARL0150
11        ED = 37.6946                                                    CARL0160
12        K1 = 19.1450                                                    CARL0170
13        K2 = .000784733                                                 CARL0180
14        K3 = 5643730.0                                                  CARL0190
15        R = .001986                                                     CARL0200
16        CL = 1.0                                                        CARL0210
17        STORE = 0.0                                                     CARL0220
18        DO 40 I=1,N                                                     CARL0230
19        TEMPK = TVOL(I)                                                 CARL0240
20        HCAT(I)=CL*(K2*(TEMPK**2-298.**2)+K3*EXP(-ED/R/TEMPK)           CARL0250
        *  +K1*TKEL*(1./(EXP(TKEL/TEMPK)-1.)-1./(EXP(TKEL/298.)-1.)))     CARL0260
21        STORE = STORE + HCAT(I)*AREA(I)                                 CARL0270
22     40 CONTINUE                                                        CARL0280
23        STORE = STORE*4./(PI*DFS**2)                                    CARL0290
    C                                                                     CARL0300
    C     NOW CONVERT IT TO CAL./GRAM OF UO2                              CARL0310
    C                                                                     CARL0320
24        STORE = STORE/270.                                              CARL0330
25        RETURN                                                          CARL0340
    C*****************************************************************CARL0350
26        END                                                             CARL0360
```

* SOURCE STATEMENT *

```
 1        SUBROUTINE CHECK(KE)                                          CHEC0010
   C                                                                    CHEC0020
   C      THIS SUBROUTINE INPUT THE DATA CHECK                          CHEC0030
   C      THIS SUBROUTINE IS CALLED FROM DATINP                         CHEC0040
   C                                                                    CHEC0050
 2        COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  CHEC0060
         1                PKPOWR,IPEAK,DELP,PMAX                        CHEC0070
 3        COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPU02,FR35,FR40,FR41,DFS,DCI,  CHEC0080
         1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V,  CHEC0090
         2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   CHEC0100
         3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,  CHEC0110
         4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   CHEC0120
         5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELL  CHEC0130
         6                ,NEXP,MEXP,NHIST                              CHEC0140
 4        COMMON /INPUTA/ MREST,LCREP,DDISH,HDISH                       CHEC0150
 5        COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20)  CHEC0160
 6        COMMON /COM 21/ N,NN,NNN,NF                                   CHEC0170
 7        COMMON /D15   / MDEN,MRELOC, SINTEM                           CHEC0180
 8        DIMENSION II(10),III(10)                                      CHEC0190
   C                                                                    CHEC0200
 9        GO TO (10000,20000,30000,40000            ),KE                CHEC0210
   C      ==================================================================CHEC0220
10  10000 CONTINUE                                                      CHEC0230
11        DO 1 J=1,10                                                   CHEC0240
12      1 II(J) = 0                                                     CHEC0250
13        IF(NPOW.LE.0.OR.NPOW.GT.20) II(1)=1                           CHEC0260
14        IF(KOOL.EQ.1) GO TO 10                                        CHEC0270
15        IF(.NOT.(SIGHF.EQ.0..OR.SIGHF.EQ.-1.)) GO TO 10               CHEC0280
16        IF(V.LE.0..OR.DE.LE.0.) II(2)=1                               CHEC0290
17     10 CONTINUE                                                      CHEC0300
18        IF(MDEN.EQ.0 .OR. MDEN.EQ.2) GO TO 14                         CHEC0310
19        IF(MDEN.EQ.1) GO TO 12                                        CHEC0320
20        IF(FRDEN.LT.0.8.OR.FRDEN.GT.1.0.OR.                           CHEC0330
         1   SINTEM.LT.1300.).OR.SINTEM.GT.1700.)  II(3)=1              CHEC0340
21        GO TO 14                                                      CHEC0350
22     12 IF(MDEN.NE.2) GO TO 13                                        CHEC0360
23        IF(FRDEN.LT.0.895.OR.FRDEN.GT.0.945.OR.                       CHEC0370
         1   SINTEM.LT.1400..OR.SINTEM.GT.1800.)  II(3)=2               CHEC0380
24     13 CONTINUE                                                      CHEC0390
25     14 CONTINUE                                                      CHEC0400
26        IF(MREST.EQ.1.AND.FRSIN.LE.FRDEN) II(4)=1                     CHEC0410
27        HATA = 0.0                                                    CHEC0420
28        DO 2 J=1,10                                                   CHEC0430
29      2 IF(II(J).NE.0) HATA=1.0                                       CHEC0440
30        IF(HATA.NE.0) GO TO 20                                        CHEC0450
31        RETURN                                                        CHEC0460
32     20 CONTINUE                                                      CHEC0470
33        PRINT 501                                                     CHEC0480
34        IF(II(1).EQ.1) WRITE(6,1000) NPOW                             CHEC0490
35        IF(II(2).EQ.1) WRITE(6,1010) SIGHF,DE,V                       CHEC0500
36        IF(II(3).EQ.1) WRITE(6,1020) MDEN,FRDEN,SINTEM                CHEC0510
37        IF(II(3).EQ.2) WRITE(6,1030) MDEN,FRDEN,SINTEM                CHEC0520
38        IF(II(4).EQ.1) WRITE(6,1040) MREST,FRSIN,FRDEN                CHEC0530
39        WRITE(6,502)                                                  CHEC0540
40        STOP                                                          CHEC0550
   C      ==================================================================CHEC0560
41  20000 CONTINUE                                                      CHEC0570
42        DO 201 J=1,10                                                 CHEC0580
43    201 III(J) = 0                                                    CHEC0590
```


* SOURCE STATEMENT (CHECK)*

```
44        IF(RV(1,NF).LT.DFS) III(1) = 2                                CHEC0600
45        HATA = 0.0                                                    CHEC0610
46        DO 202 J=1,10                                                 CHEC0620
47    202 IF(III(J).NE.0) HATA = 1.0                                    CHEC0630
48        IF(HATA.NE.0) GO TO 220                                       CHEC0640
49        RETURN                                                        CHEC0650
50    220 CONTINUE                                                      CHEC0660
51        WRITE(6,501)                                                  CHEC0670
52        IF(III(1).EQ.2) WRITE(6,2010) DFS,RV(1,NF)                    CHEC0680
53        WRITE(6,502)                                                  CHEC0690
54        STOP                                                          CHEC0700
   C      ==================================================================CHEC0710
55  30000 CONTINUE                                                      CHEC0720
56        RETURN                                                        CHEC0730
57  40000 CONTINUE                                                      CHEC0740
58        RETURN                                                        CHEC0750
   C  *    1    *    2    *    3    *    4    *    5    *    6    *    7  CHEC0760
59    501 FORMAT(///7X,50(1H*),24H  INPUT THE DATA ERROR  , 50(1H*)    //)  CHEC0770
60    502 FORMAT( 3/ 7X, 124(1H*)                                     / )  CHEC0780
61   1000 FORMAT( 7X,                                                     CHEC0790
         1116H*   (  )  NUMBER OF AXIAL SEGMENTS   *** NPOW SHOULD BE ( NPOW  CHEC0800
         2.GE.1.AND.NPOW.LE.20) ***                      NPOW  =, I4    //)  CHEC0810
62   1010 FORMAT( 7X,                                                     CHEC0820
         1116H*   (  )  CALCULATE THE CALDDING-TO-COOLANT HEAT TRANSFER COEF  CHEC0830
         2FICIENT                                       SIGHF =, F10.4 /7X,  CHEC0840
         3116H*   (  )  COOLANT PASSAGE EQUIVALENT DIAMETER                 CHEC0850
         4                                              DE    =, F10.4 /7X,  CHEC0860
         5116H*   (  )  COOLANT VELOCITY                                    CHEC0870
         6                                              V     =, F10.4 /7X,  CHEC0880
         7126H*          WHEN (SIGHF.EQ.0.) OR (SIGHF.EQ.-1.),   V AND DE SHO  CHEC0890
         8ULD NOT BE ZERO,                                               )  CHEC0900
63   1020 FORMAT( 7X,                                                     CHEC0910
         1 60HIF(FRDEN.EQ.1)  (0.8  ,LE.FRDEN.LE.1.0  ) AND (1300..LE.SINT  CHEC0920
         2 19HEM.LE.1700.)  MDEN=,I3,     8H, FRDEN=, E12.5,  9H, SINTEM=,  CHEC0930
         3    E12.5,  6H,CHECK                                           )  CHEC0940
64   1030 FORMAT( 7X,                                                     CHEC0950
         1 60HIF(FRDEN.EQ.2)  (0.895,LE.FRDEN.LE.0.945) AND (1400..LE.SINT  CHEC0960
         2 19HEM.LE.1800.)  MDEN=,I3,     8H, FRDEN=, E12.5,  9H, SINTEM=,  CHEC0970
         3    E12.5,  6H,CHECK                                           )  CHEC0980
65   1040 FORMAT( 7X,                                                     CHEC0990
         1 58HIF(MREST.EQ.1) FRSIN SHOULD BE GREATER THAN FRDEN,  MREST=,I2,  CHEC1000
         2 10H,   FRSIN=,F10.5,10H,   FRDEN=,F10.5                       )  CHEC1010
66   2010 FORMAT( 7X,                                                     CHEC1020
         1116H*   (  )  PELLET DIAMETER                                     CHEC1030
         2                                              DFS   =, F10.4 /7X,  CHEC1040
         3116H*   (  )  FLUX DEPRESSION VALUES USED                         CHEC1050
         4              MAXIMUM DIAMETER                RV(1,NF)=, F10.4 /7X,  CHEC1060
         5 40H          SHOULD BE ( RV(1,NF),GE,DFS )                   )  CHEC1070
67        END                                                           CHEC1080
```

* SOURCE STATEMENT *

```
      SUBROUTINE CREEP(TAU,PHI,SIGC,CTEM,PEXT,PINT,DCO,DCI,SC1,SC2,
     1                 EPST,DEPS,ICREEP)
C
C     THIS SUBROUTINE IS CALLED FROM STEP5
C
      COMMON /CREP1/ A1,A2,A3,A4,A5
     1       /CREP2/ B1,B2,B3,B4
     2       /CREP3/ C1,C2
     3       /CREP4/ D1,D2
     4       /CREP5/ E1,E2,E3
     5       /CREP6/ F1,F2,F3,F4,F5,F6,G1,G2,G3,G4
C---------- INPUT PARAMETERS ----------
C         PHI..... FAST NEUTRON FLUX (N/CM2/SEC)
C         TAU..... TIME IN REACTOR (HOUR)
C         CTEM.... MEAN CLADDING TEMPERATURE (DEG C)
C         PEXT.... EXTERNAL PRESSURE (KG/MM2)
C         DCO..... CLAD OD (CM)
C         DCI..... CLAD ID(CM)
C         SIGC.... CIRCUMFERENTIAL STRESS (KG/MM2)
C         ICREEP.. CREEP DEFORMATION MODELS AND EQUATION OPTION
C                  = 1  BUCKLE (BNWL-B-253,1973)
C                  = 2  OLD ATR(PNC) MODEL
C                  = 3  ZRY PRESSURE TUBE        ROSS-ROSS,P,A.,HUNT
C                  =( ) ZR-2.5NB PRESSURE TUBE
C                  = 4  FIGRO (WAPD-TM-618 ADDENDUM 2 P-5)
C                  = 5  ATR(PNC) NEW
C
      CLTK=CTEM+273.
      PEXTP=PEXT*100.*14.22
      PINTP=PINT*100.*14.22
      RCOH =DCO/2./2.54
      RCIH =DCI/2./2.54
      SIGCP=SIGC*100.*14.22
C
      IF(ICREEP) 20,20,21
   20 WRITE(6,110) ICREEP
  110 FORMAT(///10X,35HAPOINTED OPTION ERROR          ICR=    I3  /)
      ICREEP=1
   21 CONTINUE
C
      GO TO (1,2,3,4,5,6,7,8,9,10                    ),ICREEP
    1 CONTINUE
CC
C ---------- BUCKLE ----------
C     CONSTANTS
C         R ........ GAS CONSTANT              1.98 CAL/MOLE/DEG K
C         Q ........ ACTIVATION ENERGY        16980 CAL/MOLE
C         ALP ...... TRANSIENT CREEP COEFF.    900
C         K ........ ;                         0.006
C         SC ....... STRESS COEFFICIENT        1.E-4 - 1.7E-4
C
      Q=16980.
      R=1.98
      A=900.
      C=0.006
C
      A1=SINH(SC1*SIGCP)
      A2=EXP(-Q/R/CLTK)
      A3=PHI**0.85
```


* SOURCE STATEMENT (CREEP)*

```
      A4=(TAU+A  *(1.-EXP(-C*TAU)))
      A5=(1.+A  *C*EXP(-C*TAU))
C
      EPST=9.5E-13*A1*A2*A3*A4
      DEPS=9.5E-13*A1*A2*A3*A5
C
      RETURN
    2 CONTINUE
C ---------- OLD ATR ----------
C     CONSTANTS
C         Q ........ ACTIVATION ENERGY        14000 CAL/MOLE
C         R ........ GAS CONSTANT              1.98 CAL/MOLE/DEG K
C         SC ....... STRESS COEFFICIENT       1.15E-4
C
      R=1.98
      Q=14000.
C
      B1=SINH(SC2*SIGCP)
      B2=EXP(-Q/R/CLTK)
      B3=PHI**0.85
      B4=TAU
C
      EPST=1.02E-13*B1*B2*B3*B4
      DEPS=1.02E-13*B1*B2*B3
      RETURN
C
    3 CONTINUE
C
C ---------- ZRY PRESSURE TUBE  (COLD WORKED ZRY2)
C     CONSTANTS
C         BETA ..... MATERIAL PROPERTY COEFF.   1422*4 E-27
C         TREF ..... REFERENCE TEMP.            160 DEG C
C
      BETA=1422.*4./1.E27
      TREF=160.
      C1=BETA
      C2=CTEM-TREF
C
      EPST=C1*SIGC*PHI*C2*TAU
      DEPS=C1*SIGC*PHI*C2
      RETURN
C
   44 CONTINUE
C
C ---------- ZR PRESSURE TUBE   ( ZIRCONIUM 2.5 NB )
C     CONSTANT
C         BETA ..... MATERIAL PROPERTY COEFF.  1422*4/3 E-27
C         TREF ..... REFERENCE TEMP.            160 DEGC
C
      BETA=1422.*4./3./1.E27
      TREF=160.
C
      D1=BETA
      D2=CTEM-TREF
C
      EPST=D1*SIGC*PHI*D2*TAU
      DEPS=D1*SIGC*PHI*D2
      RETURN
C
```

```
* SOURCE STATEMENT (CREEP    )*

      4 CONTINUE                                                        CREP1190
C ---------- FIGRO ----------                                           CREP1200
C     CONSTANTS                                                         CREP1210
C         C ........                    1.11E-24                        CREP1220
C         D ........                  1.03E-24                          CREP1230
C         TREF ..... REFERENCE TEMP.    149 DEG C                       CREP1240
C                    SIGA=REFERENCE STRESS 8.44KG/MM2                   CREP1250
C                    SIGG=GENERALIZED STRESS (KG/MM2)                   CREP1260
C         PINT.... INTERNAL PRESSURE (KG/MM2)                           CREP1270
C                                                                       CREP1280
      C=1.11E-24                                                        CREP1290
      D=1.03E-24                                                        CREP1300
      TREF=149.                                                         CREP1310
      SIGA=8.44                                                         CREP1320
      RC=(DCO+DCI)/4.                                                   CREP1330
      TC=(DCO-DCI)/2.                                                   CREP1340
      SIGG=SQRT(3.)*(PEXT-PINT)*RC/(2.*TC)                              CREP1350
      E1=SIGG                                                           CREP1360
      IF(SIGG.GE.SIGA) GO TO 50                                         CREP1370
      EPST=C*SIGG*(CTEM-TREF)*PHI*TAU                                   CREP1380
      DEPS=C*SIGG*(CTEM-TREF)*PHI                                       CREP1390
      GO TO 51                                                          CREP1400
   50 CONTINUE                                                          CREP1410
      E2=D*SIGG**4                                                      CREP1420
      E3=C*SIGG*(CTEM-TREF)                                             CREP1430
      EPST=(E3+E2)*PHI*TAU                                              CREP1440
      DEPS=(E2+E3)*PHI                                                  CREP1450
   51 CONTINUE                                                          CREP1460
      RETURN                                                            CREP1470
C                                                                       CREP1480
    5 CONTINUE                                                          CREP1490
C                                                                       CREP1500
C ---------- ATR (NE*) ----------                                       CREP1510
C    CONSTANTS                                                          CREP1520
C         R1 ....... GAS CONSTANT            1.985 CAL/MOLE/DEG K      CREP1530
C         TREF ..... REFERENCE TEMP.           300 DEG C               CREP1540
C         HCAP .....                         14000 CAL/MOLE            CREP1550
C                                                                       CREP1560
      R1=1.985                                                          CREP1570
      TREF=300.                                                         CREP1580
      HCAP=14000.                                                       CREP1590
      F1=TAU**0.085                                                     CREP1600
      F2=SIGCP**2.61                                                    CREP1610
      F3=EXP(1.19*(CTEM-TREF)/CLTK)                                     CREP1620
      F4=SIGCP**1.225                                                   CREP1630
      F5=PHI**0.85                                                      CREP1640
      F6=EXP(-HCAP/R1/CLTK)                                             CREP1650
C                                                                       CREP1660
      G1=1.196E-15*F1*F2*F3                                             CREP1670
      G2=2.12E-18*TAU*F4*F5*F6                                          CREP1680
      EPST=G1+G2                                                        CREP1690
      F7=TAU**(0.085-1.)                                                CREP1700
      G3=1.186E-15 *0.085*F7*F2*F3                                      CREP1710
      G4=2.12 E-18*F4*F5*F6                                             CREP1720
      DEPS=G3+G4                                                        CREP1730
      RETURN                                                            CREP1740
C                                                                       CREP1750
    6 CONTINUE                                                          CREP1760
    7 CONTINUE                                                          CREP1770
```



```
* SOURCE STATEMENT (CREEP    )*

    8 CONTINUE                                                          CREP1780
    9 CONTINUE                                                          CREP1790
   10 CONTINUE                                                          CREP1800
      RETURN                                                            CREP1810
      END                                                               CREP1820
```

* SOURCE STATEMENT *

```
      SUBROUTINE CURIE(KS)                                              CURI0010
C ***************************************************************************CURI0020
C     THIS ROUTINE CALCULATE NUMBERS OF CURIES OF EACH ISOTOPES         CURI0030
C     DC( ) .... DECAY CONSTANT (1/SEC)                                 CURI0040
C     A( , ) ... NUMBERS OF ATOM PER UNIT LENGTH                        CURI0050
C     DISIN = 3.7 E10  DISINTEGRATION / SEC                             CURI0060
C                                                                       CURI0070
C ***************************************************************************CURI0080
      COMMON /NUCLEI/ NUCLEI,A(40,23)                                   CURI0090
      COMMON /DECAY / DC2,DC3,DC4,DC5,DC6,DC12,DC14,DC15,DC21,DC22,DC23,CURI0100
     1          DC25,DC26,DC28,DC31,DC33,DC34,DC35,DC85,DC85M           CURI0110
      COMMON /FEMOL / FF(6,23),RKR(6,23),RXE(6,23),AKX(10,20,2)         CURI0120
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  CURI0130
     1                PKPOWR,IPEAK,DELP,PMAX                            CURI0140
C                                                                       CURI0150
      DIMENSION CURRI(19,21),ATOMS(19,21)                               CURI0160
      DIMENSION DC(19),B(20),C(20)                                      CURI0170
      DATA DISIN /3.7E10/                                               CURI0180
C                                                                       CURI0190
C                                                                       CURI0200
      GO TO (1,2,3) , KS                                                CURI0210
C-----------------------------------                                    CURI0220
C      SET UP DECAY CONSTANT ARRAY                                      CURI0230
C-----------------------------------                                    CURI0240
    1 CONTINUE                                                          CURI0250
      DC(1)=0.0                                                         CURI0260
      DC(2)=0.0                                                         CURI0270
      DC(3)=DC85M                                                       CURI0280
      DC(4)=DC85                                                        CURI0290
      DC(5)=0.0                                                         CURI0300
      DC(6)=DC21                                                        CURI0310
      DC(7)=DC22                                                        CURI0320
      DC(8)=DC23                                                        CURI0330
      DC(9)=0.0                                                         CURI0340
      DC(10)=DC25                                                       CURI0350
      DC(11)=DC31                                                       CURI0360
      DC(12)=0.0                                                        CURI0370
      DC(13)=DC26                                                       CURI0380
      DC(14)=DC33                                                       CURI0390
      DC(15)=0.0                                                        CURI0400
      DC(16)=DC28                                                       CURI0410
      DC(17)=DC34                                                       CURI0420
      DC(18)=DC35                                                       CURI0430
      DC(19)=0.0                                                        CURI0440
      RETURN                                                            CURI0450
C-----------------------------------                                    CURI0460
    2 CONTINUE                                                          CURI0470
C-----------------------------------                                    CURI0480
C     CALCULATE ATOMS AND CURIES                                        CURI0490
      DO 10 I=1,19                                                      CURI0500
      B(I)=C(I)=0.0                                                     CURI0510
      DO 10 J=1,21                                                      CURI0520
      ATOMS(I,J)=CURRI(I,J)=0.0                                         CURI0530
   10 CONTINUE                                                          CURI0540
      BB=CC=0.0                                                         CURI0550
C                                                                       CURI0560
      DO 15 I=1,NPOW                                                    CURI0570
      DO 20 K=1,19                                                      CURI0580
      J=K+20                                                            CURI0590
```


* SOURCE STATEMENT (CURIE)*

```
      ATOMS(K,I)=A(J,I)*FL                                              CURI0600
      CURRI(K,I)=DC(K)*ATOMS(K,I)/DISIN                                 CURI0610
      B(I)=B(I)+ATOMS(K,I)                                              CURI0620
      C(I)=C(I)+CURRI(K,I)                                              CURI0630
      ATOMS(K,21)=ATOMS(K,21)+ATOMS(K,I)                                CURI0640
      CURRI(K,21)=CURRI(K,21)+CURRI(K,I)                                CURI0650
   20 CONTINUE                                                          CURI0660
      BB=BB+B(I)                                                        CURI0670
      CC=CC+C(I)                                                        CURI0680
   15 CONTINUE                                                          CURI0690
C                                                                       CURI0700
C***** PRINT OUT PIN INVENTORY                                          CURI0710
C                                                                       CURI0720
      FLAG=0.0                                                          CURI0730
      CALL HEAD(-1)                                                     CURI0740
      WRITE(6,100)                                                      CURI0750
 1000 CONTINUE                                                          CURI0760
      WRITE(6,103)                                                      CURI0770
      WRITE(6,104) (DC(I),I=1,10)                                       CURI0780
C                                                                       CURI0790
      WRITE(6,107)                                                      CURI0800
      WRITE(6,113)                                                      CURI0810
      DO 25 I=1,NPOW                                                    CURI0820
      WRITE(6,105) I,(ATOMS(J,I),J=1,10)                                CURI0830
   25 CONTINUE                                                          CURI0840
      WRITE(6,108) (ATOMS(J,21),J=1,10)                                 CURI0850
      WRITE(6,114)                                                      CURI0860
      DO 26 I=1,NPOW                                                    CURI0870
      WRITE(6,105) I,(CURRI(J,I),J=1,10)                                CURI0880
   26 CONTINUE                                                          CURI0890
      WRITE(6,108) (CURRI(J,21),J=1,10)                                 CURI0900
C                                                                       CURI0910
      IF(NPOW.GE.8) CALL HEAD(-1)                                       CURI0920
      IF(NPOW.LT.8) WRITE(6,110)                                        CURI0930
C                                                                       CURI0940
      WRITE(6,112)                                                      CURI0950
      WRITE(6,104) (DC(I),I=11,19)                                      CURI0960
      WRITE(6,107)                                                      CURI0970
      WRITE(6,113)                                                      CURI0980
      DO 30 I=1,NPOW                                                    CURI0990
      WRITE(6,105) I,(ATOMS(J,I),J=11,19),B(I)                          CURI1000
   30 CONTINUE                                                          CURI1010
      WRITE(6,108) (ATOMS(J,21),J=11,19),BB                             CURI1020
      WRITE(6,114)                                                      CURI1030
      DO 32 I=1,NPOW                                                    CURI1040
      WRITE(6,105) I,(CURRI(J,I),J=11,19),C(I)                          CURI1050
   32 CONTINUE                                                          CURI1060
      WRITE(6,108) (CURRI(J,21),J=11,19),CC                             CURI1070
C                                                                       CURI1080
      IF(FLAG.LE.0.0) WRITE(6,115)                                      CURI1090
      IF(FLAG.GE.1.0) WRITE(6,116)                                      CURI1100
      IF(FLAG.GE.1.) RETURN                                             CURI1110
      FLAG=1.0                                                          CURI1120
C-----------------------------------------------                        CURI1130
C      RELEASED TO PLENUM AND GAP                                       CURI1140
C-----------------------------------------------                        CURI1150
      DO 45 I=1,19                                                      CURI1160
      B(I)=C(I)=0.0                                                     CURI1170
      ATOMS(I,21)=CURRI(I,21)=0.0                                       CURI1180
```

SOURCE STATEMENT (CURIE)*

```
 90     45 CONTINUE                                                        CURI1190
 91        BB=CC=0.0                                                       CURI1200
 92        DO 35 I=1,NPOW                                                  CURI1210
 93        DO 40 K=1,19                                                    CURI1220
 94        ATOMS(K,I)=ATOMS(K,I)*FF(1,I)                                   CURI1230
 95        CURRI(K,I)=CURRI(K,I)*FF(1,I)                                   CURI1240
 96        B(I)=B(I)+ATOMS(K,I)                                            CURI1250
 97        C(I)=C(I)+CURRI(K,I)                                            CURI1260
 98        ATOMS(K,21)=ATOMS(K,21)+ATOMS(K,I)                              CURI1270
 99        CURRI(K,21)=CURRI(K,21)+CURRI(K,I)                              CURI1280
100     40 CONTINUE                                                        CURI1290
101        BB=BB+B(I)                                                      CURI1300
102        CC=CC+C(I)                                                      CURI1310
103     35 CONTINUE                                                        CURI1320
      C                                                                    CURI1330
104        CALL HEAD(-1)                                                   CURI1340
105        WRITE(6,100)                                                    CURI1350
106        WRITE(6,201)                                                    CURI1360
107        GO TO 1000                                                      CURI1370
      C                                                                    CURI1380
108      3 CONTINUE                                                        CURI1390
109        RETURN                                                          CURI1400
      C                                                                    CURI1410
110    100 FORMAT(40X,25HRADIO-ACTIVITY OF ISOTOPE  / 40X,25(1H=) / )      CURI1420
111    101 FORMAT(10X,5(1H.),15H RIN INVENTORY ,5(1H.)/)                   CURI1430
112    103 FORMAT(4X,5HAXIAL /                                             CURI1440
          1 5X,  122HNODE      83 KR        84 KR        85M KR        85 KR      CURI1450
          2 86 KR      131M TE       131 TE       131 I       131 XE      132 TECURI1460
          3                                                                CURI1470
          4/2X,8(1H-),10(2X,10(1H-)) )                                     CURI1480
113    104 FORMAT(1X,11HDECAY CONST / 3X,7H(1/SEC),10(1X,1PE11.4) )        CURI1490
114    105 FORMAT(6X,I2,2X,10(1X,1PE11.4) )                                CURI1500
115    106 FORMAT(1X,I2,1X,6HCURRIE,10(1X,1PE11.4)  )                      CURI1510
116    107 FORMAT(1H )                                                     CURI1520
117    108 FORMAT(/1X,9HSUB-TOTAL,10(1X,1PE11.4) )                         CURI1530
118    112 FORMAT(4X,5HAXIAL,111X,4HNODE    /                              CURI1540
          1 5X,  124HNODE      132 I        132 XE       133 I       133 XE      CURI1550
          2134 XE       135 I       135M XE       135 XE       136 XE      SUB-TOTCURI1560
          3AL    /                                                         CURI1570
          4 2X,8(1H-),10(2X,10(1H-)) )                                     CURI1580
119    110 FORMAT(/)                                                       CURI1590
120    113 FORMAT(2X,12HNO. OF ATOMS )                                     CURI1600
121    114 FORMAT(//2X,6HCURIE )                                           CURI1610
122    115 FORMAT(// 1X,110(1H*), 25H INVENTORY FP GAS SUMMARY    )        CURI1620
123    116 FORMAT(// 1X,110(1H=),25H RELEASED FP GAS SUMMARY    )          CURI1630
124    201 FORMAT(10X,5(1H.),17H RELEASED FP GAS ,5(1H.)/)                 CURI1640
      C                                                                    CURI1650
      C                                                                    CURI1660
125        END                                                             CURI1670
```


SOURCE STATEMENT *

```
  1        SUBROUTINE DATAPR                                               DAPR0010
      C                                                                    DAPR0020
      C    THIS SUBROUTINE IS CALLED FROM MAIN                             DAPR0030
      C                                                                    DAPR0040
  2        DIMENSION IA(20)                                                DAPR0050
  3        IC=0                                                            DAPR0060
  4      1 IC=IC+1                                                         DAPR0070
  5        READ(5,100,END=500) IA                                          DAPR0080
  6        IF(IC.EQ.1) GO TO 1000                                          DAPR0090
  7        IF(.NOT.(MOD(IC,50).EQ.1)) GO TO 800                            DAPR0100
  8    700 WRITE(6, 900)    (K,K=1,8)                                      DAPR0110
  9   1000 WRITE(6, 200)    (K,K=1,8)                                      DAPR0120
 10    800 CONTINUE                                                        DAPR0130
 11        WRITE(6, 300) IC,IA                                             DAPR0140
 12        GO TO 1                                                         DAPR0150
 13    500 CONTINUE                                                        DAPR0160
 14        WRITE(6, 400)    (K,K=1,8)                                      DAPR0170
 15        REWIND 5                                                        DAPR0180
 16        RETURN                                                          DAPR0190
 17    100 FORMAT(20A4)                                                    DAPR0200
 18    200 FORMAT(1H1 4(/) 40X,35HI N P U T      D A T A      L I S T /    DAPR0210
          2        40X, 35(1H=) /                                          DAPR0220
          3        10X,10HCARD NO.    ,2X,8(9H....*....,I1) / )            DAPR0230
 19    300 FORMAT(10X,I9,1H,,2X,20A4)                                      DAPR0240
 20    400 FORMAT(/22X,8(9H....*....,I1) 10X,11HEND OF CARD    )           DAPR0250
 21    900 FORMAT(/22X,8(9H....*....,I1) )                                 DAPR0260
      C*****************************************************************DAPR0270
 22        END                                                             DAPR0280
```

* SOURCE STATEMENT *

```
      BLOCK DATA  DATA1                                                 DAT10010
C                                                                       DAT10020
C                                                                       DAT10030
C                                                                       DAT10040
      REAL  MUF,MOL,MOLEFR,MOLFR                                        DAT10050
      COMMON /DATA 1/ ZR(7,6),ZR4(7,6),ST(7,26),TABLE(2, 80)            DAT10060
      COMMON /DATA 2/ EKLJ(6),GMWT(6),SIGLJ(6)                          DAT10070
      COMMON /DATA 3/ VOLAT(29),FISGR(29)                               DAT10080
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                  DAT10090
      COMMON /DATA 5/ SDOT,SDOTT,EF,MUF,EPSIF,EPSIC                     DAT10100
      COMMON /DATA 6/ NZR2,NZR4,NST                                     DAT10110
      DATA  NZR2,NZR4,NST / 6,6,26 /                                    DAT10120
C                                                                       DAT10130
C     FP GAS RELEASE RATE FROM UO2 PELLET          REF. O-936           DAT10140
      DATA VOLAT/0.,0.,7*5.,.755,.760,.785,.800,.810,.820,.825,         DAT10150
     1.830,.840,.850,.855,.890,.920,.940,.955,.975,.985,.1000,.1015,.103DAT10160
     20.,1100.,1160.,1300.,1470.,1690.,2000.,10000./                    DAT10170
      DATA FISGR/0.,.0006,.0008,.001,.002,.003,.004,.005,.006,.007,.006,DAT10180
     1 .009,.01,.02,.03,.04,.05,.06,.07,.08,.09,.1,.16,.2,.3,.4,.5,.52, DAT10190
     2 1.0/                                                             DAT10200
C                                                                       DAT10210
C I=1 INDEXING TEMPERATURE FOR TABULATION    (C)                        DAT10220
C I=2 THERMAL CONDUCTIVITY                   (W/CM/C)                   DAT10230
C I=3 YIELD STRENGTH                         (KG/CM2)                   DAT10240
C I=4 YOUNGS MODULUS                         (KG/CM2)                   DAT10250
C I=5 POISSONS RATIO                         (ND)                       DAT10260
C I=6 LIN. COEF. THERMAL EXPANSION           ( /C)                      DAT10270
C I=7 MEYER HARDNESS NUMBER                  (KG/CM2)                   DAT10280
C                                                                       DAT10290
C     ZR(I,J)= PROPERTIES OF ZIRCALOY-2                                 DAT10300
C                                                                       DAT10310
      DATA ((ZR(I,J),I=1,7),J=1,6)/                                     DAT10320
     1   25. , 0.126 , 3150. ,  972000. , 0.370 ,  5.83E-6 ,  9470. ,   DAT10330
     2  100. , 0.134 , 2450. ,  914000. , 0.400 ,  6.25E-6 ,  7360. ,   DAT10340
     3  200. , 0.143 , 1670. ,  850000. , 0.446 ,  6.66E-6 ,  5030. ,   DAT10350
     4  300. , 0.156 , 1110. ,  780000. , 0.492 ,  6.97E-6 ,  3340. ,   DAT10360
     5  400. , 0.170 ,  850. ,  710000. , 0.492 ,  7.18E-6 ,  2560. ,   DAT10370
     6  500. , 0.184 ,  700. ,  640000. , 0.492 ,  7.34E-6 ,  2110. /   DAT10380
C                                                                       DAT10390
C     ZINC-4 DATA BY B.B.SCOTT (WCAP-3629-41) PAGE 6                    DAT10400
C                                                                       DAT10410
      DATA ((ZR4(I,J),I=1,7),J=1,6)/                                    DAT10420
     1   25. , 0.129 , 3150. ,  972000. , 0.370 ,  5.83E-6 ,  9470. ,   DAT10430
     2  100. , 0.136 , 2450. ,  914000. , 0.400 ,  6.25E-6 ,  7360. ,   DAT10440
     3  200. , 0.143 , 2450. ,  914000. , 0.400 ,  6.25E-6 ,  7360. ,   DAT10450
     4  300. , 0.152 , 2450. ,  914000. , 0.400 ,  6.25E-6 ,  7360. ,   DAT10460
     5  400. , 0.164 , 2450. ,  914000. , 0.400 ,  6.25E-6 ,  7360. ,   DAT10470
     6  500. , 0.180 , 2450. ,  914000. , 0.400 ,  6.25E-6 ,  7360. /   DAT10480
C                                                                       DAT10490
C     ST(I,J)= PROPERTIES OF 20-PERCENT COLD WORKED TYPE 316 SS         DAT10500
C                                                                       DAT10510
      DATA  ((ST(I,J),I=1,7),J= 1,10) /                                 DAT10520
     1   25. , 0.145 , 6350. , 1972000. , 0.267 , 16.45E-6 , 19200. ,   DAT10530
     2   50. , 0.146 , 6150. , 1966000. , 0.268 , 16.60E-6 , 18400. ,   DAT10540
     3   75. , 0.152 , 6000. , 1960000. , 0.270 , 16.75E-6 , 17800. ,   DAT10550
     4  100. , 0.155 , 5850. , 1945000. , 0.272 , 16.87E-6 , 17500. ,   DAT10560
     5  125. , 0.159 , 5730. , 1925000. , 0.274 , 17.00E-6 , 17200. ,   DAT10570
     6  150. , 0.162 , 5650. , 1910000. , 0.276 , 17.12E-6 , 17000. ,   DAT10580
     7  175. , 0.166 , 5590. , 1890000. , 0.278 , 17.23E-6 , 16800. ,   DAT10590
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* SOURCE STATEMENT (DATA1)*

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     8  200. , 0.169 , 5540. , 1872000. , 0.280 , 17.32E-6 , 16600. ,   DAT10600
     9  225. , 0.173 , 5500. , 1850000. , 0.282 , 17.42E-6 , 16480. ,   DAT10610
     *  250. , 0.176 , 5450. , 1835000. , 0.283 , 17.48E-6 , 16350. /   DAT10620
      DATA  ((ST(I,J),I=1,7),J=11,20) /                                 DAT10630
     1  275. , 0.180 , 5400. , 1815000. , 0.285 , 17.55E-6 , 16220. ,   DAT10640
     2  300. , 0.183 , 5350. , 1795000. , 0.287 , 17.65E-6 , 16100. ,   DAT10650
     3  325. , 0.187 , 5320. , 1785000. , 0.288 , 17.73E-6 , 16000. ,   DAT10660
     4  350. , 0.190 , 5300. , 1755000. , 0.290 , 17.84E-6 , 15900. ,   DAT10670
     5  375. , 0.194 , 5250. , 1735000. , 0.292 , 17.94E-6 , 15850. ,   DAT10680
     6  400. , 0.197 , 5260. , 1715000. , 0.294 , 18.05E-6 , 15820. ,   DAT10690
     7  425. , 0.201 , 5230. , 1695000. , 0.297 , 18.14E-6 , 15760. ,   DAT10700
     8  450. , 0.204 , 5210. , 1680000. , 0.299 , 18.22E-6 , 15680. ,   DAT10710
     9  475. , 0.208 , 5200. , 1650000. , 0.301 , 18.32E-6 , 15550. ,   DAT10720
     *  500. , 0.211 , 5120. , 1625000. , 0.302 , 18.40E-6 , 15390. /   DAT10730
      DATA  ((ST(I,J),I=1,7),J=21,26) /                                 DAT10740
     1  525. , 0.215 , 5020. , 1600000. , 0.304 , 18.50E-6 , 15180. ,   DAT10750
     2  550. , 0.218 , 4900. , 1575000. , 0.306 , 18.56E-6 , 14850. ,   DAT10760
     3  575. , 0.221 , 4750. , 1550000. , 0.308 , 18.65E-6 , 14400. ,   DAT10770
     4  600. , 0.225 , 4600. , 1525000. , 0.309 , 18.71E-6 , 13750. ,   DAT10780
     5  625. , 0.229 , 4250. , 1490000. , 0.311 , 18.85E-6 , 12850. ,   DAT10790
     6  650. , 0.232 , 3900. , 1454000. , 0.313 , 18.89E-6 , 11650. /   DAT10800
C                                                                       DAT10810
      DATA ((TABLE(I,J),I=1,2),J=1,40)/                                 DAT10820
     *  .0 , 2.745, 0.3 , 2.785, 0.35, 2.628, 0.40, 2.492, 0.45, 2.368, DAT10830
     *  .50, 2.227, 0.55, 2.156, 0.60, 2.065, 0.65, 1.982, 0.70, 1.908, DAT10840
     *  .75, 1.841, 0.80, 1.780, 0.85, 1.725, 0.90, 1.675, 0.95, 1.629, DAT10850
     * 1.0 , 1.587, 1.05, 1.549, 1.10, 1.514, 1.15, 1.482, 1.20, 1.424, DAT10860
     * 1.25, 1.424, 1.30, 1.399, 1.35, 1.375, 1.40, 1.353, 1.45, 1.333, DAT10870
     * 1.50, 1.314, 1.55, 1.296, 1.60, 1.279, 1.65, 1.264, 1.70, 1.248, DAT10880
     * 1.75, 1.234, 1.80, 1.221, 1.85, 1.209, 1.90, 1.197, 1.95, 1.186, DAT10890
     * 2.00, 1.175, 2.10, 1.156, 2.20, 1.136, 2.30, 1.122, 2.40, 1.107/ DAT10900
C                                                                       DAT10910
      DATA ((TABLE(I,J),I=1,2),J=41,80)/                                DAT10920
     * 2.50, 1.093, 2.60, 1.081, 2.7 , 1.069, 2.8 , 1.058, 2.9 , 1.048, DAT10930
     * 3.0 , 1.039, 3.1 , 1.030, 3.2 , 1.022, 3.3 , 1.014, 3.4 , 1.007, DAT10940
     * 3.5 , .9979, 3.6 , .9932, 3.7 , .9870, 3.8 , .9811, 3.9 , .9755, DAT10950
     * 4.0 , .9700, 4.1 , .9649, 4.2 , .9600, 4.3 , .9533, 4.4 , .9507, DAT10960
     * 4.5 , .9464, 4.6 , .9422, 4.7 , .9382, 4.8 , .9343, 4.9 , .9305, DAT10970
     * 5.0 , .9269, 6.0 , .8963, 7.  , .8727, 8.  , .8538, 9.  , .8379, DAT10980
     *10.  , .8242, 20. , .7432, 30. , .7005, 40. , .6718, 50. , .6504, DAT10990
     *60.  , .6335, 70. , .6194, 80. , .6076, 90. , .5973,200. , .5882/ DAT11000
C                                                                       DAT11010
      DATA (GMWT(I),I=1,6)  / 4.003, 39.944, 2.016, 28.02, 83.8 ,131.3/ DAT11020
      DATA (SIGLJ(I),I=1,6) / 2.576,  3.418, 2.915, 3.681, 3.498,4.055/ DAT11030
      DATA (EKLJ(I),I=1,6)  / 10.2 , 124.  , 38.  , 91.5 , 225. ,229. / DAT11040
      DATA PI, CCPIN3, SECDAY, AVOGAD,RR, CONEN/3.14159, 16.387, 86400.,DAT11050
     1   6.023E23, 22400., 3.2E-14/                                     DAT11060
      DATA SDOT,SDOTT,EF,MUF,EPSIF,EPSIC/.016,.004,1.54E6,.30,.8,.9 /   DAT11070
C*********************************************************************DAT11080
      END                                                               DAT11090
```

* SOURCE STATEMENT *

```
 1        SUBROUTINE DATINP(KS)                                          DATP0010
 C                                                                       DATP0020
 C        THIS SUBROUTINE IS CALLED FROM STEP1                           DATP0030
 C        THIS SUBROUTINE INPUT THE DATA (IF UNIT IS C.G.S., KUNIT=1)    DATP0040
 C                                                                       DATP0050
 2        REAL KB,LVOIDZ,LFUEL                                           DATP0060
 3        COMMON /IYIELD/ IYIELD                                         DATP0070
 4           COMMON /MCONV / MCONV                                       DATP0080
 5        COMMON /COM  1/                                                DATP0090
         1 TT( 51),TSR( 51),QIN(51),Q(51),TS(51),CLCRPD(2,20)            DATP0100
 6        COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP               DATP0110
 7        COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR               DATP0120
 8        COMMON /COM 10/ VVOIDZ,FRUO2,TPLENA,NPOW1                      DATP0130
 9        COMMON /COM 12/ DENSIT,FR38,FR39                               DATP0140
10        COMMON /COM 15/ NCK,GAP                                        DATP0150
11        COMMON /COM 21/ N,NN,NNN,NF                                    DATP0160
12        COMMON /COM128/ IOUT1,IIPROF                                   DATP0170
13        COMMON /D15   / MDEN,MRELOC, SINTED                            DATP0180
14           COMMON /IXIR  / IX,IR,IIH,MAXIEP                            DATP0190
 C                                                                       DATP0200
15        COMMON /POWRAY/                                                DATP0210
         1 PAVRGD,FUELL ,FL     ,POWER(21),AI(21),NPOW,PTOT,EPMAX,       DATP0220
         2 PKPOWD,IPEAK ,DELPD ,PMAXD                                    DATP0230
16        COMMON /POWREF/ POWREF(21)                                     DATP0240
 C                                                                       DATP0250
17        COMMON /COM  0/                                                DATP0260
         1 TITLE(20),AADUM(7, 30),BBDUM(6, 51),CFDUM(3, 30),RVDUM(2, 20) DATP0270
 C                                                                       DATP0280
18        COMMON /INPUT/                                                 DATP0290
         1 FRDEN ,FRSIN ,DSINZD,FRPUO2,FR35  ,FR40  ,FR41  ,DFSDUM,DCIDUM, DATP0300
         2 DCODUM,DVOIDD,VPLEND,ATMOS ,S     ,XX    ,ROUFD ,ROUCD ,EXTPD ,  DATP0310
         2 DEDUM ,VDUM  ,                                                DATP0320
         3 TINLED,DELT  ,TMAX  ,TFR   ,TM    ,DBDDUM,BKDUM ,HBCDUM,SIGHFD,  DATP0330
         3 IFLUX ,                                                       DATP0340
         4 NCLAD ,NCON  ,NFLX  ,KOOL  ,NEWK  ,NEWFLX,VOIDZL,NOH    ,     DATP0350
         5 FRACHE,FRACAR,FRACH ,FRACN ,FRACKR,FRACXE,MGACEL,             DATP0360
         6 DTEMPD,ZCLAD ,HG    ,PEKAVG,MINI  ,ICOF  ,ISTOR ,ICREP ,ISWELL, DATP0370
         7 NEXP  ,MLXP  ,NHIST                                           DATP0380
19        COMMON /PRINT / PRINT                                          DATP0390
 C                                                                       DATP0400
20        COMMON /MREV1 / MREV1                                          DATP0410
21        COMMON /HIST  / HIST(7,50),IPD(5,50)                           DATP0420
22        COMMON /HIS   / BASE(100),HIS(7,100),MODE(5,100)               DATP0430
23        COMMON /HIST1/ NWHIST,MXSTEP                                   DATP0440
24        COMMON /IOUT2 / IOUT2                                          DATP0450
25        COMMON /INPUT A/ MREST,LCREP,DDISHD,HDISHD                     DATP0460
26        COMMON /NUCLEI/ NUCLEI,A(40,23)                                DATP0470
27        COMMON /SPARE/ ISPA,NAMSP(3)                                   DATP0480
28        COMMON /NEWGAS/ MGAS                                           DATP0490
29        COMMON /DIAL/ FPDIAL                                           DATP0500
30        COMMON / PLOT / IPLOT                                          DATP0510
 C                                                                       DATP0520
31        DIMENSION AA1(30),AA2(30),AA3(30),AA4(30),AA5(30),AA6(30),AA7(30) DATP0530
32        DIMENSION CF1(30),CF2(30),CF3(30)                              DATP0540
33        DIMENSION CLCRP(2,20)                                          DATP0550
34        DIMENSION HISTIN(7,50)                                         DATP0560
35        DIMENSION RV1(20),RV2(20)                                      DATP0570
 C                                                                       DATP0580
36        DATA  PMAX,DELP,FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,   DATP0590
```


* SOURCE STATEMENT (DATINP)*

```
         *       DVOIDZ,DCI,DCO,VPLENZ,ATMOS,S,XX,ROUC,ROUF,EXTP,TINLET,  DATP0600
         *       DE,V,PAVRG,TDAYS,DELT,TMAX,TFR,TM,        SIGHF,FRACHE,  DATP0610
         *       FRACAR,FRACH,FRACN,FRACKR,FRACXE,MGACEL,ZCLAD,PKPOWR,    DATP0620
         *       PEKAVG,DTEMP,LFUEL,LVOIDZ,SINTED,SINTEM / 45*0.0 /       DATP0630
                                                                          DATP0640
 C
37        DATA HG /0.5678 /                                              DATP0650
38        DATA NOH,KUNIT    / 1,1 /                                      DATP0660
                                                                          DATP0670
 C
39        DATA    MCONV ,MMM   ,MREV1 ,NUCLEI,                           DATP0680
         1 ISTOR ,IFLUX ,NCLAD ,NCON  ,KOOL  ,MEXP  ,NHIST ,ICREP ,MINI  DATP0690
         2 ICOF  ,ISWELL,NEXP  ,IOUT1 ,IOUT2 ,IIPROF,MDEN  ,MRELOC /21*0 DATP0700
                                                                          DATP0710
 C
40        DATA PRINT / 0. /                                              DATP0720
41        DATA NPOW /10 /                                                DATP0730
42        DATA POWER/.23,.63,.96,1.21,1.35,1.4,1.35,1.21,.96,.63,.23     DATP0740
         1 ,10*0.0/                                                       DATP0750
43        DATA MREST,LCREP,DDISH,HDISH / 2*0 , 2*0. /                    DATP0760
                                                                          DATP0770
 C
44        DATA WORD1/4HSTOP  /                                           DATP0780
45        DATA HIST /350*0.0/,  HISTIN/ 350*0.0 / , IPD/250*0/           DATP0790
46        DATA RVDUM(1,1),RVDUM(1,2),RVDUM(2,1),RVDUM(2,2) /0.0,1.0,1.0,1.0/DATP0800
         1      ,  NF,NFLX / 2,2 /                                       DATP0810
 C        IF(MODE(4,1).EQ.0) RVDUM(1,2)=DFSDUM(CM)  SEE STATEMENT NO.160 DATP0820
47        DATA CF1,CF2,CF3                          /  30*0.0 /          DATP0830
48        DATA AA1,AA2,AA3,AA4,AA5,AA6,AA7 / 210*0.0 /                   DATP0840
49        DATA POWREP / 21*0.0 /                                         DATP0850
50        DATA IYIELD / 0 /                                              DATP0860
51        DATA  ISPA/0/,NAMSP/3*0/                                       DATP0870
52        DATA MGAS/0/                                                   DATP0880
53        DATA FPDIAL/1.0/                                               DATP0890
54        DATA IPOLT / 0 /                                               DATP0900
                                                                          DATP0910
 C
 C                                                                        DATP0920
55        NAMELIST /INPUT /     MREV1 ,NUCLEI,                           DATP0930
         1 FRPUO2,FR40  ,FR41  ,FR35  ,FRDEN ,FRSIN ,SINTEM,             DATP0940
         2 DFS   ,DSINZ ,DVOIDZ,DCI   ,DCO   ,LFUEL ,LVOIDZ,S     ,XX    , DATP0950
         3 VPLENZ,DTEMP ,DE    ,V     ,ROUF  ,ROUC  ,TM    ,ATMOS ,      DATP0960
         4 FRACHE,FRACAR,FRACH ,FRACN ,FRACKR,FRACXE ,                   DATP0970
         5 SIGHF ,IFLUX ,NEXP  ,KOOL  ,                     NPOW  ,      DATP0980
         6 NOH   ,MINI  ,ICREP ,ICOF  ,ISWELL,IPEAK ,IOUT1 ,IOUT2 ,IIPROF, DATP0990
         7 MEXP  ,MCONV ,KUNIT ,ISTOR ,NHIST ,MDEN  ,MRELOC,IYIELD       DATP1000
         8,MREST,LCREP,DDISH,HDISH                                       DATP1010
         9 , ISPA,NAMSP,MGAS                                             DATP1020
         * ,NUCLEI,FPDIAL,IPLOT                                          DATP1030
                                                                          DATP1040
 C
56        NAMELIST /INPUT2/ CF1,CF2,CF3                                  DATP1050
57        NAMELIST /INPUT3/ AA1,AA2,AA3,AA4,AA5,AA6,AA7                  DATP1060
58        NAMELIST /INPUT4/   RV1, RV2                                   DATP1070
59        NAMELIST /INPUT5/   POWER                                      DATP1080
                                                                          DATP1090
 C
 C                                                                        DATP1100
60        GO TO (1000,2000,3000,4000      )  , KS                        DATP1110
61   1000 CONTINUE                                                       DATP1120
                                                                          DATP1130
 C
 C        TITLE CARD INPUT                                               DATP1140
                                                                          DATP1150
 C
 C                                  CONTROL SIGNAL......INPUT GROUP NO. 1 DATP1160
62        READ(5,1520,END=5000) TITLE                                    DATP1170
63        DO 5001 I=1,20                                                 DATP1180
```

```
* SOURCE STATEMENT (DATINP  )*

      IF(TITLE(1).NE.1H )  GO TO 5002                                   DATP1190
 5001 CONTINUE                                                          DATP1200
 5000 STOP                                                              DATP1210
 5002 CONTINUE                                                          DATP1220
      IF(TITLE(1).EQ.WORD1) STOP                                        DATP1230
C                                                                       DATP1240
C     NAMELIST INPUT                                                    DATP1250
C                                                                       DATP1260
C                                   CONTROL SIGNAL......INPUT GROUP NO. 2  DATP1270
                                                   READ(5,INPUT)        DATP1280
C                                                                       DATP1290
      NPOW1 = NPOW + 1                                                  DATP1300
C     HISTORY CARDS INPUT                                               DATP1310
C                                                                       DATP1320
C         HIST(1,J)   TIME(DAY)                                         DATP1330
C         HIST(2,J)   POWER(W/CM)                                       DATP1340
C         HIST(3,J)   TEMP.  AT  INLET  COOLANT                         DATP1350
C         HIST(4,J)   EXTERNAL  PRESS.  ON  CLADDING  SURFACE           DATP1360
C     IPD(1,J) =                                                        DATP1370
C     IPD(2,J) =0(NOT CHANGE),+(NEW FUEL THERMAL CONDUCTIVITY INPUT)    DATP1380
C     IPD(3,J) =0(NOT CHANGE), =-(BUILTIN DATA),+(EXTERNAL)             DATP1390
C     IPD(4,J) =0(NOT CHANGE), =+(NEW RAD.FLUX DEPRESS.), =-1(BUILT IN) DATP1400
C     IPD(5,J) =0(NOT CHANGE), =+(NEW AXIAL POWER DISTRIBUTION)         DATP1410
      J =0                                                              DATP1420
   10 J =J+1                                                            DATP1430
C                                   CONTROL SIGNAL......INPUT GROUP NO. 3  DATP1440
      READ(5,551)  (HISTIN(I,J),I=1,7) ,(IPD(I,J),I=1,5)                DATP1450
      IF(HISTIN(1,J).LT.0.0)      GO TO 11                              DATP1460
      GO TO 10                                                          DATP1470
  551 FORMAT (7F10.0, 5I2 )                                             DATP1480
   11 CONTINUE                                                          DATP1490
      NNHIST = J-1                                                      DATP1500
      MMM = MMM + 1                                                     DATP1510
      TO = TDAYS                                                        DATP1520
      IF(MMM.GT.1) GO TO 521                                            DATP1530
  521 CONTINUE                                                          DATP1540
      IF(ICREP.LE.0) GO TO 140                                          DATP1550
C                                   CONTROL SIGNAL......INPUT GROUP NO. 4  DATP1560
      READ(5,2110) ((CLCRP(I,J),I=1,2),J=1,ICREP)                       DATP1570
      NCR=ICREP                                                         DATP1580
  140 CONTINUE                                                          DATP1590
C                                                                       DATP1600
      IF(KUNIT.EQ.1) GO TO 150                                          DATP1610
      DFSDUM = DFS    * 2.54                                            DATP1620
      DSINZD = DSINZ  * 2.54                                            DATP1630
      DVOIDD = DVOIDZ * 2.54                                            DATP1640
      DCIDUM = DCI     * 2.54                                           DATP1650
      DCODUM = DCO    * 2.54                                            DATP1660
      FUELL  = LFUEL  * 2.54                                            DATP1670
      VOIDZL = LVOIDZ * 2.54                                            DATP1680
      VPLEND = VPLENZ * 2.54**3                                         DATP1690
      SINTED = (SINTEM - 32.0) / 1.8                                    DATP1700
      DTEMPD =  DTEMP / 1.8                                             DATP1710
      DEDUM  = DE     * 2.54                                            DATP1720
      VDUM   = V * 0.3048                                               DATP1730
      EXTPD  = EXTP   / 14.22                                           DATP1740
      ROUFD  = ROUF   * 2.54                                            DATP1750
      ROUCD  = ROUC   * 2.54                                            DATP1760
      DDISHD = DDISH * 2.54                                             DATP1770
```



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* SOURCE STATEMENT (DATINP  )*

      HDISHD = HDISH * 2.54                                             DATP1780
      GO TO 160                                                         DATP1790
  150 CONTINUE                                                          DATP1800
      DFSDUM = DFS                                                      DATP1810
      DSINZD = DSINZ                                                    DATP1820
      DVOIDD = DVOIDZ                                                   DATP1830
      DCIDUM = DCI                                                      DATP1840
      DCODUM = DCO                                                      DATP1850
      FUELL  = LFUEL                                                    DATP1860
      VOIDZL = LVOIDZ                                                   DATP1870
      VPLEND = VPLENZ                                                   DATP1880
      SINTED = SINTEM                                                   DATP1890
      DEDUM  = DE                                                       DATP1900
      VDUM   = V                                                        DATP1910
      EXTPD  = EXTP                                                     DATP1920
      ROUFD  = ROUF                                                     DATP1930
      ROUCD  = ROUC                                                     DATP1940
      DTEMPD = DTEMP                                                    DATP1950
  160 CONTINUE                                                          DATP1960
      PVDUM(1,2) = DFSDUM                                               DATP1970
      SIGHFD = SIGHF                                                    DATP1980
      DDISHD = DDISH                                                    DATP1990
      HDISHD = HDISH                                                    DATP2000
      IF(SIGHF.LE.0.) GO TO 170                                         DATP2010
      IF(KUNIT.EQ.1) SIGHFD = SIGHF                                     DATP2020
      IF(KUNIT.NE.1) SIGHFD = SIGHF / 1763.                             DATP2030
  170 CONTINUE                                                          DATP2040
C                                                                       DATP2050
C     CLADDING CREEP DOWN    (DAY VS. CLADDING DIAMETRAL CHANGE)        DATP2060
C                                                                       DATP2070
      IF(ICREP.LE.0) GO TO 350                                          DATP2080
      IF(KUNIT.EQ.1) GO TO 330                                          DATP2090
      DO 320 J=1,ICREP                                                  DATP2100
      CLCRPD(1,J) = CLCRP(1,J)                                          DATP2110
      CLCRPD(2,J) = CLCRP(2,J) * 2.54                                   DATP2120
  320 CONTINUE                                                          DATP2130
      GO TO 350                                                         DATP2140
  330 DO 340 J=1,ICREP                                                  DATP2150
      CLCRPD(1,J) = CLCRP(1,J)                                          DATP2160
      CLCRPD(2,J) = CLCRP(2,J)                                          DATP2170
  340 CONTINUE                                                          DATP2180
  350 CONTINUE                                                          DATP2190
C                                                                       DATP2200
C     HISTORY CONVERSION                                                DATP2210
C                                                                       DATP2220
      IF(KUNIT.EQ.1) GO TO 370                                          DATP2230
      DO 360 J=1,NNHIST                                                 DATP2240
      HIST(1,J) = HISTIN(1,J)                                           DATP2250
      HIST(2,J) = HISTIN(2,J) * 1000. / 30.48                           DATP2260
      HIST(3,J) =(HISTIN(3,J) - 32.0) / 1.8                             DATP2270
      HIST(4,J) = HISTIN(4,J) / 14.22                                   DATP2280
      HIST(5,J) = HISTIN(5,J)                                           DATP2290
      HIST(6,J) = HISTIN(6,J)                                           DATP2300
      HIST(7,J) = HISTIN(7,J)                                           DATP2310
  360 CONTINUE                                                          DATP2320
      GO TO 390                                                         DATP2330
  370 DO 380 J=1,NNHIST                                                 DATP2340
      DO 380 I=1,7                                                      DATP2350
      HIST(I,J) = HISTIN(I,J)                                           DATP2360
```

```
* SOURCE STATEMENT (DATINP )*

  380 CONTINUE                                                          DATP2370
  390 CONTINUE                                                          DATP2380
      CALL CHECK(1)                                                     DATP2390
      RETURN                                                            DATP2400
C     ================================================================DATP2410
 2000 CONTINUE                                                          DATP2420
C                                                                       DATP2430
C     MODE(1,IIH)=3 SWITCHING SIGN OF PRINT CONTROL                     DATP2440
C                    IF MODE(1, )=3 , REPLACE PRINT2 TO PRINT1          DATP2450
      IF(IIH.LE.1) GO TO 222                                            DATP2460
      IF(MODE(1,IIH).EQ.0) MODE(1,IIH)=MODE(1,IIH-1)                    DATP2470
      IF(MODE(1,IIH).EQ.3) MODE(1,IIH) = 0                              DATP2480
C                                                                       DATP2490
  222 CONTINUE                                                          DATP2500
C                                                                       DATP2510
      IIPROF = MODE(1,IIH)                                              DATP2520
C                                                                       DATP2530
      NEWK =0                                                           DATP2540
      IF(MODE(2,IIH).EQ.0) GO TO 230                                    DATP2550
      NEWK = 1                                                          DATP2560
      NCON = MODE(2,IIH)                                                DATP2570
      IF(NCON.LE.0) GO TO 230                                           DATP2580
C                                CONTROL SIGNAL......INPUT GROUP NO. 5  DATP2590
C                                                                       DATP2600
                                                READ(5,INPUT2)          DATP2610
C                                                                       DATP2620
      DO 220 J=1,NCON                                                   DATP2630
      CFDUM(1,J) = CF1(J)                                               DATP2640
      CFDUM(2,J) = CF2(J)                                               DATP2650
      CFDUM(3,J) = CF3(J)                                               DATP2660
  220 CONTINUE                                                          DATP2670
  230 CONTINUE                                                          DATP2680
C                                                                       DATP2690
C     CLADDING PROPERTIES READ AND CONVERSION                           DATP2700
C                                                                       DATP2710
      NEWCL = 0                                                         DATP2720
      IF(MODE(3,IIH).EQ.0) GO TO 270                                    DATP2730
      NEWCL = 1                                                         DATP2740
      NCLAD = MODE(3,IIH)                                               DATP2750
      IF(NCLAD.LE.0) GO TO 270                                          DATP2760
C                                CONTROL SIGNAL......INPUT GROUP NO. 6  DATP2770
C                                                                       DATP2780
                                                READ(5,INPUT3)          DATP2790
C                                                                       DATP2800
      IF(KUNIT.EQ.1) GO TO 250                                          DATP2810
      DO 240 J=1,NCLAD                                                  DATP2820
      AADUM(1,J) = (AA1(J) - 32.0) / 1.8                                DATP2830
      AADUM(2,J) = AA2(J) * 0.0173                                      DATP2840
      AADUM(3,J) = AA3(J) / 14.22                                       DATP2850
      AADUM(4,J) = AA4(J) / 14.22                                       DATP2860
      AADUM(5,J) = AA5(J)                                               DATP2870
      AADUM(6,J) = AA6(J) * 1.8                                         DATP2880
      AADUM(7,J) = AA7(J)                                               DATP2890
  240 CONTINUE                                                          DATP2900
      GO TO 270                                                         DATP2910
  250 CONTINUE                                                          DATP2920
      AADUM(1,J) = AA1(J)                                               DATP2930
      AADUM(2,J) = AA2(J)                                               DATP2940
      AADUM(3,J) = AA3(J)                                               DATP2950
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* SOURCE STATEMENT (DATINP )*

      AADUM(4,J) = AA4(J)                                               DATP2960
      AADUM(5,J) = AA5(J)                                               DATP2970
      AADUM(6,J) = AA6(J)                                               DATP2980
      AADUM(7,J) = AA7(J)                                               DATP2990
  270 CONTINUE                                                          DATP3000
C                                                                       DATP3010
C     FLUX DEPRESSION CONVERSION                                        DATP3020
C                                                                       DATP3030
      NEWFLX = 0                                                        DATP3040
      IF(MODE(4,IIH)) 2010,2030,2020                                    DATP3050
 2010 CALL DEPRES(DENSIT,FR35,FR38,DFSDUM,RVDUM)                        DATP3060
      NF = 11                                                           DATP3070
      GO TO 2030                                                        DATP3080
 2020 CONTINUE                                                          DATP3090
      NEWFLX = 1                                                        DATP3100
      NFLX = NF = MODE(4,IIH)                                           DATP3110
C                                CONTROL SIGNAL......INPUT GROUP NO. 7  DATP3120
C                                                                       DATP3130
                                                READ(5,INPUT4)          DATP3140
C                                                                       DATP3150
      IF(KUNIT.EQ.1) GO TO 290                                          DATP3160
      DO 280 J=1,NF                                                     DATP3170
      RVDUM(1,J) = RV1(J) * 2.54                                        DATP3180
      RVDUM(2,J) = RV2(J)                                               DATP3190
  280 CONTINUE                                                          DATP3200
      GO TO 310                                                         DATP3210
  290 DO 300 J=1,NF                                                     DATP3220
      RVDUM(1,J) = RV1(J)                                               DATP3230
      RVDUM(2,J) = RV2(J)                                               DATP3240
  300 CONTINUE                                                          DATP3250
  310 CONTINUE                                                          DATP3260
 2030 CONTINUE                                                          DATP3270
C                                                                       DATP3280
C     AXIAL POWER DISTRIBUTION READ                                     DATP3290
C                                                                       DATP3300
      IF(MODE(5,IIH).EQ.0) GO TO 2050                                   DATP3310
C                                                                       DATP3320
C                                CONTROL SIGNAL......INPUT GROUP NO. 8  DATP3330
                                                READ(5,INPUT5)          DATP3340
      DO 100 I=1,NPOW1                                                  DATP3350
  100 POWREF(I) = POWER(I)                                              DATP3360
 2050 CONTINUE                                                          DATP3370
      CALL CHECK(2)                                                     DATP3380
      RETURN                                                            DATP3390
 3000 CONTINUE                                                          DATP3400
      RETURN                                                            DATP3410
 4000 CONTINUE                                                          DATP3420
      RETURN                                                            DATP3430
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 DATP3440
 1520 FORMAT(20A4)                                                      DATP3450
 2110 FORMAT(F10.0,E10.0)                                               DATP3460
      END                                                               DATP3470
```

* SOURCE STATEMENT *

```
      SUBROUTINE DENSF(DEN,BURN,TSIN,RFS,DELDEN,MDEN,DFS)
C
C     THIS SUBROUTINE IS CALLED FROM MAIN
C     ******************************************
C     FUEL DENSIFICATION MODEL
      COMMON /COM 20/ RHO,RHOS,FRUU,FRPUPU
      COMMON / GT5DEN/ ANS,DENSL
C        DEN ...... INITIAL FUEL FRACTIONAL DENSITY
C        BURN ..... BURNUP (M*D/MTU)
C        TSIN ..... INITIAL SINTERED TEMPERATURE (DEG C)
C        RFS ...... INITIAL FUEL RADIUS (CM)
C        DELDEN ... RADIUS CHANGE DUE TO DENSIFICATION (CM)
C        MDEN
C              = 0  DENSIFICATION IS NOT TAKEN INTO ACCOUNT.
C              = 1  HALDEN MODEL
C              = 2  GAPCON THERMAL-2 MODEL
C     ******************************************
C
      GO TO (1,2,3,4) , MDEN
    1 CONTINUE
C----- HALDEN
      BU=BURN/1000.
      TD=DEN*100.
      TS=TSIN
      CALL DENSHA(TD,BU,TS,ANS)
      ANS=ANS/100.
      DELDEN=-1.*RFS*ANS
      RETURN
    2 CONTINUE
C----- GAPCON THERMAL-2
      BU=BURN
      CALL DENSGT(DELPI,DFS,RHO,RHOS,BU,ANS)
      DELDEN=DELPI
    3 CONTINUE
    4 CONTINUE
      RETURN
      END
```


* SOURCE STATEMENT *

```
      SUBROUTINE DENSGT(DELPI,DFS,ROW,ROWS,BN,ANS)
C     DELRHO=M*ALOG(BU)+B
C     ALOG5=1.6094
C     ALOG20=2.996
C     ALOG2000=7.601
      ANS=0.0
      DELPI=0.
      BU=BN
      IF(BU.LE.20) GO TO 30
      IF(ROWS.LE.ROW) GO TO 30
      DR=ROWS-ROW
      IF(BU.GT.2000) BU=2000.
      IF(ROW.GT.10.08) GO TO 10
      DELR=0.156*ALOG(BU/5.)*DR
      GO TO 20
   10 DELR=0.2171*DR*ALOG(BU/20.)
   20 DELPI=-DELR*DFS/4./ROW
      ANS=-DELR/2./ROW
   30 RETURN
      END
```


* SOURCE STATEMENT *

```
      SUBROUTINE DENSHA(TD,BU,TS,FT)
C
C     THIS SUBROUTINE IS CALLED FROM DENSF
C
C     DATA  A,C1,C2,C3,C4/22.22,0.9337,-0.96085,2.06620,-35.63738 /
      DATA  A,C1,C2,C3,C4/22.2 ,0.93  ,-1.0   ,2.07   ,-35.       /
C
      DM=A*(100.-TD)/(TS-1180.)
      BU1=0.0
      DBU=0.1
      IT=0
   15 DM1=C1*EXP(C2*BU1)+C3*EXP(C4*BU1)
      IF(ABS((DM-DM1)/DM) - 1.E-4) 50,50,20
   20 IF(DM-DM1) 40,50,30
   30 BU1=BU1-DBU
      DBU=DBU/10.
   40 BU1=BU1+DBU
      IT=IT+1
      IF(IT.GE.50) GO TO 55
      GO TO 15
   55 WRITE(6, 400)  DM,DM1,BU1,DBU
   50 BUS=BU1
      BU1=BU
   60 FT   =C1*EXP(C2*(BU1+BUS))+C3*EXP(C4*(BU1+BUS))
      FT=DM1-FT
  400 FORMAT( 5X,47HITERATION TIME OVER  , DM,DM1,BU1,DBU,TD,TS =
     1          ,6F10.5 / )
      RETURN
      END
```

* SOURCE STATEMENT *

```
 1        SUBROUTINE DEPRES(DENSIT,FR10,FR1,DFS,RV)                      DEPR0010
    C                                                                    DEPR0020
    C     THIS SUBROUTINE IS CALLED FROM STEP 1                          DEPR0030
    C     REFER BN#L-1778,GAPCON THERMAL-1,A-2, AND GRAPH D-916, D-917   DEPR0040
    C                                                                    DEPR0050
 2        DIMENSION RV(2,20)                                             DEPR0060
 3        DATA SIGA5,SIGA8,SIGAO,SIGT5,SIGT8,SIGTO/578.,2.33,0.,586.5,10.8, DEPR0070
         14.2 /                                                          DEPR0080
 4        EN5=DENSIT*FR10*.00225927                                      DEPR0090
 5        EN8=DENSIT*FR1*.00223079                                       DEPR0100
 6        ENO=(EN5+EN8)*2.                                               DEPR0110
 7        SGA=(EN5*SIGA5+EN8*SIGA8+ENO*SIGAO)                            DEPR0120
 8        SGT=(EN5*SIGT5+EN8*SIGT8+ENO*SIGTO)                            DEPR0130
 9        CAPSQ=3.*SGA*SGT/(1.-.6*SGA/SGT)                               DEPR0140
10        CAPPA=SQRT(CAPSQ)                                              DEPR0150
11        RV(1,1)=0.                                                     DEPR0160
12        RV(2,1)=1.                                                     DEPR0170
13        DO 10 I=2,11                                                   DEPR0180
14     10 RV(1,I)=RV(1,I-1)+DFS/10.                                      DEPR0190
15        DO 20 I=2,11                                                   DEPR0200
16        R = RV(1,I) / 4. * CAPPA                                       DEPR0210
17     20 RV(2,I)=1.+R**2.+R**4./4.+R**6./36.+R**8./576.                 DEPR0220
18        RETURN                                                         DEPR0230
    C*****************************************************************DEPR0240
19        END                                                            DEPR0250
```


* SOURCE STATEMENT *

```
 1        SUBROUTINE ERROR(IN3,IN4,VALUE)                                ERR00010
    C                                                                    ERR00020
    C     THIS SUBROUTINE IS CALLED FROM TERP                            ERR00030
    C                                                                    ERR00040
 2        DIMENSION ERR(3,150)                                           ERR00050
    C                                                                    ERR00060
    C                                                                    ERR00070
 3        DATA IE/0/                                                     ERR00080
 4        IF(IN4.EQ.45.OR.IN4.EQ.52.OR.IN4.EQ.53.OR.IN4.EQ.54.OR.IN4.EQ.55  ERR00090
         *     .OR.IN4.EQ.81.OR.IN4.EQ.82.OR.IN4.EQ.43 ) RETURN         ERR00100
 5        IE=IE+1                                                        ERR00110
 6        ERR(1,IE)=FLOAT(IN3)                                           ERR00120
 7        ERR(2,IE)=FLOAT(IN4)                                           ERR00130
 8        ERR(3,IE)=VALUE                                                ERR00140
    C                                                                    ERR00150
 9        IF(IE.LT.150) RETURN                                           ERR00160
10        WRITE(6,100)                                                   ERR00170
11        DO 10 I=1,150,10                                               ERR00180
12        I1=I                                                           ERR00190
13        I2=I1+9                                                        ERR00200
14        WRITE(6,201) (ERR(1,II),II=I1,I2)                              ERR00210
15        WRITE(6,202) (ERR(2,II),II=I1,I2)                              ERR00220
16        WRITE(6,203) (ERR(3,II),II=I1,I2)                              ERR00230
17        WRITE(6,300)                                                   ERR00240
18     10 CONTINUE                                                       ERR00250
19        IE=0                                                           ERR00260
20    100 FORMAT(1H1,20X,43HINTERPORATION FUNCTION (TERP) ERROR SUMMARY //) ERR00270
21    201 FORMAT(3X,5H  IN3,3X,10F12.0)                                  ERR00280
22    202 FORMAT(3X,5H  IN4,3X,10F12.0)                                  ERR00290
23    203 FORMAT(3X,5HVALUE,3X,10G12.5)                                  ERR00300
24    300 FORMAT(1H )                                                    ERR00310
25        RETURN                                                         ERR00320
26        END                                                            ERR00330
```

* SOURCE STATEMENT *

```
      SUBROUTINE EXPAND  (RFS,RD,TT,TFS,FRPU02,DELRT,DELCT,DELL,L,NEXP,  EXPA0010
     1                    MEXP , RVOID )                                 EXPA0020
C                                                                        EXPA0030
C     THIS SUBROUTINE IS CALLED FROM STEP 5                              EXPA0040
C     REFER BNWL-1778,GAPCON THERMAL-1,A-5, AND GRAPH D-812.             EXPA0050
C                                                                        EXPA0060
      DIMENSION TT(100),DELCT(50),DELL(50),DAREA(50)                     EXPA0070
      DATA TBAND / 1800. /                                               EXPA0080
      TA(T1,T2) = ((T1 + T2) / 2. )                                      EXPA0090
C                                                                        EXPA0100
      MESHR=20                                                           EXPA0110
      N=MESHR                                                            EXPA0120
      INDX=MESHR                                                         EXPA0130
      KEXP=NEXP                                                          EXPA0140
      DELRT = 0.0                                                        EXPA0150
      FR = FRPU02 * 100.                                                 EXPA0160
      DO 6 I=1,MESHR                                                     EXPA0170
      DELL(I) = 0.0                                                      EXPA0180
      DAREA(I)=0.0                                                       EXPA0190
    6 DELCT(I) = 0.0                                                     EXPA0200
      LFLAG=0                                                            EXPA0210
C                                                                        EXPA0220
      DO 1 I=1,MESHR                                                     EXPA0230
      RIN = RFS - RD * I                                                 EXPA0240
      RON = RIN + RD                                                     EXPA0250
    2 IF(I.GT.1) GO TO 4                                                 EXPA0260
      TAC = TA(TFS,TT(1))                                                EXPA0270
      GO TO 16                                                           EXPA0280
    4 TAC = TA(TT(I-1),TT(I))                                            EXPA0290
   16 CONTINUE                                                           EXPA0300
      IF(LFLAG.GE.1) GO TO 5                                             EXPA0310
      IF(TAC.GE.TBAND) 7,5                                               EXPA0320
    7 INDX=I                                                             EXPA0330
      LFLAG=1                                                            EXPA0340
    5 CONTINUE                                                           EXPA0350
C     ********************                                               EXPA0360
      ALPHA=FALPHA(TAC,KEXP)                                             EXPA0370
C     ********************                                               EXPA0380
      RAVG=(RIN+RON)*.5                                                  EXPA0390
      DELCT(I)=ALPHA*(TAC-25.)*RAVG                                      EXPA0400
      DELL(I) = ALPHA*(TAC-25.)*RD                                       EXPA0410
      DAREA(I)=ALPHA*(TAC-25.)*(RON**2-RIN**2)/RFS                       EXPA0420
    1 CONTINUE                                                           EXPA0430
C                                                                        EXPA0440
      DELVOI=RVOID*FALPHA(TT(N),KEXP)*(TT(N)-25.)                        EXPA0450
      DAREAV=RVOID**2/RFS     * FALPHA(TT(N),KEXP)*(TT(N)-25.)           EXPA0460
C                                                                        EXPA0470
      GO TO (10,20,30,40,50),MEXP                                        EXPA0480
C                                                                        EXPA0490
   10 CONTINUE                                                           EXPA0500
C----- GAPCON ORIGINAL MODEL (HALF CRACK TYPE)                           EXPA0510
    3 BIG = ABS(DELCT(1))                                                EXPA0520
      L = 1                                                              EXPA0530
      DO 11 I=2,MESHR                                                    EXPA0540
      AB = ABS(DELCT(I))                                                 EXPA0550
      IF(AB-BIG) 11,11,12                                                EXPA0560
   12 BIG = ABS(DELCT(I))                                                EXPA0570
      L = I                                                              EXPA0580
   11 CONTINUE                                                           EXPA0590
```


* SOURCE STATEMENT (EXPAND)*

```
      DO 13 I=1,L                                                        EXPA0600
   13 DELRT = DELRT + DELL(I)                                            EXPA0610
      DELRT = DELRT-DELL(L)/2.+DELCT(L)                                  EXPA0620
      RETURN                                                             EXPA0630
   20 CONTINUE                                                           EXPA0640
C----- AREA BALANCE TYPE                                                 EXPA0650
      DO 21 I=1,MESHR                                                    EXPA0660
      DELRT=DELRT+DAREA(I)                                               EXPA0670
   21 CONTINUE                                                           EXPA0680
      DELRT=DELRT +DAREAV                                                EXPA0690
      RETURN                                                             EXPA0700
   30 CONTINUE                                                           EXPA0710
C----- HALF CRACK (TWO REGION TYPE)                                      EXPA0720
      DO 31 I=1,INDX                                                     EXPA0730
      DELRT=DELRT+DELL(I)                                                EXPA0740
   31 CONTINUE                                                           EXPA0750
C                                                                        EXPA0760
      INDX1=INDX+1                                                       EXPA0770
      IF(INDX1.GE.MESHR) GO TO 33                                        EXPA0780
      DO 32 I=INDX1,MESHR                                                EXPA0790
      DELRT=DELRT+DAREA(I)                                               EXPA0800
   32 CONTINUE                                                           EXPA0810
   33 CONTINUE                                                           EXPA0820
      DELRT=DELRT +DAREAV                                                EXPA0830
C                                                                        EXPA0840
      RETURN                                                             EXPA0850
   40 CONTINUE                                                           EXPA0860
C *****  COMPLETE CRACK MODEL                                            EXPA0870
      DO 35 I=1,MESHR                                                    EXPA0880
      DELRT=DELRT+DELL(I)                                                EXPA0890
   35 CONTINUE                                                           EXPA0900
      DELRT=DELRT + DELVOI                                               EXPA0910
      RETURN                                                             EXPA0920
   50 CONTINUE                                                           EXPA0930
      RETURN                                                             EXPA0940
C*********************************************************************EXPA0950
      END                                                                EXPA0960
```

* SOURCE STATEMENT *

```
      FUNCTION  FALPHA(T,KEXP)                                          FALP0010
C                                                                       FALP0020
C     THIS FUNCTION IS CALLED FROM EXPAND.                              FALP0030
C                                                                       FALP0040
C---------- FUEL LINEAR THERMAL EXPANSION COEFFICIENT ----------       FALP0050
C         IN THIS FUNCTION , THE FALPHA IS AVERAGE ALPHA ( (DL/L)/DT)   FALP0060
C         AND IS NOT INSTANTENIOUS ALPHA ( D(DL/L)/DT) ,                FALP0070
C         NOW REFERENCE(ROOM) TEMPERATURE IS TR  SETTED TO 25. DEG C    FALP0080
C        THE AVERAGE ALPHA IS DEFINED BY THE NEXT EQUATION              FALP0090
C             AVG.ALPHA = ( F(T)-F(TREF)) / (T-TREF)                    FALP0100
C                 F(T) = DL/LO AT T (DEG C)                             FALP0110
C                                                                       FALP0120
C         THE DEFORMATION DUE TO THERMAL EXPANSION IS CALCULATED BY     FALP0130
C         NEXT EQUATION IN SUBROUTINE (EXPAND)                          FALP0140
C                                                                       FALP0150
C            DELR(I) = ALPHA * (T(I)-TR) * R(I)                         FALP0160
C            T(I)=LOCAL TEMPERATURE  ,  R(I)=RING AVERAGE RADIUS        FALP0170
C            I=RING POINT NUMBER                                        FALP0180
C                                                                       FALP0190
C     ..... PARAMETERS .....                                            FALP0200
C         T=LOCAL TEMPERATURE IN DEG C                                  FALP0210
C         OPTION                                                        FALP0220
C            KEXP =  1   ROTH AND HALTEMAN (GAPCON HEDL-TM72-128)       FALP0230
C                        (PURE UO2)                                     FALP0240
C                 =  2   CONWAY,FANCEL AND HEIN (BNWL-1778 GAPCON-THERMAFALP0250
C                                                                       FALP0260
C                                                                       FALP0270
C       AVERAGE LINEAR THERMAL EXPANSION COEFFICIENT TABLE ( X 1.E-6)   FALP0280
C                                                                       FALP0290
C=======================================================================FALP0300
C  TEMP(C)    GAPCON        GAPCON-THERM                                FALP0310
C  (25./ )  (ROTH -     )   (CONWAY-    )                               FALP0320
C .......  ............   ............   ............  ............    FALP0330
C    100.        9.52500        7.15900                                FALP0340
C    300.        9.64500        7.73820                                FALP0350
C    500.        9.76500        8.31740                                FALP0360
C    800.        9.94500        9.18620                                FALP0370
C   1000.       10.06500        9.76540                                FALP0380
C   1500.       10.36500       11.21340                                FALP0390
C   2000.       10.66500       12.66140                                FALP0400
C   2500.       10.96500       14.10940                                FALP0410
C-----------------------------------------------------------------------FALP0420
C                                                                       FALP0430
C (500./ )                                                              FALP0440
C    800.       10.23000       10.56180                                FALP0450
C   1000.       10.35000       11.14100                                FALP0460
C   1500.       10.65000       12.58900                                FALP0470
C   2000.       10.95000       14.03700                                FALP0480
C   2500.       11.25000       15.48500                                FALP0490
C   2800.       11.43000       16.35380                                FALP0500
C-----------------------------------------------------------------------FALP0510
C                                                                       FALP0520
      DATA TR/24.999999/                                                FALP0530
      TC=T                                                              FALP0540
      TF=TC*1.8+32.                                                     FALP0550
      TRF=TR*1.8+32.                                                    FALP0560
      IF(KEXP.GT.0) GO TO 100                                           FALP0570
      PRINT 500,KEXP                                                    FALP0580
      STOP                                                              FALP0590
```


* SOURCE STATEMENT (FALPHA)*

```
  500 FORMAT(1H0,47H***** FUEL THERMAL EXPANSION OPTION ERROR KEXP=,I2) FALP0600
  100 CONTINUE                                                          FALP0610
      GO TO (1,2,3,4,5,6) , KEXP                                        FALP0620
C--------- ROTH AND HALTEMAN                                            FALP0630
    1 CONTINUE                                                          FALP0640
      FALPHA=( (TC**2-TR**2)*0.0006 + (TC-TR)*9.45 )*1.E-6 / (TC-TR)    FALP0650
      GO TO 10                                                          FALP0660
C--------- GAPCON-THERMAL-1                                             FALP0670
    2 CONTINUE                                                          FALP0680
      FALPHA=( (TC**2-TR**2)*2.896E-9 + (TC-TR)*6.797E-6 ) / (TC-TR)    FALP0690
      GO TO 10                                                          FALP0700
    3 CONTINUE                                                          FALP0710
      GO TO 10                                                          FALP0720
    4 CONTINUE                                                          FALP0730
      GO TO 10                                                          FALP0740
C                                                                       FALP0750
    5 CONTINUE                                                          FALP0760
    6 CONTINUE                                                          FALP0770
   10 CONTINUE                                                          FALP0780
      RETURN                                                            FALP0790
      END                                                               FALP0800
```

* SOURCE STATEMENT *

```
      FUNCTION  FCOND(DENS,TEMP,KCON)                                   FCON0010
C                                                                       FCON0020
C     THIS SUBROUTINE IS CALLED FROM STEP 2 STEP 4  AND STEP 7          FCON0030
C                                                                       FCON0040
C-----------------------------------------------------------------------FCON0050
C                                                                       FCON0060
C              FUEL THERMAL CONDUCTIVITY EQUATION                       FCON0070
C         FCOND...THERMAL CONDUCTIVITY (WATT/CM-C)                      FCON0080
C         DENS....FUEL DENSITY (FRACTION)                               FCON0090
C         TEMP....TEMPERATURE (DEG K)                                   FCON0100
C     ***** OPTIONS *****                                               FCON0110
C         KCON.LE.0 (NCON.GT.0)      READ IN TABLE FROM CARDS           FCON0120
C         KCON = 1  (NCON = -2)      WARD DESIGN EQUATION (DENS.LT.0.95) FCON0130
C         KCON = 2  (NCON = -2)      WARD DESIGN EQUATION (DENS.GE.0.95) FCON0140
C         KCON = 3  (NCON = -3)      GODFREY EQUATION                   FCON0150
C         KCON = 4  (NCON = -4)      LYONS (DOCKET STN-5-447-1 P.4.2-3) FCON0160
C         KCON = 5  (NCON = -5)      RESAR-41(DOCKET STN-50480-1 P.4.4-9)FCON0170
C                                                                       FCON0180
C-----------------------------------------------------------------------FCON0190
      D = DENS                                                          FCON0200
      T = TEMP                                                          FCON0210
      IF(KCON.GT.0) GO TO 100                                           FCON0220
      WRITE(6,1000)                                                     FCON0230
      FCOND = 0.0                                                       FCON0240
      RETURN                                                            FCON0250
  100 CONTINUE                                                          FCON0260
      GO TO (1,2,3,4,5                        ),KCON                    FCON0270
C         ***** WARD DESIGN EQUATION (DENS.LT.0.95) *****               FCON0280
    1  FCOND=(1.-2.1*D+D**2)*(-1./(.288+.00252*T)-5.83E-12*T**3)        FCON0290
      GO TO 50                                                          FCON0300
C         ***** WARD DESIGN EQUATION (DENS.GE.0.95) *****               FCON0310
    2  FCOND=(3.*D-1.)*(1./(5.75+.0503*T)+2.91E-13*T**3)                FCON0320
      GO TO 50                                                          FCON0330
C         ***** GODFREY EQUATION *****                                  FCON0340
    3  FCOND=(1.-2.5*(1.-D))*(45.1/(135.+T) + 4.79E-13*T**3)            FCON0350
      GO TO 50                                                          FCON0360
C         ***** LYONS EQUATION *****                                    FCON0370
C     NOW CONVERT TEMPERATURE DEG-C TO DEG-K IN ORIGINAL EQUATION       FCON0380
C                                                                       FCON0390
    4 FCOND=((1.025/.95)*(D/(1.+(1.-D)*.5)))*((38.24/(129.4+T))+(6.1256EFCON0400
     A-13*((T)**3)))                                                    FCON0410
      GO TO 50                                                          FCON0420
C         ***** RESAR-41 MODEL *****                                    FCON0430
C                                                                       FCON0440
    5 FCOND=((1.025/.95)*(D/(1.+(1.-D)*.5)))*((1./(11.8+0.0238*(T-273.))FCON0450
     A)+(8.775E-13*((T-273.)**3)))                                      FCON0460
      GO TO 50                                                          FCON0470
   50 CONTINUE                                                          FCON0480
      RETURN                                                            FCON0490
C                                                                       FCON0500
 1000 FORMAT( 1H0, 40H*****  THERMAL CONDUCTIVITY OPTION ERROR      )   FCON0510
C***********************************************************************FCON0520
      END                                                               FCON0530
```

* SOURCE STATEMENT *

```
      SUBROUTINE FISGAS(TIN,PHH,P,CONEN,IFLUX,MTIME,AKR,AXE,IP)
C
C     THIS SUBROUTINE IS CALLED FROM MOLMOL(2)
C
C
C     SUBROUTINE FISGAS IS USED TO CALCULATE THE AMOUNT
C     OF FISSION GAS PRODUCED FOR A GIVEN TIME AND POWER.
C     CALCULATIONS ARE BASED ON TWO MODELS. THE FIRST ASSUMES
C     A PRIMARILY FAST SPECTRUM, AND THE SECOND ASSUMES A
C     THERMAL SPECTRUM.
C
      COMMON /NUCLEI/ NUCLEI,A(40,23)
      COMMON /BRNRAY/ VOLCC,A1Z,A7Z,A8Z,A9Z,A10Z
      COMMON /DECAY/ DC2,DC3,DC4,DC5,DC6,DC12,DC14,DC15,DC21,DC22,DC23,
     *               DC25,DC26,DC28,DC31,DC33,DC34,DC35,DC85,DC85M
      DIMENSION TCX(30),FCX(30),TFX(30),FFX(30),CX(30),FX(30),AX(30),
     *FY(4,20),TY(4,20)
      DIMENSION Y(20,20),F(20)
      DOUBLE PRECISION X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X13,X14,
     *X15, X101, X103, X104, X106,X107,X108,X109,X110,X111,X112,X113,
     *X114,X116,X117,X118
      DOUBLE PRECISION X,T
C
      DATA A/ 920*0.0/
      DATA  FX/30 * 0.0/
      DATA KKK / 0 /
      DATA DC2,DC3,DC4,DC5,DC6,DC12,DC14,DC15/4.915E-04,3.413E-06,1.365E
     *-05,1.582E-03,1.925E-04,1.188E-06,3.820E-06,2.469E-10/
C
      DATA DC85M,DC85,DC21,DC22,DC23,DC26,DC28,DC31,DC33,DC34,DC35,DC25/
     *4.375E-05,2.042E-09,6.684E-06,4.620E-04,9.964E-07,9.167E-06,2.873E
     *-05,8.370E-05,1.522E-06,7.219E-04,2.092E-05,2.468E-06/
C
C FISSION CROSS-SECTION USED FOR THE HEAVY METAL ATOMS
C FAST    FISSION CROSS SECTIONS (BARNS) = FFX
C THERMAL FISSION CROSS SECTIONS (BARNS) = TFX
C FAST    CAPTURE CROSS SECTIONS (BARNS) = FCX
C THERMAL CAPTURE CROSS SECTIONS (BARNS) = TCX
C N          TCX      TFX      FCX      FFX
C 1          2.7 ,    0.0 ,   14.0 ,    0.1 ,
C 2         36.0 ,   14.0 ,    0.0 ,    0.0 ,
C 3         65.0 ,    0.0 ,    0.0 ,    0.0 ,
C 4          0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 5          0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 6          0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 7       1110.0 ,  740.0 ,    1.6 ,    1.6 ,
C 8        290.0 ,    0.0 ,    1.6 ,    1.6 ,
C 9       1350.0 ,  950.0 ,    1.6 ,    1.6 ,
C 10       693.0 ,  553.0 ,    6.6 ,    1.4 ,
C 11         6.0 ,    0.0 ,    0.3 ,    0.0 ,
C 12         0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 13       170.0 ,    0.0 ,   13.0 ,    1.5 ,
C 14      1600.0 ,    0.0 ,    0.0 ,    0.0 ,
C 15       597.0 ,   17.0 ,    2.6 ,    2.6 ,
C 16         0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 17         0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 18         0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 19         0.0 ,    0.0 ,    0.0 ,    0.0 ,
C 20       180.0 ,    0.0 ,    0.0 ,    0.0 ,
```


* SOURCE STATEMENT (FISGAS)*

```
C 21        15.0 ,    0.0 ,    0.0 ,    0.0 ,
C 22        65.0 ,    0.0 ,    0.0 ,    0.0 ,
C 23         5.0 ,    0.0 ,    0.0 ,    0.0 ,
C 24       190.0 ,    0.0 ,    0.0 ,    0.0 ,
C 25        27.E5 ,   0.0 ,    0.0 ,    0.0 /
C
C TABLE FOR DECAY CONSTANT OF THE HEAVY METAL ATOMS
C N      DC     HALF LIFE    DECAY CONSTANT
C 1
C 2      2      23.5  M       4.915E-4
C 3      3      2.35 D       3.413E-6
C 4      4      14.1  H       1.365E-5
C 5      5       7.3  M       1.582E-3
C 6      6       1.   H       1.925E-4
C 7
C 8
C 9
C 10
C 11
C 12     12      6.75 D       1.188E-6
C 13
C 14     14      2.1  D       3.820E-6
C 15     15     89.   Y       2.469E-10
C 16
C 17
C 18
C 19
C 20
C 21
C 22
C 23
C 24
C 25
C
      DATA(TCX(I),I=1,15)/
     * 2.7E-24, 36.E-24, 60.E-24, 0., 0., 0., 1110.E-24, 290.E-24,
     * 1350.E-24, 693.E-24, 6.E-24, 0., 170.E-24, 1600.E-24, 597.E-24/
C
      DATA(TFX(I),I=1,25)/
     * 0., 14.E-24, 0., 0., 0., 0., 740.E-24, 0., 950.E-24, 553.E-24,
     * 0., 0., 0., 0., 17.E-24,    10*0.0          /
C
      DATA(TCX(I),I=16,25)/          4*0.0,
     * 180.E-24, 15.E-24, 85.E-24, 5.E-24, 190.E-24, 2.7E-18/
C
      DATA(FCX(I),I=1,15)/
     *14.E-24,0., 0., 0., 0., 0., 1.6E-24, 1.6E-24, 1.6E-24, 6.6E-24,
     *.3E-24,0., 13.E-24, 0., 2.6E-24/
C
      DATA(FFX(I),I=1,15)/
     * 0.1E-24, 0., 0., 0., 0., 0., 1.6E-24, 1.6E-24, 1.6E-24, 1.4E-24,
     * 0., 0., 1.5E-24, 0., 2.6E-24/
C
      DATA(FCX(I),I=16,25)/   10*0.0          /
      DATA(FFX(I),I=16,25)/   10*0.0          /
C
C FISSION YIELDS FOR THOSE ISOTOPES THAT CONTRIBUTE TO THE GAS INVENTORY
C        *** FAST FISSION YIELDS *** ** THERMAL FISSION YIELDS **
C          YIELDS (PS) FROM FISSION    YIELDS (PS) FROM FISSION
```

```
* SOURCE STATEMENT (FISGAS )*

C          ************************* *************************
C N        U-235  U-238  PU-239 PU-241 U-235  U-238  PU-239 PU-241
C101        0.77 , 0.40 , 0.38 , 0.0  , 0.52 , 0.0  , 0.29 , 0.208,
C102        0.92 , 0.85 , 0.52 , 0.0  , 0.97 , 0.0  , 0.47 , 0.341,
C103        1.22 , 0.73 , 0.69 , 0.0  , 1.30 , 0.0  , 0.535, 0.30 ,
C104        0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  ,
C105        1.70 , 1.38 , 0.9  , 0.0  , 1.93 , 0.0  , 0.75 , 0.40 ,
C106        0.52 , 0.0  , 0.0  , 0.0  , 0.44 , 0.0  , 0.0  , 0.0  ,
C107        3.11 , 3.2  , 3.3  , 0.0  , 2.52 , 0.0  , 3.7  , 3.01 ,
C108        0.0  , 0.0  , 0.1  , 0.0  , 0.0  , 0.0  , 0.09 , 0.0  ,
C109        0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  ,
C110        5.5  , 4.4  , 3.5  , 0.0  , 4.33 , 0.0  , 5.2  , 4.44 ,
C111        0.2  , 0.3  , 0.26 , 0.0  , 0.0  , 0.0  , 0.15 , 0.03 ,
C112        0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  ,
C113        5.5  , 5.5  , 5.7  , 0.0  , 6.69 , 0.0  , 5.3  , 6.54 ,
C114        0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 1.2  , 0.0  ,
C115        5.9  , 6.6  , 6.4  , 0.0  , 7.92 , 0.0  , 7.47 , 7.81 ,
C116        5.6  , 5.9  , 6.3  , 0.0  , 6.17 , 0.0  , 5.7  , 7.23 ,
C117        0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  , 0.0  ,
C118        0.5  , 0.1  , 0.5  , 0.0  , 0.13 , 0.0  , 1.51 , 0.07 ,
C119        6.0  , 5.9  , 6.9  , 0.0  , 6.46 , 0.0  , 6.66 , 7.04 /
C
C TABLE FOR DECAY CONSTANT OF THE FISSION GAS   ( 1 / SEC )
C N      DC    HALF LIFE   DECAY CONSTANT
C101
C102
C103     85M     4.4  H      4.37594E-5
C104     85     10.76 Y      2.04271E-9
C105
C106     21     30.   H      6.41805E-6
C107     22     25.   H      4.621E-4
C108     23      8.05 D      9.965E-7
C109
C110     25     78.   H      2.46848E-6
C111     31      2.3  H      8.3713E-5
C112
C113     26     21.   H      9.16865E-6
C114     33      5.27 D      1.5223E-6
C115
C116     28      6.7  H      2.87375E-5
C117     34     15.6  M      7.40544E-4
C118     35      9.2  H      2.09284E-5
C119
C
C      I=1   YIELDS FROM FISSION OF U235
C      I=2   YIELDS FROM FISSION OF U238
C      I=3   YIELDS FROM FISSION OF PU239
C      I=4   YIELDS FROM FISSION OF PU241
C.....REFER HEDL TME 72 128 PAGE B-3  OR  JAERI-MEMO 5335 PAGE 20+21,22
21      DATA((TY(I,J),I=1,4),J=1,10)/
     *   .00320,   .0     ,   .00290,   .00206,
     *   .00970,   .0     ,   .00470,   .00341,
     *   .01300,   .0     ,   .00535,   .00300,
     *   .0     ,   .0     ,   .0     ,   .0     ,
     *   .01930,   .0     ,   .00750,   .00400,
     *   .00440,   .0     ,   .0     ,   .0     ,
     *   .02520,   .0     ,   .03700,   .03010,
     *   .0     ,   .0     ,   .00090,   .0     ,
     *   .0     ,   .0     ,   .0     ,   .0     ,
```



```
* SOURCE STATEMENT (FISGAS )*

     *   .04330,   .0     ,   .05200,   .04440                    /
C
22      DATA((TY(I,J),I=1,4),J=11,19)/
     *   .0     ,   .0     ,   .00150,   .00030,
     *   .0     ,   .0     ,   .0     ,   .0     ,
     *   .06690,   .0     ,   .05300,   .06540,
     *   .0     ,   .0     ,   .01200,   .0     ,
     *   .07920,   .0     ,   .07470,   .07810,
     *   .06170,   .0     ,   .05700,   .07230,
     *   .0     ,   .0     ,   .0     ,   .0     ,
     *   .00130,   .0     ,   .01510,   .00070,
     *   .06460,   .0     ,   .06660,   .07040                    /
C
23      DATA((FY(I,J),I=1,4),J=1,10)/
     *   .0077 ,   .0040 ,   .0038 ,   .0    ,
     *   .0092 ,   .0085 ,   .0052 ,   .0    ,
     *   .0122 ,   .0073 ,   .0069 ,   .0    ,
     *   .0    ,   .0    ,   .0    ,   .0    ,
     *   .0170 ,   .0138 ,   .0090 ,   .0    ,
     *   .0052 ,   .0    ,   .0    ,   .0    ,
     *   .0311 ,   .0320 ,   .0330 ,   .0    ,
     *   .0    ,   .0    ,   .0010 ,   .0    ,
     *   .0    ,   .0    ,   .0    ,   .0    ,
     *   .0550 ,   .0440 ,   .0350 ,   .0                        /
C
24      DATA((FY(I,J),I=1,4),J=11,19)/
     *   .0020 ,   .0030 ,   .0026 ,   .0    ,
     *   .0    ,   .0    ,   .0    ,   .0    ,
     *   .0550 ,   .0550 ,   .0570 ,   .0    ,
     *   .0    ,   .0    ,   .0    ,   .0    ,
     *   .0590 ,   .0660 ,   .0640 ,   .0    ,
     *   .0560 ,   .0590 ,   .0630 ,   .0    ,
     *   .0    ,   .0    ,   .0    ,   .0    ,
     *   .0050 ,   .0010 ,   .0050 ,   .0    ,
     *   .0600 ,   .0590 ,   .0690 ,   .0                        /
C
C
C
25      EN1(A,X,T) = A*DEXP(-X*T)
26      EN2(F,AB,B,X,T) = F*AB*B*(1.-DEXP(-X*T))/X
27      EN3(DC,C,X,T) = DC*C*(1.-DEXP(-X*T))/X
28      FAC(X,T) = (1.-DEXP(-X*T))/X
C
29      T = TIN
30      IF(MTIME.GT.0) GO TO 4
31      A1=A2=A3=A4=A5=A6=A7=A8=A9=A10=A11=A12=A13=A14=A15=0.0
32      A101=A102=A103=A104=A105=A106=A107=A108=A109=A110 =0.0
33      A111=A112=A113=A114=A115=A116=A117=A118=A119      =0.0
34      A1  = A1Z
35      A7  = A7Z
36      A8  = A8Z
37      A9  = A9Z
38      A10 = A10Z
39      GO TO 6
C
40    4 CONTINUE
C     **** FISILE  MATERIALS  ****
C     A1                        238U------ABS.N
C     A2        238U  ABS.N----239U------ABS.N AND DECAY(DC2)
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* SOURCE STATEMENT (FISGAS  )*
C     A3        239U  DECAY----239NP-----ABS.N AND DECAY(DC3)          FISG2370
C     A4        239U  ABS.N----240U------DECAY(DC4)                   FISG2380
C     A5        240U  DECAY----240NP(M)--DECAY(DC5)                   FISG2390
C     A5        239NP ABS.N----*                                      FISG2400
C     A6     (M)240NP DECAY----240NP-----DECAY(DC6)                   FISG2410
C     A7        238NP ABS.N----239PU-----ABS.N                        FISG2420
C     A7        239NP DECAY----*                                      FISG2430
C     A8        239PU ABS.N----240PU-----ABS.N                        FISG2440
C     A8        240NP DECAY----*                                      FISG2450
C     A9        240PU ABS.N----241PU-----ABS.N                        FISG2460
C     A10                      235U------ABS.N                        FISG2470
C     A11       235U  ABS.N----236U------ABS.N                        FISG2480
C     A12       236U  ABS.N----237U------DECAY(C12)                   FISG2490
C     A13       237U  DECAY----237NP-----ABS.N                        FISG2500
C     A14       237NP ABS.N----238NP-----ABS.N AND DECAY(DC14)        FISG2510
C     A15       238NP DECAY----238PU-----ABS.N AND DECAY(DC15)        FISG2520
C     ****   GASES  OF FISSION  PRODUCTS  **                          FISG2530
C     A101      YIELD----------83KR------ABS.N                        FISG2540
C     A102      YIELD----------84KR                                   FISG2550
C     A102      83KR  ABS.N----*                                      FISG2560
C     A103      YIELD----------85KR(M)---DECAY(DC85M)                 FISG2570
C     A104      YIELD----------85KR------ABS.N AND DECAY(DC85)        FISG2580
C     A104   (M)85KR  DECAY----*                                      FISG2590
C                     (0.21)                                          FISG2600
C     A105      YIELD----------86KR                                   FISG2610
C     A105      85KR  ABS.N----*                                      FISG2620
C     A106      YIELD----------131TE(M)--DECAY(DC21)                 FISG2630
C     A107      YIELD----------131TE-----DECAY(DC22)                 FISG2640
C     A107   (M)131TE DECAY----*                                      FISG2650
C                     (0.18)                                          FISG2660
C     A108      131TE DECAY----131I------DECAY(DC23)                 FISG2670
C     A108   (M)131TE DECAY----*                                      FISG2680
C                     (0.82)                                          FISG2690
C     A109      131I  DECAY----131XE-----ABS.N                        FISG2700
C     A110      YIELD----------132TE-----DECAY(DC25)                 FISG2710
C     A111      132TE DECAY----132I------DECAY(DC31)                 FISG2720
C     A112      132I  DECAY----132XE-----ABS.N                        FISG2730
C     A112      131XE ABS.N----*                                      FISG2740
C     A113      YIELD----------133I------DECAY(DC26)                 FISG2750
C     A114      133I  DECAY----133XE-----ABS.N AND DECAY(DC33)        FISG2760
C     A115      YIELD----------134XE                                  FISG2770
C     A115      134XE ABS.N----*                                      FISG2780
C     A115      134XE ABS.N----*                                      FISG2790
C     A116      YIELD----------135I------DECAY(DC28)                 FISG2800
C     A117      135I  DECAY----135XE(M)--DECAY(DC34)                  FISG2810
C                     (0.3)                                           FISG2820
C     A118      YIELD----------135XE-----ABS.N AND DECAY(DC35)        FISG2830
C     A118      135I  DECAY----*                                      FISG2840
C                     (0.7)                                           FISG2850
C     A118   (M)135XE----------*                                      FISG2860
C     A119      YIELD----------136XE                                  FISG2870
C     A119      135XE ABS.N----*                                      FISG2880
      A1 = A(1,IP)                                                    FISG2890
      A2 = A(2,IP)                                                    FISG2900
      A3 = A(3,IP)                                                    FISG2910
      A4 = A(4,IP)                                                    FISG2920
      A5 = A(5,IP)                                                    FISG2930
      A6 = A(6,IP)                                                    FISG2940
      A7 = A(7,IP)                                                    FISG2950
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* SOURCE STATEMENT (FISGAS  )*
      A8 = A(8,IP)                                                    FISG2960
      A9 = A(9,IP)                                                    FISG2970
      A10 = A(10,IP)                                                  FISG2980
      A11 = A(11,IP)                                                  FISG2990
      A12 = A(12,IP)                                                  FISG3000
      A13 = A(13,IP)                                                  FISG3010
      A14 = A(14,IP)                                                  FISG3020
      A15 = A(15,IP)                                                  FISG3030
      A101 = A(21,IP)                                                 FISG3040
      A102 = A(22,IP)                                                 FISG3050
      A103 = A(23,IP)                                                 FISG3060
      A104 = A(24,IP)                                                 FISG3070
      A105 = A(25,IP)                                                 FISG3080
      A106 = A(26,IP)                                                 FISG3090
      A107 = A(27,IP)                                                 FISG3100
      A108 = A(28,IP)                                                 FISG3110
      A109 = A(29,IP)                                                 FISG3120
      A110 = A(30,IP)                                                 FISG3130
      A111 = A(31,IP)                                                 FISG3140
      A112 = A(32,IP)                                                 FISG3150
      A113 = A(33,IP)                                                 FISG3160
      A114 = A(34,IP)                                                 FISG3170
      A115 = A(35,IP)                                                 FISG3180
      A116 = A(36,IP)                                                 FISG3190
      A117 = A(37,IP)                                                 FISG3200
      A118 = A(38,IP)                                                 FISG3210
      A119 = A(39,IP)                                                 FISG3220
C                                                                     FISG3230
    6 CONTINUE                                                        FISG3240
      IF(IFLUX.NE.0) GO TO 10                                         FISG3250
      DO 5 I=1,25                                                     FISG3260
      CX(I)=FCX(I)                                                    FISG3270
    5 FX(I)=FFX(I)                                                    FISG3280
      GO TO 20                                                        FISG3290
   10 DO 15 I=1,25                                                    FISG3300
      CX(I)=TCX(I)                                                    FISG3310
   15 FX(I)=TFX(I)                                                    FISG3320
   20 CONTINUE                                                        FISG3330
      DO 25 I=1,15                                                    FISG3340
   25 AX(I) = CX(I)-FX(I)                                             FISG3350
      IF(IFLUX.NE.0) GO TO 35                                         FISG3360
      DO 30 I=1,4                                                     FISG3370
      DO 30 J=1,19                                                    FISG3380
   30 Y(I,J) = FY(I,J)                                                FISG3390
      GO TO 45                                                        FISG3400
   35 DO 40 I=1,4                                                     FISG3410
      DO 40 J=1,19                                                    FISG3420
   40 Y(I,J) = TY(I,J)                                                FISG3430
   45 CONTINUE                                                        FISG3440
C        PHI= NUETRON  FLUX , A1Z = U-235 CONCENTRATION               FISG3450
C        A1 = U-238 , A7 = PU-239 , A8 = PU-240 , A9 = PU-241 , A10 = UFISG3460
      PHH=P/(CONEN*(A1 *FX(1)+A7 *FX(7)+A8 *FX(8)+A9 *FX(9)+A10 *FX(10) FISG3470
     *        )) / 1000.0                                               FISG3480
      PHI = PHH                                                       FISG3490
      IF(PHI.LE.0.0) PHI = 1.0E-24                                    FISG3500
C     CALL SETIO(26,-2)                                               FISG3510
C        F(I) = FISSION GASS ATOMS YIELDED BY FISSION                 FISG3520
      DO 50 I=1,19                                                    FISG3530
   50 F(I)=PHI*(FX(10)*A10*Y(1,I)+FX(1)*A1*Y(2,I)+FX(7)*A7*Y(3,I)+FX(9)*FISG3540
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          *A9*Y(4,1)  )                                                    FISG3550
 101   9996 FORMAT( 1H , ' N INPUT TERMS ' / (1X,1P6E12.6))                FISG3560
       C ******  NO  NECESITY  CARDS  FROM  HERE  TO  FISG 1910  *****      FISG3570
 102        X1=PHI*CX(1)                                                   FISG3580
 103        X2=PHI*CX(2)+DC2                                               FISG3590
 104        X3=PHI*CX(3)+DC3                                               FISG3600
 105        X4=DC4                                                         FISG3610
 106        X5=DC5                                                         FISG3620
 107        X6=DC6                                                         FISG3630
 108        X7=PHI*CX(7)                                                   FISG3640
 109        X8=PHI*CX(8)                                                   FISG3650
 110        X9=PHI*CX(9)                                                   FISG3660
 111        X10=PHI*CX(10)                                                 FISG3670
 112        X11=PHI*CX(11)                                                 FISG3680
 113        X12=DC12                                                       FISG3690
 114        X13=PHI*CX(13)                                                 FISG3700
 115        X14=PHI*CX(14)+DC14                                            FISG3710
 116        X15=PHI*CX(15)+DC15                                            FISG3720
 117        A1=EN1(A1,X1,T)                                                FISG3730
 118        A2=EN1(A2,X2,T)+EN2(PHI,AX(1),A1,X2,T)                         FISG3740
 119        A3=EN1(A3,X3,T)+EN3(DC2,A2,X3,T)                               FISG3750
 120        A4=EN1(A4,X4,T)+EN2(PHI,AX(2),A2,X4,T)                         FISG3760
 121        A5=EN1(A5,X5,T)+EN2(PHI,AX(3),A3,X5,T)+EN3(DC4,A4,X5,T)        FISG3770
 122        A6=EN1(A6,X6,T)+EN3(DC5,A5,X6,T)                               FISG3780
 123        A10=EN1(A10,X10,T)                                             FISG3790
 124        A11=EN1(A11,X11,T)+EN2(PHI,AX(10),A10,X11,T)                   FISG3800
 125        A12=EN1(A12,X12,T)+EN2(PHI,AX(11),A11,X12,T)                   FISG3810
 126        A13=EN1(A13,X13,T)+EN3(DC12,A12,X13,T)                         FISG3820
 127        A14=EN1(A14,X14,T)+EN2(PHI,AX(13),A13,X14,T)                   FISG3830
 128        A15=EN1(A15,X15,T)+EN3(DC14,A14,X15,T)                         FISG3840
 129        A7=EN1(A7,X7,T)+EN2(PHI,AX(15),A15,X7,T)+EN3(DC3,A3,X7,T)      FISG3850
 130        A8=EN1(A8,X8,T)+EN2(PHI,AX(7),A7,X8,T)+EN3(DC6,A6,X8,T)        FISG3860
 131        A9=EN1(A9,X9,T)+EN2(PHI,AX(8),A8,X9,T)                         FISG3870
       C*****************************************************************FISG3880
 132        X101=PHI*CX(20)                                                FISG3890
 133        X103=DC85M                                                     FISG3900
 134        X104=PHI*CX(21)+DC85                                           FISG3910
 135        X106=DC21                                                      FISG3920
 136        X107=DC22                                                      FISG3930
 137        X108=DC23                                                      FISG3940
 138        X109=PHI*CX(22)                                                FISG3950
 139        X110=DC25                                                      FISG3960
 140        X111=DC31                                                      FISG3970
 141        X112=PHI*CX(23)                                                FISG3980
 142        X113=DC26                                                      FISG3990
 143        X114=PHI*CX(24)+DC33                                           FISG4000
 144        X116=DC28                                                      FISG4010
 145        X117=DC34                                                      FISG4020
 146        X118=PHI*CX(25)+DC35                                           FISG4030
 147        IF(CX(20).LE.1.E-30) GO TO 100                                 FISG4040
 148        A101=EN1(A101,X101,T)+F(1)*FAC(X101,T)                         FISG4050
 149        GO TO 101                                                      FISG4060
 150    100 A101=A101+F(1)*T                                               FISG4070
 151    101 A102=A102+(F(2)+PHI*CX(20)*A101)*T                             FISG4080
 152        A103=EN1(A103,X103,T)+F(3)*FAC(X103,T)                         FISG4090
 153        A104=EN1(A104,X104,T)+(F(4)+.21*X103*A103)*FAC(X104,T)         FISG4100
 154        A105=A105+(F(5)+PHI*CX(21)*A104)*T                             FISG4110
 155        A106=EN1(A106,X106,T)+F(6)*FAC(X106,T)                         FISG4120
 156        A107=EN1(A107,X107,T)+(F(7)+.18*X106*A106)*FAC(X107,T)         FISG4130
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 157        A108=EN1(A108,X108,T)+(.82*X106*A106+X107*A107)*FAC(X108,T)    FISG4140
 158        IF(CX(22).LE.1.E-30) GO TO 102                                 FISG4150
 159        A109=EN1(A109,X109,T)+X108*A108*FAC(X109,T)                    FISG4160
 160        GO TO 103                                                      FISG4170
 161    102 A109=A109+X108*A108*T                                          FISG4180
 162    103 A110=EN1(A110,X110,T)+F(10)*FAC(X110,T)                        FISG4190
 163        A111=EN1(A111,X111,T)+X110*A110*FAC(X111,T)                    FISG4200
 164        IF(CX(23).LE.1.E-30) GO TO 104                                 FISG4210
 165        A112=EN1(A112,X112,T)+(X111*A111+X109*A109)*FAC(X112,T)        FISG4220
 166        GO TO 105                                                      FISG4230
 167    104 A112=A112+(X111*A111+X109*A109)*T                              FISG4240
 168    105 A113=EN1(A113,X113,T)+F(13)*FAC(X113,T)                        FISG4250
 169        A114=EN1(A114,X114,T)+X113*A113*FAC(X114,T)                    FISG4260
 170        A115=A115+(F(15)+PHI*CX(24)*A114)*T                            FISG4270
 171        A116=EN1(A116,X116,T)+F(16)*FAC(X116,T)                        FISG4280
 172        A117=EN1(A117,X117,T)+.3*X116*A116*FAC(X117,T)                 FISG4290
 173        A118=EN1(A118,X118,T)+(F(18)+.7*X116*A116+X117*A117)*FAC(X118,T) FISG4300
 174        A119=A119+(F(19)+PHI*CX(25)*A118)*T                            FISG4310
       C          ANSWER                                                   FISG4320
 175        ARR=A101+A102+A103+A104+A105                                   FISG4330
 176        ASE=A109+A112+A114+A115+A117+A118+A119                         FISG4340
       C                                                                   FISG4350
 177        A(1,IP) = A1                                                   FISG4360
 178        A(2,IP) = A2                                                   FISG4370
 179        A(3,IP) = A3                                                   FISG4380
 180        A(4,IP) = A4                                                   FISG4390
 181        A(5,IP) = A5                                                   FISG4400
 182        A(6,IP) = A6                                                   FISG4410
 183        A(7,IP) = A7                                                   FISG4420
 184        A(8,IP) = A8                                                   FISG4430
 185        A(9,IP) = A9                                                   FISG4440
 186        A(10,IP) = A10                                                 FISG4450
 187        A(11,IP) = A11                                                 FISG4460
 188        A(12,IP) = A12                                                 FISG4470
 189        A(13,IP) = A13                                                 FISG4480
 190        A(14,IP) = A14                                                 FISG4490
 191        A(15,IP) = A15                                                 FISG4500
 192        A(21,IP) = A101                                                FISG4510
 193        A(22,IP) = A102                                                FISG4520
 194        A(23,IP) = A103                                                FISG4530
 195        A(24,IP) = A104                                                FISG4540
 196        A(25,IP) = A105                                                FISG4550
 197        A(26,IP) = A106                                                FISG4560
 198        A(27,IP) = A107                                                FISG4570
 199        A(28,IP) = A108                                                FISG4580
 200        A(29,IP) = A109                                                FISG4590
 201        A(30,IP) = A110                                                FISG4600
 202        A(31,IP) = A111                                                FISG4610
 203        A(32,IP) = A112                                                FISG4620
 204        A(33,IP) = A113                                                FISG4630
 205        A(34,IP) = A114                                                FISG4640
 206        A(35,IP) = A115                                                FISG4650
 207        A(36,IP) = A116                                                FISG4660
 208        A(37,IP) = A117                                                FISG4670
 209        A(38,IP) = A118                                                FISG4680
 210        A(39,IP) = A119                                                FISG4690
       C                                                                   FISG4700
 211        RETURN                                                         FISG4710
       C*****************************************************************FISG4720
```

* SOURCE STATEMENT (FISGAS)*

```
212        END                                                          FISG4730
```


* SOURCE STATEMENT *

```
1          FUNCTION FYIELD (IYIELD,TEMP,FNVT)                           FYIE0010
     C                                                                  FYIE0020
     C     THIS FUNCTION IS CALLED FROM STEP2 AND STEP7.                FYIE0030
     C                                                                  FYIE0040
     C     CALCULATION OF YIELD STRENGTH OF ZRY  REFER D-1001,1002      FYIE0050
2          COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) FYIE0060
3          COMMON /COM 21/ N,NN,NNN,NF                                  FYIE0070
4          IN1 = 7                                                      FYIE0080
5          IN2 = 30                                                     FYIE0090
6          IN3 = 0                                                      FYIE0100
7          FYIELD = TERP(TEMP,AA,3,NN,IN1,IN2,IN3,100)                  FYIE0110
8          RETURN                                                       FYIE0120
9          END                                                          FYIE0130
```

* SOURCE STATEMENT *

```
      SUBROUTINE GAPRO(ICASE,JCASE)                                     GPR00010
C                                                                       GPR00020
C     THIS SUBROUTINE IS CALLED FROM STEP8                              GPR00030
C                                                                       GPR00040
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),A1(21),NPOW,PTOT,LPMAX,  GPR00050
     1                PKPOWR,IPEAK,DELP,PMAX                            GPR00060
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) GPR00070
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             GPR00080
      COMMON /COM 8G/ GG(20,100)                                        GPR00090
      COMMON /HIZUKE/ K1,K2,K3,K4,K5,K6                                 GPR00100
      DIMENSION Z(9),P(121)                                             GPR00110
      DATA Z / 1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9  /                   GPR00120
      JINI = 1                                                          GPR00130
      D = 0.0001                                                        GPR00140
      IMAX = 120                                                        GPR00150
      JMAX = ITER                                                       GPR00160
      WRITE(6,1710) JCASE,IPOW,NPOW,K1,K2,K3,K4,K5,K6                   GPR00170
      WRITE(6,600) TITLE                                                GPR00180
      DO 4 I=1,121                                                      GPR00190
    4 P(I) = 1H                                                         GPR00200
      DO 20 JJ=1,3                                                      GPR00210
      FACT = 0.01 * 10.0**JJ                                            GPR00220
      DO 10 J=1,9                                                       GPR00230
      X = FACT * FLOAT(J)                                               GPR00240
      I = 1.0 + (1.0 + ALOG10(X)) * 60.0                                GPR00250
      IF(I.LE.1) I=1                                                    GPR00260
      IF(I.GT.121) GO TO 20                                             GPR00270
   10 P(I) = Z(J)                                                       GPR00280
   20 CONTINUE                                                          GPR00290
      WRITE(6,604) P                                                    GPR00300
      DO 1 J=JINI,JMAX                                                  GPR00310
      DO 2 I=1,121                                                      GPR00320
    2 P(I) = 1H                                                         GPR00330
      IH = 1.0 + ( 1.0 + ALOG10 ( D + GG(3,J))) * 60.0                  GPR00340
      IC = 1.0 + ( 1.0 + ALOG10 ( D + GG(4,J))) * 60.0                  GPR00350
      IS = 1.0 + ( 1.0 + ALOG10 ( D + GG(5,J))) * 60.0                  GPR00360
      IG = 1.0 + ( 1.0 + ALOG10 ( D + GG(6,J))) * 60.0                  GPR00370
      IR = 1.0 + ( 1.0 + ALOG10 ( D + GG(7,J))) * 60.0                  GPR00380
      IF(IH.LE.0) IH = 1                                                GPR00390
      IF(IC.LE.0) IC = 1                                                GPR00400
      IF(IS.LE.0) IS = 1                                                GPR00410
      IF(IG.LE.0) IG = 1                                                GPR00420
      IF(IR.LE.0) IR = 1                                                GPR00430
      IF(IH.GT.121) IH = 121                                            GPR00440
      IF(IC.GT.121) IC = 121                                            GPR00450
      IF(IS.GT.121) IS = 121                                            GPR00460
      IF(IG.GT.121) IG = 121                                            GPR00470
      P(IH) = 1HH                                                       GPR00480
      P(IC) = 1HC                                                       GPR00490
      P(IS) = 1HS                                                       GPR00500
      P(IG) = 1HG                                                       GPR00510
      P(IR) = 1HR                                                       GPR00520
      WRITE(6,601) GG(3,J),GG(4,J),P                                    GPR00530
    1 CONTINUE                                                          GPR00540
      WRITE(6,602)                                                      GPR00550
      DO 3 J=JINI,JMAX                                                  GPR00560
    3 WRITE(6,603) (GG(I,J),I=1,9)                                      GPR00570
      WRITE(6,606) (LL,LL=1,10)                                         GPR00580
      DO 5 J=JINI,JMAX                                                  GPR00590
```


* SOURCE STATEMENT (GAPRO)*

```
    3 WRITE(6,605) GG(1,J),(GG(I,J),I=10,20)                            GPR00600
      WRITE(6,607)                                                      GPR00610
      RETURN                                                            GPR00620
C     *    1    *    2    *    3    *    4    *    5    *    6    *    7 GPR00630
 1710 FORMAT(1H1,2X,'STEP ',I3,5X,'AXIAL SEGMENT ',I2,2X,'OF ',I2,2X,   GPR00640
     * 22X,   2A4,I5,3H HR,I3,7H MINUTE,I3,4H SEC,I4                   / )GPR00650
 600  FORMAT(1H , 5X,5(1H*),3X,20A4,3X,5(1H*) /)                        GPR00660
 601  FORMAT(1H ,F6.4,F7.4,1X,121A1 )                                   GPR00670
 602  FORMAT(   9X,4HITER,  9X, 4HTMAX, 11X,4HHG=H, 11X,5HHGC=C, 11X,   GPR00680
     *          8HHSOLID=S, 7X,6HHGAS=G, 9X,6HHRAD=R , 9X, 6HHGACEL ,   GPR00690
     *          6X, 3HCEE                                             / )GPR00700
 603  FORMAT(2X,F4.0,F16.2,6X,2G15.5, 2X,  4G15.5, F12.6                ) GPR00710
 604  FORMAT( 1X, 121A1       )                                         GPR00720
 605  FORMAT( 2X,F3.0, 10F12.6, 4X,A4 )                                 GPR00730
 606  FORMAT(//5H ITER,10(5X,1H(,I2,1H),3X),6H  (11) / )                GPR00740
 607  FORMAT(5X,50H(1)  INCREASE DUE TO THERMAL EXPANSION              /GPR00750
     1 5X,58H(2)  INCREASE DUE TO SWELLING (OLD MODEL)                 /GPR00760
     2 5X,58H(3)  (6) - MEAN ROUGHNESS(R)  (R=1.98*(ROUF+ROUC))        /GPR00770
     3 5X,58H(4)  INCREASE DUE TO SWELLING (NEW MODEL)                 /GPR00780
     4 5X,58H(5)                 ;              (IF (4).GT.(2) , (5)=(4) )  /GPR00790
     5 5X,58H(6)  RADIAL HOT GAP (=GAP/2.-(DELRT+DELRB+DELRDE)+DELC)   ,GPR00800
     6 5X,58H     DELRT=(1),DELRB=(5),DELRDE=DENSIFIC.,DELRC=CLAD DEFOM /GPR00810
     7 5X,58H(7)  RADIAL HOT GAP WHICH IS TAKEN INTO ACCOUNT NEW SWELL ,GPR00820
     8 5X,58H     IF HOT GAP .LT. (R) , GAP IS TOUCH AND HOT GAP =(R)  /GPR00830
     9 5X,58H(8)  RADIAL HOT GAP = (R) + 1.E-6 (SOFT TOUCH CONDITION)  ,GPR00840
     A 5X,58H     IF GAP IS NOT TOUCH , (8) = 0.0                      /GPR00850
     B 5X,58H(9)  =((6)-RELOCATION) - (R) , IF (9).LT.0 ,GAP IS CONTACT/GPR00860
     C 5X,58H(10) RADIAL HOT GAP  (CONTACT CONDITION)                  /GPR00870
     D 5X,58H(11) OLD OR NEW SWELLING MODEL SIGN                       )GPR00880
C*********************************************************************GPR00890
      END                                                               GPR00900
```

* SOURCE STATEMENT *

```
      SUBROUTINE HCAP(TEMP,CPNOM,CPMIN,CPMAX)                           HCAP0010
C                                                                       HCAP0020
C     THIS SUBROUTINE IS CALLED FROM STEP 8                             HCAP0030
C     REFER ENAL-1778, GAPCON THERMAL-1                                 HCAP0040
C     HEAT CAPACITY OF UO2  ( KERRISK AND CLIFTON )                     HCAP0050
C                                                                       HCAP0060
      DIMENSION TTK(10),CLMIN(10),CLMAX(10)                             HCAP0070
      REAL K1,K2,K3                                                     HCAP0080
      DATA (TTK(I),I=1,10)/0.,298.,500.,1000.,1500.,2000.,2500.,3000.,  HCAP0090
     *3100.,6000./                                                      HCAP0100
      DATA (CLMIN(I),I=1,10)/0.,0.,.02,.02,.02,.02,.03,.06,.10,.10/     HCAP0110
      DATA (CLMAX(I),I=1,10)/1.0,1.0,1.02,1.02,1.02,1.02,1.03,1.08,1.1, HCAP0120
     *1.1/                                                              HCAP0130
  150 TKEL = 535.285                                                    HCAP0140
      ED = 37.6946                                                      HCAP0150
      K1 = 19.1450                                                      HCAP0160
      K2 =  0.0007R4733                                                 HCAP0170
      K3 = 5643730.0                                                    HCAP0180
      R  =  0.001986                                                    HCAP0190
C     TEMP = AVERAGE VOLUMETRIC FUEL TEMPERATURE                        HCAP0200
      TEMPK = TEMP + 273.0                                              HCAP0210
      CL = 1.0                                                          HCAP0220
      CPNOM=CL*(((K1*TKEL**2*EXP(TKEL/TEMPK))/(TEMPK**2*(EXP(TKEL/TEMPK)HCAP0230
     *-1)**2))+(2*K2*TEMPK)+(((K3*ED)/(R*TEMPK**2))*EXP(-ED/(R*TEMPK))))HCAP0240
      CLN = TEPP(TEMPK,CLMIN,TTK,10)                                    HCAP0250
      C1 = 1.0-CLN                                                      HCAP0260
      CPMIN=C1*(((K1*TKEL**2*EXP(TKEL/TEMPK))/(TEMPK**2*(EXP(TKEL/TEMPK)HCAP0270
     *-1)**2))+(2*K2*TEMPK)+(((K3*ED)/(R*TEMPK**2))*EXP(-ED/(R*TEMPK))))HCAP0280
      C2 = TEPP(TEMPK,CLMAX,TTK,10)                                     HCAP0290
      CPMAX=C2*(((K1*TKEL**2*EXP(TKEL/TEMPK))/(TEMPK**2*(EXP(TKEL/TEMPK)HCAP0300
     *-1)**2))+(2*K2*TEMPK)+(((K3*ED)/(R*TEMPK**2))*EXP(-ED/(R*TEMPK))))HCAP0310
      RETURN                                                            HCAP0320
C*********************************************************************HCAP0330
      END                                                               HCAP0340
```

* SOURCE STATEMENT *

```
 1        SUBROUTINE HEAD (IF )                                          HEAD0010
    C                                                                    HEAD0020
    C                                                                    HEAD0030
 2        COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),MV(2, 20) HEAD0040
 3        COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI,  HEAD0050
         1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, HEAD0060
         2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   HEAD0070
         3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,HEAD0080
         4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   HEAD0090
         5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICKEP,ISWELLHEAD0100
         6                ,NEXP,MEXP,NHIST                                 HEAD0110
 4        COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                           HEAD0120
 5        COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                HEAD0130
 6        COMMON /COM 06/ II,JCASE,TCOOLF,XMUTOT                          HEAD0140
 7        COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX, HEAD0150
         1                PKPOWR,IPEAK,DELP,PMAX                          HEAD0160
 8        COMMON /COM91/ SEC                                              HEAD0170
 9        DATA IP,JP /2*0/                                                HEAD0180
10        DATA TSEC/0.0/                                                  HEAD0190
    C                                                                    HEAD0200
    C                                                                    HEAD0210
    C     IF (IF) . GT . 0  ONLY TITLE PRINT                             HEAD0220
    C     IF (IF) . LE . 0  HISTORICAL DATA PRINT PAGE HEADING           HEAD0230
11        IP=IP+1                                                         HEAD0240
12        IF(IP.GT.0) JP=0                                                HEAD0250
13        JP=JP+1                                                         HEAD0260
    C                                                                    HEAD0270
14        WRITE(6,100) JCASE,TITLE,JP,IP                                  HEAD0280
15        IF(IF.LE.0) RETURN                                              HEAD0290
16        WRITE(6,105)                                                    HEAD0300
17        A1=PAVRG/1000.*30.48                                            HEAD0310
18        A2=TINLET*1.8 + 32.                                             HEAD0320
19        A3=TINLET+DTEMP                                                 HEAD0330
20        A4=A3*1.8 + 32.                                                 HEAD0340
21        A5=EXTP*14.22                                                   HEAD0350
22        A6=TOTBUR/1000. * 3.37 E19                                      HEAD0360
23        TSEC=TSEC+SEC                                                   HEAD0370
24        THOR=TOTLDY*24.                                                 HEAD0380
25        WRITE(6,110) A1,PAVRG                                           HEAD0390
26        WRITE(6,111) TOTBUR,A6                                          HEAD0400
27        WRITE(6,115) TOTLDY,THOR                                        HEAD0410
28        WRITE(6,120) A2,TINLET                                          HEAD0420
29        WRITE(6,130) A4,A3                                              HEAD0430
30        WRITE(6,140) A5,EXIP                                            HEAD0440
31        WRITE(6,150) TSEC,SEC                                           HEAD0450
32        WRITE(6,105)                                                    HEAD0460
33        RETURN                                                          HEAD0470
    C                                                                    HEAD0480
34    100 FORMAT(1H1 / 4X,6HSTEP  ,I3,5X,20A4,10X,5HPAGE ,I2,1H/,I3 / )   HEAD0490
35    105 FORMAT( 15X,95(1H=) )                                           HEAD0500
36    110 FORMAT(22X,27HLINEAR HEAT RATING(AVRAGE) ,F10.3,10H (KW/FT)  ,  HEAD0510
         1  F10.3,10H (WATT/CM)    )                                     HEAD0520
37    111 FORMAT(22X,27HBURNUP (PIN AVERAGE)       ,F10.3 ,10H (MWD/MTU) ,HEAD0530
         1  E15.4,14H (FISSIONS/CC)    )                                 HEAD0540
38    115 FORMAT(22X,27HTIME IN REACTOR            ,F10.3,10H (DAYS)    ,HEAD0550
         1  F10.3,10H (HOURS)      )                                     HEAD0560
39    120 FORMAT(22X,27HCOOLANT INLET TEMPERATURE  ,F10.3,10H (DEG F)   ,HEAD0570
         1  F10.3,10H (DEG C)      )                                     HEAD0580
40    130 FORMAT(22X,27HCOOLANT OUTLET TEMPERATURE ,F10.3,10H (DEG F)   ,HEAD0590
```


* SOURCE STATEMENT (HEAD)*

```
         1  F10.3,10H (DEG C)      )                                     HEAD0600
41    140 FORMAT(22X,27HCOOLANT PRESSURE           ,F10.3,10H (PSI)     ,HEAD0610
         1  F10.3,10H (KG/CM2)    )                                     HEAD0620
42    150 FORMAT(/22X,20HCUMULATED CP TIME   ,F10.4,5H(SEC),5X,          HEAD0630
         1  26HCOMPUTED TIME AT THIS STEP,F10.4,5H(SEC)      )           HEAD0640
    C                                                                    HEAD0650
43        END                                                             HEAD0660
```

* SOURCE STATEMENT *

```
      SUBROUTINE HISTR(KS,NEXT)                                         HIST0010
C                                                                       HIST0020
C     THIS SUBROUTINE IS CALLED FROM STEP1(KS=1), AND MAIN(KS=2)        HIST0030
C                                                                       HIST0040
C                                                                       HIST0050
      COMMON /HIST  / HIST(7,50),IPD(5,50)                              HIST0060
      COMMON /HIS   / BASE(100),HIS(7,100),MODE(5,100)                  HIST0070
      COMMON /HIST1/ NNHIST,MXSTEP                                      HIST0080
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  HIST0090
     1                PKPOWR,IPEAK,DELP,PMAX                            HIST0100
      COMMON / COM 0 / TITLE(20),AA(7,30),BB(6,51),CF(3,30),HV(2,20)    HIST0101
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  HIST0110
      COMMON /COM 08/ II,JCASE,TCOOLF,XMOTOT                            HIST0120
      COMMON /COM 10/ VVOID2,FRCO2,TPLENA,NPOW1                         HIST0130
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI,  HIST0140
     1                DCO,DVOID2,VPLENZ,ATMOS,S,XX,RODF,RODC,EXTP,DE,V, HIST0150
     2                TINLET,DELT,TMAX,IFR,TM,DBD,BR,HBC,SIGHF,IFLUX,   HIST0160
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,HIST0170
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACAE,MGACEL,   HIST0180
     5                DTEMP,ITOT ,HG,PEKAVG,MINI,ICOF,ISTOR,ICREP,ISWELLHIST0190
     6                ,NEXP,MEXP,NHIST                                  HIST0200
          COMMON /IXIR  / IX,IR,IIH,MAXTEP                              HIST0210
      COMMON /SOTTEM/ LCOUNT                                            HIST0220
      COMMON /HISTMA/ APOWER                                            HIST0230
      COMMON /SPARE/ ISPA,NAMSP(3)                                      HIST0240
      DIMENSION DEL(7)                                                  HIST0250
      DIMENSION IS(100)                                                 HIST0260
      DIMENSION BPOW(100)                                               HIST0270
      DIMENSION UTJT(10,7),XFORM(10,5),          FORM(5)                HIST0280
C                                                                       HIST0290
      DATA DINC,PINC / 150. , 150. /                                    HIST0300
      DATA BINC /1500./                                                 HIST0310
      DATA DP1,DP2,DP3,DB1,DB2,DB3 /0.5,2.0,5.0,50.,200.,500. /         HIST0320
      DATA PLENT/5.5555555/                                             HIST0330
C                                                                       HIST0340
      DATA NSYB/10/                                                     HIST0350
      DATA ((UTJT(I,J), J=1,7),I=1,10) /                                HIST0360
     1 4HPLEN,4HUM =,4H COO,4HLANT,4H(TOP,4H) TE,4HMP. ,                HIST0370
     2 4HCOOL,4HANT ,4H(OUT,4H=IN),4H TEM,4HP.(C,4H)   ,                HIST0380
     3 4HSINT,4HERED,4H DEN,4HSITY,4H (FR,4HACTI,4HON) ,                HIST0390
     4 4HFELL,4HET S,4HURFA,4HCE P,4HOWER,4HNESS,4H(CM),                HIST0400
     5 4HCLAD,4HDING,4H ID ,4HROUG,4HNNES,4HS (C,4HM)  ,                HIST0410
     6 4HHEAT,4H TRA,4HNSFL,4HR CO,4HEFF(,4HW/CM,4H2-C),                HIST0420
     7 28*0  /                                                          HIST0430
C                                                                       HIST0440
      DATA ((XFORM(I,J),J=1,5),I=1,10) /                                HIST0450
     1 4H(1X,,4H7A4,,4H2X, ,4H10F1,4H0.2),                              HIST0460
     2 4H(1X,,4H7A4,,4H2X, ,4H10F1,4H0.2),                              HIST0470
     3 4H(1X,,4H7A4,,4H2X, ,4H10F1,4H0.4),                              HIST0480
     3 4H(1X,,4H7A4,,4H2X, ,4H10E1,4H0.2),                              HIST0490
     3 4H(1X,,4H7A4,,4H2X, ,4H10E1,4H0.2),                              HIST0500
     4 4H(1X,,4H7A4,,4H2X, ,4H10E1,4H0.3),                              HIST0510
     7 20*0.0  /                                                        HIST0520
C                                                                       HIST0530
C                                                                       HIST0540
      GO TO (100,1000),KS                                               HIST0550
  100 CONTINUE                                                          HIST0560
      DO 1 J=1,100                                                      HIST0570
      DO 2 I=1,7                                                        HIST0580
```


* SOURCE STATEMENT (HISTR)*

```
    2 HIS(I,J) = 0.0                                                    HIST0590
      DO 3 I=1,5                                                        HIST0600
    3 MODE(I,J) = 0                                                     HIST0610
      IS(J) = 4H                                                        HIST0620
    1 BASE(J) = 0.0                                                     HIST0630
      IIH = JCASE = 0                                                   HIST0640
      IMAX=NNHIST                                                       HIST0650
C                                                                       HIST0660
C---------- HISTORY STEP GENERATION BY USING INPUTED HISTORY DATAS------HIST0670
C                                                                       HIST0680
      IF(NHIST.EQ.0) GO TO 90                                           HIST0690
C.....  BURNUP DEPEND HISTORY STEP                                      HIST0700
      MAXS=MXSTEP*IMAX                                                  HIST0710
      DO 91 II=1,IMAX                                                   HIST0720
      IF(II.GT.1) GO TO 92                                              HIST0730
      HIS(1,1)=0.0                                                      HIST0740
      GO TO 93                                                          HIST0750
   92 HIS(1,II)=HIST(1,II)   - HIST(1,II-1)                              HIST0760
   93 CONTINUE                                                          HIST0770
      BASE(II)=HIST(1,II)                                               HIST0780
      DO 94 K=2,7                                                       HIST0790
   94 HIS(K,II)=HIST(K,II)                                              HIST0800
      DO 95 K=1,5                                                       HIST0810
   95 MODE(K,II)=IPD(K,II)                                              HIST0820
      IS(II)=2H**                                                       HIST0830
   91 CONTINUE                                                          HIST0840
      GO TO 99                                                          HIST0850
C                                                                       HIST0860
C.....  TIME DEPEND HISTORY STEP                                        HIST0870
   90 CONTINUE                                                          HIST0880
C..... INITIALIZATION                                                   HIST0890
      BASE(1)=HIST(1,1)                                                 HIST0900
      HIS(1,1)=0.0                                                      HIST0910
      BPOW(1)=HIST(2,1)                                                 HIST0920
      DO 61 K=2,7                                                       HIST0930
   61 HIS(K,1)=HIST(K,1)                                                HIST0940
      DO 63 K=1,5                                                       HIST0950
   63 MODE(K,1)=IPD(K,1)                                                HIST0960
      IS(1)=2H**                                                        HIST0970
C                                                                       HIST0980
      T1=HIST(1,1)                                                      HIST0990
      P1=HIST(2,1)                                                      HIST1000
      JJ=1                                                              HIST1010
C                                                                       HIST1020
C     GENERATE TIME DEPEND HISTORY STEP                                 HIST1030
C                                                                       HIST1040
      DO 80 II=2,IMAX                                                   HIST1050
      T2=HIST(1,II)                                                     HIST1060
      P2=HIST(2,II)                                                     HIST1070
      DELT=T2-T1                                                        HIST1080
      DELP=P2-P1                                                        HIST1090
      INC=JNC=MNC=1                                                     HIST1100
      IF(ABS(DELP).LE.PINC) GO TO 65                                    HIST1110
      INC=ABS(DELP)/PINC+1                                              HIST1120
      MNC=INC                                                           HIST1130
   65 CONTINUE                                                          HIST1140
      IF(DELT.LE.DINC) GO TO 66                                         HIST1150
      JNC=(DELT/DINC) + 1                                               HIST1160
      IF(JNC.GE.INC) MNC=JNC                                            HIST1170
```

```
* SOURCE STATEMENT (HISTR    )*
   78     46 CONTINUE                                                      HIST1180
C..... LINEAR INTERPOLATE EACH OPERATION PARAMETER                         HIST1190
   79        DO 71 M=1,MNC                                                 HIST1200
   80        JJ=JJ+1                                                       HIST1210
   81        HIS(1,JJ)=DELT/FLOAT(MNC)                                     HIST1220
   82        DO 73 K=2,7                                                   HIST1230
   83        HIS(K,JJ)=HIST(K,II-1)+( HIST(K,II)-HIST(K,II-1) )/MNC * FLOAT(M) HIST1240
   84     73 CONTINUE                                                      HIST1250
C..... BPOW( ) IS THE AVERAGE LINEAR POWER FOR BURNUP CALCULATION          HIST1260
   85        BPOW(JJ)=(HIS(2,JJ)+HIS(2,JJ-1)) / 2.                         HIST1270
C..... BASE( ) IS THE TOTAL IRRADIATION TIME IN DAYS                       HIST1280
   86        BASE(JJ)=BASE(JJ-1)+HIS(1,JJ)                                 HIST1290
   87     71 CONTINUE                                                      HIST1300
C                                                                          HIST1310
   88        DO 75 K=1,5                                                   HIST1320
   89     75 MODE(K,JJ)=IPD(K,II)                                          HIST1330
   90        IS(JJ)=2**                                                    HIST1340
C..... CORRECT INTERPOLATING ERROR FOR EACH VALUE AT NODAL POINT           HIST1350
   91        IF(BASE(JJ).GE.T2) BASE(JJ)=T2                                HIST1360
   92        DO 79 K=2,7                                                   HIST1370
   93        IF(HIS(K,JJ).NE.HIST(K,II)) HIS(K,JJ)=HIST(K,II)              HIST1380
   94     79 CONTINUE                                                      HIST1390
   95        T1=T2                                                         HIST1400
   96        P1=P2                                                         HIST1410
C                                                                          HIST1420
   97     80 CONTINUE                                                      HIST1430
C                                                                          HIST1440
   98        MASTEP=JJ                                                     HIST1450
   99        MAXS=MASTEP                                                   HIST1460
  100     99 CONTINUE                                                      HIST1470
C--------- HISTORY STEP GENERATION END ----------                          HIST1480
C                                                                          HIST1490
  101        IF(ISPA.LE.0) GO TO 101                                       HIST1500
  102        DO 102 I=1,ISPA                                               HIST1510
  103        IF(NAMSP(I).LE.0.OR.NAMSP(I).GT.NSYB) WRITE(6,105) NAMSP(I)   HIST1520
  104        IF(NAMSP(I).LE.0 .OR. NAMSP(I).GT.NSYB) NAMSP(I) = 0          HIST1530
  105    102 CONTINUE                                                      HIST1540
  106    105 FORMAT(5X,5(1H*),28H SPARE OPTION ERROR      NO.=,I2)         HIST1550
  107    101 CONTINUE                                                      HIST1560
C                                                                          HIST1570
  108        WRITE(6,6010)                                                 HIST1571
  109        WRITE(6,9000) TITLE                                           HIST1572
C                                                                          HIST1580
C     HISTORY STEP PRINT OUT                                               HIST1590
C                                                                          HIST1600
  110        IF(NHIST.EQ.1) GO TO 51                                       HIST1610
  111        WRITE(6,6000)                                                 HIST1620
  112        DO 600 J=1,MAXS                                               HIST1630
  113        DUM5=BASE(J)*24.                                              HIST1640
  114        DUM6=HIS(1,J)*24.                                             HIST1650
  115        DUM2 = HIS(2,J) * 30.48 / 1000.                               HIST1660
  116        DUM3 = HIS(3,J) * 1.8 + 32.0                                  HIST1670
  117        DUM4 = HIS(4,J) * 14.22                                       HIST1680
  118        WRITE(6,6100) J,IS(J),BASE(J),DUM5,HIS(1,J),DUM6,HIS(2,J),DUM2, HIST1690
            1              HIS(3,J),DUM3,HIS(4,J),DUM4,(MODE(IM,J),IM=1,5) HIST1700
  119        IF(MOD(J,40).NE.0) GO TO 600                                  HIST1701
  120        WRITE(6,6010)                                                 HIST1702
  121        WRITE(6,6000)                                                 HIST1703
  122    600 CONTINUE                                                      HIST1710
```



```
* SOURCE STATEMENT (HISTR    )*
  123        GO TO 52                                                      HIST1720
  124     51 CONTINUE                                                      HIST1730
  125        WRITE(6,7000)                                                 HIST1740
  126        DO 700 J=1,MAXS                                               HIST1750
  127        DUM5=BASE(J)/1000. * 3.37E19                                  HIST1760
  128        DUM6=HIS(1,J)/1000.*3.37E19                                   HIST1770
  129        DUM2=HIS(2,J) * 30.48 / 1000.                                 HIST1780
  130        DUM3=HIS(3,J) * 1.8 + 32.                                     HIST1790
  131        DUM4=HIS(4,J) * 14.22                                         HIST1800
  132        WRITE(6,7100) J,IS(J),BASE(J),DUM5,HIS(1,J),DUM6,HIS(2,J),DUM2, HIST1810
            1              HIS(3,J),DUM3,HIS(4,J),DUM4,(MODE(IM,J),IM=1,5) HIST1820
  133    700 CONTINUE                                                      HIST1830
C                                                                          HIST1840
  134     52 CONTINUE                                                      HIST1850
C                                                                          HIST1860
  135        WRITE(6,6002)                                                 HIST1870
C                                                                          HIST1880
  136        IF(IPEAK) 31,31,32                                            HIST1890
  137     31 WRITE(6,6003)                                                 HIST1900
  138        GO TO 33                                                      HIST1910
  139     32 WRITE(6,6004)                                                 HIST1920
  140     33 CONTINUE                                                      HIST1930
  141        WRITE(6,6005)                                                 HIST1940
C                                                                          HIST1950
  142        IF(ISPA.LE.0) GO TO 109                                       HIST1960
  143        WRITE(6,8000)                                                 HIST1970
  144        DO 113 K=1,MAXS,10                                            HIST1980
  145        K1=K+9                                                        HIST1990
  146        IF(K1.GE.MAXS) K1=MAXS                                        HIST2000
  147        WRITE(6,8001) (KK,KK=K,K1)                                    HIST2010
  148        IF(NHIST.LE.0) 114,115                                        HIST2020
  149    114 WRITE(6,8002) (BASE(KK),KK=K,K1)                              HIST2030
  150        GO TO 116                                                     HIST2040
  151    115 WRITE(6,8003) (BASE(KK),KK=K,K1)                              HIST2050
  152    116 CONTINUE                                                      HIST2060
C                                                                          HIST2070
  153        DO 117 I=1,ISPA                                               HIST2080
  154        II=NAMSP(I)                                                   HIST2090
  155        IF(II.LE.0) GO TO 117                                         HIST2100
  156        DO 118 J=1,5                                                  HIST2110
  157    118 FORM(J)=XFORM(II,J)                                           HIST2120
  158        PRINT FORM,(JTJT(II,J),J=1,7),(HIS(I+4,KK),KK=K,K1)           HIST2130
  159    117 CONTINUE                                                      HIST2140
  160    113 CONTINUE                                                      HIST2150
C                                                                          HIST2160
  161    109 CONTINUE                                                      HIST2170
C                                                                          HIST2180
  162        RETURN                                                        HIST2190
C                                                                          HIST2200
  163   1000 CONTINUE                                                      HIST2210
C                                                                          HIST2220
  164        IIH = JCASE = JCASE + 1                                       HIST2230
  165        LCOUNT = 0                                                    HIST2240
  166        NEXT = 4H                                                     HIST2250
  167        IF(IIH.GT.MXSTEP) NEXT = 4HNEXT                               HIST2260
  168        IF(IIH.GT.MXSTEP) RETURN                                      HIST2270
C                                                                          HIST2280
  169        IF(NHIST.EQ.1) GO TO 53                                       HIST2290
  170        TDAYS = HIS(1,IIH)                                            HIST2300
```

```
* SOURCE STATEMENT (HISTR    )*
C      **********                                                        HIST2310
      TOTLDY=BASE(IIH)                                                    HIST2320
      APOWER=BPOW(IIH)                                                    HIST2330
      GO TO 477                                                           HIST2340
   53 CONTINUE                                                            HIST2350
      BURNUP=HIS(1,IIH)                                                   HIST2360
      TOTBUR=BASE(IIH)                                                    HIST2370
  477 CONTINUE                                                            HIST2380
      IF(IPEAK.LE.0) GO TO 472                                            HIST2390
      PAVRG = HIS(2,IIH)                                                  HIST2400
      GO TO 474                                                           HIST2410
  472 PKPOWR = HIS(2,IIH)                                                 HIST2420
  474 CONTINUE                                                            HIST2430
      IF(HIS(3,IIH).LE.0.) GO TO 475                                      HIST2440
      TINLET = HIS(3,IIH)                                                 HIST2450
  475 IF(HIS(4,IIH).LE.0.) GO TO 476                                      HIST2460
      EXTP  = HIS(4,IIH)                                                  HIST2470
      LCOUNT = 1                                                          HIST2480
  476 CONTINUE                                                            HIST2490
C                                                                         HIST2500
C***** DATA SET BY USING SPARE OPTION                                     HIST2510
      IF(ISPA.LE.0) GO TO 490                                             HIST2520
      DO 491 I=1,ISPA                                                     HIST2530
      III=NAMSP(I)                                                        HIST2540
      IF(III.LE.0) GO TO 491                                              HIST2550
      LL=4*I                                                              HIST2560
      IF(III.EQ.1) GO TO 19                                               HIST2570
C PLENUM TEMPERATURE MODEL  IF PLENT=-1 ,GAS CONDUCTION                   HIST2580
C PLENUM TEMPERATURE MODEL  IF PLENT=-2 ,GAS NATURAL CONVECTION           HIST2590
      IF(III.EQ.2) GO TO 19                                               HIST2600
C... III.EQ.2 COOLANT OUTLET-INLET TEMPERATURE (DTEMP=0.0 IS PROBABLE)    HIST2610
      IF(HIS(LL,IIH).LE.0.0) GO TO 491                                    HIST2620
   19 CONTINUE                                                            HIST2630
C                                                                         HIST2640
      GO TO (20,21,22,23,24,25,26,27,28,29) , III                         HIST2650
   20 PLENT=HIS(LL,IIH)                                                   HIST2660
      GO TO 491                                                           HIST2670
   21 DTEMP=HIS(LL,IIH)                                                   HIST2680
      GO TO 491                                                           HIST2690
   22 FRSIN=HIS(LL,IIH)                                                   HIST2700
      GO TO 491                                                           HIST2710
   23 ROUF=HIS(LL,IIH)                                                    HIST2720
      GO TO 491                                                           HIST2730
   24 ROUC=HIS(LL,IIH)                                                    HIST2740
      GO TO 491                                                           HIST2750
   25 CONTINUE                                                            HIST2760
      IF(HIS(LL,IIH).LE.0.0) GO TO 491                                    HIST2770
      SIGHF = HIS(LL,IIH)                                                 HIST2780
      GO TO 491                                                           HIST2790
   26 CONTINUE                                                            HIST2800
   27 CONTINUE                                                            HIST2810
   28 CONTINUE                                                            HIST2820
   29 CONTINUE                                                            HIST2830
  491 CONTINUE                                                            HIST2840
  490 CONTINUE                                                            HIST2850
C                                                                         HIST2860
      IF(PLENT.LE.0.) CALL TEMPPL(TPLENA,PLENT,IIH)                       HIST2870
      IF(PLENT.LE.0) RETURN                                               HIST2880
C                                                                         HIST2890
```



```
* SOURCE STATEMENT (HISTR    )*
      TPLENA=TINLET+DTEMP+PLENT+273.                                      HIST2900
      IF(IPEAK.GT.0) GO TO 501                                            HIST2910
      IF(PKPOWR.LE.0.0) TPLENA=TINLET+DTEMP+273.0                         HIST2920
      GO TO 502                                                           HIST2930
  501 IF(PAVRG.LE.0.0) TPLENA=TINLET+DTEMP+273.0                          HIST2940
  502 CONTINUE                                                            HIST2950
C                                                                         HIST2960
      RETURN                                                              HIST2970
C  *    1    *    2    *    3    *    4    *    5    *    6    *    7    HIST2980
 6000 FORMAT( ///                                                         HIST2990
     1 43X,39(1H*)/45X,35HH  I  S  T  O  R  Y      D  A  T  A  /          HIST3000
     2 43X,39(1H*)  //                                                    HIST3010
     3 6X,54HTIME   IRRADIATION TIME    TIME   INTERVALS    LINEAR        HIST3020
     4  54HHEAT RATE    COOLANT    INLET    COOLANT PRESSURE              HIST3030
     A ,20H    OPERATION MODE    /                                        HIST3040
     5 8X,4HSTEP,63X,11HTEMPERATURE,29X,20H  INPUT CONTROL SIGN          /HIST3050
     6 8X,35HNO.       (DAYS) (HOURS)       (DAYS) (HOURS)       (W/CM)   HIST3060
     7  48H (KW/FT)      (DEG C) (DEG F)     (KG/CM2)    (PSI)            HIST3070
     8 ,4X,20H (1) (2) (3) (4) (5)  /                                     HIST3080
     8 8X,4(1H=),3X,5(15(1H=),4X),20(1H=) / )                             HIST3090
 6100 FORMAT(8X,I4,1X,A2,2(F8.3,F8.1,4X),2(2F8.3,4X),2F8.2,4X,5I4)        HIST3100
 6002 FORMAT(/5X,31H..NOTE..    (**) IS INPUT DATA    )                   HIST3110
 6003 FORMAT(1H+,55X,12H(PEAK POWER)  )                                   HIST3120
 6004 FORMAT(1H+,55X,15H(AVERAGE POWER)  )                                HIST3130
 6005 FORMAT(/ 5X,14HOPERATION MODE / 5X,14(1H=) /                        HIST3140
     1 5X,124H(1) TEMPERATURE PROFILE PRINT-OUT OPTION  =0  NOT PRINTED   HIST3150
     2=1 DETAIL PROFILE PRINT     = 2 PLOT PROFILE BY LINE PRINTER        HIST3160
     3/5X,124H(2) FUEL THERMAL CONDUCTIVITY CONTROLLER  =0  NOT CHANGE    HIST3170
     4=N N-TH DATA READ-IN        =-N  USE PREPARATED EQUATION            HIST3180
     5/5X,124H(3) CLADDING PROPERTY CONTROLLER          =0  NOT CHANGE    HIST3190
     6=N N-TH DATA READ-IN        =-N  USE PREPARATED TABLE(ZRY2,ZRY4,ST)HIST3200
     7/5X,124H(4) RADIAL FLUX DEPRESSION CONTROLLER     =0  NOT CHANGE    HIST3210
     8=N N-TH DATA READ-IN        =-1  USE SUBROUTINE DLPRES              HIST3220
     9/5X,120H(5) AXIAL POWER PROFILE CONTROLLER        =0  NOT CHANGE    HIST3230
     A=1 NEW POWER DISTRIBUTION DATA READ-IN                             ) HIST3240
                                                                          HIST3250
 7000 FORMAT(1H1 ///                                                      HIST3260
     1 43X,39(1H*)/45X,35HH  I  S  T  O  R  Y      D  A  T  A  /          HIST3270
     2 43X,39(1H*)  //                                                    HIST3280
     3 6X,54HTIME          BURNUP        BURNUP INCREMENT    LINEAR      HIST3290
     4  54HHEAT RATE    COOLANT                COOLANT PRESSURE          HIST3300
     A ,20H    OPERATION MODE    / 8X,4HSTEP,3X,38H(MWD/      (FISSIONS  (HIST3310
     5MWD/     (FISSIONS,23X,11HTEMPERATURE,31X,18HINPUT CONTROL SIGN  / HIST3320
     6 8X,55HNO.        MTU)        /CC)      MTU)        /CC)     (W/CM) HIST3330
     7  48H (KW/FT)      (DEG C) (DEG F)     (KG/CM2)    (PSI)            HIST3340
     8 ,4X,20H (1) (2) (3) (4) (5)  /                                     HIST3350
     8 8X,4(1H=),3X,2(18(1H=),2X),   3(16(1H=),4X),20(1H=) / )            HIST3360
 7100 FORMAT(8X,I4,1X,A2,2(F7.1,E11.3,2X),2(2F8.3,4X),2F8.2, 4X,5I4)      HIST3370
C                                                                         HIST3380
 8000 FORMAT(///5X,40HSPECIAL HISTORICAL DATA  (USER,S OPTION)      /)    HIST3390
 8001 FORMAT(/ 1X,20HHISTORY STEP NO.    ,10X,10(5X,I3,2X) )              HIST3400
 8002 FORMAT(  1X,30HIRRADIATION TIME (DAYS)        ,10F10.2 )           HIST3410
 8003 FORMAT(  1X,30HBURNUP  (MWD/MT)               ,10F10.1 / )         HIST3420
C                                                                         HIST3430
 8010 FORMAT(1H1)                                                         HIST3430
 9000 FORMAT(/// 20X,100(1H*),/ 20X,1H*,98X,1H* / 20X,1H*,9X,20A4,9X,1H*HIST3431
     1  / 20X,1H*,98X,1H* / 20X,100(1H*)  / )                            HIST3432
       END                                                                HIST3440
```

* SOURCE STATEMENT *

```
      SUBROUTINE HTCLM(HF,TCOOLF,DE,V)                                  HTCM0010
C                                                                       HTCM0020
C     THIS SUBROUTINE IS CALLED FROM STEP 3                             HTCM0030
C     REFER BNWL-1778,GAPCON THERMAL-1, APPENDIX(A-1)                   HTCM0040
C     CLADDING-TO-COOLANT HEAT TRANSFER COEFFICIENT OF SODIUM           HTCM0050
C                                                                       HTCM0060
C     HF = HEAT TRANSFER COEFFICIENT IN W/CM2/C                         HTCM0070
C     HFF= HEAT TRANSFER COEFFICIENT IN BTU/FT2/HR/F                    HTCM0080
C     TCOOLC = COOLANT TEMPERATURE   IN C                               HTCM0090
C     DE = EQUIVALENT HYDRAULIC DIAMETER   IN CM                        HTCM0100
C     V  = COOLANT VELOCITY          IN CM/SEC                          HTCM0110
      DEF   = DE/30.48                                                  HTCM0120
      TCOOL = TCOOLF                                                    HTCM0130
      VF    = V /30.48 *3600.0                                          HTCM0140
      CNA=54.306-1.678E-2*TCOOL+2.0914E-6*TCOOL**2                      HTCM0150
      RHONA=59.566-7.9504E-3*TCOOL-.2872E-6*TCOOL**2 +.06035E-9*TCOOL**3HTCM0160
      CPNA=.34574-.79226E-4*TCOOL+.34086E-7*TCOOL**2                    HTCM0170
      HFF = CNA/DEF*(7.+.025*(DEF*VF*RHONA*CPNA/CNA)**(.8))             HTCM0180
      HF    = HFF * 5.67E-4                                             HTCM0190
      RETURN                                                            HTCM0200
C*********************************************************************HTCM0210
      END                                                               HTCM0220
```

* SOURCE STATEMENT *

```
      SUBROUTINE HTCW(KS,T,FLUX,V,D,H,TW,EXTP,TSAT)                     HTCW0010
C                                                                       HTCW0020
C     THIS SUBROUTINE IS CALLED FROM STEP 3                             HTCW0030
C     CLADDING-TO-COOLANT HEAT TRANSFER COEFFICIENT OF WATER            HTCW0040
C                                                                       HTCW0050
C     KS=1...DITTUS BOELTER (D-929),    KS=2...JENS LOTTES (D-526)      HTCW0060
C     KS=3... SUBCOOL--DITTUS BOELTER , BOILING--JENS LOTTES            HTCW0070
C                                                                       HTCW0080
      COMMON /SUTTEM/ LCOUNT                                            HTCW0090
      DIMENSION TTTB(2,37)                                              HTCW0100
C     DIMENSION OF TTTB(I,J) IS   (SEC**0.8)*(CM**0.2)*(WATT) /         HTCW0110
C                                 ---------------------------           HTCW0120
C                                   (M  **0.8)*(CM**2)  *(DEGC)         HTCW0130
      DATA ((TTTB(I,J),I=1,2),J=1,37)  /                                HTCW0140
     * 0.,0.375,  10.,0.428,  20.,0.471,  30.,0.533,  40.,0.582,        HTCW0150
     * 50.,0.631,  60.,0.678,  70.,0.720,  80.,0.760,  90.,0.797,       HTCW0160
     *100.,0.831, 110.,0.864, 120.,0.896, 130.,0.925, 140.,0.950,       HTCW0170
     *150.,0.972, 160.,0.989, 170.,1.004, 180.,1.016, 190.,1.028,       HTCW0180
     *200.,1.038, 210.,1.044, 220.,1.049, 230.,1.052, 240.,1.055,       HTCW0190
     *250.,1.056, 260.,1.054, 270.,1.051, 280.,1.047, 290.,1.040,       HTCW0200
     *300.,1.032, 310.,1.024, 320.,1.021, 330.,1.026, 340.,1.046,       HTCW0210
     *350.,1.107, 360.,1.255                                  /         HTCW0220
      DATA W1,W2,W3,W4,W5,W6,W7,W8,W9                                   HTCW0230
     1 / 147.40,  4.1932 ,-0.059187,5.2595E-4,-1.5756E-6,-1.2442E-8,    HTCW0240
     2 1.2722E-10,-4.0803E-13,4.3416E-16 /                              HTCW0250
      DATA LCOUNT/0/                                                    HTCW0260
C                                                                       HTCW0270
C     T = COOLANT TEMPERATURE, C                                        HTCW0280
C     FLUX = HEAT FLUX, W/CM2                                           HTCW0290
C     V = COOLANT VELOSITY   M/SEC                                      HTCW0300
C     D = EQUIVALENT HYDRAULIC DIAMETER CM                              HTCW0310
C     H = HEAT TRANSFER COEFFICIENT  W/CM2/C                            HTCW0320
C     TW = TEMPERATURE AT CLADDING OD.                                  HTCW0330
C     TSAT = SATURATION TEMPERATURE OF COOLANT PRESSURE (EXTP)          HTCW0340
C                                                                       HTCW0350
      IF(LCOUNT.LE.0) GO TO 111                                         HTCW0360
      P=EXTP                                                            HTCW0370
C.... TSAT IS WATER SUTURATION TEMPERATURE IN DEG C                     HTCW0380
      TSAT=W1+P*(W2+P*(W3+P*(W4+P*(W5+P*(W6+P*(W7+P*(W8+P*W9)))))))     HTCW0390
C-----------------------------------------------------------------------HTCW0400
  111 CONTINUE                                                          HTCW0410
      GO TO (1111,2222,3333,4444,5555 ) ,KS                             HTCW0420
 3333 CONTINUE                                                          HTCW0430
      IF(T.GE.TSAT) GO TO 2222                                          HTCW0440
 1111 CONTINUE                                                          HTCW0450
      ITRY = 0                                                          HTCW0460
      TF1  = T                                                          HTCW0470
      C=V**.8/D**.2                                                     HTCW0480
    6 CONTINUE                                                          HTCW0490
      IN1 = 2                                                           HTCW0500
      IN2 = 37                                                          HTCW0510
      H = TERP(TF1,TTTB,2,37,IN1,IN2,IN3,99)                            HTCW0520
      H=H*C                                                             HTCW0530
      TW = T + FLUX/H                                                   HTCW0540
      TF = (TW + T) / 2.                                                HTCW0550
      DIFF = ABS(TF - TF1)                                              HTCW0560
      IF( DIFF - 2.0) 1,1,2                                             HTCW0570
    2 ITRY = ITRY + 1                                                   HTCW0580
      IF( ITRY-50) 3,3,4                                                HTCW0590
```


* SOURCE STATEMENT (HTCW)*

```
    3 TF1 = (TF+TF1)/2.                                                 HTCW0600
      GO TO 6                                                           HTCW0610
    4 WRITE(6,600)                                                      HTCW0620
    1 CONTINUE                                                          HTCW0630
      IF(TW.LE.T) TW=T                                                  HTCW0640
      GO TO 9999                                                        HTCW0650
 2222 CONTINUE                                                          HTCW0660
C     @OVRAC IS HEAT FLUX (WATT/CM2) , NOW CHANGE TO HFLUX (KCAL/M2-HR) HTCW0670
C                                                                       HTCW0680
      HFLX = FLUX * 8600.                                               HTCW0690
      HF = 1.22*(HFLX**0.75)*EXP(EXTP/63.3)                             HTCW0700
      H = HF/8600.                                                      HTCW0710
      IF(H.LE.0.0) TW = T                                               HTCW0720
      IF(H.LE.0.0) RETURN                                               HTCW0730
      TW = TSAT + FLUX / H                                              HTCW0740
      IF(TW.LE.T) TW=T                                                  HTCW0750
      GO TO 9999                                                        HTCW0760
 4444 CONTINUE                                                          HTCW0770
C--------- TOM,S CORRELATION                                            HTCW0780
C     FLUX (W/CM2) CONVERT TO (BTU/HR-FT2)      3170.                   HTCW0790
C     PRESSURE (KG/CM2)    TO (PSIA)            14.22                   HTCW0800
C                                                                       HTCW0810
      FLX = FLUX*3170.                                                  HTCW0820
      P   = EXTP*14.22                                                  HTCW0830
      HF  = (1./0.072)*EXP(P/1260.)*FLX**0.5                            HTCW0840
      H   = HF*5.677E-4                                                 HTCW0850
      IF(H.LE.0.0) TW=T                                                 HTCW0860
       GO TO 9999                                                       HTCW0870
 5555 CONTINUE                                                          HTCW0880
 9999 CONTINUE                                                          HTCW0890
      ITEMP = 0                                                         HTCW0900
      IF(TW.GT.500.) ITEMP = 500                                        HTCW0910
      IF(TW.GT.1200.) ITEMP = 1200                                      HTCW0920
      IF(ITEMP.GT.0) WRITE(6,610) ITEMP,TW,T,V,FLUX,D,H                 HTCW0930
      IF(ITEMP.EQ.1200) STOP                                            HTCW0940
      RETURN                                                            HTCW0950
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 HTCW0960
  600 FORMAT(10X, 'NO CONVERGENCE, ITERATION TIME IS 50TIMES OVER       HTCW0970
     1    FROM HTCW'                                                   ) HTCW0980
  610 FORMAT( //7X,                                                     HTCW0990
     1 50H*** CAUTION ***    CLADDING SURFACE TEMPERATURE IS, I5,       HTCW1000
     2 33H DEG=C OVER        SURFACE TEMP.=,  E12.5,     6H DEG=C,/7X,  HTCW1010
     3 30HCOOLANT TEMPERATURE   (TCOOL)=,E12.5,20HDEG-C,   COOLANT VEL, HTCW1020
     4 10HOCITY (V)=,E12.5,26HM/SEC,  HEAT FLUX(@OVRAC)=,E12.5,         HTCW1030
     5  5HW/CM2,                                                 /7X,  HTCW1040
     6 30HEQUIVALENT HYDRAULIC DIA.(DE)=,E12.5,20HCM,  HEAT TRANSFER C, HTCW1050
     7 10HOEFF.(HF)=,E12.5,30HW/CM2=C   ....SUBROUTINE HTCW           ) HTCW1060
C     ************************************************************    HTCW1070
      END                                                               HTCW1080
```

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* SOURCE STATEMENT *
 1        SUBROUTINE HYOSHI                                              HYOS0010
C                                                                        HYOS0020
 2        COMMON /HIZUKE/ K1,K2,K3,K4,K5,K6                              HYOS0030
C                                                                        HYOS0040
 3        WRITE(6,10)                                                    HYOS0050
 4        WRITE(6,20)                                                    HYOS0060
 5        WRITE(6,30)                                                    HYOS0070
 6        WRITE(6,20)                                                    HYOS0080
 7        WRITE(6,40) K1,K2,K3,K4                                        HYOS0090
 8        WRITE(6,60)                                                    HYOS0100
C                                                                        HYOS0110
 9     10 FORMAT(1H1/)                                                   HYOS0120
10     20 FORMAT(40X,55(1H*))                                            HYOS0130
11     30 FORMAT(40X,1H*,53X,1H* / 40X,1H*,53X,1H* /                     HYOS0140
       1 40X,55H*                    F    R    E    G    3              * / HYOS0150
       2 40X,55H*                                                       * / HYOS0160
       3 40X,55H*                                                       * / HYOS0170
       4 40X,55H*      TIME DEPEND PELLET-CLADDING GAP CONDUCTANCE      * / HYOS0180
       5 40X,55H*           ANALYSIS COMPUTER PROGRAM                   * / HYOS0190
       6 40X,55H*                                                       * / HYOS0200
       7 40X,55H*                                                       * / HYOS0210
       8 40X,55H*                                                       * / HYOS0220
       9 40X,55H*                        JAERI                          * / HYOS0230
       A 40X,55H*                        DIVISION OF REACTOR SAFETY     * / HYOS0240
       B 40X,55H*                        FUEL RELIABILITY LABORATORY-1  * / HYOS0250
       C 40X,55H*                                                       * / HYOS0260
       D 40X,55H*                                                       * / HYOS0270
       E 40X,55H*                                                       * ) HYOS0280
12     40 FORMAT(//40X,10HRUN DATE...,2X,2A4,15,3H HR,I3,7H MINUTE        ) HYOS0290
13     50 FORMAT(/ 40X,10HTITLE.....,2X,20A4)                            HYOS0300
14     60 FORMAT(/  7X,10H***NOTE***    )                                HYOS0310
15        RETURN                                                         HYOS0320
16        END                                                            HYOS0330
```

* SOURCE STATEMENT *

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      SUBROUTINE MOLMOL(KS)                                             MOLM0010
C                                                                       MOLM0020
C      THIS SUBROUTINE IS CALLED FROM MAIN  (KS=1,2,5)                  MOLM0030
C                                   AND ST3TO8 (KS=3,4)                 MOLM0040
C                                                                       MOLM0050
C                                                                       MOLM0060
C                                                                       MOLM0070
      REAL  MUF,MOL,MOLEFR,MOLFR                                        MOLM0080
          COMMON /FFMOL / FF(6,23),RKR(6,23),RXE(6,23),AKX(10,20,2)     MOLM0090
          COMMON /IXIR  / IX,IR,IIH,MAXTEP                              MOLM0100
      COMMON /MOLPRI/ GMOLI(6),GMOLR(6),FRACTN(6),MOL(6),XMOLS(21)      MOLM0110
      COMMON /MAIMOL/ TAVGX,VOLTXS                                      MOLM0120
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  MOLM0130
     1                PKPOWR,IPEAK,DELP,PMAX                            MOLM0140
      COMMON /BRNGAS/ AKR(20),AXE(20),PHI(20),ENAE(20),ENKR(20)         MOLM0150
      COMMON /MOL676/ MOLEFR(6)                                         MOLM0160
      COMMON /ML593B/ TBAR(20)                                          MOLM0170
      COMMON /MOL9  / FXMOL(6,21),RDOT(20)                              MOLM0180
      COMMON /MOL579/ PRESTO(20)                                        MOLM0190
      COMMON /MOLM9 / TAVGXX(20)                                        MOLM0200
      COMMON /ML338 / VOLTX(20)                                         MOLM0210
      COMMON /DATA 3/ VOLAT(29),FISGR(29)                               MOLM0220
      COMMON /DATA 4/ PI,CCPIN3,SECDAY,AVOGAD,RR,CONEN                  MOLM0230
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             MOLM0240
      COMMON /COM 03/ TO,P,DELRCO,DELRC,DELR,TCOOL,STP                  MOLM0250
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  MOLM0260
      COMMON /COM 06/ II,JCASE,TCOOLF,XMOTOT                            MOLM0270
      COMMON /COM 10/ VVOIDZ,FRUO2,IPLENA,NPOW1                         MOLM0280
      COMMON /COM 13/ RFS,FNPOW,RSINZ,RVOIDZ                            MOLM0290
      COMMON /COM046/ DSIN,RSIN,TSIN,TSINC,DVOID,RVOID,T                MOLM0300
      COMMON /COM 56/ VOLGP,VOLGAP                                      MOLM0310
      COMMON /COM 90/ VOLGAS,W,HGC                                      MOLM0320
      COMMON /COM566/ DELRB,DELRP,DELRCI,DELRT,TAVGF,VAVGT              MOLM0330
      COMMON /COM676/ TOTMOL,ABTGAS,VISMIX,GK,GASKON                    MOLM0340
      COMMON /NEWGAS/NGAS                                               MOLM0350
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI,  MOLM0360
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, MOLM0370
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   MOLM0380
     3                NCLAD,NCCN,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,MOLM0390
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   MOLM0400
     5                DTEMP,ZCLAD,HG,PEKAVG,MINI,ICDF,ISTOR,ICHEP,IS,ELLMOLM0410
     6                ,NEXP,MEXP,NHIST                                  MOLM0420
      COMMON /PRINT / PRINT                                             MOLM0430
      COMMON /PRIMOL/ AANKR,AANXE                                       MOLM0440
      COMMON /FTNVT / FNVT(20),TNVT(20)                                 MOLM0450
      COMMON /GASRE/ FFMAX(23),RKRMAX(23),RXEMAX(23),AKRO(20),AXEO(20)  MOLM0460
      COMMON /DIMEN2/ DENSFL(5,20)                                      MOLM0470
      COMMON /D15   / MDEN,MRELOC,SINTEN                                MOLM0480
      COMMON /HIS   / BASE(100),HIS(7,100),MODE(5,100)                  MOLM0490
C                                                                       MOLM0500
      DATA FACTFT / 1.0 /                                               MOLM0510
C     ******************************************************************MOLM0520
      GO TO (100,200,300,400,500) ,KS                                   MOLM0530
  100 CONTINUE                                                          MOLM0540
      STP=273./298.                                                     MOLM0550
C                                                                       MOLM0560
C     SETUP PLENUM MOLE CONTENT.                                        MOLM0570
C                                                                       MOLM0580
      XMOLS(NPOW1) = STP*VPLENZ*ATMOS/RR                                MOLM0590
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* SOURCE STATEMENT (MOLMOL)*

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C                                                                       MOLM0600
          DO 710 J=1,23                                                 MOLM0610
  710     FF(1,J) = RKR(1,J) = RXE(1,J) = 0.0                           MOLM0620
      DO 711 I=1,NPOW                                                   MOLM0630
      AKRO(I)=AXEO(I)=0.0                                               MOLM0640
  711 CONTINUE                                                          MOLM0650
      RETURN                                                            MOLM0660
C     ******************************************************************MOLM0670
  200 CONTINUE                                                          MOLM0680
      ANKR = ANXE = AVKR = AVXE = GTMKR = GTMXE = RRKR = RRXE = 0.0     MOLM0690
          IX=MOD(IIH,IR)                                                MOLM0700
          IF(IX.EQ.0) IX=IR                                             MOLM0710
      DO 20  IPOW=1,NPOW                                                MOLM0720
      P=(POWER(IPOW)+POWER(IPOW+1))*0.5                                 MOLM0730
C                                                                       MOLM0740
      MTIME =1                                                          MOLM0750
      IF(IIH.EQ.1)  MTIME = 0                                           MOLM0760
C     FISSION GAS GENERATION CALC. AKR( ),AXE( ) CALL FISGAS            MOLM0770
      T = TDAYS * SECDAY                                                MOLM0780
      CALL FISGAS (T,PHI(IPOW),F,CONEN,IFLUX,MTIME,AKR(IPOW),AXE(IPOW), MOLM0790
     *             IPOW )                                               MOLM0800
      ANKR=ANKR+AKR(IPOW)                                               MOLM0810
      ANXE=ANXE+AXE(IPOW)                                               MOLM0820
      AANKR=ANKR/AVOGAD/FLOAT(NPOW)*FUELL                               MOLM0830
      AANXE=ANXE/AVOGAD/FLOAT(NPOW)*FUELL                               MOLM0840
          AKX(IX,IPOW,1) = AKR(IPOW)                                    MOLM0850
          AKX(IX,IPOW,2) = AXE(IPOW)                                    MOLM0860
      FNVT(IPOW) = FNVT(IPOW) + PHI(IPOW)*T*FACTFT                      MOLM0870
      TNVT(IPOW) = TNVT(IPOW) + PHI(IPOW)*T                             MOLM0880
   20 CONTINUE                                                          MOLM0890
          DO 720 I=2,6                                                  MOLM0900
          DO 720 J=1,23                                                 MOLM0910
  720     FF(I,J) = RKR(I,J) = RXE(I,J) = 0.0                           MOLM0920
      RETURN                                                            MOLM0930
C     ******************************************************************MOLM0940
  300     CONTINUE                                                      MOLM0950
C                                                                       MOLM0960
C     INTERPOLATE FISSION GAS RELEASE TABLE ON VOL. AVG. TEMP.          MOLM0970
C                                                                       MOLM0980
      TVOLAV=VAVGT                                                      MOLM0990
      IF(ISTEP.GT.1) GO TO 1030                                         MOLM1000
      F=TEPF(TVOLAV,FISGR,VOLAT,29)                                     MOLM1010
      RDOT(IPOW)=F                                                      MOLM1020
      RD=RDOT(IPOW)                                                     MOLM1030
      IF(MDEN.GE.1.AND.MGAS.EQ.-1)  RD=DENSFL(1,IPOW)/0.03              MOLM1040
C                                                                       MOLM1050
C     CALCULATE GAS COMPOSITION                                         MOLM1060
C                                                                       MOLM1070
      FILMOL=STP*VOLGAS*        ATMOS/RR                                MOLM1080
      MOL(1)=FILMOL*FRACHE                                              MOLM1090
      MOL(2)=FILMOL*FRACAR                                              MOLM1100
      MOL(3)=FILMOL*FRACH+W*S*XX*FL/RR*RD                               MOLM1110
      IF(NOH.GT.0) MOL(3)=0.                                            MOLM1120
      MOL(4)=FILMOL*FRACN+W*S*(1.-XX)*FL/RR*RD                          MOLM1130
      MOL(5)=FILMOL*FRACKR+AKR(IPOW)/AVOGAD*FL*RDOT(IPOW)               MOLM1140
      MOL(6)=FILMOL*FRACXE+AXE(IPOW)/AVOGAD*FL*RDOT(IPOW)               MOLM1150
C                                                                       MOLM1160
C     CALCULATE MOLE FRACTIONS OF GAS IN THE FUEL PIN.                  MOLM1170
C                                                                       MOLM1180
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* SOURCE STATEMENT (MOLMOL  )*
 86          XMOLS(IPOW)=0.0                                                MOLM1190
 87          DO 1010 I=1,6                                                  MOLM1200
 88          XMOLS(IPOW)=XMOLS(IPOW)+MOL(I)                                 MOLM1210
 89    1010  CONTINUE                                                       MOLM1220
 90          DO 1020 I=1,6                                                  MOLM1230
C            FXMOL(I,IPOW)=MOL(I)/XMOLS(IPOW)                               MOLM1240
C            MOLEFR(I)=FXMOL(I,IPOW)                                        MOLM1250
 91          MOLEFR(I)=MOL(I)/XMOLS(IPOW)                                   MOLM1260
 92    1020  CONTINUE                                                       MOLM1270
 93    1030  CONTINUE                                                       MOLM1280
 94          TOTMOL=XMOLS(IPOW)                                             MOLM1290
C             RETURN TO BETWEEN STEP5 AND STEP6                             MOLM1300
 95          RETURN                                                         MOLM1310
C            ==============================================================MOLM1320
C                                                                           MOLM1330
 96      400 CONTINUE                                                       MOLM1340
 97              IST1 = ISTEP + 1                                           MOLM1350
 98              FFS = RKRS = RXES = 0.0                                    MOLM1360
 99              FFD=0.0                                                    MOLM1370
100              DO 1372 IPOW = 1,NPOW                                      MOLM1380
101              FF(ISTEP+1,IPOW) = TEPP(TBAR(IPOW),FISGR,VOLAT,29)         MOLM1390
102              FF(ISTEP+1,21  ) = FF(ISTEP+1,21) + FF(ISTEP+1,IPOW)       MOLM1400
103              RKR(ISTEP+1,IPOW) = AKR(IPOW) * FF(ISTEP+1,IPOW)           MOLM1410
104              RXE(ISTEP+1,IPOW) = AXE(IPOW) * FF(ISTEP+1,IPOW)           MOLM1420
105          RKR(IST1,21)=RKR(IST1,21) + RKR(IST1,IPOW)                     MOLM1430
106          RXE(IST1,21)=RXE(IST1,21) + RXE(IST1,IPOW)                     MOLM1440
C                                                                           MOLM1450
C                                                                           MOLM1460
107              FFMAX (IPOW) = FF (1,IPOW)                                 MOLM1470
108              RKRMAX(IPOW) = RKR(1,IPOW)                                 MOLM1480
109              RXEMAX(IPOW) = RXE(1,IPOW)                                 MOLM1490
110              IF(FF (IST1,IPOW).GT.FF (1,IPOW)) FFMAX (IPOW)=FF (IST1,IPOW) MOLM1500
111              IF(RKR(IST1,IPOW).GT.RKR(1,IPOW)) RKRMAX(IPOW)=RKR(IST1,IPOW) MOLM1510
112              IF(RXE(IST1,IPOW).GT.RXE(1,IPOW)) RXEMAX(IPOW)=RXE(IST1,IPOW) MOLM1520
113              FFS  = FFS  + FFMAX (IPOW)                                 MOLM1530
114              RKRS = RKRS + RKRMAX(IPOW)                                 MOLM1540
115              RXES = RXES + RXEMAX(IPOW)                                 MOLM1550
116              FFD=FFD+DENSFL(1,IPOW)/0.03                                MOLM1560
117    1372      CONTINUE                                                   MOLM1570
118              FFMAX (21) = FFS                                           MOLM1580
119              RKRMAX(21) = RKRS                                          MOLM1590
120              RXEMAX(21) = RXES                                          MOLM1600
121              FFMAX (22) = FFS /FNPOW                                    MOLM1610
122              FFD=FFD/FNPOW                                              MOLM1620
123              FD=FFMAX(22)                                               MOLM1630
124              IF(MDEN.GE.1.AND.MGAS.EQ.-1) FD=FFD                        MOLM1640
125              RKRMAX(22) = RKRS/FNPOW                                    MOLM1650
126              RXEMAX(22) = RXES/FNPOW                                    MOLM1660
127          FF(IST1,22)=FF(IST1,21)/FNPOW                                  MOLM1670
128          RKR(IST1,22)=RKR(IST1,21)/FNPOW                                MOLM1680
129          RXE(IST1,22)=RXE(IST1,21)/FNPOW                                MOLM1690
C------------------------------------------------------------------------MOLM1700
C              CONTINUE OF SUB. MOLM04 (NEW GAS RELEASE CALCULATION)        MOLM1710
130          ENTRY MOLM4D                                                   MOLM1720
C                                                                           MOLM1730
C------------------------------------------------------------------------MOLM1740
131          TAVGXX(ISTEP+1)=TAVGX/FNPOW                                    MOLM1750
132          VOLTXS=VOLTXS+VPLENZ/TPLENA                                    MOLM1760
133          TVOLAV = TAVGXX(ISTEP + 1 )                                    MOLM1770
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* SOURCE STATEMENT (MOLMOL  )*
134          F=TEPP(TVOLAV,FISGR,VOLAT,29)                                  MOLM1780
135             FF(ISTEP+1,23) = F                                          MOLM1790
C                                                                           MOLM1800
C            CALCULATE GAS COMPOSITION                                      MOLM1810
C                                                                           MOLM1820
136          FILMOL=STP*(FNPOW*VOLGAS+VPLENZ)*        ATMOS/RR              MOLM1830
137          MOL(1)=FILMOL*FRACHE                                           MOLM1840
138          MOL(2)=FILMOL*FRACAR                                           MOLM1850
139              MOL(3)=FILMOL*FRACH + W*S*XX*FUELL/RR*FD                   MOLM1860
140           IF(NOH.GT.0) MOL(3)=0.                                        MOLM1870
141              MOL(4)=FILMOL*FRACN+W*S*(1.-XX) *FUELL/RR*FD               MOLM1880
142              MOL(5)=FILMOL*FRACKR + RKRMAX(22)/AVOGAD * FUELL           MOLM1890
143              MOL(6)=FILMOL*FRACXE + RXEMAX(22)/AVOGAD * FUELL           MOLM1900
C                                                                           MOLM1910
144          GMOLI(1) = FILMOL*FRACHE                                       MOLM1920
145          GMOLI(2) = FILMOL*FRACAR                                       MOLM1930
146          GMOLI(3) = FILMOL*FRACH                                        MOLM1940
147          IF(NOH.GT.0) GMOLI(3) = 0.0                                    MOLM1950
148          GMOLI(4) = FILMOL*FRACN                                        MOLM1960
149          GMOLI(5) = FILMOL*FRACKR                                       MOLM1970
150          GMOLI(6) = FILMOL*FRACXE                                       MOLM1980
C                                                                           MOLM1990
151          GMOLR(1) = GMOLR(2) = 0.0                                      MOLM2000
152          GMOLR(3) = W*S*XX*FUELL/RR*FD                                  MOLM2010
153          IF(NOH.GT.0) GMOLR(3) = 0.0                                    MOLM2020
154          GMOLR(4) = W*S*(1.-XX)*FUELL/RR*FD                             MOLM2030
155          GMOLR(5) = RKRMAX(22)/AVOGAD*FUELL                             MOLM2040
156          GMOLR(6) = RXEMAX(22)/AVOGAD*FUELL                             MOLM2050
C                                                                           MOLM2060
C                                                                           MOLM2070
C            CALCULATE MOLE FRACTIONS OF GAS IN THE FUEL PIN.               MOLM2080
C                                                                           MOLM2090
157          XMOTOT=0                                                       MOLM2100
158          DO 1380 I=1,6                                                  MOLM2110
159          XMOTOT=XMOTOT+MOL(I)                                           MOLM2120
160    1380  CONTINUE                                                       MOLM2130
161          DO 1390 I=1,6                                                  MOLM2140
162          MOLEFR(I)=MOL(I)/XMOTOT                                        MOLM2150
163    1390  CONTINUE                                                       MOLM2160
C                                                                           MOLM2170
164          PRESTO(ISTEP+1)=84.80804*XMOTOT/VOLTXS                         MOLM2180
165          XMOLS(NPO+1)=PRESTO(ISTEP+1)*VPLENZ/(84.80804*TPLENA)          MOLM2190
166          DO 1400 I=1,NPOW                                               MOLM2200
167              RDOT(I) = FFMAX(22)                                        MOLM2210
168          XMOLS(I)=PRESTO(ISTEP+1)*VOLTX(I)/84.80804                     MOLM2220
169    1400  CONTINUE                                                       MOLM2230
170          RETURN                                                         MOLM2240
C            ==============================================================MOLM2250
171      500 CONTINUE                                                       MOLM2260
C                                                                           MOLM2270
172          IF(MODE(1,IIH).LT.0) GO TO 1840                                MOLM2280
C                                                                           MOLM2290
173          IF(ANKR.EQ.0.0.AND.ANXE.EQ.0.0) GO TO 10000                    MOLM2300
174          AVKR=ANKR/FNPOW                                                MOLM2310
175          AVXE=ANXE/FNPOW                                                MOLM2320
176          GTMKR=AVKR/AVOGAD*FUELL                                        MOLM2330
177          GTMXE=AVXE/AVOGAD*FUELL                                        MOLM2340
178          RRKR=GMOLR(5)/GTMKR                                            MOLM2350
179          RRXE=GMOLR(6)/GTMXE                                            MOLM2360
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10000 CONTINUE                                                          MOLM2370
C                                                                       MOLM2380
      CALL HEAD(-1)                                                     MOLM2390
C                                                                       MOLM2400
      WRITE(6,405)                                                      MOLM2410
      WRITE(6,410)                                                      MOLM2420
      DO 45 I=1,NPOW                                                    MOLM2430
      WRITE(6,420) I,AKR(I),AXE(I),FF(1,I),FFMAX(I),RKR(1,I),RKRMAX(I), MOLM2440
     1             RXE(1,I),RXEMAX(I)                                   MOLM2450
   45 CONTINUE                                                          MOLM2460
      I=21                                                              MOLM2470
      WRITE(6,430) ANKR,ANXE,FF(1,I),FFMAX(I),RKR(1,I),RKRMAX(I),       MOLM2480
     1             RXE(1,I),RXEMAX(I)                                   MOLM2490
      I=22                                                              MOLM2500
      WRITE(6,440) AVKR,AVXE,FF(1,I),FFMAX(I),RKR(1,I),RKRMAX(I),       MOLM2510
     1             RXE(1,I),RXEMAX(I)                                   MOLM2520
      WRITE(6,450) GTMKR,GTMXE,GMOLR(5),GMOLR(6)                        MOLM2530
      WRITE(6,460) FF(IST1,23),RKRR,RRXE                                MOLM2540
C     **** PLENUM VOLUME AND PRESSURE CHANGE DUE TO ELONGATION          MOLM2550
      A1=A2=A3=0.0                                                      MOLM2560
      DO 1830 I=1,NPOW                                                  MOLM2570
      A1=A1+DENSFL(2,I)                                                 MOLM2580
      A2=A2+DENSFL(3,I)                                                 MOLM2590
      A3=A3+DENSFL(4,I)                                                 MOLM2600
 1830 CONTINUE                                                          MOLM2610
      XL1=A1                                                            MOLM2620
      XL2=A2                                                            MOLM2630
      XL3=A3                                                            MOLM2640
      VP1=PI*A1*DC!**2 /4.                                              MOLM2650
      VP2=PI*A2*DC!**2 /4.                                              MOLM2660
      VP3=PI*A3*DC!**2 /4.                                              MOLM2670
C                                                                       MOLM2680
      VPLE1=VPLENZ-VP1                                                  MOLM2690
      VPLE2=VPLENZ-VP2                                                  MOLM2700
      VPLE3=VPLENZ-VP3                                                  MOLM2710
C                                                                       MOLM2720
      VOLPT=VOLTX5-VPLENZ/TPLENA                                        MOLM2730
C                                                                       MOLM2740
      VOLPT1=VOLPT+VPLE1/TPLENA                                         MOLM2750
      VOLPT2=VOLPT+VPLE2/TPLENA                                         MOLM2760
      VOLPT3=VOLPT+VPLE3/TPLENA                                         MOLM2770
C                                                                       MOLM2780
      PREST1=84.80804*XMOTOT/VOLPT1                                     MOLM2790
      PREST2=84.80804*XMOTOT/VOLPT2                                     MOLM2800
      PREST3=84.80804*XMOTOT/VOLPT3                                     MOLM2810
C                                                                       MOLM2820
      WRITE(6,470)                                                      MOLM2830
      WRITE(6,472) XL3,VP3,VPLE3,PREST3                                 MOLM2840
      WRITE(6,474) XL1,VP1,VPLE1,PREST1                                 MOLM2850
      WRITE(6,476) XL2,VP2,VPLE2,PREST2                                 MOLM2860
 1840 CONTINUE                                                          MOLM2870
C                                                                       MOLM2880
C                                                                       MOLM2890
C                                                                       MOLM2900
          DO 1810 J=1,23                                                MOLM2910
          FF(1,J) = FFMAX (J)                                           MOLM2920
          RKR(1,J) = RKRMAX(J)                                          MOLM2930
 1810     RXE(1,J) = RXEMAX(J)                                          MOLM2940
      DO 1811 I=1,NPOW                                                  MOLM2950
```



```
      AKRO(I)=AKR(I)                                                    MOLM2960
      AXEO(I)=AXE(I)                                                    MOLM2970
 1811 CONTINUE                                                          MOLM2980
          RETURN                                                        MOLM2990
C                                                                       MOLM3000
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7  MOLM3010
  405 FORMAT(10X,33HGAS RELEASE MECHANISM INFORMATION  / 10X,33(1H-)/ ) MOLM3020
  410 FORMAT(5X,115H       AXIAL          GENERATED F.P. GAS          GAS RMOLM3030
     1RELEASE RATE                  RELEASED GAS (ATOMS PER UNIT LENGTH)  /MOLM3040
     3        5X,127H      SECTION      (ATOMS PER UNIT LENGTH)      UNTIL NMOLM3050
     4OW   THIS TIME      ======== KRYPTON ========     ======== XENON =MOLM3060
     5======== /                                                        MOLM3070
     6        5X,127H      NUMBER       KRYPTON        XENON          MAX, VAMOLM3080
     7LUE  STEP             MAX, VALUE  IN THIS STEP       MAX, VALUE  IN MOLM3090
     8THIS STEP /                                                       MOLM3100
     9  10X,7(1H-),1X,2(2X,12(1H-)),2X,2(2X,10(1H-)),2X,2(2X,12(1H-)),  MOLM3110
     *  2X,2(2X,12(1H-))    )                                           MOLM3120
  420 FORMAT(10X,I7,1X,2E14.5,2X,2F12.6,2X,2E14.5,2X,2E14.5)            MOLM3130
  430 FORMAT(/7X,10HAXIAL SUM,,1X,2E14.5,2X,2F12.6,2(2X,2E14.5) )       MOLM3140
  440 FORMAT(7X,10HAXIAL AVG.,1X,2E14.5,2X,2F12.6,2(2X,2E14.5) )        MOLM3150
  450 FORMAT(/6X,11HTOTAL MOLES  / 6X,12HIN   FUEL                      MOLM3160
     1  2E14.5,42X,E14.5,16X,E14.5 )                                    MOLM3170
  460 FORMAT(//10X,50HRELEASE RATE (BY VOLUME AVERAGE TEMP.)............MOLM3180
     1,F10.5 / 10X,50HRECALCULATED RELEASE RATE  KR , XE ...............MOLM3190
     2,2F10.5 )                                                         MOLM3200
  470 FORMAT( 3(/)                                                      MOLM3210
     1  10X,110HAXIAL PELLET                        PELLET STUCK       PELLMOLM3220
     2ET VOLUME       CHANGED PLENUM      PLENUM PRESSURE               MOLM3230
     3 /10X,110HLENGTH CHANGE                     LENGTH CHANGE      CHANGEMOLM3240
     4 BY ELONG          VOLUME           INDUCED PELLET                MOLM3250
     5 /10X,110H                                      (CM)       =ATIONMOLM3260
     6    (CM3)                  (CM3)      LENGTH CHANGE               MOLM3270
     7 / 35X,4(5X,15(1H.))      )                                       MOLM3280
  472 FORMAT(10X,30HDUE TO THERMAL EXPANSION       ,3(F15.7,5X),F15.5 ) MOLM3290
  474 FORMAT(10X,30HDUE TO AXIAL DENSIFICATION     ,3(F15.7,5X),F15.5 ) MOLM3300
  476 FORMAT(10X,30HDUE TO EXPANSION + DENSIFY     ,3(F15.7,5X),F15.5)  MOLM3310
C                                                                       MOLM3320
      END                                                               MOLM3330
```

* SOURCE STATEMENT *

```
      SUBROUTINE MOLMO4                                                 MOL40010
C      *******  THIS ROUTINE CALCULATE FP GAS RELEASE                   MOL40020
C                 BY NEW RELEASED MODEL (HARAYAMA)                     MOL40030
C                                                                       MOL40040
C                                                                       MOL40050
          COMMON /FFMOL / FF(6,23),RKR(6,23),RXE(6,23),AKX(10,20,2)     MOL40060
          COMMON /IXIR  / IX,IR,IIM,MAXTEP                              MOL40070
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  MOL40080
     1                PKPOWR,IPEAK,DELP,PMAX                            MOL40090
      COMMON /BRNGAS/ AKR(20),AXE(20),PHI(20),ENXE(20),ENKR(20)         MOL40100
      COMMON /ML5938/ TBAR(20)                                          MOL40110
      COMMON /DATA 3/ VOLAT(29),FISGR(29)                               MOL40120
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             MOL40130
      COMMON /GASRE/ FFMAX(23),RKRMAX(23),RXEMAX(23),AKRO(20),AXEO(20)  MOL40140
C                                                                       MOL40150
      IST1=ISTEP+1                                                      MOL40160
      FNPOW = FLOAT(NPOW)                                               MOL40170
      FFS=RKRS=RXES=0.0                                                 MOL40180
      TB=0.0                                                            MOL40190
      DO 1372 IPOW= 1,NPOW                                              MOL40200
      TOTGO=AKRO(IPOW)+AXEO(IPOW)                                       MOL40210
      TOTGN=AKR(IPOW) +AXE(IPOW)                                        MOL40220
      IF(TOTGN.LE.0.0) GO TO 1377                                       MOL40230
      IF(TOTGO/TOTGN.GE.1.0001) GO TO 1375                              MOL40240
 1377 CONTINUE                                                          MOL40250
      FF(IST1,IPOW)=TEPP(TBAR(IPOW),FISGR,VOLAT,29)                     MOL40260
C                                                                       MOL40270
C***** FP GAS INVENTORY INCREASE TO PRIVIOUS STEP                       MOL40280
C                                                                       MOL40290
      IF(FF(IST1,IPOW).LT.FF(1,IPOW)) GO TO 1373                        MOL40300
C     GAS RELEASE RATE INCREASE TO PRIVIOUS RELEASE RATE(FF(1,IPOW))    MOL40310
      FFMAX(IPOW)=FF(IST1,IPOW)                                         MOL40320
      GO TO 1374                                                        MOL40330
 1373 CONTINUE                                                          MOL40340
C     GAS RELEASE RATE DECREASE TO PRIVIOUS RELEASE RATE                MOL40350
      IF(TOTGN.LE.0.0) FFMAX(IPOW) = FF(IST1,IPOW)                      MOL40360
      IF(TOTGN.LE.0.0) GO TO 1374                                       MOL40370
      RATG = TOTGO / TOTGN                                              MOL40380
      FFMAX(IPOW)=(1.-RATG)*FF(IST1,IPOW) + RATG*FF(1,IPOW)             MOL40390
 1374 CONTINUE                                                          MOL40400
      GO TO 1376                                                        MOL40410
 1375 CONTINUE                                                          MOL40420
C                                                                       MOL40430
C***** FP GAS INVENTORY DECREASE TO PRIVIOUS STEP                       MOL40440
C                                                                       MOL40450
      FFMAX(IPOW)=FF(1,IPOW)                                            MOL40460
 1376 CONTINUE                                                          MOL40470
C                                                                       MOL40480
      RKRMAX(IPOW)=RKR(IST1,IPOW)*AKR(IPOW)*FFMAX(IPOW)                 MOL40490
      RXEMAX(IPOW)=RXE(IST1,IPOW)*AXE(IPOW)*FFMAX(IPOW)                 MOL40500
C                                                                       MOL40510
      FF(IST1,21)=FF(IST1,21) + FF(IST1,IPOW)                           MOL40520
      RKR(IST1,21)=RKR(IST1,21) + RKR(IST1,IPOW)                        MOL40530
      RXE(IST1,21)=RXE(IST1,21) + RXE(IST1,IPOW)                        MOL40540
C                                                                       MOL40550
      FFS=FFS + FFMAX(IPOW)                                             MOL40560
      RKRS=RKRS + RKRMAX(IPOW)                                          MOL40570
      RXES=RXES + RXEMAX(IPOW)                                          MOL40580
      TB=TB+TBAR(IPOW)                                                  MOL40590
```


* SOURCE STATEMENT (MOLMO4)*

```
C                                                                       MOL40600
 1372 CONTINUE                                                          MOL40610
C                                                                       MOL40620
      TB=TB/FNPOW                                                       MOL40630
      FF(IST1,23) = TEPP(TB,FISGR,VOLAT,29)                             MOL40640
      FFMAX(21)=FFS                                                     MOL40650
      RKRMAX(21)=RKRS                                                   MOL40660
      RXEMAX(21)=RXES                                                   MOL40670
      FFMAX(22)=FFS/FNPOW                                               MOL40680
      RKRMAX(22)=RKRS/FNPOW                                             MOL40690
      RXEMAX(22)=RXES/FNPOW                                             MOL40700
C                                                                       MOL40710
      FF(IST1,22)=FF(IST1,21)/FNPOW                                     MOL40720
      RKR(IST1,22)=RKR(IST1,21)/FNPOW                                   MOL40730
      RXE(IST1,22)=RXE(IST1,21)/FNPOW                                   MOL40740
C                                                                       MOL40750
      CALL MOLM4D                                                       MOL40760
C                                                                       MOL40770
      RETURN                                                            MOL40780
      END                                                               MOL40790
```

* SOURCE STATEMENT *

```
      SUBROUTINE OUT1                                                   OUT10010
C                                                                       OUT10020
C     OPTIONAL EQUATION OUTPUT                                          OUT10030
C     THIS SUBROUTINE IS CALLED FROM MAIN WHEN IOUT1=1                  OUT10040
C                                                                       OUT10050
C                                                                       OUT10060
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),RV(2, 20) OUT10070
      COMMON /HIZUKE/ K1,K2,K3,K4,K5,K6                                 OUT10080
      COMMON /IOUT2 / IOUT2                                             OUT10090
      COMMON /COM128/ IOUT1,IIPROF                                      OUT10100
      COMMON /HIS  / HASE(100),HIS(7,100),MODE(5,100)                   OUT10110
      COMMON /IYIELD/ IYIELD                                            OUT10120
      COMMON /POWRAY/ PAVRG,FUELL,FL,POWER(21),AI(21),NPOW,PTOT,LPMAX,  OUT10130
     1                PKPOWR,IPEAK,DELP,PMAX                            OUT10140
      COMMON /MCONV / MCONV                                             OUT10150
      COMMON /D15   / MDEN,MRELOC,SINTED                                OUT10160
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCJ,  OUT10170
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, OUT10180
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGHF,IFLUX,   OUT10190
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOH,OUT10200
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   OUT10210
     5                DTEMP,ITOT,HG ,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELLOUT10220
     6                ,NEXP,MEXP,NHIST                                  OUT10230
      COMMON /INPUT A/ MREST,LCHEP,DDISH,HDISH                          OUT10240
      COMMON /MREV1 / MREV1                                             OUT10250
C                                                                       OUT10260
      CALL STEPO                                                        OUT10270
      WRITE(6, 503)  TITLE,K1,K2,K3,K4                                  OUT10280
      WRITE(6,1010)                                                     OUT10290
      WRITE(6,1020)                                                     OUT10300
      WRITE(6,1011)                                                     OUT10310
      WRITE(6,1030)                                                     OUT10320
      WRITE(6,1060)                                                     OUT10330
                    WRITE(6,1100) MODE(2,1)                             OUT10340
      WRITE(6,1040)                                                     OUT10350
                    WRITE(6,1103)                                       OUT10360
                    WRITE(6,1101)                                       OUT10370
                    WRITE(6,1102)                                       OUT10380
      WRITE(6,1104)                                                     OUT10390
      WRITE(6,1050)                                                     OUT10400
                    WRITE(6,1120) MODE(3,1)                             OUT10410
      WRITE(6,1040)                                                     OUT10420
                    WRITE(6,1121)                                       OUT10430
                    WRITE(6,1122)                                       OUT10440
      WRITE(6,1050)                                                     OUT10450
                    WRITE(6,1125) IYIELD                                OUT10460
      WRITE(6,1040)                                                     OUT10470
                    WRITE(6,1126)                                       OUT10480
      WRITE(6,1050)                                                     OUT10490
                    WRITE(6,1130) MODE(4,1)                             OUT10500
      WRITE(6,1040)                                                     OUT10510
                    WRITE(6,1131)                                       OUT10520
      WRITE(6,1050)                                                     OUT10530
                    WRITE(6,1140) MODE(5,1)                             OUT10540
      WRITE(6,1040)                                                     OUT10550
                    WRITE(6,1141)                                       OUT10560
      WRITE(6,1050)                                                     OUT10570
                    WRITE(6,1142) IFLUX                                 OUT10580
      WRITE(6,1040)                                                     OUT10590
```


* SOURCE STATEMENT (OUT1)*

```
                    WRITE(6,1143)                                       OUT10600
      WRITE(6,1050)                                                     OUT10610
                    WRITE(6,1145) IPEAK                                 OUT10620
      WRITE(6,1040)                                                     OUT10630
                    WRITE(6,1146)                                       OUT10640
      WRITE(6,1050)                                                     OUT10650
                    WRITE(6,1150) ICREP                                 OUT10660
      WRITE(6,1040)                                                     OUT10670
                    WRITE(6,1151)                                       OUT10680
                    WRITE(6,1153)                                       OUT10690
      WRITE(6,1050)                                                     OUT10700
                    WRITE(6,1160) ISTOR                                 OUT10710
      WRITE(6,1040)                                                     OUT10720
                    WRITE(6,1161)                                       OUT10730
      WRITE(6,1050)                                                     OUT10740
                    WRITE(6,1170) NHIST                                 OUT10750
      WRITE(6,1040)                                                     OUT10760
                    WRITE(6,1171)                                       OUT10770
      WRITE(6,1050)                                                     OUT10780
                    WRITE(6,1180) ICDF                                  OUT10790
      WRITE(6,1040)                                                     OUT10800
                    WRITE(6,1181)                                       OUT10810
      WRITE(6,1050)                                                     OUT10820
                    WRITE(6,1190) ISWELL                                OUT10830
      WRITE(6,1040)                                                     OUT10840
                    WRITE(6,1191)                                       OUT10850
      WRITE(6,1050)                                                     OUT10860
                    WRITE(6,1200) NEXP                                  OUT10870
      WRITE(6,1040)                                                     OUT10880
                    WRITE(6,1202)                                       OUT10890
                    WRITE(6,1201)                                       OUT10900
      WRITE(6,1050)                                                     OUT10910
                    WRITE(6,1210) SIGHF                                 OUT10920
      WRITE(6,1040)                                                     OUT10930
                    WRITE(6,1211)                                       OUT10940
                    WRITE(6,1212)                                       OUT10950
      WRITE(6,1050)                                                     OUT10960
                    WRITE(6,1220) MEXP                                  OUT10970
      WRITE(6,1040)                                                     OUT10980
                    WRITE(6,1221)                                       OUT10990
      WRITE(6,1050)                                                     OUT11000
                    WRITE(6,1230) MCONV                                 OUT11010
      WRITE(6,1040)                                                     OUT11020
                    WRITE(6,1231)                                       OUT11030
      WRITE(6,1050)                                                     OUT11040
                    WRITE(6,1235) MREV1                                 OUT11050
      WRITE(6,1040)                                                     OUT11060
                    WRITE(6,1236)                                       OUT11070
      WRITE(6,1050)                                                     OUT11080
                    WRITE(6,1240) MDEN                                  OUT11090
      WRITE(6,1040)                                                     OUT11100
                    WRITE(6,1241)                                       OUT11110
      WRITE(6,1242)                                                     OUT11120
      WRITE(6,1050)                                                     OUT11130
                    WRITE(6,1250) MRELOC                                OUT11140
      WRITE(6,1040)                                                     OUT11150
                    WRITE(6,1251)                                       OUT11160
      WRITE(6,1252)                                                     OUT11170
      WRITE(6,1050)                                                     OUT11180
```

```
* SOURCE STATEMENT (OUT1     )*
                          WRITE(6,1260) IIPROF                                  OUT11190
          WRITE(6,1040)                                                         OUT11200
                          WRITE(6,1261)                                         OUT11210
          WRITE(6,1050)                                                         OUT11220
                          WRITE(6,1270) MREST                                   OUT11230
          WRITE(6,1040)                                                         OUT11240
                          WRITE(6,1271)                                         OUT11250
          WRITE(6,1050)                                                         OUT11260
                          WRITE(6,1275) LCREP                                   OUT11270
          WRITE(6,1040)                                                         OUT11280
                          WRITE(6,1276)                                         OUT11290
          WRITE(6,1060)                                                         OUT11300
          WRITE(6,1030)                                                         OUT11310
          RETURN                                                                OUT11320
C     *    1    *    2    *    3    *    4    *    5    *    6    *    7        OUT11330
  503 FORMAT( 1H1/ 20A4,10X,2A4,I5,3H HR,I3,7H MINUTE                          ) OUT11340
 1000 FORMAT( 1H1                                                              ) OUT11350
 1010 FORMAT( // 50X, 39(1H-)                                                  ) OUT11360
 1011 FORMAT(    50X, 39(1H-)                                                  ) OUT11370
 1020 FORMAT(    50X, 39H|  FREG3 OPTIONAL MODEL AND EQUATION  |               ) OUT11380
 1030 FORMAT( 7X, 126(1H-)                                                     ) OUT11390
 1040 FORMAT( 7X,1H|,124X,1H|                                                  ) OUT11400
 1050 FORMAT( 7X,1H|,124X,1H|, / 7X,1H|,124X,1H|                               ) OUT11410
 1060 FORMAT( 7X,1H|,124X,1H|, / 7X,1H|,124X,1H| / 7X,1H|,124X,1H|             ) OUT11420
 1100 FORMAT( 7X, 1H|,  4X,                                                      OUT11430
     *117H*****  FUEL THERMAL CONDUCTIVITY EQUATION  *****   CONTROL SIGOUT11440
     *NAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 73-74 K2=, I2,2H |) OUT11450
 1101 FORMAT( 7X, 1H|,                                                           OUT11460
     *124H            K2 = (NCON).GT.0   :   READ IN TABLE FROM CARDS (INOUT11470
     *PUT GROUP NO. 5).   NAMELIST  INPUT2                                 ,   OUT11480
     * 1H| /  7X, 1H|,                                                          OUT11490
     *124H            K2 =            0   :   SAME AS PREVIOS STEP.            OUT11500
     *                                                                     ,   OUT11510
     * 1H| /  7X, 1H|,                                                          OUT11520
     *124H            K2 = (NCON) = -2   :   WARD DESIGN EQUATION  ( DENSOUT11530
     *ITY.LT.0.95 FRACTIONAL ).                                            ,   OUT11540
     * 1H|                                                                   ) OUT11550
 1102 FORMAT( 7X, 1H|,                                                           OUT11560
     *124H            K2 = (NCON) = -2   :   WARD DESIGN EQUATION  ( DENSOUT11570
     *ITY.GE.0.95 FRACTIONAL )                  89.5      59.0             ,   OUT11580
     * 1H| /  7X, 1H|,                                                          OUT11590
     *124H            K2 = (NCON) = -3   :   GODFREY EQUATION.                 OUT11600
     *                                          90.7      59.0             ,   OUT11610
     * 1H| /  7X, 1H|,                                                          OUT11620
     *124H          *  K2 = (NCON) = -4   :   LYONS EQUATION.   (DOCKET STOUT11630
     *M-50447-1 P.4,2-3)                        93.0      62.0             ,   OUT11640
     * 1H|                                                                   ) OUT11650
 1104 FORMAT( 7X, 1H|,                                                           OUT11660
     *124H            K2 = (NCON) = -5   :   RESAR-41 EQUATION (DOCKET STOUT11670
     *M-50480-1 P.4,4-9)                        86.2      64.5             ,   OUT11680
     * 1H|                                                                   ) OUT11690
 1103 FORMAT( 7X, 1H|,                                                           OUT11700
     *124H                                                  ----INTEGRAL KDT (WOUT11710
     */CM)----   FROM TO(DEG-C), AT RHO=0.95   0/2800  500/2800            ,   OUT11720
     * 1H| /  7X, 1H|,                                                          OUT11730
     *124H                                                                      OUT11740
     *                                              -----(W/CM)----          ,   OUT11750
     * 1H|                                                                   ) OUT11760
 1120 FORMAT( 7X, 1H|,  4X,                                                      OUT11770
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```
* SOURCE STATEMENT (OUT1     )*
     *117H*****  CLADDING PROPERTIES  *****                  CONTROL SIGOUT11780
     *NAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 75-76 K3=, I2,2H |) OUT11790
 1121 FORMAT( 7X, 1H|,                                                           OUT11800
     *124H            K3  (NCLAD).GT.0   :   READ IN TABLE FROM CARDS (INOUT11810
     *PUT GROUP NO. 6).   NAMELIST  INPUT3                                 ,   OUT11820
     * 1H| /  7X, 1H|,                                                          OUT11830
     *124H            K3 =            0   :   SAME AS PREVIOUS STEP.           OUT11840
     *                                                                     ,   OUT11850
     * 1H| /  7X, 1H|,                                                          OUT11860
     *124H            K3 =(NCLAD) = -2   :   ZIRCALOY-2  ( BUILT IN DATA OUT11870
     *).                                      REFER D- 964                 ,   OUT11880
     * 1H|                                                                   ) OUT11890
 1122 FORMAT( 7X, 1H|,                                                           OUT11900
     *124H            K3 =(NCLAD) = -4   :   ZIRCALOY-4  ( BUILT IN DATA OUT11910
     *).                                      REFER D- 964                 ,   OUT11920
     * 1H| /  7X, 1H|,                                                          OUT11930
     *124H            K3 =(NCLAD) = -9   :   20-PERCENT COLD WORKED TYPE OUT11940
     *316 STAINLESS STEEL.                                                 ,   OUT11950
     * 1H|                                                                   ) OUT11960
 1125 FORMAT( 7X, 1H|, 4X,                                                       OUT11970
     *113H*****  CLADDING YIELD STRENGTH EQUATION  *****     CONTROL SIGOUT11980
     *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IYIELD=,I2,5X , 1H| ) OUT11990
 1126 FORMAT( 7X, 1H|,                                                           OUT12000
     *124H                IYIELD=  0   :   YIELD STRENGTH IS USED FROM OUT12010
     *TABLE DATA WHICH IS ASSIGNED BY NCLAD.                               ,   OUT12020
     * 1H|                                                                   ) OUT12030
 1130 FORMAT( 7X, 1H|,  4X,                                                      OUT12040
     *117H*****  RADIAL FLUX DEPRESSION  *****                CONTROL SIGOUT12050
     *NAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 77-78 K4=, I2,2H |) OUT12060
 1131 FORMAT( 7X, 1H|,                                                           OUT12070
     *124H            K4   (NFLX).GT.0   :   READ IN TABLE FROM CARDS (INOUT12080
     *PUT GROUP NO. 7).   NAMELIST  INPUT4                                 ,   OUT12090
     * 1H| /  7X, 1H|,                                                          OUT12100
     *124H            K4 =            0   :   FLAT (FIRST STEP). SAME AS POUT12110
     *REVIOUS STEP (FROM SECOND STEP)                                      ,   OUT12120
     * 1H| /  7X, 1H|,                                                          OUT12130
     *124H            K4 = (NFLX) = -1   :   BUILT IN EQUATION ( BESSEL IOUT12140
     *-ZERO DISTRIBUTION )                    REFER D- 916,917             ,   OUT12150
     * 1H|                                                                   ) OUT12160
 1140 FORMAT( 7X, 1H|,  4X,                                                      OUT12170
     *117H*****  AXIAL POWER DISTRIBUTION  *****              CONTROL SIGOUT12180
     *NAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 79-80 K5=, I2,2H |) OUT12190
 1141 FORMAT( 7X, 1H|,                                                           OUT12200
     *124H            K5          ,GT.0   :   READ IN TABLE FROM CARDS (INOUT12210
     *PUT GROUP NO. 8).   NAMELIST  INPUT5                                 ,   OUT12220
     * 1H| /  7X, 1H|,                                                          OUT12230
     *124H            K5 =            0   :   SAME AS PREVIOUS STEP.           OUT12240
     *                                                                     ,   OUT12250
     * 1H|                                                                   ) OUT12260
 1142 FORMAT( 7X, 1H|, 4X,                                                       OUT12270
     *113H*****  IRRADIATION MODEL  *****                     CONTROL SIGOUT12280
     *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IFLUX =,I2,5X , 1H| ) OUT12290
 1143 FORMAT( 7X, 1H|,                                                           OUT12300
     *124H                IFLUX =  0   :   FAST FLUX IRRADIATION.               OUT12310
     *                                                                     ,   OUT12320
     * 1H| /  7X, 1H|,                                                          OUT12330
     *124H                IFLUX =  1   :   THERMAL FLUX IRRADIATION,            OUT12340
     *                                                                     ,   OUT12350
     * 1H|                                                                   ) OUT12360
```

```
* SOURCE STATEMENT (OUT1    )*

145   1145 FORMAT( 7X, 1HI, 4X,                                          OUT12370
           *113H*****  LINEAR HEAT RATE ASSIGNMENT SIGNAL  *****   CONTROL SIGOUT12380
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IPEAK =,I2,5X , 1HI ) OUT12390
146   1146 FORMAT( 7X, 1HI,                                              OUT12400
           *124H                    IPEAK.GT.0   :   LINEAR HEAT RATE WHICH IS ASOUT12410
           *SIGNED BY GROUP-3-INPUT IS CONSIDERED TO ROD-AVG-VALUE.        ,   OUT12420
           * 1HI /  7X, 1HI,                                                  OUT12430
           *124H                    IPEAK.LE.0   :   LINEAR HEAT RATE WHICH IS ASOUT12440
           *SIGNED BY GROUP-3-INPUT IS CONSIDERED TO ROD-PEAK-VALUE.       ,   OUT12450
           * 1HI                                                            ) OUT12460
147   1150 FORMAT( 7X, 1HI,  4X,                                          OUT12470
           *113H*****  CLADDING CREEP  *****                       CONTROL SIGOUT12480
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ICREP =,I2,5X , 1HI ) OUT12490
148   1151 FORMAT( 7X, 1HI,                                              OUT12500
           *124H                    ICREP.GT.0   :   READ IN TABLE FROM CARDS (INOUT12510
           *PUT GROUP NO. 4).   FORMATTED  F10.0, E10.0                    ,   OUT12520
           * 1HI /  7X, 1HI,                                                  OUT12530
           *124H                    ICREP =  0   :   NOT CREEP.             ,   OUT12540
           *                                                                ,   OUT12550
           * 1HI                                                            ) OUT12560
149   1153 FORMAT( 7X, 1HI,                                              OUT12570
           *124H                    ICREP = -2   :   SAME AS ATR ZIRCALOY TUBE.  OUT12580
           *J.NUCL.MAT. 41,(1971). P327.             REFER D- 950          ,   OUT12590
           * 1HI /  7X, 1HI,                                                  OUT12600
           *124H                    ICREP = -3   :   SAME AS PRESSURE TUBE.     OUT12610
           *                                          REFER D- 951          ,   OUT12620
           * 1HI /  7X, 1HI,                                                  OUT12630
           *124H                    ICREP = -4   :   SAME AS FIGRO WAPD-TM 618.  OUT12640
           *                                          REFER D- 952          ,   OUT12650
           * 1HI /  7X, 1HI,                                                  OUT12660
           *124H                    ICREP = -5   :   ATR(NEW) MODEL             OUT12670
           *                                          REFER D- 953          ,   OUT12680
           * 1HI                                                            ) OUT12690
150   1160 FORMAT( 7X, 1HI,  4X,                                          OUT12700
           *113H*****  STORED ENERGY CALCULATION  *****            CONTROL SIGOUT12710
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ISTOR =,I2,5X , 1HI ) OUT12720
151   1161 FORMAT( 7X, 1HI,                                              OUT12730
           *124H                    ISTOR =  0   :   STORED ENERGY CALCULATION ISOUT12740
           * NOT PERFORMED.                                                ,   OUT12750
           * 1HI /  7X, 1HI,                                                  OUT12760
           *124H                    ISTOR.LT.0   :   STORED ENERGY CALCULATION ISOUT12770
           * PERFORMED.                                 REFER D- 700        ,   OUT12780
           * 1HI                                                            ) OUT12790
152   1170 FORMAT( 7X, 1HI,  4X,                                          OUT12800
           *113H*****  HISTORY INPUT  *****                       CONTROL SIGOUT12810
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  NHIST =,I2,5X , 1HI ) OUT12820
153   1171 FORMAT( 7X, 1HI,                                              OUT12830
           *124H                    NHIST =  0   :   TIME DEPENDENT HISTORY.    OUT12840
           *                                                                ,   OUT12850
           * 1HI /  7X, 1HI,                                                  OUT12860
           *124H                    NHIST =  1   :   BURNUP DEPENDENT HISTORY.  OUT12870
           *                                                                ,   OUT12880
           * 1HI                                                            ) OUT12890
154   1180 FORMAT( 7X, 1HI,  4X,                                          OUT12900
           *113H*****  CLADDING ELASTIC DEFORMATION  *****          CONTROL SIGOUT12910
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ICDF  =,I2,5X , 1HI ) OUT12920
155   1181 FORMAT( 7X, 1HI,                                              OUT12930
           *124H                    ICDF  =  0   :   ELASTIC CLAD DEFLECTION NOT OUT12940
           *TAKEN INTO ACCOUNT.                                            ,   OUT12950
```



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* SOURCE STATEMENT (OUT1    )*

           * 1HI /  7X, 1HI,                                                  OUT12960
           *124H                    ICDF .LT.0   :   ELASTIC CLAD DEFLECTION TAKEOUT12970
           *N INTO ACCOUNT.                                                ,   OUT12980
           * 1HI                                                            ) OUT12990
156   1190 FORMAT( 7X, 1HI,  4X,                                          OUT13000
           *113H*****  FUEL SWELLING MODEL  *****                   CONTROL SIGOUT13010
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ISWELL=,I2,5X , 1HI ) OUT13020
157   1191 FORMAT( 7X, 1HI,                                              OUT13030
           *124H                    ISWELL=  0   :   FUEL SWELLING IS NOT TAKEN IOUT13040
           *NTO ACCOUNT.                                                   ,   OUT13050
           * 1HI /  7X, 1HI,                                                  OUT13060
           *124H                    ISWELL=  1   :   GEITHOFF. ET AL. MODEL IS USOUT13070
           *ED.                USED IN GAPCON ( CONSERVATIVE MODEL )       ,   OUT13080
           * 1HI /  7X, 1HI,                                                  OUT13090
           *124H                    ISWELL=  2   :   REVISED GAP CLOSURE MODEL ISOUT13100
           * USED.             USED IN GAPCON THERMAL-1 ( OPTIONAL )       ,   OUT13110
           * 1HI                                                            ) OUT13120
158   1200 FORMAT( 7X, 1HI,  4X,                                          OUT13130
           *113H*****  FUEL THERMAL EXPANSION EQUATION  *****       CONTROL SIGOUT13140
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  NEXP  =,I2,5X , 1HI ) OUT13150
159   1202 FORMAT( 7X, 1HI,                                              OUT13160
           *124H                                          ----THERMAL EXPANSIOUT13170
           *ON COEFF. AVERAGE   DELTA.L/L/(T2-T1)   25/2800  500/2800      ,   OUT13180
           * 1HI /  7X, 1HI,                                                  OUT13190
           *124H                                                              OUT13200
           *                                        ----(   /DEG-C)----    ,   OUT13210
           * 1HI                                                            ) OUT13220
160   1201 FORMAT( 7X, 1HI,                                              OUT13230
           *124H                    NEXP  =  0   :   FUEL THERMAL EXPANSION IS NOOUT13240
           *T TAKEN INTO ACCOUNT.                                          ,   OUT13250
           * 1HI /  7X, 1HI,                                                  OUT13260
           *124H                    NEXP  =  1   :   ROTH AND HALTEMAN.      ( GAOUT13270
           *PCON )                  REFER D-812      1.1145E-5 1.1430E-5    ,   OUT13280
           * 1HI /  7X, 1HI,                                                  OUT13290
           *124H          *         NEXP  =  2   :   CONWAY,FINCEL AND MAIN  ( GAOUT13300
           *PCON THERMAL-1 )        REFER D-812      1.4978E-5 1.6354E-5    ,   OUT13310
           * 1HI                                                            ) OUT13320
161   1210 FORMAT( 7X, 1HI,  4X,                                          OUT13330
           *120H*****  CALCULATE THE CALDDING-TO-COOLANT HEAT TRANSFER COEFFICOUT13340
           *IENT  *****                                                  , 1HI / OUT13350
           *        7X, 1HI,  4X,                                          OUT13360
           *113H                                                   CONTROL SIGOUT13370
           *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  SIGHF =,  F7.3, 1HI ) OUT13380
162   1211 FORMAT( 7X, 1HI,                                              OUT13390
           *124H                    SIGHF.GT.0.  :   COOLANT IS UNSPECIFIED AND TOUT13400
           *HE FILM COEFFICIENT WILL BE SET TO SIGHF.                      ,   OUT13410
           * 1HI /  7X, 1HI,                                                  OUT13420
           *124H                    SIGHF =  0.  :   COOLANT IS LIQUID SODIUM. ( OUT13430
           *PRESENTED HEDL-TME 71-32, JUNE 1971 ).                         ,   OUT13440
           * 1HI /  7X, 1HI,                                                  OUT13450
           *124H                    SIGHF = -1.  :   COOLANT IS WATER.       ( OUT13460
           *DITTUS-BOELTER EQUATION ).                REFER D- 929         ,   OUT13470
           * 1HI                                                            ) OUT13480
163   1212 FORMAT( 7X, 1HI,                                              OUT13490
           *124H                    SIGHF = -2.  :   COOLANT IS WATER.       ( OUT13500
           *JENS LOTTES EQUATION )                    REFER D- 526         ,   OUT13510
           * 1HI /  7X, 1HI,                                                  OUT13520
           *124H                    SIGHF = -3.  :   SUBCOOL-DITTUS BOELTER.  SATOUT13530
           *URATE-JENS LOTTES                                              ,   OUT13540
```

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* SOURCE STATEMENT (OUT1     )*
                                                                                  ) OUT13550
          * 1H1                                                                     OUT13560
  164   1220 FORMAT( 7X, 1H1, 4X,
          *113H*****  FUEL THERMAL EXPANSION MODEL  *****          CONTROL SIGOUT13570
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MEXP  =,I2,5X , 1H1 ) OUT13580
  165   1221 FORMAT( 7X,1H1,                                                      OUT13590
          *124H                    MEXP  =  1   :   GAPCON MODEL,      ( MOST CONOUT13600
          *SERVATIVE    )                                                  ,      OUT13610
          * 1H1 /  7X, 1H1,                                                        OUT13620
          *124H                    MEXP  =  2   :   PLASTIC MODEL,     ( AREA BALOUT13630
          *ANCE TYPE    )                                                  ,      OUT13640
          * 1H1 /  7X, 1H1,                                                        OUT13650
          *124H                    MEXP  =  3   :   TWO REGION MODEL, ( HALF CRAOUT13660
          *CK TYPE      )                                                  ,      OUT13670
          * 1H1 /  7X,1H1 ,                                                        OUT13680
          *124H                    MEXP  =  4   :   BRITTLE MODEL,     ( CONPLETEOUT13690
          * CRACK TYPE )                                                    ,      OUT13700
          * 1H1                                                                 ) OUT13710
  166   1230 FORMAT( 7X, 1H1, 4X,                                                 OUT13720
          *113H*****  GAP CONDUCTANCE CONVERGENCE METHOD  *****   CONTROL SIGOUT13730
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MCONV =,I2,5X , 1H1 ) OUT13740
  167   1231 FORMAT( 7X, 1H1,                                                     OUT13750
          *124H                    MCONV =  0   :   SIMILAR METHOD WHICH IS USEDOUT13760
          * FOR GAPCON-THERMAL-1.                                           ,      OUT13770
          * 1H1 /  7X, 1H1,                                                        OUT13780
          *124H                    MCONV =  1   :   NEWTON-RAPHSON METHOD.         OUT13790
          *                                                                  ,      OUT13800
          * 1H1                                                                 ) OUT13810
  168   1235 FORMAT( 7X, 1H1, 4X,                                                 OUT13820
          *113H*****  GAP CONDUCTANCE EQUATION  *****          CONTROL SIGOUT13830
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MREV1 =,I2,5X , 1H1 ) OUT13840
  169   1236 FORMAT( 7X, 1H1,                                                     OUT13850
          *124H                    MREV1 = -1   :   RESAR-41 EQUATION              OUT13860
          *                                                                  ,      OUT13870
          * 1H1 /  7X, 1H1,                                                        OUT13880
          * 60H                    MREV1 =  1   :   ROSS AND STOUTE EQUATION       OUT13890
          * ,64X,1H1                                                            ) OUT13900
  170   1240 FORMAT( 7X, 1H1, 4X,                                                 OUT13910
          *113H*****  FUEL DENSIFICATION MODEL  *****          CONTROL SIGOUT13920
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MDEN  =,I2,5X , 1H1 ) OUT13930
  171   1241 FORMAT( 7X, 1H1,                                                     OUT13940
          *124H                    MDEN  =  0   :   DENSIFICATION IS NOT TAKEN IOUT13950
          *NTO ACCOUNT.                                                    ,      OUT13960
          * 1H1                                                                 ) OUT13970
  172   1242 FORMAT( 7X, 1H1,                                                     OUT13980
          *124H                    MDEN  =  1   :   HALDEN DENSIFICATION MODEL, OUT13990
          *                                          REFER D- 946          ,      OUT14000
          * 1H1 /  7X, 1H1,                                                        OUT14010
          *124H                    MDEN  =  2   :   GAPCON THERMAL-2 DENSIFICATIOUT14020
          *ON MODEL                                                        ,      OUT14030
          * 1H1                                                                 ) OUT14040
  173   1250 FORMAT( 7X, 1H1, 4X,                                                 OUT14050
          *113H*****  FUEL RELOCATION MODEL  *****          CONTROL SIGOUT14060
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MRELOC=,I2,5X , 1H1 ) OUT14070
  174   1251 FORMAT( 7X, 1H1,                                                     OUT14080
          *124H                    MRELOC=  0   :   RELOCATION IS NOT TAKEN INTOOUT14090
          * ACCOUNT.                                                        ,      OUT14100
          * 1H1                                                                 ) OUT14110
  175   1252 FORMAT( 7X, 1H1,                                                     OUT14120
          *124H                    MRELOC=  1   :   GAPCON THERMAL 2 RELOCATION OUT14130
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* SOURCE STATEMENT (OUT1     )*
          *MODEL                                     REFER D-1123          ,      OUT14140
          * 1H1                                                                 ) OUT14150
  176   1260 FORMAT( 7X, 1H1, 4X,                                                 OUT14160
          *113H*****  TEMPERATURE DISTRIBUTION PRINTED  *****   CONTROL SIGOUT14170
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IIPROF=,I2,5X , 1H1 ) OUT14180
  177   1261 FORMAT( 7X, 1H1,                                                     OUT14190
          *124H                    IIPROF=  0   :   RADIAL TEMPERATURE PROFILE IOUT14200
          *S NOT PRINTED.                                                  ,      OUT14210
          * 1H1 /  7X, 1H1,                                                        OUT14220
          *124H                    IIPROF=  1   :   RADIAL TEMPERATURE PROFILE IOUT14230
          *S PRINTED.                                                      ,      OUT14240
          * 1H1                                                                 ) OUT14250
  178   1270 FORMAT( 7X, 1H1, 4X,                                                 OUT14260
          *113H*****  RESTRUCTURING MODEL  *****          CONTROL SIGOUT14270
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MREST =,I2,5X , 1H1 ) OUT14280
  179   1271 FORMAT( 7X, 1H1,                                                     OUT14290
          *124H                    MREST =  0   :   RESTRUCTURING CALCULATION ISOUT14300
          *NOT PERFORMED.                                                  ,      OUT14310
          * 1H1 /  7X, 1H1,                                                        OUT14320
          *124H                    MREST =  1   :   RESTRUCTURNIG CALCULATION ISOUT14330
          * PERFORMED.                                 REFER D- 936          ,      OUT14340
          * 1H1                                                                 ) OUT14350
  180   1275 FORMAT( 7X, 1H1, 4X,                                                 OUT14360
          *113H*****  FUEL CREEP  *****          CONTROL SIGOUT14370
          *NAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  LCREP =,I2,5X , 1H1 ) OUT14380
  181   1276 FORMAT( 7X, 1H1,                                                     OUT14390
          *124H                    LCREP =  0   :   FUEL NOT CREEP.                OUT14400
          *                                                                  ,      OUT14410
          * 1H1 /  7X, 1H1,                                                        OUT14420
          *124H                    LCREP =  1   :   FUEL CREEP.                    OUT14430
          *                                                                  ,      OUT14440
          * 1H1                                                                 ) OUT14450
      C   *    1    *    2    *    3    *    4    *    5    *    6    *    7  OUT14460
  182       END                                                                   OUT14470
```

* SOURCE STATEMENT *

```
      SUBROUTINE PAPLOT(NPOW,NEWK,NEWCL,NEWFLX)                         PAPL0010
C                                                                       PAPL0020
C     THIS SUBROUTINE IS CALLED FROM MAIN                               PAPL0030
C     AXIAL POWER DISTRIBUTION PRINT                                    PAPL0040
C                                                                       PAPL0050
      COMMON /POWREF/ POWREF(21)                                        PAPL0060
      DIMENSION POWE1(21),PNORM(21),PLOT(51)                            PAPL0070
      DIMENSION IF(7)                                                   PAPL0080
      DATA ISPAN,ISPAN1 / 50,51 /                                       PAPL0090
      IFLAT = 0                                                         PAPL0100
C                                                                       PAPL0110
      DO 10 I=1,NPOW                                                    PAPL0120
      POWE1(I) = (POWREF(I) + POWREF(I+1)) / 2.0                        PAPL0130
   10 CONTINUE                                                          PAPL0140
      PAMAX = PAMIN = PTOT = POWE1(1)                                   PAPL0150
C                                                                       PAPL0160
      IF(NPOW.LE.1) GO TO 30                                            PAPL0170
      DO 20 I=2,NPOW                                                    PAPL0180
      IF(PAMAX.LT.POWE1(I))   PAMAX = POWE1(I)                          PAPL0190
      IF(PAMIN.GT.POWE1(I))   PAMIN = POWE1(I)                          PAPL0200
      PTOT = PTOT + POWE1(I)                                            PAPL0210
   20 CONTINUE                                                          PAPL0220
   30 CONTINUE                                                          PAPL0230
      PAAVG = PTOT / FLOAT(NPOW)                                        PAPL0240
      FSPAN = PAMAX - PAMIN                                             PAPL0250
      IF(FSPAN.LT.0.0001) IFLAT = 1                                     PAPL0260
      DO 40 I=1,NPOW                                                    PAPL0270
      PNORM(I) = POWE1(I) / PAAVG                                       PAPL0280
   40 CONTINUE                                                          PAPL0290
      IAVG = FLOAT(ISPAN) * (PAAVG - PAMIN) / (PAMAX - PAMIN) + 1.0     PAPL0300
C     IPOS=100                                                          PAPL0310
      IPOS = 64 + IAVG                                                  PAPL0320
      ENCODE(4,100,IF(3)) IPOS                                          PAPL0330
      IF(1)=4H(1H+                                                      PAPL0340
      IF(2)=4H,                                                         PAPL0350
      IF(4)=4HMAX,4H                                                    PAPL0360
      IF(5)=4HAVG,                                                      PAPL0370
      IF(6)=4H )                                                        PAPL0380
      IF(NEWK.GT.0.OR.NEWCL.GT.0.OR.NEWFLX.GT.0) GO TO 45               PAPL0390
      WRITE(6,600)                                                      PAPL0400
   45 CONTINUE                                                          PAPL0410
      NPOW1 = NPOW + 1                                                  PAPL0420
      WRITE(6,660)                                                      PAPL0430
      WRITE(6,610) NPOW,NPOW1,NPOW1                                     PAPL0440
      WRITE(6,670)                                                      PAPL0450
      WRITE(6,612)                                                      PAPL0460
      IF(IAVG.LT.6.OR.IAVG.GT.46) GO TO 47                              PAPL0470
      WRITE(6,IF)                                                       PAPL0480
   47 CONTINUE                                                          PAPL0490
      WRITE(6,675)                                                      PAPL0500
      WRITE(6,620) NPOW1,POWREF(NPOW1)                                  PAPL0510
C                                                                       PAPL0520
      DO 70 III=1,NPOW                                                  PAPL0530
      I = NPOW + 1 - III                                                PAPL0540
      DO 50 IS=1,ISPAN1                                                 PAPL0550
   50 PLOT(IS) = 1H                                                     PAPL0560
      PLOT(1) = PLOT(IAVG) = PLOT(ISPAN1) = 1H!                         PAPL0570
      II = 1                                                            PAPL0580
      IF(IFLAT.EQ.1) GO TO 60                                           PAPL0590
```


* SOURCE STATEMENT (PAPLOT)*

```
      II = (FLOAT(ISPAN) * (POWE1(I) - PAMIN))/ FSPAN + 1.0             PAPL0600
   60 PLOT(II) = 1H*                                                    PAPL0610
      IF(I.GT.1) WRITE(6,630) I,POWREF(I),PNORM(I),PLOT                 PAPL0620
      IF(I.EQ.1) WRITE(6,640) I,POWREF(I),PNORM(I),PLOT                 PAPL0630
   70 CONTINUE                                                          PAPL0640
      WRITE(6,650)                                                      PAPL0650
      RETURN                                                            PAPL0660
C  *    1    *    2    *    3    *    4    *    5    *    6    *    7   PAPL0670
  100 FORMAT(I4)                                                        PAPL0680
  600 FORMAT(1H1 / 7X,126(1H*), / 7X,1H*,124X,1H* )                     PAPL0690
  610 FORMAT( 7X,                                                       PAPL0700
     A 56H*   (  )  AXIAL POWER DISTRIBUTION          SEGMENT NO.=,I3,  PAPL0710
     B 21H,    NODAL POINT NO.=, I3,22X,6HPOWER(,     I2 ,1H),11X ,1H*) PAPL0720
  612 FORMAT( 7X, 1H*, 34X,                                             PAPL0730
     1 60HINPUT       SEGMENT        ......AXIAL POWER DISTRIBUTION (SEG, PAPL0740
     2 1HMENT MEAN)...... ,  14X,1H* /                                  PAPL0750
     3          7X, 1H*, 34X,                                          PAPL0760
     4 30HVALUE        MEAN          MIN.  , 44X,  4HMAX, ,12X, 1H*    ) PAPL0770
  620 FORMAT( 7X,1H*,5X                                                 PAPL0780
     1 20H    TOP.......POWER(,I2, 2H)=,  F12.6 ,83X            ,1H*   ) PAPL0790
  630 FORMAT( 7X,1H*,5X                                                 PAPL0800
     1 20H                POWER(,I2, 2H)=, 2F12.6 , 6X, 51A1, 14X,1H*  ) PAPL0810
  640 FORMAT( 7X,1H*,5X                                                 PAPL0820
     1 20H    BOTTOM....POWER(,I2, 2H)=, 2F12.6 , 6X, 51A1, 14X,1H*    ) PAPL0830
  650 FORMAT(  7X,1H*,124X,1H* /    7X,126(1H*)                         ) PAPL0840
  660 FORMAT( 7X,1H*,124X,1H*       )                                   PAPL0850
  670 FORMAT( 7X, 1H*, 124X, 1H*  )                                     PAPL0860
C  *    1    *    2    *    3    *    4    *    5    *    6    *    7   PAPL0870
      END                                                               PAPL0880
```

* SOURCE STATEMENT *

```
 1        SUBROUTINE POADIS                                              PDIS0010
    C                                                                    PDIS0020
    C     THIS SUBROUTINE IS CALLED FROM STEP=1 AND MAIN                 PDIS0030
    C     REFER ENAL-1778, GAPCON THERMAL=1                              PDIS0040
    C                                                                    PDIS0050
 5        COMMON /POARAY/ PAVRG,FUELL,FL,POW(21)  ,AI(21),NPOW,PTOT,LPMAX, PDIS0060
         *                PKPOWR,IPEAK,DELP,PMAX                         PDIS0070
 3        COMMON /POWREF/ POWER(21)                                      PDIS0080
    C                                                                    PDIS0090
    C                                                                    PDIS0100
    C                                                                    PDIS0110
 4        AINCR = .5/FLOAT(NPOW)                                         PDIS0120
 5        NPOW1 = NPOW + 1                                               PDIS0130
 6        AI(1) = (POWER(1)+POWER(2))*AINCR                              PDIS0140
 7        LPMAX = 1                                                      PDIS0150
 8        POLD = (POWER(1)+POWER(2))*.5                                  PDIS0160
 9        IF(NPOW.LE.1) GO TO 101                                        PDIS0170
10        DO 100 I=2,NPOW                                                PDIS0180
11        P = (POWER(I)+POWER(I+1))*.5                                   PDIS0190
12        AI(I) = AI(I-1) + (POWER(I+1)+POWER(I))*AINCR                  PDIS0200
13        IF(P.LT.POLD) GO TO 100                                        PDIS0210
14        LPMAX = I                                                      PDIS0220
15        POLD = P                                                       PDIS0230
16    100 CONTINUE                                                       PDIS0240
17    101 CONTINUE                                                       PDIS0250
18        AITOT = AI(NPOW)                                               PDIS0260
    C                                                                    PDIS0270
    C     RENORMALIZE THE POWER AND SUCH THAT AI(1)=1.0                  PDIS0280
    C                                                                    PDIS0290
19        IF(IPEAK.LE.0) GO TO 300                                       PDIS0300
20        DO 200 I=1,NPOW                                                PDIS0310
21        POW(I) = POWER(I) * PAVRG / AITOT                              PDIS0320
22        AI(I) = AI(I)/AITOT                                            PDIS0330
23    200 CONTINUE                                                       PDIS0340
24        POW(NPOW+1) = POWER(NPOW+1) * PAVRG / AITOT                    PDIS0350
    C                                                                    PDIS0360
25        GO TO 900                                                      PDIS0370
    C                                                                    PDIS0380
    C     CALCULATE POWER DISTRIBUTION BASED ON PEAK POWER (KW/FT)       PDIS0390
    C                                                                    PDIS0400
26    300 CONTINUE                                                       PDIS0410
27        PEAK = POWER(1)                                                PDIS0420
28        DO 310 I=2,NPOW1                                               PDIS0430
29        PEAK = AMAX1(PEAK,POWER(I))                                    PDIS0440
30    310 CONTINUE                                                       PDIS0450
    C                                                                    PDIS0460
    C     NORMALIZE THE POWER DISTRIBUTION TO PKPOWR                     PDIS0470
    C                                                                    PDIS0480
31        DO 320 I=1,NPOW1                                               PDIS0490
32        POW(I) = POWER(I) * PKPOWR / PEAK                              PDIS0500
33        AI(I) = AI(I)/AITOT                                            PDIS0510
34    320 CONTINUE                                                       PDIS0520
35        PAVRG = AITOT*PKPOWR/(PEAK)                                    PDIS0530
36    900 CONTINUE                                                       PDIS0540
37        PTOT = FUELL*PAVRG                                             PDIS0550
38        RETURN                                                         PDIS0560
    C*************************                                           PDIS0570
39        END                                                            PDIS0580
```

* SOURCE STATEMENT *

```
      SUBROUTINE PRINT1                                                 PRIN0010
C                                                                       PRIN0020
C                                                                       PRIN0030
      REAL LFUEL,LF,MOL,MOLEFR                                          PRIN0040
C-----------------------------------------------------------------------PRIN0050
      COMMON /MOL678/ MOLEFR(6)                                         PRIN0060
      COMMON /ML5938/ TBAR(20)                                          PRIN0070
      COMMON /MOL9  / FXMOL(6,21),RDOT(20)                              PRIN0080
      COMMON /MOL579/ PRESTO(20)                                        PRIN0090
      COMMON /MOLM9 / TAVGXX(20)                                        PRIN0100
      COMMON /COM39 / HFLUX(20)                                         PRIN0110
      COMMON /COM89 / HGX(20),RGAPX(20),TCLINE(20)                      PRIN0120
C                                                                       PRIN0130
      COMMON /BURN / BURN(20),BUOLD(20)                                 PRIN0140
      COMMON /MOLPRI/ GMOLI(6),GMOLR(6),FRACTN(6),MOL(6),XMOLS(21)      PRIN0150
      COMMON /PRINO1/ TCOLT(20) ,HFILM(20) ,TCOCA(20) ,TCICA(20) ,      PRIN0160
     *     CCONB(20) ,TGAPC(20) ,HFLXFB(20),GCS(20)   ,GCG(20)   ,      PRIN0170
     *     GCR(20)   ,GCT(20)   ,TJUMP(20) ,DRTF(20)  ,DRSF(20)  ,      PRIN0180
     *     DRF(20)   ,DRTC(20)  ,DRPC(20)  ,DRCLD(20) ,TFSCA(20) ,      PRIN0190
     *     DRCC(20)  ,BR1(20)   ,BR2(20)   ,BR3(20)   ,BR4(20)   ,      PRIN0200
     *     RATF(20)  ,RATC(20)  ,CPRES(20) ,CSTRES(20),GASCC(20) ,      PRIN0210
     *     GASCB(20) ,ITERZ(20)                                         PRIN0220
      COMMON /PRINO2/ CP1(20)   ,CP2(20)   ,ST1(20)   ,ST2(20)   ,      PRIN0230
     *                ST3(20)   ,ST4(20)   ,ST5(20)   ,ST6(20)          PRIN0240
      COMMON /PRINO3/ DRDF(20),DRRF(20),FCONT(20),TDISM(20)             PRIN0250
C-----------------------------------------------------------------------PRIN0260
      COMMON /INPUT / FRDEN,FRSIN,DSINZ,FRPUO2,FR35,FR40,FR41,DFS,DCI,  PRIN0270
     1                DCO,DVOIDZ,VPLENZ,ATMOS,S,XX,ROUF,ROUC,EXTP,DE,V, PRIN0280
     2                TINLET,DELT,TMAX,TFR,TM,DBO,BK,HBC,SIGMF,IFLUX,   PRIN0290
     3                NCLAD,NCON,NFLX,KOOL,NEWK,NEWCL,NEWFLX,VOIDZL,NOM,PRIN0300
     4                FRACHE,FRACAR,FRACH,FRACN,FRACKR,FRACXE,HGACEL,   PRIN0310
     5                DTEMP,ITOT,HG ,PEKAVG,MINI,ICDF,ISTOR,ICREP,ISWELLPRIN0320
     6                ,NEXP,HEXP,NHIST                                  PRIN0330
      COMMON /COM 08/ II,JCASE,TCOOLF,XMOTOT                            PRIN0340
      COMMON /COM 10/ VVOIDZ,FRUO2,TPLENA,NPOW1                         PRIN0350
      COMMON /POWRAY/ PAVRG      ,LFUEL      ,LF         ,POWER(21)     PRIN0360
     1    ,AI(21)    ,NPOW       ,PTOT       ,LPMAX      ,PKPOWR        PRIN0370
     2    ,IPEAK     ,DELP       ,PMAX                                  PRIN0380
      COMMON /BRNGAS/ NKR(20)    ,NXE(20)    ,PHI(20)    ,ENXE(20)      PRIN0390
     1    ,ENKR(20)                                                     PRIN0400
      COMMON /COM 02/ IPOW,ISTEP,ITER,KOUNT                             PRIN0410
      COMMON /COM 05/ BURNUP,TDAYS,VVOID,TOTLDY,TOTBUR                  PRIN0420
      COMMON /MEMO1 / MEMO1(20,5),HATA(20)                              PRIN0430
      COMMON /FFMOL / FF(6,23),RKR(6,23),RXE(6,23),AKX(10,20,2)         PRIN0440
      COMMON /PRIMOL/ AANKR,AANXE                                       PRIN0450
      COMMON /DIMEN1/ DVOIDX(20),DVOIDM(20),DFSX(20),DCIX(20),DCOX(20), PRIN0460
     1                VVOIDX(20),VVOIDM(20),TSINX(20),RSINX(20)         PRIN0470
     2               ,ZLENGT(5,20),VOIDL(20)                            PRIN0480
      COMMON /COM3P/ TSAT                                               PRIN0490
      COMMON /NUCLEI/ NUCLEI,A(40,23)                                   PRIN0500
      COMMON /COM128/ IOUT1,IIPROF                                      PRIN0510
      COMMON /CON49P/ DC(20,51),IPROF                                   PRIN0520
      COMMON /DIMEN2/ DENSFL(5,20)                                      PRIN0530
      COMMON / PLOT / IPLOT                                             PRIN0540
C                                                                       PRIN0550
      DIMENSION XDUM1(20),XDUM2(20),XDUM3(20)                           PRIN0560
      DIMENSION NAM(6,2)                                                PRIN0570
      DIMENSION GMOLG(6)                                                PRIN0580
C                                                                       PRIN0590
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* SOURCE STATEMENT (PRINT1)*

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      DATA (NAM(1,J),J=1,2) /4H  HE,4HLIUM/                             PRIN0600
     1    ,(NAM(2,J),J=1,2) /4H   A,4HRGON/                             PRIN0610
     2    ,(NAM(3,J),J=1,2) /4HHYDR,4HOGEN/                             PRIN0620
     3    ,(NAM(4,J),J=1,2) /4HNITR,4HOGEN/                             PRIN0630
     4    ,(NAM(5,J),J=1,2) /4H KRY,4HPTON/                             PRIN0640
     5    ,(NAM(6,J),J=1,2) /4H   X,4HENON/                             PRIN0650
      DATA GMOLG / 6*0.0 /                                              PRIN0660
      DATA KATG /0/                                                     PRIN0670
      DATA IDUMB/1H /                                                   PRIN0680
      DATA IMODE/4HNODE/                                                PRIN0690
C                                                                       PRIN0700
C================== PARAMETERS DISCRIPTION ==========================PRIN0710
C                                                                       PRIN0720
C     NPOW      NUMBER OF AXIAL NODES                                   PRIN0730
C     LFUEL     PELLET STACK LENGTH (CM)                                PRIN0740
C     POWER     AXIAL POWER DISTRIBUTION (WATT/CM)                      PRIN0750
C                                                                       PRIN0760
C     BURN      BURNUP AT EACH NODE AND TIME  (MWD/TON)                 PRIN0770
C     TCOLT     COOLANT TEMPERATURE (DEG C)                             PRIN0780
C     HFILM     FILM COEFFICIENT (W/CM2/C)                              PRIN0790
C     TCOCA     CLAD OD TEMPERATURE (DEG C)                             PRIN0800
C     TCOFA               ;           (DEG F)                           PRIN0810
C     TCICA     CLAD ID TEMPERATURE (DEG C)                             PRIN0820
C     TCIFA               ;           (DEG F)                           PRIN0830
C     CCONB     CLAD THERMAL CONDUCTIVITY (W/CM/C)                      PRIN0840
C     TGAPC     MEAN GAP TEMPERATURE (DEG C)                            PRIN0850
C     HFLXFB    FUEL SURFACE HEAT FLUX (W/CM2)                          PRIN0860
C     GCS       SOLID-SOLID CONTACT CONDUCTANCE (W/CM2/C)               PRIN0870
C     GCG       CONDUCTION THROUGH THE GASES     (      ;       )       PRIN0880
C     GCR       RADIATION CONDUCTANCE            (      ;       )       PRIN0890
C     GCT       TOTAL GAP CONDUCTANCE            (      ;       )       PRIN0900
C     RDOT      FP GAS RELEASE RATE AT EACH AXIAL NODE                  PRIN0910
C     TJUMP     TEMPERATURE JUMP DISTANCE (CM)                          PRIN0920
C     DRTF      INCREASE OF FUEL OD DUE TO THERMAL EXPANSION (CM)       PRIN0930
C     DRSF                ;                 SWELLING (CM)               PRIN0940
C     DRRF                ;                 RELOCATION                  PRIN0950
C     DRDF      DECREASE OF FUEL OD DUE TO DENSIFICATION                PRIN0960
C     DRF       TOTAL FUEL OD INCREASE  (CM)    = DRTF + DRSF           PRIN0970
C     DRTC      INCREASE OF CLAD OD DUE TO THERMAL EXPANSION  (CM)      PRIN0980
C     DRPC                ;                 ELACTIC DEFORMATION ( ; )   PRIN0990
C     DRCC                ;                 CREEP             ( ; )     PRIN1000
C     DRCLD     TOTAL CLAD OD INCREASE  = DRTC + DRPC + DRCC   ( ; )    PRIN1010
C     TFSCA     FUEL SURFACE TEMPERATURE (DEG C)                        PRIN1020
C     TCLINE    FUEL CENTER-LINE TEMPERATURE (DEG C)                    PRIN1030
C     TBAR      VOLUME AVERAGED FUEL TEMPERATURE (DEG C)                PRIN1040
C     BR1       CENTRAL VOID RADIUS (CM)                                PRIN1050
C     BR2       AT 1700DEG C RADIUS ( ; )                               PRIN1060
C     BR3       AT 1350      ;                                          PRIN1070
C     BR4       FUEL SURFACE RADIUS  ( HOT OD )   (CM)                  PRIN1080
C     RATF      PERCENT CHANGE IN ORIGINAL PELLET OD (PERCENT)          PRIN1090
C     RATC                ;                 CLAD OD                     PRIN1100
C     CPRES     FUEL-CLAD CONTACT PRESSURE (KG/CM2)                     PRIN1110
C     CSTRES    CLADDING HOOP STRESS (KG/CM2)                           PRIN1120
C                                                                       PRIN1130
C     CP1       NOMINAL HEAT CAPACITY (CAL/K-MOLE)                      PRIN1140
C     CP2                 ;           (BTU/LB-F)                        PRIN1150
C     ST1       STORED ENERGY AT TBAR (CAL/GRAM)                        PRIN1160
C     ST2                 ;           (BTU/LB)                          PRIN1170
C     ST3       VOLUME AVERAGED STORED ENERGY (CAL/GRAM)                PRIN1180
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* SOURCE STATEMENT (PRINT1  )*
C     ST4                    :                    (BTU/LB)                    PRIN1190
C     ST5        STORED ENERGY PER UNIT LENGTH (CAL/CM)                       PRIN1200
C     ST6                    :                    (BTU/FT)                    PRIN1210
C                                                                             PRIN1220
C     NKR        GENERATED KR PER UNIT LENGTH IN FUEL (MOLES/INCH)            PRIN1230
C     NXE                XE                 :                                 PRIN1240
C     PHI         NEUTRON FLUX (NV)                                           PRIN1250
C     HFLUX      CLAD OD HEAT FLUX                                            PRIN1260
C     PRESTO     INTERNAL GAS PRESSURE AT EACH AXIAL ITERATION (KG/CM2)       PRIN1270
C     TAVGXX     VOLUME AVERAGED TEMPERATURE OF TOTAL FUEL      (DEG C)       PRIN1280
C     GASCC      THERMAL CONDUCTIVITY OF FILL GAS (W/CM/C)                    PRIN1290
C     GASCB                  :                    (BTU/HR-FT-F)               PRIN1300
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7        PRIN1310
C                                                                             PRIN1320
C                                                                             PRIN1330
      IF(IPLOT.LE.0) GO TO 81                                                 PRIN1340
C                                                                             PRIN1350
      DUM = 0.0                                                               PRIN1360
      WRITE(8)  TOTLDY                                                        PRIN1370
      NN = NPOW+1                                                             PRIN1380
      WRITE(8)  (POWER(I),I=1,NN)                                             PRIN1390
      DO 10 I = 1 , NPOW                                                      PRIN1400
      WRITE(8)  BURN(I),TCOLT(I),TCICA(I),TFSCA(I),TCLINE(I),DRTF(I),         PRIN1410
     1          DRDF(I),DRSF(I),DRRF(I),RGAPX(I),DRTC(I),DRPC(I),             PRIN1420
     2          DRCC(I),GCT(I),CPRES(I),CSTRES(I),                            PRIN1430
     3          PRESTO(ISTEP+1) ,MOLEFR(5),MOLEFR(6),ST1(I),                  PRIN1440
     4          RATC(I),DUM,DUM,DUM                                           PRIN1450
   10 CONTINUE                                                                PRIN1460
C                                                                             PRIN1470
   81 CONTINUE                                                                PRIN1480
C                                                                             PRIN1490
      IF(NPOW.GT.15) KAIG=10                                                  PRIN1500
      IF(NPOW.GT.10.AND.NPOW.LE.15) KAIG=NPOW/2+1                             PRIN1510
      CALL HEAD(1)                                                            PRIN1520
      DIST=-1.*LF/2.                                                          PRIN1530
      WRITE(6,101)                                                            PRIN1540
      DO 11 I=1,NPOW                                                          PRIN1550
      DIST=DIST+LF                                                            PRIN1560
      A1  =DIST/2.54                                                          PRIN1570
      POWF=(POWER(I)+POWER(I+1))*.5                                           PRIN1580
      A2  =POWF/1000.*30.48                                                   PRIN1590
      A3  =HFILM(I)*30.48**2 * 3600./1.8/1055.                                PRIN1600
      A4  =HFLUX(I)*3170.                                                     PRIN1610
      IF(I.EQ.KAIG) WRITE(6,99)                                               PRIN1620
      WRITE(6,102) I,DIST,A1,POWF,A2,BURN(I),PHI(I),TCOLT(I),HFILM(I),A3PRIN1630
     1             ,HFLUX(I),A4                                               PRIN1640
   11 CONTINUE                                                                PRIN1650
      IF(NPOW.GE.20) WRITE(6,99)                                              PRIN1660
      IF(NPOW.LT.20) WRITE(6,1000)                                            PRIN1670
C                                                                             PRIN1680
      WRITE(6,201)                                                            PRIN1690
      WRITE(6,203)                                                            PRIN1700
      ITSUB = 0                                                               PRIN1710
      DO 21 I=1,NPOW                                                          PRIN1720
      A1=CCONB(I)*57.8                                                        PRIN1730
      A2=HFLAFB(I)*3170.                                                      PRIN1740
      A3=TGAPC(I)*1.8+32.                                                     PRIN1750
      TCOF=TCOCA(I)*1.8 + 32.                                                 PRIN1760
      TCIF=TCICA(I)*1.8 + 32.                                                 PRIN1770
```



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* SOURCE STATEMENT (PRINT1  )*
      IF(I.EQ.KAIG) WRITE(6,99)                                               PRIN1780
      WRITE(6,202) I,TCOCA(I),TCOF,TCICA(I),TCIF,CCONB(I),A1,TGAPC(I),        PRIN1790
     1             A3,HFLXFB(I),A2,(MEMO1(I,J),J=1,5),HA1A(I)                 PRIN1800
      DO 20 J=1,5                                                             PRIN1810
   20 ITSUB = ITSUB + MEMO1(I,J)                                              PRIN1820
   21 CONTINUE                                                                PRIN1830
      ITOT = ITOT + ITSUB                                                     PRIN1840
      WRITE(6,204) ITSUB,ITOT                                                 PRIN1850
C                                                                             PRIN1860
      IF(NPOW.GT.5) CALL HEAD(-1)                                             PRIN1870
      IF(NPOW.LE.5) WRITE(6,1000)                                             PRIN1880
C                                                                             PRIN1890
      WRITE(6,301)                                                            PRIN1900
      DO 31 I=1,NPOW                                                          PRIN1910
      A1=TJUMP(I)*10.                                                         PRIN1920
      A2=DRTF(I)*10.                                                          PRIN1930
      A3=DRSF(I)*10.                                                          PRIN1940
      A4=DRF(I)*10.                                                           PRIN1950
      A5=DRTC(I)*10.                                                          PRIN1960
      A6=DRCC(I)*10.                                                          PRIN1970
      A7=DRPC(I)*10.                                                          PRIN1980
      A8=DRCLD(I)*10.                                                         PRIN1990
      A9=RGAPX(I)*10.                                                         PRIN2000
      A10=GCS(I)*1763.                                                        PRIN2010
      A11=GCG(I)*1763.                                                        PRIN2020
      A12=GCK(I)*1763.                                                        PRIN2030
      A13=GCT(I)*1763.                                                        PRIN2040
C                                                                             PRIN2050
      IF(I.EQ.KAIG) WRITE(6,99)                                               PRIN2060
      WRITE(6,302) I,A10,A11,A12,A13,FF(ISTEP+1,I),A1,A2,A3,A4,A5,A6,A7,PRIN2070
     1             A8,A9,FCONT(I)                                             PRIN2080
   31 CONTINUE                                                                PRIN2090
      WRITE(6,1000)                                                           PRIN2100
C                                                                             PRIN2110
      WRITE(6,401)                                                            PRIN2120
      WRITE(6,403)                                                            PRIN2130
      DO 41 I=1,NPOW                                                          PRIN2140
      A1=BR1(I)*10.                                                           PRIN2150
      A2=BR2(I)*10.                                                           PRIN2160
      A3=BR3(I)*10.                                                           PRIN2170
      A4=BR4(I)*10.                                                           PRIN2180
      A5=CPRES(I)                                                             PRIN2190
      A6=CSTRES(I)                                                            PRIN2200
      A7=GASCB(I)*57.79                                                       PRIN2210
C                                                                             PRIN2220
      IF(I.EQ.KAIG) WRITE(6,99)                                               PRIN2230
      WRITE(6,402) I,TFSCA(I),TCLINE(I),TBAR(I),A1,A2,A3,A4,                  PRIN2240
     1             RATF(I),RATC(I),GASCC(I),A7,A5,A6                          PRIN2250
C                                                                             PRIN2260
   41 CONTINUE                                                                PRIN2270
      CALL HEAD(-1)                                                           PRIN2280
C ..... INFORMATION FOR GAS .....                                             PRIN2290
      A1=VPLENZ/16.3871                                                       PRIN2300
      WRITE(6,501) VPLENZ,A1                                                  PRIN2310
      A1 = TPLENA - 273.                                                      PRIN2320
      A2 = A1*1.8 + 32.                                                       PRIN2330
      WRITE(6,502) A1,A2                                                      PRIN2340
      IF(SIGHF.LT.0) WRITE(6,516) TSAT                                        PRIN2350
      A1=ATMOS*14.22                                                          PRIN2360
```

```
* SOURCE STATEMENT (PRINT1  )*
      WRITE(6,503) ATMOS,A1                                             PRIN2370
      A1=PRESTO(ISTEP+1)*14.22                                          PRIN2380
      WRITE(6,504) PRESTO(ISTEP+1),A1                                   PRIN2390
C                                                                       PRIN2400
      WRITE(6,505) XMOTOT                                               PRIN2410
      WRITE(6,506) XMOLS(NPOW+1)                                        PRIN2420
      A1=XMOTOT-XMOLS(NPOW+1)                                           PRIN2430
      WRITE(6,507) A1                                                   PRIN2440
      WRITE(6,515) RDOT(1)                                              PRIN2450
C                                                                       PRIN2460
      WRITE(6,508)                                                      PRIN2470
      A1=0.                                                             PRIN2480
      A2=0.                                                             PRIN2490
      GMOLG(5)=AANKP                                                    PRIN2500
      GMOLG(6)=AANXE                                                    PRIN2510
      A3=GMOLG(5)+GMOLG(6)                                              PRIN2520
      DO 51 I=1,6                                                       PRIN2530
      WRITE(6,509) (NAM(I,J),J=1,2),GMOLI(I),GMOLG(I),GMOLP(I),         PRIN2540
     1             MOL(I),MOLEFR(I)                                     PRIN2550
      A1=A1+GMOLI(I)                                                    PRIN2560
      A2=A2+GMOLR(I)                                                    PRIN2570
   51 CONTINUE                                                          PRIN2580
      WRITE(6,510) A1,A3,A2,XMOTOT                                      PRIN2590
C                                                                       PRIN2600
C ==== STORED ENERGY ====                                               PRIN2610
C                                                                       PRIN2620
      WRITE(6,511)                                                      PRIN2630
      DO 52 I=1,NPOW                                                    PRIN2640
      IF(.EQ.KAIG) WRITE(6,99)                                          PRIN2650
      WRITE(6,512) I,CP1(I),CP2(I),ST1(I),ST2(I),ST3(I),ST4(I),         PRIN2660
     1             ST5(I),ST6(I)                                        PRIN2670
   52 CONTINUE                                                          PRIN2680
C                                                                       PRIN2690
C ==== CONVERGENCE STATUS                                               PRIN2700
C                                                                       PRIN2710
      WRITE(6,1000)                                                     PRIN2720
      WRITE(6,513)                                                      PRIN2730
      DO 53 J=1,ISTEP                                                   PRIN2740
      I=J-1                                                             PRIN2750
      A1=TAVGXX(I)*1.8 - 32.                                            PRIN2760
      A2=PRESTO(I)*14.22                                                PRIN2770
      WRITE(6,514) J,TAVGXX(I),A1,PRESTO(I),A2                          PRIN2780
   53 CONTINUE                                                          PRIN2790
      ERROR=ABS((TAVGXX(ISTEP)-TAVGXX(ISTEP-1)) / TAVGXX(ISTEP-1))      PRIN2800
      WRITE(6,610) ERROR                                                PRIN2810
C                                                                       PRIN2820
      CALL HEAD(-1)                                                     PRIN2830
      WRITE(6,620)                                                      PRIN2840
      DO 54 I=1,NPOW                                                    PRIN2850
      A1=DRDF(I)*10.                                                    PRIN2860
      A2=DRRF(I)*10.                                                    PRIN2870
C                                                                       PRIN2880
      A3=RSTRX(I)*10.                                                   PRIN2890
      A4=CSTRX(I)                                                       PRIN2900
      A5=DVGIDX(I)*10./2.                                               PRIN2910
      A6=DFSX(I)*10./2.                                                 PRIN2920
      A7=DCIX(I)*10./2.                                                 PRIN2930
      A8=DCOX(I)*10./2.                                                 PRIN2940
      A9=VVOIDH(I)*1000.                                                PRIN2950
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* SOURCE STATEMENT (PRINT1  )*
      A10=DVOIDH(I)*10./2.                                              PRIN2960
      A11=VOIDE(I)*10.                                                  PRIN2970
C                                                                       PRIN2980
      IF(I.EQ.KAIG) WRITE(6,99)                                         PRIN2990
      WRITE(6,630) I,A1,A2,A3,A4,A10,A11,A9,A5,A6,A7,A8                 PRIN3000
   54 CONTINUE                                                          PRIN3010
C                                                                       PRIN3020
      WRITE(6,1000)                                                     PRIN3030
      WRITE(6,640)                                                      PRIN3040
      B1=B2=B3=B4=B5=0.0                                                PRIN3050
      B6=B7=B8=B9=B10=B11=0.0                                           PRIN3060
      DO 55 I=1,NPOW                                                    PRIN3070
      A1=ZLENGT(1,I)                                                    PRIN3080
      A2=ZLENGT(2,I)                                                    PRIN3090
      A3=ZLENGT(3,I)                                                    PRIN3100
      A4=ZLENGT(4,I)                                                    PRIN3110
      A5=ZLENGT(5,I)                                                    PRIN3120
      A6=TDISH(I)                                                       PRIN3130
      A7=DENSFL(1,I)                                                    PRIN3140
      A8=DENSFL(2,I)                                                    PRIN3150
      A9=DENSFL(3,I)                                                    PRIN3160
      A10=DENSFL(4,I)                                                   PRIN3170
      A11=DENSFL(5,I)                                                   PRIN3180
      B1=B1+A1                                                          PRIN3190
      B2=B2+A2                                                          PRIN3200
      B3=B3+A3                                                          PRIN3210
      B4=B4+A4                                                          PRIN3220
      B5=B5+A5                                                          PRIN3230
      B6=B6+A6                                                          PRIN3240
      B9=B9+A9                                                          PRIN3250
      IF(I.EQ.KAIG) WRITE(6,99)                                         PRIN3260
      WRITE(6,650) I,A1,A2,A3,A4,A5,A6,A7,A8,A9                         PRIN3270
   55 CONTINUE                                                          PRIN3280
      WRITE(6,655) B1,B2,B3,B4,B5,B6,B9                                 PRIN3290
C                                                                       PRIN3300
      IF(IIPROF.NE.1) RETURN                                            PRIN3310
C***** DETAIL TEMPERATURE DISTRIBUTION PRINT OUT (IF IIPROF.EQ.1 ONLY) PRIN3320
C                                                                       PRIN3330
      CALL HEAD(-1)                                                     PRIN3340
      NRING = 50                                                        PRIN3350
      WRITE(6,661)                                                      PRIN3360
C                                                                       PRIN3370
      DO 71 I=1,NPOW,2                                                  PRIN3380
C                                                                       PRIN3390
      I1 = I                                                            PRIN3400
      I6 = I + 6                                                        PRIN3410
      IF(I6.GE.NPOW) I6 = NPOW                                          PRIN3420
      WRITE(6,662) (INODE,II,II=I1,I6)                                  PRIN3430
      WRITE(6,663) (IDUMB,II=I1,I6)                                     PRIN3440
      WRITE(6,673) (IDUMB,II=I1,I6)                                     PRIN3450
      WRITE(6,664) (TCOLT(II),II=I1,I6)                                 PRIN3460
C                                                                       PRIN3470
      DO 72 J=I1,I6                                                     PRIN3480
      XDUM1(J )=BCOX(J)/2. + DRCLD(J)                                   PRIN3490
      XDUM2(J )=BCIX(J)/2. + DRCLD(J)                                   PRIN3500
   72 CONTINUE                                                          PRIN3510
C                                                                       PRIN3520
      WRITE(6,665) (XDUM1(II),TCOCA(II),II=I1,I6)                       PRIN3530
      WRITE(6,666) (XDUM2(II),TCICA(II),II=I1,I6)                       PRIN3540
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* SOURCE STATEMENT (PRINT1  )*

221        WRITE(6,667) (TGAPC(II),II=I1,I6)                                PRIN3550
222        WRITE(6,668) (BR4(II),TFSCA(II),II=I1,I6)                        PRIN3560
C                                                                           PRIN3570
223        K=5                                                              PRIN3580
224        DO 73 II=I1,I6                                                   PRIN3590
225     73 XDUM3(II)=BR4(II)-(BR4(II)-BR1(II))/FLOAT(NRING)*FLOAT(K)        PRIN3600
226        WRITE(6,669) K,(XDUM3(II),DC(II,K+1),II=I1,I6)                   PRIN3610
C                                                                           PRIN3620
227        DO 74 K=10,NRING,5                                               PRIN3630
228        IF(K.GE.NRING) GO TO 74                                          PRIN3640
229        DO 75 II=I1,I6                                                   PRIN3650
230     75 XDUM3(II)=BR4(II)-(BR4(II)-BR1(II))/FLOAT(NRING)*FLOAT(K)        PRIN3660
231        WRITE(6,670) K,(XDUM3(II),DC(II,K+1),II=I1,I6)                   PRIN3670
232     74 CONTINUE                                                         PRIN3680
233        WRITE(6,671) (BR1(II),TCLINE(II),II=I1,I6)                       PRIN3690
234        WRITE(6,672)                                                     PRIN3700
235     71 CONTINUE                                                         PRIN3710
C                                                                           PRIN3720
236        RETURN                                                           PRIN3730
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7     PRIN3740
C                                                                           PRIN3750
237     99 FORMAT(1H )                                                      PRIN3760
238   1000 FORMAT(/)                                                        PRIN3770
239    101 FORMAT(/3X,127H  AXIAL        AXIAL              LINEAR  HEAT   PRIN3780
           1GROUP      AVERAGE   COOLANT        FILM  COEFFICIENT        CLAD PRIN3790
           2D SURFACE  / 3X,122HSECTION      DISTANCE            RATING      PRIN3800
           3                    NEUTRON      TEMP.                 BTU      PRIN3810
           4 HEAT FLUX / 3X,131H NUMBER     (CM)  (INCH)       (W/CM)   (KW/FT) PRIN3820
           5   (MeV/N)   FLUX (NV)   (DEG C)     WATT/CM2-C   /HR-FT2-F   WATPRIN3830
           6T / CM2  BTU/HR-FT2  /                                          PRIN3840
           7  3X,7(1H-),2X,14(1H-),4X,18(1H-),4X,8(1H-),2X,10(1H-),2X,8(1H-), PRIN3850
           8  4X,22(1H-),4X,22(1H-)      )                                  PRIN3860
240    102 FORMAT(3X,I7,2F8.2,2X,2F10.4,2X,F10.2,2X,1PE10.3,0PF10.2,2X,2F12.3PRIN3870
           1,2X,2F12.3 )                                                    PRIN3880
241    201 FORMAT( 3X,                                                      PRIN3890
           *126H                 CLAD OD              CLAD ID             CLAD  THERPRIN3900
           *MAL        GAP                      FUEL  SURFACE        NO, OF GAP = /PRIN3910
           *  3X,                                                           PRIN3920
           *127HM   AXIAL     TEMPERATURE         TEMPERATURE          CONDUCTIVIPRIN3930
           *TY          AVERAGE                  HEAT  FLUX          CONDUCTANCE  /PRIN3940
           *  3X,                                                           PRIN3950
           *125HSECTION                                                   (WATT /      (BTPRIN3960
           *U /          TEMPERATURE                                       ITERATIONS   /PRIN3970
242    203 FORMAT(3X,                                                       PRIN3980
           *130H NUMBER  (DEG C)  (DEG F)   (DEG C)  (DEG F)        CM2-C)  HR-PRIN3990
           *FT-F)    (DEG C)  (DEG F)    WATT / CM2  BTU/HR-FT2       1  2  3  4 PRIN4000
           *U    / 3X,7(1H-),2X,15(1H-),3X,16(1H-),3X,20(1H-),3X,16(1H-),       PRIN4010
           * 3X,22(1H-),3X,15(1H-)      )                                   PRIN4020
243    202 FORMAT(3X,I7,2X,2F5.2,3X,2F8.2,3X,2F10.6,3X,2F8.2,3X,F11.3,F11.2, PRIN4030
           1    3X,5I3 ,2X,AL /                                             PRIN4040
244    204 FORMAT(        90X,   33HITERATION SUBTOTAL   (THIS STEP)=, I5  /  PRIN4050
           1                  90X,   33HITERATION TOTAL(UP TO THIS STEP)=, I5   ) PRIN4060
245    301 FORMAT(/2X,130H  AXIAL  GAP CONDUCTANCE(BTU/HR-FT2-F)     GAS    PRIN4070
           1EMP.       INCREASE IN FUEL RADIUS(MM)    INCREASE IN CLAD RADIUS(MMPRIN4080
           2)       RADIAL                                                   PRIN4090
           3 / 2X,132HSECTION SOLID   GAS-                          RELEASE  DUMP  PRIN4100
           4    THERMAL                          THERMAL                    *      PRIN4110
           5  GOT GAP                                                        PRIN4120
           6 / 2X,132H NUMBER  -SOLID CONDUCT RADIANT   TOTAL   RATE    DIST, PRIN4130


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* SOURCE STATEMENT (PRINT1  )*

           7+  SUBMISSION SWELLING     TOTAL  EXPAN.   CREEP  PRESSURE   TOTALPRIN4140
           8    (MM)                                                        PRIN4150
           9 / 2X,7(1H-),4(2X,7(1H-)),2X,7(1H-),2X,3(1H-),2X,2X(1H-),2X,      PRIN4160
           *   33(1H-),2X,8(1H-) )                                           PRIN4170
246    302 FORMAT(2X,I7,4F8.2,2X,F7.5,2X,F8.6,3F10.6,2X,4F5.5,2X,F4.5,1X,A1) PRIN4180
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7     PRIN4190
247    401 FORMAT(/2X,130H  AXIAL   FUEL      FUEL      VOL. AVG    FUEL  BOUPRIN4200
           INDRY  RADIUS  (MM)      PERCENT CHANGE    FILL GAS          CONTPRIN4210
           2ACT  CLAD ID                                                    PRIN4220
           3 / 2X,130HSECTION   SURFACE   CENTER    FUEL      CENTRAL   1700  PRIN4230
           4   1350              ORIGINAL RADIUS   CONDUCTIVITY      PRESSURE PRIN4240
           5THERMAL                                                         PRIN4250
           6 / 2X,130H NUMBER   TEMP.      TEMP.      TEMP.        VOID  DEG  C PRIN4260
           7  )DEG C    SURFACE  FUEL OD  CLAD OD  CAL/SEC C   BTU /         PRIN4270
           8STRESS      )                                                   PRIN4280
248    403 FORMAT(3X, 132H          (DEG C)   (DEG C)   (DEG C)     (MM)     (KPRIN4290
           1M)      (MM)      (MM)      (0/0)     (0/0)     -CM-C   HR-FT-F  (KG/CMPRIN4300
           2)  (KG/CM2)                                                     PRIN4310
           *  /2X,7(1H-),1X,3(2X,8(1H-)),2X,34(1H-),2(2X,16(1H-)),2(2X,8(1H-))PRIN4320
           *  )                                                             PRIN4330
249    402 FORMAT(2X,I7,1X,3F10.3,4F9.5,2F9.4,2F9.5,2F10.3)                 PRIN4340
C                                                                           PRIN4350
250    501 FORMAT(10X,35HPLENUM VOLUME                          ,F12.5,14H (CM3) PRIN4360
           1        ,5X,F12.5,14H (INCH3)          )                        PRIN4370
251    502 FORMAT(10X,35HPLENUM TEMPERATURE                     ,F12.5,14H (DEG CPRIN4380
           1)       ,5X,F12.5,14H (DEG F)          )                        PRIN4390
252    503 FORMAT(10X,35HINITIAL PLENUM PRESSURE                ,F12.5,14H (KG/CMPRIN4400
           12)      ,5X,F12.5,14H (PSI)            )                        PRIN4410
253    506 FORMAT(10X,35HCOOLANT SATURATE TEMPERATURE           ,F12.5,14H (DEG CPRIN4420
           1)                                                               PRIN4430
254    504 FORMAT(10X,35HINTERNAL GAS PRESSURE                  ,F12.5,14H (KG/CMPRIN4440
           12,      ,5X,F12.5,14H (PSI)            )                        PRIN4450
C   *    1    *    2    *    3    *    4    *    5    *    6    *    7     PRIN4460
255    505 FORMAT(10X,35HTOTAL GAS MOLES IN A PIN               ,E12.5,14H (MOLESPRIN4470
           1)       )                                                       PRIN4480
256    506 FORMAT(10X,35HGASES IN PLENUM                        ,E12.5,14H (MOLESPRIN4490
           1)       )                                                       PRIN4500
257    507 FORMAT(10X,35HGASES IN A GAP OR CENTRAL VOID         ,E12.5,14H (MOLESPRIN4510
           1)       )                                                       PRIN4520
258    512 FORMAT(23X,I7,2X,2F10.3,  3(3X,2F10.3)  )                        PRIN4530
259    513 FORMAT( 10X,65HAXIAL   VOLUME-TEMPERATURE AVERAGED   (CONVERGENCE PRIN4540
           1 IN ITERATION)  //15X,5HITER.,6X,11HTEMPERATURE,11X,14HINNER PRESSPRIN4550
           2URE  / 2X,13H(DEG. C)  (DEG. F),7X,18H(KG/CM2)      (PSI)  )    PRIN4560
260    514 FORMAT(25X,I4,1X,2F10.3,5X,2F10.3)                               PRIN4570
261    515 FORMAT(10X,35HFF GAS RELEASED RATE (PIN AVERAGE) ,F12.5,14H (FRACTPRIN4580
           1ION)          )                                                 PRIN4590
262    508 FORMAT(/ 10X,30HCOMPOSITION OF PIN GAS (MOLES) / 10X,30(1H-) //  PRIN4600
           1  24X,      96HINITIAL FILL GAS   GENERATED IN FUEL      RELEASED PRIN4610
           2 GAS              CUMULATED   GAS     FRACTION    /              PRIN4620
           3  20X,3(5X,15(1H-)),10X,15(1H-),5X,8(1H-)      )                 PRIN4630
263    509 FORMAT(12X,2A4,3(5X,F15.10),10X,F15.10,5X,F8.6)                  PRIN4640
264    510 FORMAT(12X,8(1H-),3(5X,15(1H-)),10X,15(1H-),5X,8(1H-)            PRIN4650
           1 13X,5HTOTAL,3(5X,F15.10),10X,F15.10)                           PRIN4660
265    511 FORMAT( / 10X,13HSTORED ENERGY  , / 10X,13(1H-) /                PRIN4670
           1   23X,9H  AXIAL    ,                 89HNOMINAL HEAT CAPACITY  PRIN4680
           2  STORED ENERGY          VOLUME AVERAGE          STORED ENERGY  /PRIN4690
           3 23X,7HSECTION,50X,41H    STORED ENERGY        PER UNIT LENGTH  /PRIN4700
           4 23X 96H NUMBER  CAL/K-MOLE  BTU/LB-F     CAL/GRAM    BTU/LB   PRIN4710
           5AL/GRAM    BTU/LB        CAL/CM  BTU/FOOT /23X,7(1H-),2X,20(1H-),  PRIN4720
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* SOURCE STATEMENT (PRINT1  )*

                6 5X,18(1H-),5X,18(1H-),5X,18(1H-)  )                          PRIN4730
266           610 FORMAT(/10X,40HCONVERGENCE RELATIVE ERROR   (FRACTION)  ,F8.5 ,  PRIN4740
                1 5X, 35H(CONVERGENCE CRITERION  0.005)                 )      PRIN4750
267           620 FORMAT( 135H   AXIAL      DENSI-      RELOCATION      RESTRUCTURINGPRIN4760
                1              CENTRAL   VOID  (HOT)          RADIUS FOR NEXT STEP (PRIN4770
                2MM)                /                                          PRIN4780
                3         135H SECTION        FICATION                 RADIUS   TEMP. PRIN4790
                4          RADIUS    LENGTH    VOLUME   CENTRAL    PELLET  CLAD INNEPRIN4800
                5R CLAD OUTER    /                                             PRIN4810
                6         135H      NO.          (MM)          (MM)            (MM)   (DEGPRIN4820
                7 C)          (MM)       (MM)  (CUB MM)      VOID    SURFACE    SURFACEPRIN4830
                8    SURFACE      /                                            PRIN4840
                9 1X,7(1H-),3X,2(2X,10(1H-)),2X,20(1H-),2X,30(1H-),2X,40(1H-),1H- )PRIN4850
268           630 FORMAT(6X,I2,3X,2F12.6,2X,F10.5,F10.2,2X,3F10.5,2X,4F10.3)   PRIN4860
269           640 FORMAT( 135H   AXIAL                    PELLET ELONGATION LENGTH (CM)   PRIN4870
                1              DISH              PELLET AXIAL DENSIFICATION     PRIN4880
                2                    /                                         PRIN4890
                3         135H SECTION                    DISH              (COLD -    (CPRIN4900
                4OLD -     SHOULDER      DENSIFI-    DENSIFIED   DENSIFY +     PRIN4910
                5                    /                                         PRIN4920
                6         135H      NO.          COLD  SHOULDER    CENTER      DISH)    PRIN4930
                7CENTER)  TEMP.  (C)        CATION  LENGTH(CM)  EXPANSION      PRIN4940
                8                    /                                         PRIN4950
                9 1X,7(1H-),3X,50(1H-),2X,10(1H-),1X,3(2X,10(1H-))  )          PRIN4960
          C                                                                    PRIN4970
270           650 FORMAT(6X,I2,3X,5F10.4,2X,F10.2,1X,3F12.5)                   PRIN4980
271           655 FORMAT(/ 1X,7H(TOTAL),3X,5F10.4,25X,2F12.5)                  PRIN4990
          C                                                                    PRIN5000
272           661 FORMAT(  40X,33HDETAIL  TEMPERATURE  DISTRIBUTION            PRIN5010
                1  40X,33(1H-) / )                                             PRIN5020
273           662 FORMAT(1X,14HAXIAL SECTION ,7(7X,A4,I3,3X) )                 PRIN5030
274           663 FORMAT(1X,14X,7(A1,16HRADI(CM) TEMP(C)     )  )               PRIN5040
275           664 FORMAT(1X,14HCOOLANT        ,7F17.1)                         PRIN5050
276           665 FORMAT(1X,14HCLAD OD        ,7(1X,F8.4, F8.1)  )             PRIN5060
277           666 FORMAT(1X,14HCLAD ID        ,7(1X,F8.4, F8.1)  )             PRIN5070
278           667 FORMAT(1X,14HGAP AVG. TEMP,,7F17.1  )                        PRIN5080
279           668 FORMAT(1X,14HPELLET SURFACE,7(1X,F8.4, F8.1  ) )             PRIN5090
280           669 FORMAT(1X,11HRADIAL NODE,I3,7(1X,F8.4, F8.1)  )              PRIN5100
281           670 FORMAT(1X,11X,          I3,7(1X,F8.4, F8.1)  )               PRIN5110
282           671 FORMAT(1X,14HPELLET CENTER ,7(1X,F8.4, F8.1)  )              PRIN5120
283           672 FORMAT(/)                                                    PRIN5130
284           673 FORMAT(1X,14(1H-),7(41,16(1H-)) )                            PRIN5140
          C                                                                    PRIN5150
          C    *    1    *    2    *    3    *    4    *    5    *    6    *    7  PRIN5160
285             END                                                            PRIN5170
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* SOURCE STATEMENT *

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      SUBROUTINE  PRINT2                                                PRI20010
C                                                                       PRI20020
C********* NEW SHORT OUTPUT ROUTINE                                     PRI20030
C                                                                       PRI20040
      REAL  LFUEL,LF ,MOL , MOLEFR                                      PRI20050
C-----------------------------------------------------------------------PRI20060
      COMMON /MOL678/ MOLEFR(6)                                         PRI20070
      COMMON /ML5938/ TBAR(20)                                          PRI20080
      COMMON /MOL9  / FXMOL(6,21),RDOT(20)                              PRI20090
      COMMON /MOL579/ PRESTO(20)                                        PRI20100
      COMMON /MOLM9 / TAVGXX(20)                                        PRI20110
      COMMON /COM39 / HFLUX (20)                                        PRI20120
      COMMON /COM89 / HGX(20),RGAPX(20),TCLINE(20)                      PRI20130
      COMMON /BURN  / BURN(20),BUOLD(20)                                PRI20140
      COMMON /MOLPR1/ GMOLI(6),GMOLR(6),FRACTN(6),MOL(6),XMOLS(21)      PRI20150
      COMMON /PRINO1/ TCOLT(20) ,HFILM(20) ,TCOCA(20) ,TCICA(20),       PRI20160
     *     CCONB(20) ,TGAPC(20) ,HFLXFB(20),GCS(20)   ,GCG(20)  ,       PRI20170
     *     GCR(20)   ,GCT(20)   ,TJUMP(20) ,DRTF(20)  ,DRSF(20) ,       PRI20180
     *     DRF(20)   ,DRTC(20)  ,DRPC(20)  ,DRCLD(20) ,TFSCA(20),       PRI20190
     *     DRCC(20)  ,BR1(20)   ,BR2(20)   ,BR3(20 )  ,BR4(20)  ,       PRI20200
     *     RATF(20)  ,RATC(20)  ,CPRES(20) ,CSTRES(20),GASCC(20),       PRI20210
     *     GASCB(20) ,ITERZ(20)                                         PRI20220
      COMMON /PRINO2/ CP1(20)   ,CF2(20)   ,ST1(20)   ,ST2(20)  ,       PRI20230
     *                ST3(20)   ,ST4(20)   ,ST5(20)   ,ST6(20)          PRI20240
      COMMON /PRINO3/ DRDF(20)  ,DRRF(20)  ,FCONT(20) ,TDISH(20)        PRI20250
C-----------------------------------------------------------------------PRI20260
      COMMON /INPUT / FRDEN ,FRSIN ,DSINZ ,FRPUO2,FR35  ,FR40  ,FR41  , PRI20270
     1        DFS   ,DCI   ,DCO   ,DVOIDZ,VPLENZ,ATMOS ,S     ,XX    , PRI20280
     2        ROUF  ,ROUC  ,EXTP  ,DE, V ,TINLET,DELT  ,TMAX  ,TFR,TM, PRI20290
     3        DBO   ,BK,HBC,SIGHF ,IFLUX ,NCLAD ,NCON  ,NFLX  ,KOOL  , PRI20300
     4        NEWK  ,NEWCL ,NEWFLX,VOIDZL,NOH   ,FRACHE,FRACAR,FRACH , PRI20310
     5        FRACN ,FRACKR,FRACXE,HGACEL,DTEMP ,ITOT  ,HG    ,PEKAVG, PRI20320
     6        MINI  ,ICDF  ,ISTOR ,ICREP ,ISWELL,NEXP  ,MEXP  ,NHIST  PRI20330
      COMMON /COM 08/ II,JCASE,TCOOLF,XMOTOT                            PRI20340
      COMMON /COM 1C/ VVOIDZ,FRUO2,TPLENA,NPOW1                         PRI20350
      COMMON /POWRAY/ PAVRG ,LFUEL ,LF    ,POWER(21)                    PRI20360
     1               ,AI(21),NPOW  ,PTOT  ,LPMAX   ,PKPOWR              PRI20370
     2               ,IPEAK ,DELP  ,PMAX                                PRI20380
      COMMON /BRNGAS/ NKR(20),NXE(20),PHI(20) ,ENXE(20),ENKR(20)        PRI20390
      COMMON /COM 02/ IPOW  ,ISTEP  ,ITER   ,KOUNT                      PRI20400
      COMMON /COM 05/ BURNUP ,TDAYS  ,VVOID  ,TOTLDY  ,TOTBUR           PRI20410
      COMMON /MEMO1 / MEMO1(20,5)    ,MATA(20)                          PRI20420
      COMMON /FFMOL / FF(6,23),RKR(6,23)      ,RXE(6,23),AKX(10,20,2)   PRI20430
      COMMON /PRIMOL/ AANKR  ,AANXE                                     PRI20440
      COMMON /DIMEN1/ DVOIDX(20),DVOIDH(20),DFSX(20)  ,DCIX(20),DCOX(20)PRI20450
     1               ,VVOIDX(20),VVOIDH(20),TSINX(20) ,HSINX(20)        PRI20460
     2               ,ZLENGT(5,20),VOIDL(20)                            PRI20470
      COMMON /COM3P / TSAT                                              PRI20480
      COMMON /NUCLEI/ NUCLEI,A(40,23)                                   PRI20490
      COMMON /COM128/ IOUT1 ,IIPROF                                     PRI20500
      COMMON /COM49P/ DC(20,51) , IPROF                                 PRI20510
      COMMON /DIMEN2/ DENSFL(5,20)                                      PRI20520
      COMMON /RELO1/ RGAPC(20),RFS0(20),DELEXP(20)                      PRI20530
      COMMON / PLOT / IPLOT                                             PRI20540
      DIMENSION  GMOLG(6)                                               PRI20550
C                                                                       PRI20560
      DATA   GMOLG / 6*0.0/                                             PRI20570
      DATA   KAIG  / 0    /                                             PRI20580
      DATA   IDUMB /1H    /                                             PRI20590
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* SOURCE STATEMENT (PRINT2)*

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      DATA   INODE /4HNODE/                                             PRI20600
C                                                                       PRI20610
C                                                                       PRI20620
      IF(IPLOT.LE.0) GO TO 61                                           PRI20630
C                                                                       PRI20640
      DUM=0.0                                                           PRI20650
      WRITE(8) TOTLDY                                                   PRI20660
      NN = NPOW + 1                                                     PRI20670
      WRITE(8) (POWER(I),I = 1, NN)                                     PRI20680
      DO 10  I = 1 , NPOW                                               PRI20690
      WRITE(8)  BURN(I),TCOLT(I),TCICA(I),TFSCA(I),TCLINE(I),DRTF(I),   PRI20700
     1          DRDF(I),DRSF(I) ,DRRF(I) ,RGAPX(I),DRTC(I)  ,DRPC(I),  PRI20710
     2          DRCC(I),GCT(I)  ,CPRES(I),CSTRES(I),                    PRI20720
     3          PRESTO(ISTEP+1) ,MOLEFR(5),MOLEFR(6),ST1(I) ,           PRI20730
     4          RATC(I)         ,DUM , DUM , DUM                        PRI20740
   10 CONTINUE                                                          PRI20750
C                                                                       PRI20760
   61 CONTINUE                                                          PRI20770
C                                                                       PRI20780
      IF(NPOW.GT.15) KAIG = 10                                          PRI20790
      IF(NPOW.GT.10.AND.NPOW.LE.15)  KAIG = NPOW / 2 + 1                PRI20800
      CALL HEAD(1)                                                      PRI20810
      DISI = -1.*LF/2.                                                  PRI20820
      PRINT 101                                                         PRI20830
      DO 11  I = 1 , NPOW                                               PRI20840
      DISI = DISI + LF                                                  PRI20850
      A1   = DISI / 2.54                                                PRI20860
      POWF = (POWER(I) + POWER(I+1))*.5                                 PRI20870
      A2   = POWF/1000.*30.48                                           PRI20880
      A3   =HFILM(I)*30.48**2 * 3600./1.8/1055.                         PRI20890
      IF(I.EQ.KAIG)  PRINT 99                                           PRI20900
      PRINT 102,I,DISI,A1,POWF,A2,BURN(I),PHI(I),TCOLT(I),HFILM(I),A3,  PRI20910
     1          TCOCA(I),TCICA(I)                                       PRI20920
   11 CONTINUE                                                          PRI20930
      IF(NPOW.GE.20)  PRINT 99                                          PRI20940
      IF(NPOW.LT.20)  PRINT 1000                                        PRI20950
C                                                                       PRI20960
      PRINT 301                                                         PRI20970
      DO 31 I = 1 , NPOW                                                PRI20980
      A2  = DRTF(I) *10.                                                PRI20990
      A3  = DRSF(I) *10.                                                PRI21000
      A4  = DRF (I) *10.                                                PRI21010
      A5  = DRTC(I) *10.                                                PRI21020
      A6  = DRCC(I) *10.                                                PRI21030
      A7  = DRPC(I) *10.                                                PRI21040
      A8  = DRCLD(I)*10.                                                PRI21050
      A9  = RGAPX(I)*10.                                                PRI21060
      A10 = GCS(I)  * 1763.                                             PRI21070
      A11 = GCG(I)  * 1763.                                             PRI21080
      A12 = GCR(I)  * 1763.                                             PRI21090
      A13 = GCT(I)  * 1763.                                             PRI21100
      A15 = DRDF(I) * 10.                                               PRI21110
      A16 = DRRF(I) * 10.                                               PRI21120
C                                                                       PRI21130
      IF(I.EQ.KAIG)  PRINT 99                                           PRI21140
      PRINT 302,I,A10 , A11 , A12 , A13 , A2 , A3 , A15    , A16 ,      PRI21150
     1          A4  , A5  , A6  , A7  , A8 , A9 , FCONT(I)              PRI21160
   31 CONTINUE                                                          PRI21170
C                                                                       PRI21180
```

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* SOURCE STATEMENT (PRINT2  )*

      CALL HEAD(-1)                                                     PRI21190
      PRINT 401                                                         PRI21200
      PRINT 403                                                         PRI21210
      DO 41  I = 1 , NPOW                                               PRI21220
      A5  = CPRES(I)                                                    PRI21230
      IF(I.EQ.KAIG)  PRINT 99                                           PRI21240
      PRINT 402,I,TFSCA(I),TCLINE(I),TBAR(I),CP1(I),CP2(I),ST1(I),ST2(I)PRI21250
     1        ,ST3(I),ST4(I),ST5(I),ST6(I),A5                           PRI21260
   41 CONTINUE                                                          PRI21270
      PRINT 1000                                                        PRI21280
C..... INFORMATION FOR GAS .....                                        PRI21290
      A1 = VPLENZ/16.3871                                               PRI21300
        PRINT 501,VPLENZ,A1                                             PRI21310
      A1 = TPLENA + 273.                                                PRI21320
      A2 = A1 * 1.8 + 32.                                               PRI21330
        PRINT 502,A1 , A2                                               PRI21340
      IF(SIGHF.LT.0.) PRINT 516,TSAT                                    PRI21350
      A1 = ATMOS * 14.22                                                PRI21360
        PRINT 503,ATMOS , A1                                            PRI21370
      A1 = PRESTO(ISTEP+1)*14.22                                        PRI21380
        PRINT 504, PRESTO(ISTEP+1) , A1                                 PRI21390
C                                                                       PRI21400
        PRINT 505, XMOTOT                                               PRI21410
        PRINT 506, XMOLS(NPOW+1)                                        PRI21420
      A1 = XMOTOT - XMOLS(NPOW+1)                                       PRI21430
        PRINT 507,A1                                                    PRI21440
        PRINT 515,RDOT(1)                                               PRI21450
C                                                                       PRI21460
      PRINT 509, (MOLEFR(I),I = 1 ,6)                                   PRI21470
C                                                                       PRI21480
      PRINT 1000                                                        PRI21490
      PRINT 513                                                         PRI21500
      DO 53  J = 1 , ISTEP                                              PRI21510
      I = J + 1                                                         PRI21520
      A1= TAVGXX(I)*1.8 + 32.                                           PRI21530
      A2= PRESTO(I)*14.22                                               PRI21540
      PRINT 514, J , TAVGXX(I) , A1 , PRESTO(I) , A2                    PRI21550
   53 CONTINUE                                                          PRI21560
      ERROR = ABS((TAVGXX(ISTEP)-TAVGXX(ISTEP+1)) / TAVGXX(ISTEP+1))    PRI21570
      PRINT 610 , ERROR                                                 PRI21580
C                                                                       PRI21590
C     PRINT 640,(DELEXP(I),I=1,NPOW)                                    PRI21600
C     PRINT 620,(PGAPC(I),I=1,NPOW)                                     PRI21610
C     PRINT 630,(RFSO(I) ,I=1,NPOW)                                     PRI21620
C                                                                       PRI21630
  620 FORMAT(//  3X,'COLD RADIAL GAP AT THE END OF THIS STEP (MM)'      PRI21640
     1        / (5X,1P10F12.7)  )                                       PRI21650
  630 FORMAT(//  3X,'COLD PELLET SURFACE RADIUS  (MM) '                 PRI21660
     1        / (5X,1P10F12.7)  )                                       PRI21670
  640 FORMAT(// 3X,'THERMAL EXPANSION OF HOT FUEL RADIUS FOR REDECE'    PRI21680
     1      ,' TO COLD STATE (MM) '                                     PRI21690
     2   / (5X,1P10F12.7)  )                                            PRI21700
C                                                                       PRI21710
      RETURN                                                            PRI21720
   99 FORMAT(1H  )                                                      PRI21730
 1000 FORMAT(/)                                                         PRI21740
  101 FORMAT(/3X,127H  AXIAL        AXIAL            LINEAR  HEAT       BPRI21750
     1UKNUP      AVERAGE   COOLANT        FILM  COEFFICIENT        CLAD TPRI21760
     2EMPERATURE / 3X,129HSECTION     DISTANCE            RATING        PRI21770
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```
* SOURCE STATEMENT (PRINT2  )*

     3                NEUTRON     TEMP.                BTU              PRI21780
     4   OD          ID/3X,131H NUMBER    (CM)   (INCH)       (W/CM)   (KWPRI21790
     5/FT)     (NWD/MT)   FLUX (NV)   (DEG C)    WATT/CM2-C   /HR-FT2-F  PRI21800
     6      (DEG C)      (DEG C)      /                                  PRI21810
     7  3X,7(1H-),2X,14(1H-),4X,18(1H-),4X,8(1H-),2X,10(1H-),2X,8(1H-), PRI21820
     8  4X,22(1H-),6X,20(1H-)       )                                   PRI21830
  102 FORMAT(3X,I7,2F8.2,2X,2F10.4,2X,F10.2,2X,1PE10.3,0PF10.2,2X,2F12.3PRI21840
     1      ,2X,2F12.3)                                                 PRI21850
  301 FORMAT(/2X,131H  AXIAL  GAP CONDUCTANCE(BTU/HR-FT2-F)             PRI21860
     1  INCREASE  IN  FUEL  RADIUS(MM)          INCREASE IN CLAD RADIUS(PRI21870
     2MM)    RADIAL      / 2X,20HSECTION SOLID   GAS-    ,              PRI21880
     3    21X, 7HTHERMAL  , 13X, 13HDENSI-    RE-    ,  17X,            PRI21890
     4        7HTHERMAL ,26X , 7HHOT GAP     /                          PRI21900
     5       3X ,13OHNUMBER  -SOLID CONDUCT RADIANT   TOTAL  EXPANSION SPRI21910
     6WELLING  FICATION  LOCATION     TOTAL  EXPAN.   CREEP  PRESSURE  PRI21920
     7TOTAL   (MM)                                   /                  PRI21930
     8        1X,5(9H -------),2X,38(1H-),2X,8(1H-),2X,32(1H-),1X,7(1H-))PRI21940
  302 FORMAT(2X,I7,4F8.2    ,5F10.6,1X,3F8.5,1X,2F8.5,1X,A1)            PRI21950
  401 FORMAT(/2X,130H  AXIAL   FUEL      FUEL      VOL. AVG  NOMINAL HEAPRI21960
     1T CAPACITY          S  T  O  R  E  D      E  N  E  R  G  Y        PRI21970
     2      CONTACT                  /                                  PRI21980
     3        2X, 34HSECTION   SURFACE   CENTER   FUEL ,30X ,15HAT VOLUPRI21990
     4METRIC, 8X, 45HVOLUME AVERAGE     PER UNIT LENGTH   PRESSURE     /PRI22000
     5        2X, 35H NUMBER   TEMP.      TEMP.      TEMP.  , 31X ,     PRI22010
     6       13HAVERAGE TEMP.      )                                    PRI22020
  403 FORMAT(12X,122H(DEG C)   (DEG C)   (DEG C)   CAL/K-MOLE   BTU/LB-FPRI22030
     1  CAL/GRAM  BTU/LB   CAL/GRAM   BTU/LB    CAL/CM   BTU/FOOT   (KG/CPRI22040
     2M2)                                  /                            PRI22050
     3        2X,7(1H-),3X,7(1H-),3X,8(1H-),2X,8(1H-),2X,21(1H-),2X,    PRI22060
     4        16(1H-), 3X ,17(1H-),3X,17(1H-),3X,8(1H-)              )  PRI22070
  402 FORMAT(2X,I7,1X,3F10.3,1X,2F11.3,2F9.3 ,2X,2F9.3,2F10.3,1X,F10.3) PRI22080
  501 FORMAT(10X,35HPLENUM VOLUME                          ,F12.5,14H (CM3) PRI22090
     1        ,5X,F12.5,14H (INCM3)                 )                  PRI22100
  502 FORMAT(10X,35HPLENUM TEMPERATURE                     ,F12.5,14H (DEG CPRI22110
     1)       ,5X,F12.5,14H (DEG F)                 )                  PRI22120
  503 FORMAT(10X,35HINITIAL PLENUM PRESSURE                ,F12.5,14H (KG/CMPRI22130
     12)      ,5X,F12.5,14H (PSI)                   )                  PRI22140
  516 FORMAT(10X,35HCOOLANT SATURATE TEMPERATURE           ,F12.5,14H (DEG CPRI22150
     1)                                            )                  PRI22160
  504 FORMAT(10X,35HINTERNAL GAS PRESSURE                  ,F12.5,14H (KG/CMPRI22170
     12)      ,5X,F12.5,14H (PSI)                   )                  PRI22180
  505 FORMAT(10X,35HTOTAL GAS MOLES IN A PIN               ,E12.5,14H (MOLESPRI22190
     1)                                            )                  PRI22200
  506 FORMAT(10X,35HGASES IN PLENUM                        ,E12.5,14H (MOLESPRI22210
     1)                                            )                  PRI22220
  507 FORMAT(10X,35HGASES IN A GAP OR CENTRAL VOID         ,E12.5,14H (MOLESPRI22230
     1)                                            )                  PRI22240
  515 FORMAT(10X,35HFP GAS RELEASED RATE (PIN AVERAGE) ,F12.5,14H (FRACTPRI22250
     1ION)                                         )                  PRI22260
  509 FORMAT(/10X,90HCOMPOSITION OF PIN GAS (MOLES)    HELIUM     ARGON PRI22270
     1 HYDROGEN  NITROGEN    KRYPTON     XENON /  32X, 8HFRACTION,6F10.6)PRI22280
  513 FORMAT( 10X,65HAXIAL   VOLUME-TEMPERATURE AVERAGED   (CONVERGENCE PRI22290
     1 IN ITERATION)  //15X,5HITER.,6X,11HTEMPERATURE,11X,14HINNER PRESSPRI22300
     2URE  / 22X,18H(DEG. C)  (DEG. F),7X,18H(KG/CM2)      (PSI)       ) PRI22310
  514 FORMAT(15X,I4,1X,2F10.3,5X,2F10.3)                                PRI22320
  610 FORMAT(/10X,40HCONVERGENCE RELATIVE ERROR   (FRACTION)  , F8.5 ,  PRI22330
     15X ,   30H(CONVERGENCE CRITERION  0.005)              )           PRI22340
C                                                                       PRI22350
      END                                                               PRI22360
```

* SOURCE STATEMENT *

```
      SUBROUTINE PROF(TM,TCI,TCO,TCOOL,THH,HGDUM,JCASE,IPOW,NPOW,MIN1,  PROF0010
     *                ISTEP,LPMAX)                                      PROF0020
C                                                                       PROF0030
C     THIS SUBROUTINE IS CALLED FROM STEP8                              PROF0040
C                                                                       PROF0050
C                                                                       PROF0060
C                                                                       PROF0070
      COMMON /COM  0/ TITLE(20),AA(7, 30),BB(6, 51),CF(3, 30),HV(2, 20) PROF0080
      COMMON /COM 21/ N,NN,NNN,NF                                       PROF0090
      COMMON /COM 8M/ ISTOP,ICASE                                       PROF0100
      COMMON /COM49P/ DC(20,51),IPROF                                   PROF0110
      COMMON /HIZUKE/ K1,K2,K3,K4,K5,K6                                 PROF0120
      DIMENSION P(121), SIG(25)                                         PROF0130
      DIMENSION B(2,51),SY(20)                                          PROF0140
      DATA SIG/ 100HPELLET CENTER        PELLET OUTER SURFACECLAD INNER SPROF0150
     *URFACE  CLAD OUTER SURFACE  COOLANT                    /          PROF0160
      DATA SY / 1HA,1HB,1HC,1HD,1HE,1HF,1HG,1HH,1HO,1HP,1HQ,1HR,1HS,1HT,PROF0170
     *         1HU,1HV,1HW,1HX,1HY,1HZ /                                PROF0180
      BAR=1H1                                                           PROF0190
      CALL STEP0                                                        PROF0200
      WRITE(6,1710) JCASE,IPOW,NPOW,K1,K2,K3,K4,K5,K6                   PROF0210
      WRITE(6,600) TITLE                                                PROF0220
      IMAX = 120                                                        PROF0230
      IIMAX = IMAX + 1                                                  PROF0240
      JJMAX = N + 1                                                     PROF0250
      IF(IPROF) 20,20,22                                                PROF0260
   20 DO 1 JJ=1,JJMAX                                                   PROF0270
      J = JJMAX - JJ + 1                                                PROF0280
      DO 2 I=1,121                                                      PROF0290
    2 P(I)=1H                                                           PROF0300
      IP=1.0+FLOAT(IMAX)*BB(3,J)/3000.                                  PROF0310
      IF(IP.GT.(IMAX+1)) IP = IMAX + 1                                  PROF0320
      IF(IP.LT.1  )  IP=1                                               PROF0330
      I0 = 1                                                            PROF0340
      I1 = 1 + IMAX  /3                                                 PROF0350
      I2 = 1 + IMAX*2/3                                                 PROF0360
      I3 = 1 + IMAX                                                     PROF0370
      IF(JJ.EQ.1.OR.JJ.EQ.JJMAX) GO TO 4                                PROF0380
      P(I0)=P(I1)=P(I2)=P(I3)=BAR                                       PROF0390
    4 P(IP) = 1H+                                                       PROF0400
      IF(BB(3,J).GE.TM) P(IP) = 1HM                                     PROF0410
      B(1,J) = BB(3,J)                                                  PROF0420
      B(2,J) = BB(4,J)                                                  PROF0430
      WRITE(6,601) BB(3,J),BB(4,J),F                                    PROF0440
      IF(JJ.EQ.JJMAX) IPFEND = IP                                       PROF0450
      IF(JJ.NE.1) GO TO 1                                               PROF0460
      IF(BB(4,J).LT.0.001) WRITE(6,602)                                 PROF0470
      IF(BB(4,J).GE.0.001) WRITE(6,603)                                 PROF0480
    1 CONTINUE                                                          PROF0490
      TIC=TCI                                                           PROF0500
      TOC=TCO                                                           PROF0510
      COOLT=TCOOL                                                       PROF0520
      DUMHG=HGDUM                                                       PROF0530
      GO TO 26                                                          PROF0540
   22 CONTINUE                                                          PROF0550
      DO 25 J=1,JJMAX                                                   PROF0560
      J = JJMAX-JJ+1                                                    PROF0570
      B(1,J) = BB(4,J)                                                  PROF0580
      B(2,J) = DC(  LPMAX,J)                                            PROF0590
```


* SOURCE STATEMENT (PROF)*

```
      WRITE(6,701) B(1,J),B(2,J)                                        PROF0600
      DO 23 I=1,121                                                     PROF0610
   23 P(I)=1H                                                           PROF0620
      DO 21 II=1,IPOW                                                   PROF0630
      IP=1.+FLOAT(IMAX)*DC(  II,J)/3000.                                PROF0640
      IF(IP.GT.(IMAX+1)) IP=IMAX+1                                      PROF0650
      IF(IP.LT.1) IP=1                                                  PROF0660
      I0=1                                                              PROF0670
      I1=1+IMAX/3                                                       PROF0680
      I2=1+IMAX*2/3                                                     PROF0690
      I3=1+IMAX                                                         PROF0700
      IF(JJ.EQ.1.OR.JJ.EQ.JJMAX) GO TO 24                               PROF0710
      P(I0)=P(I1)=P(I2)=P(I3)=BAR                                       PROF0720
   24 P(IP) = SY(II)                                                    PROF0730
      IF(DC(  II,J).GE.TM) P(IP) = 1HM                                  PROF0740
      IF(JJ.EQ.JJMAX) IPFEND=IP                                         PROF0750
   21  CONTINUE                                                         PROF0760
      WRITE(6,702) P                                                    PROF0770
      IF(JJ.NE.1) GO TO 25                                              PROF0780
      IF(BB(4,J).LT.0.001) WRITE(6,602)                                 PROF0790
      IF(BB(4,J).GT.0.001) WRITE(6,603)                                 PROF0800
   25 CONTINUE                                                          PROF0810
   26 CONTINUE                                                          PROF0820
      DO 6 I=1,121                                                      PROF0830
    6 P(I)=1H                                                           PROF0840
      P(I0)=P(I1)=BAR                                                   PROF0850
      IP = 1.0 + FLOAT(IMAX) * TIC / 3000.0                             PROF0860
      P(IP) = 1H+                                                       PROF0870
      IF(THH.GT.0.0)  GO TO 7                                           PROF0880
      WRITE(6,604) (P(I),I=1,IIMAX)                                     PROF0890
      WRITE(6,605) DUMHG,TIC                                            PROF0900
      GO TO 8                                                           PROF0910
    7 CONTINUE                                                          PROF0920
      DO 13 I=2,55                                                      PROF0930
   13 P(I) = 1H-                                                        PROF0940
      P(I0)=P(I1)=BAR                                                   PROF0950
      P(IPFEND) = 1H                                                    PROF0960
      WRITE(6,607) (P(I),I=1,55),DUMHG                                  PROF0970
      DO 11 I=2,50                                                      PROF0980
   11 P(I)=1H-                                                          PROF0990
      P(I0)=P(I1)=BAR                                                   PROF1000
      P(IP)=1H+                                                         PROF1010
      WRITE(6,606) TIC,(P(I),I=1,41),(SIG(I),I=11,15)                   PROF1020
    8 CONTINUE                                                          PROF1030
      DO 9 I=1,121                                                      PROF1040
    9 P(I)=1H                                                           PROF1050
      DO 12 I=2,50                                                      PROF1060
   12 P(I)=1H-                                                          PROF1070
      P(I0)=P(I1)=BAR                                                   PROF1080
      IP = 1.0 + FLOAT(IMAX) * TOC / 3000.0                             PROF1090
      P(IP)=1H+                                                         PROF1100
      WRITE(6,606) TOC,(P(I),I=1,41),(SIG(I),I=16,20)                   PROF1110
      DO 10 I=1,121                                                     PROF1120
   10 P(I)=1H                                                           PROF1130
      P(I0)=BAR                                                         PROF1140
      IP = 1.0 + FLOAT(IMAX) * COOLT / 3000.0                           PROF1150
      P(IP)=1HC                                                         PROF1160
      WRITE(6,606) COOLT,(P(I),I=1,41),(SIG(I),I=21,25)                 PROF1170
      WRITE(6,609) (P(I),I=1,41)                                        PROF1180
```

```
* SOURCE STATEMENT (PROF     )*

111      30 IPROF = 0                                                      PROF1190
112         RETURN                                                         PROF1200
    C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 PROF1210
113   1710 FORMAT(1H1,2X,'CASE ',I3,5X,'AXIAL SEGMENT ',I2,2X,'OF ',I2,2X,  PROF1220
          *  22X,   2A4,I5,3H HR,I3,7H MINUTE,I3,4H SEC,I4                 / )PROF1230
114   600   FORMAT(1H , 5X,5(1H*),3X,20A4,3X,5(1H*) /)                     PROF1240
115   601 FORMAT(1H ,F6.0,1PE5.2,2X,121A1  )                               PROF1250
116   602 FORMAT(1H+,13X,1H0,6(1H-),13HPELLET CENTER,18(1H-),4H1000,36(1H-) PROF1260
          1,4H2000,36(1H-),4H3000                                          )  PROF1270
117   603 FORMAT(1H+,13X,1H0,6(1H-),22HPELLET HAS CENTER HOLE,9(1H-),4H1000 PROF1280
          1,36(1H-),4H2000,36(1H-),4H3000                                  )  PROF1290
118   604 FORMAT(1H+, 13X,121A1    )                                       PROF1300
119   605 FORMAT(1H+, 13X,46(1H-),36HTHERE IS NO GAP.  GAP CONDUCTANCE IS   PROF1310
          1,F7.1,17H BTU/HR/FT2/DEG F        /1H ,F6.0                   / ) PROF1320
120   606 FORMAT(1H ,F6.0,7X,41A1 ,10X,5A4                               / ) PROF1330
121   607 FORMAT(1H+, 13X,55A1    ,36H THERE IS A GAP.  GAP CONDUCTANCE IS  PROF1340
          1,F7.1,17H BTU/HR/FT2/DEG F                                    / ) PROF1350
122   609 FORMAT( 14X,41A1 )                                               PROF1360
123   701   FORMAT(1H ,F5.3,F6.0 )                                         PROF1370
124   702 FORMAT(1H+,13X,121A1 )                                           PROF1380
    C   *    1    *    2    *    3    *    4    *    5    *    6    *    7 PROF1390
    C*****************************************************************PROF1400
125         END                                                            PROF1410
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```
* SOURCE STATEMENT *

  1         SUBROUTINE RELOC(DELRRE,DFS,GAP,POW,IPOW,NPOW                  RELO0010
           1        ,MRELOC  )                                             RELO0020
    C                                                                       RELO0030
    C        REVISED MODEL (INCREMENTAL)  1976,JANU.                        RELO0040
    C                                                                       RELO0050
  2         COMMON /PRIN03 / DRDF(20),DRFF(20),FCONT(20),TOTGM(20)         RELO0060
  3         COMMON /COM89  / HGX(20),RGAPX(20),TCLINE(20)                  RELO0070
  4         COMMON /BURN   / BURN(20),BUOLD(20)                            RELO0080
  5         COMMON /IATR/ IA,IR,IIH,MAXSTP                                 RELO0090
  6         COMMON /POWRAY/ PAVRG,LFUEL,LF,POWE(21),AI(21),KPOW,PTOT,LPMAX, RELO0100
           1                PKPOWR,IPEAK,DELP,PMAX                         RELO0110
  7         COMMON /COM02/ LPOW,ISTEP,ITER,KOUNT                           RELO0120
  8         COMMON /RELO1/ RGAPC(20),RFSO(20),DELEXP(20)                   RELO0130
    C                                                                       RELO0140
  9         DIMENSION IMD(20),DRELO(20)                                    RELO0150
    C                                                                       RELO0160
    C           BURN    BURNUP AT EACH NODE AND TIME(MWD/MTM)               RELO0170
    C           POW     LINEAR HEAT RATE DURING TIME INCREMENT(KW/FT)       RELO0180
    C           GAP     INITIAL MANUFACTURED DIAMETRAL GAP(INCHES)          RELO0190
    C                                                                       RELO0200
    C                                                                       RELO0210
 10         IF(IIH.GT.1) GO TO 11                                          RELO0220
 11         RGAPC(IPOW) = GAP / 2.                                         RELO0230
 12         DRFF (IPOW) = 0.0                                              RELO0240
 13         DRELO(IPOW) = 0.0                                              RELO0250
 14      11 CONTINUE                                                       RELO0260
 15         GO TO (1,2,4,5) , MRELOC                                       RELO0270
 16       1 CONTINUE                                                       RELO0280
 17         DELGD=DRELO(IPOW)                                              RELO0290
 18         BUN=BURN(IPOW)                                                 RELO0300
 19         P  =POW*30.48/1000.                                            RELO0310
 20         GAPR=GAP/2.54                                                  RELO0320
 21         B=EXP(-4.+BUN**0.25)                                           RELO0330
 22         DELGD=(42.*(B/(1.+B))+0.9*P+3.)*GAPR/100.                      RELO0340
 23         IF(MRELOC.EQ.3) DELGD=DELGD-0.28*GAPR                          RELO0350
 24         IF(DELGD.LT.0.) DELGD=0.0                                      RELO0360
 25         DELRRE=DELGD/2.*2.54                                           RELO0370
 26         DRELO(IPOW)=AMAX1(DELRRE,DRELO(IPOW))                          RELO0380
 27         DELRRE=DRELO(IPOW)                                             RELO0390
 28         RETURN                                                         RELO0400
 29       2 CONTINUE                                                       RELO0410
 30       4 CONTINUE                                                       RELO0420
 31       5 CONTINUE                                                       RELO0430
 32         RETURN                                                         RELO0440
    C                                                                       RELO0450
 33         END                                                            RELO0460
```

* SOURCE STATEMENT *

```
      SUBROUTINE  STOREN(VAVGT,TSR,TFS,TT,N,PI,DFS,RHO,                 STOR0010
     1 CPNOM,CPMIN,CPMAX,STORE,STOR,STORB,STOREB,STOREC,STOREF,CPNOMF)  STOR0020
C          THIS SUBROUTINE CALCULATE THE HEAT CAPACITY OF UO2 AND      STOR0030
C          THE STORED ENERGY OF FUEL                                   STOR0040
C     THIS SUBROUTINE IS CALLED FROM STEP8                             STOR0050
      DIMENSION TT(100) , TSR(100)                                     STOR0060
C     ***********************    CALL HCAP , CARL    ****************STOR0070
      CALL HCAP (VAVGT,CPNOM,CPMIN,CPMAX)                              STOR0080
      CALL CARL (TSR,TFS,TT,N,PI,DFS,STORE)                            STOR0090
C     ****************************************************************STOR0100
      TEMPK=VAVGT+273.                                                 STOR0110
      C1=7.84735E-4*(TEMPK**2-298**2)+564730.*EXP(-37.6946/TEMPK/0.0019STOR0120
     1R6)                                                              STOR0130
      C2=535.285*(1.0/(EXP(535.285/TEMPK)-1.)-1./(EXP(535.285/298.)-1.))STOR0140
      STOR=(C1+19.145*C2)/270.                                         STOR0150
      STORB=STOR*1.6                                                   STOR0160
      STOREB=STORE*1.6                                                 STOR0170
C     STOREC=STORE*RHO*(DFS**2/4)*PI*2.54**2                           STOR0180
      STOREC=STORE*RHO*(DFS**2/4)*PI                                   STOR0190
      STOREF=STOREC*12.*2.54/252.                                      STOR0200
C                                                                      STOR0210
C     CONVERT CPNOM TO UNITS OF BTU/(LB-DEG F)                         STOR0220
C                                                                      STOR0230
      CPNOMF=CPNOM*270.                                                STOR0240
      RETURN                                                           STOR0250
      END                                                              STOR0260
```


* SOURCE STATEMENT *

```
      SUBROUTINE SWELL(R1300,R1500,R1700,RFS,RVOID,PI,BURNUP,TH,GAP,DELRSTOR0270
     *T,DELRC,DELRBH,ROUF,ROUC,THREF,DELRBR,DELRDE )                   SWEL0010
C                                                                      SWEL0020
C     THIS SUBROUTINE IS CALLED FROM STEP5                             SWEL0030
C     REFER BNWL-1776, GAPCON THERMAL-1,PAGE 4-25                      SWEL0040
C                                                                      SWEL0050
      BFCC = BURNUP / 3560.                                            SWEL0060
      S1700 = 14. * BFCC**.611/100.                                    SWEL0070
      S1500 = 5.0 * BFCC**.611/100.                                    SWEL0080
      S1300 = 2.0 * BFCC**.611/100.                                    SWEL0090
      STEMP = 0.4 * BFCC/100.                                          SWEL0100
      S17MAX = .2138                                                   SWEL0110
      S15MAX = .0764                                                   SWEL0120
      IF(S1500.GE.S15MAX) S1500 = S15MAX                               SWEL0130
      IF(S1700.GE.S17MAX) S1700 = S17MAX                               SWEL0140
      DELVOT=PI*(STEMP*(RFS**2-R1300**2)+S1300*(R1300**2-R1500**2)+S1500SWEL0150
     **(R1500**2-R1700**2)+S1700*(R1700**2-RVOID**2))                  SWEL0160
      DELRBH = DELVOT / (3.*PI*RFS)                                    SWEL0170
      TH = GAP/2-(DELRT+DELRBH+ DELRDE ) + DELRC                       SWEL0180
C     ****************************************************************SWEL0190
      ROUGH=1.96*(ROUF+ROUC) + 1.E-6                                   SWEL0200
      IF(TH-ROUGH) 10,10,20                                            SWEL0210
   10 CONTINUE                                                         SWEL0220
C     GAP WAS CLOSED , THEN MODIFIED GAP WIDTH TO EQUAL MEAN ROUGHNESS SWEL0230
C     AND CONSTRAIN FUEL SWELLING AMOUNT                               SWEL0240
      THREF=TH                                                         SWEL0250
      TH=1.96*(ROUF+ROUC)+1.E-6                                        SWEL0260
      DELRBR=DELRBH                                                    SWEL0270
      DELRBH= GAP/2. - ( DELRT + DELRDE )+ DELRC - TH                  SWEL0280
      RETURN                                                           SWEL0290
C     GAP IS OPEN                                                      SWEL0300
   20 CONTINUE                                                         SWEL0310
C     ****************************************************************SWEL0320
      RETURN                                                           SWEL0330
      END                                                              SWEL0340
```

* SOURCE STATEMENT *

```
      SUBROUTINE SWELLA(ISWELL,R1300,R1350,R1500,R1700,RFS,RVOID,PI,BU, SWLA0010
     1                  SDOT,SDOTT,VOLUME,FRDEN,DELVB,DELRB)          SWLA0020
C                                                                     SWLA0030
C     THIS SUBROUTINE IS CALLED FROM STEP5A                           SWLA0040
C     REFER BNWL-1776, GAPCON THERMAL-1,PAGE 4-25                     SWLA0050
      DATA S15MAX,S17MAX / .0764 , .2138  /                           SWLA0060
C                                                                     SWLA0070
C     ISWELL = 0    SWELLING IS NOT TAKEN INTO ACCOUNT                SWLA0080
C     ISWELL = 1    GEITHOF, ET AL. MODEL      (OLD SWELLING MODEL)   SWLA0090
C     ISWELL = 2    REVISED GAP CLOSURE MODEL (NEW SWELLING MODEL)   SWLA0100
      DELVB = DELRB = 0.0                                             SWLA0110
      IF(ISWELL.EQ.0) RETURN                                          SWLA0120
      BFCC = BU / 3560.                                               SWLA0130
      GO TO (1111,2222,3333                          ) ,ISWELL        SWLA0140
 1111 CONTINUE                                                        SWLA0150
      VH=PI*R1700**2                                                  SWLA0160
      VL=PI*(RFS**2-R1350**2.)                                        SWLA0170
      VC=PI*(R1350**2-R1700**2)                                       SWLA0180
      DELVB=(SDOT*VOLUME*FRDEN+SDOTT*VC)*BU    /1.E4-(1.-FRDEN)*(.8*VH+.SWLA0190
     1*VC+.3*VL)                                                      SWLA0200
      RETURN                                                          SWLA0210
 2222 CONTINUE                                                        SWLA0220
      S1700 = 14. * BFCC**.611/100.                                   SWLA0230
      S1500 = 5.0 * BFCC**.611/100.                                   SWLA0240
      S1300 = 2.0 * BFCC**.611/100.                                   SWLA0250
      STEMP = 0.4 * BFCC/100.                                         SWLA0260
      IF(S1500.GE.S15MAX) S1500 = S15MAX                              SWLA0270
      IF(S1700.GE.S17MAX) S1700 = S17MAX                              SWLA0280
      DELVB =PI*(STEMP*(RFS**2-R1300**2)+S1300*(R1300**2-R1500**2)+S1500SWLA0290
     **(R1500**2-R1700**2)+S1700*(R1700**2-RVOID**2))                 SWLA0300
      DELRB = DELVB / (3.*PI*RFS)                                     SWLA0310
      RETURN                                                          SWLA0320
 3333 CONTINUE                                                        SWLA0330
      RETURN                                                          SWLA0340
      END                                                             SWLA0350
```


* SOURCE STATEMENT *

```
      FUNCTION TEMP(TC,CRF,CRFT,N)                                    TEMP0010
C     THIS FUNCTION IS CALLED FROM MOLMOL(3),(4)                      TEMP0020
C     TEMP IS A LINEAR INTERPOLATION FUNCTION WHOSE VALUE IS EQUAL TO TEMP0030
C     THE INTERPOLATED VALUE.                                         TEMP0040
C     TC-IS THE VALUE OF THE INDEPENDENT VARIABLE                     TEMP0050
C     CRF-DEPENDENT VARIABLE ARRAY                                    TEMP0060
C     CRFT-INDEPENDENT VARIABLE ARRAY                                 TEMP0070
C     N-NUMBER OF POINTS IN VARIABLE ARRAY                            TEMP0080
      DIMENSION CRF(N),CRFT(N)                                        TEMP0090
      I = 1                                                           TEMP0100
      IF(CRFT(1).GT.CRFT(N)) GO TO 200                                TEMP0110
C                                                                     TEMP0120
      IF(TC.LT.CRFT(1)) GO TO 104                                     TEMP0130
      DO 100 I=1,N                                                    TEMP0140
      J = I                                                           TEMP0150
      IF(TC-CRFT(I)) 101,102,100                                      TEMP0160
  100 CONTINUE                                                        TEMP0170
  104 TEMP = CRF(I)                                                   TEMP0180
  106 RETURN                                                          TEMP0190
  102 TEMP = CRF(I)                                                   TEMP0200
      RETURN                                                          TEMP0210
  101 TEMP=CRF(I-1)+(CRF(I)-CRF(I-1))*(TC-CRFT(I-1))/(CRFT(I)-CRFT(I-1))TEMP0220
      RETURN                                                          TEMP0230
C                                                                     TEMP0240
  200 CONTINUE                                                        TEMP0250
      IF(TC.GE.CRFT(1)) GO TO 104                                     TEMP0260
      DO 201 I=1,N                                                    TEMP0270
      IF(TC-CRFT(I)) 201,102,101                                      TEMP0280
  201 CONTINUE                                                        TEMP0290
      I=N                                                             TEMP0300
      GO TO 104                                                       TEMP0310
C*****************************************************************TEMP0320
      END                                                             TEMP0330
```

```
* SOURCE STATEMENT *
 1        FUNCTION TERP(TT,TABLE,LL,NN,IN1,IN2,IN3,IN4)                    TERP0010
C         THIS FUNCTION IS CALLED FROM STEP3,4,5,6,7,8,HTCW,FYIELD         TERP0020
C         L = THE INDEX TO THE TABLE                                       TERP0030
 2        DIMENSION TABLE(IN1,IN2)                                         TERP0040
C                                                                          TERP0050
 3        N=NN                                                             TERP0060
 4        L=LL                                                             TERP0070
 5        IN3=0                                                            TERP0080
C                                                                          TERP0090
 6        IF(N) 30,30,31                                                   TERP0100
 7     30 WRITE(6,40) NN,IN2,IN4                                           TERP0110
 8        STOP                                                             TERP0120
 9     31 CONTINUE                                                         TERP0130
10        IF(N.GT.IN2) WRITE(6,41) NN,IN2,IN4                              TERP0140
C                                                                          TERP0150
11        IF(L.LE.1) WRITE(6,42) L,IN1,IN4                                 TERP0160
12        IF(L.LE.1) STOP                                                  TERP0170
13        IF(L.GT.IN1) WRITE(6,43) L,IN1,IN4                               TERP0180
C                                                                          TERP0190
14        I=1                                                              TERP0200
C                                                                          TERP0210
15        IF(TABLE(I,1).GT.TABLE(I,N)) GO TO 110                           TERP0220
16        IF(TT.LT.TABLE(I,1)) GO TO 104                                   TERP0230
17        IF(TT.GT.TABLE(I,N)) GO TO 106                                   TERP0240
18        DO 100 J=1,N                                                     TERP0250
19        IF(TT-TABLE(1,J)) 101,102,100                                    TERP0260
20    100 CONTINUE                                                         TERP0270
21    104 TERP = TABLE(L,1)                                                TERP0280
22        IN3=-1                                                           TERP0290
23        CALL ERROR(IN3,IN4,TT)                                           TERP0300
24        RETURN                                                           TERP0310
25    106 TERP = TABLE(L,N)                                                TERP0320
26        IN3= 1                                                           TERP0330
27        CALL ERROR(IN3,IN4,TT)                                           TERP0340
28        RETURN                                                           TERP0350
29    102 TERP = TABLE(L,J)                                                TERP0360
30        RETURN                                                           TERP0370
31    101 CONTINUE                                                         TERP0380
32        IF(.NOT.(ABS(TABLE(I,J)-TABLE(I,J-1)).LT.1.E-10) ) GO TO 109     TERP0390
33        WRITE(6,600)                                                     TERP0400
34        WRITE(6,610) TT,LL,L,N,IN1,IN2,IN3,IN4                           TERP0410
35        DO 160 JJJ=1,N                                                   TERP0420
36        WRITE(6,620) (TABLE(II,JJJ),III=1,L)                             TERP0430
37    160 CONTINUE                                                         TERP0440
38        STOP                                                             TERP0450
39    109 CONTINUE                                                         TERP0460
40        TERP=TABLE(L,J-1)+(TABLE(L,J)-TABLE(L,J-1))*(TT-TABLE(I,J-1))/   TERP0470
         1(TABLE(I,J)-TABLE(I,J-1))                                        TERP0480
41        RETURN                                                           TERP0490
42    110 IF(TT.GE.TABLE(I,1))GO TO 104                                    TERP0500
43        IF(TT.LE.TABLE(I,N)) GO TO 106                                   TERP0510
44        DO 120 J=1,N                                                     TERP0520
45        IF(TT-TABLE(1,J)) 120,102,101                                    TERP0530
46    120 CONTINUE                                                         TERP0540
C    *    1    *    2    *    3    *    4    *    5    *    6    *    7    TERP0550
47     40 FORMAT(1H0,5X,      107H*INDEX ERROR IN (TERP)   SIYO SITEIRU MATRITERP0560
         1X NO GYOSUU GA ZERO MATAWA MAINASU NANODE JOB O YAMEMASU  N,IN2=, TERP0570
         2 2I3,  12H CALLED FROM ,I4)                                      TERP0580
48     41 FORMAT(1H0,5X,      106H*INDEX ERROR IN (TERP)   SIYO SITEIRU MATRITERP0590
```



```
* SOURCE STATEMENT (TERP    )*
         1X NO GYOSUU GA MOTO NO DIMENSION YORI OOKII                N,IN2=, TERP0600
         2 2I3,  12H CALLED FROM ,I4)                                      TERP0610
49     42 FORMAT(1H0,5X,      106H*INDEX ERROR IN (TERP)   NAISO SAREBU RETU TERP0620
         1NO BANGOO GA 1 IKA NANODE JOB O YAMEMASU,                L,IN1=, TERP0630
         2 2I3,  12H CALLED FROM ,I4)                                      TERP0640
50     43 FORMAT(1H0,5X,      106H*INDEX ERROR IN (TERP)   NAISO SAREBU RETU TERP0650
         1NO BANGOO GA MOTO NO DIMENSION YORI OOKII                L,IN1=, TERP0660
         2 2I3,  12H CALLED FROM ,I4)                                      TERP0670
51    600 FORMAT( 5X,50HFUNCTION TERP(TT,TABLE,LL,N,IN1,IN2,IN3,IN4) ERROR )TERP0680
52    610 FORMAT( 5X,3HTT=E12.5,6H,  LL=,I6,5H,  L=,I6,5H,  N=,I6,         TERP0690
         1  7H,  IN1=,I6,7H,  IN2=,I6,7H,  IN3=,I6,7H,  IN4=,I6            TERP0700
         2 //10X, 5HTABLE      )                                           TERP0710
53    620 FORMAT( 5X, 10(E12.5,1X) )                                       TERP0720
C*****************************************************************************TERP0730
54        END                                                              TERP0740
```

```
                          I N P U T     D A T A     L I S T
                          ---------------------------------
CARD NO.    ....*....1....*....2....*....3....*....4....*....5....*....6....*....7....*....8

  1,              SAMPLE  PROBLEM     (TYPICAL PWR PIN)
  2,   #INPUT
  3,   FR35  = 0.03  ,  FRDEN = 0.927  ,  FRSIN = 0.960  ,  DFS   = 0.3669  ,
  4,   DCI   = 0.3734,  DCO   = 0.422  ,  LFUEL = 144.   ,  VPLENZ= 0.438   ,
  5,   ATMOS = 20,      FRACHE= 1.0    ,  S     = 0.017  ,  ROUF  = 4.E-5   ,
  6,   ROUC  = 2.E-5 ,  DTEMP = 64.8   ,  DDISH = 0.183  ,  SIGHF = -1.     ,
  7,   DE    = 0.5512,  V     = 13.973 ,  IFLUX = 1      ,  ISWELL= 1       ,
  8,   ICDF  = -1    ,  NPOW  = 10     ,  IPEAK = 0      ,  NEXP  = 2       ,
  9,   MEXP  = 4     ,  MDEN  = 2      ,  MRELOC= 1      ,  IOUT1 = 1       ,
 10,   KUNIT = 0     ,  NUCLEI= 1      ,  IIPROF= 1      ,  TM    = 2850.
 11,   *
 12,        0.0       0.0      545.     2250.                                  -4-4 0 1
 13,        1.0       4.0      545.     2250.                                 1
 14,        2.0       8.0      545.     2250.                                -1
 15,       10.0      15.0      545.     2250.                                -1
 16,       50.0      15.0      545.     2250.
 17,      200.0      15.0      545.     2250.
 18,      202.0       0.0       77.     2250.                                 3
 19,       -1.0
 20,   #INPUT5
 21,   POWER(1) = .23 , .63 , .96 , 1.21 , 1.35 , 1.4 , 1.35 , 1.21 ,
 22,              .96 , .63 , .23          *
 23,   STOP
 24,

       ....*....1....*....2....*....3....*....4....*....5....*....6....*....7....*....8          END OF CARD
```

```
*****************************************************************************************
*                                                                                       *
*                    SAMPLE  PROBLEM     (TYPICAL PWR PIN)                              *
*                                                                                       *
*****************************************************************************************
```

```
                          ************************************
                           H I S T O R Y     D A T A
                          ************************************
```

TIME STEP NO.	IRRADIATION TIME (DAYS)	IRRADIATION TIME (HOURS)	TIME INTERVALS (DAYS)	TIME INTERVALS (HOURS)	LINEAR HEAT RATE (W/CM)	LINEAR HEAT RATE (KW/FT)	COOLANT INLET TEMPERATURE (DEG C)	COOLANT INLET TEMPERATURE (DEG F)	COOLANT PRESSURE (KG/CM2)	COOLANT PRESSURE (PSI)	OPERATION MODE INPUT CONTROL SIGN (1)	(2)	(3)	(4)	(5)
1 **	0.0	0.0	0.0	0.0	0.0	0.0	285.000	545.000	158.23	2250.00	0	-4	-4	0	1
2 **	1.000	24.0	1.000	24.0	131.234	4.000	285.000	545.000	158.23	2250.00	1	0	0	0	0
3 **	2.000	48.0	1.000	24.0	262.467	8.000	285.000	545.000	158.23	2250.00	-1	0	0	0	0
4	6.000	144.0	4.000	96.0	377.297	11.500	285.000	545.000	158.23	2250.00	0	0	0	0	0
5 **	10.000	240.0	4.000	96.0	492.126	15.000	285.000	545.000	158.23	2250.00	-1	0	0	0	0
6 **	50.000	1200.0	40.000	960.0	492.126	15.000	285.000	545.000	158.23	2250.00	0	0	0	0	0
7 **	200.000	4800.0	150.000	3600.0	492.126	15.000	285.000	545.000	158.23	2250.00	0	0	0	0	0
8	200.500	4812.0	0.500	12.0	369.094	11.250	220.000	428.000	158.23	2250.00	0	0	0	0	0
9	201.000	4824.0	0.500	12.0	246.063	7.500	155.000	311.000	158.23	2250.00	0	0	0	0	0
10	201.500	4836.0	0.500	12.0	123.031	3.750	90.000	194.000	158.23	2250.00	0	0	0	0	0
11 **	202.000	4848.0	0.500	12.0	0.0	0.0	25.000	77.000	158.23	2250.00	3	0	0	0	0

..NOTE.. (**) IS INPUT DATA (PEAK POWER)

OPERATION MODE
==========

(1) TEMPERATURE PROFILE PRINT-OUT OPTION =0 NOT PRINTED =1 DETAIL PROFILE PRINT = 2 PLOT PROFILE BY LINE PRINTER
(2) FUEL THERMAL CONDUCTIVITY CONTROLLER =0 NOT CHANGE =N N-TH DATA READ-IN =-N USE PREPARATED EQUATION
(3) CLADDING PROPERTY CONTROLLER =0 NOT CHANGE =N N-TH DATA READ-IN =-N USE PREPARATED TABLE(ZRY2,ZRY4,ST)
(4) RADIAL FLUX DEPRESSION CONTROLLER =0 NOT CHANGE =N N-TH DATA READ-IN =-1 USE SUBROUTINE DEPRES
(5) AXIAL POWER PROFILE CONTROLLER =0 NOT CHANGE =1 NEW POWER DISTRIBUTION DATA READ-IN

```
                                  ------------------------------------
                                  I  FREG3 OPTIONAL MODEL AND EQUATION  I
                                  ------------------------------------

***** FUEL THERMAL CONDUCTIVITY EQUATION *****   CONTROL SIGNAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 73-74 K2=-4
                                   ----INTEGRAL KDT (W/CM)----   FROM TO(DEG-C). AT RHO=0.95   0/2800  500/2800
                                                                                              -----(W/CM)----
      K2 = (NCON).GT.0   :   READ IN TABLE FROM CARDS (INPUT GROUP NO. 5).   NAMELIST  INPUT2
      K2 =          0    :   SAME AS PREVIOS STEP.
      K2 = (NCON) = -2   :   WARD DESIGN EQUATION  ( DENSITY.LT.0.95 FRACTIONAL ).
      K2 = (NCON) = -2   :   WARD DESIGN EQUATION  ( DENSITY.GE.0.95 FRACTIONAL )                 89.5      59.0
      K2 = (NCON) = -3   :   GODFREY EQUATION.                                                    90.7      59.0
    * K2 = (NCON) = -4   :   LYONS EQUATION.   (DOCKET STN-50447-1 P.4.2-3)                       93.0      62.0
      K2 = (NCON) = -5   :   RESAR-41 EQUATION (DOCKET STN-50480-1 P.4.4-9)                       86.2      64.5

***** CLADDING PROPERTIES *****                  CONTROL SIGNAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 75-76 K3=-4

      K3  (NCLAD).GT.0   :   READ IN TABLE FROM CARDS (INPUT GROUP NO. 6).   NAMELIST  INPUT3
      K3 =          0    :   SAME AS PREVIOUS STEP.
      K3 =(NCLAD) = -2   :   ZIRCALOY-2  ( BUILT IN DATA ).                                   REFER D- 964
      K3 =(NCLAD) = -4   :   ZIRCALOY-4  ( BUILT IN DATA ).                                   REFER D- 964
      K3 =(NCLAD) = -9   :   20-PERCENT COLD WORKED TYPE 316 STAINLESS STEEL.

***** CLADDING YIELD STRENGTH EQUATION *****     CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IYIELD= 0

            IYIELD=  0   :   YIELD STRENGTH IS USED FROM TABLE DATA WHICH IS ASSIGNED BY NCLAD.

***** RADIAL FLUX DEPRESSION *****               CONTROL SIGNAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 77-78 K4= 0

      K4   (NFLX).GT.0   :   READ IN TABLE FROM CARDS (INPUT GROUP NO. 7).   NAMELIST  INPUT4
      K4 =          0    :   FLAT (FIRST STEP). SAME AS PREVIOUS STEP (FROM SECOND STEP)
      K4 = (NFLX) = -1   :   BUILT IN EQUATION ( BESSEL I-ZERO DISTRIBUTION )                 REFER D- 916.917

***** AXIAL POWER DISTRIBUTION *****             CONTROL SIGNAL...INPUT GROUP NO. 3  FORMATTED I2  COLUMN 79-80 K5= 1

      K5          .GT.0  :   READ IN TABLE FROM CARDS (INPUT GROUP NO. 8).   NAMELIST  INPUT5
      K5 =          0    :   SAME AS PREVIOUS STEP.

***** IRRADIATION MODEL *****                    CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IFLUX = 1

            IFLUX =  0   :   FAST FLUX IRRADIATION.
            IFLUX =  1   :   THERMAL FLUX IRRADIATION.

***** LINEAR HEAT RATE ASSIGNMENT SIGNAL *****   CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IPEAK = 0

            IPEAK.GT.0   :   LINEAR HEAT RATE WHICH IS ASSIGNED BY GROUP-3-INPUT IS CONSIDERED TO ROD-AVG-VALUE.
            IPEAK.LE.0   :   LINEAR HEAT RATE WHICH IS ASSIGNED BY GROUP-3-INPUT IS CONSIDERED TO ROD-PEAK-VALUE.

***** CLADDING CREEP *****                       CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ICREP = 0

            ICREP.GT.0   :   READ IN TABLE FROM CARDS (INPUT GROUP NO. 4).   FORMATTED  F10.0. E10.0
            ICREP =  0   :   NOT CREEP.
            ICREP = -2   :   SAME AS ATR ZIRCALOY TUBE.  J.NUCL.MAT. 41.(1971). P327.          REFER D- 950
            ICREP = -3   :   SAME AS PRESSURE TUBE.                                            REFER D- 951
            ICREP = -4   :   SAME AS FIGRO #APD-TM 618.                                        REFER D- 952
            ICREP = -5   :   ATR(NEW) MODEL                                                    REFER D- 953

***** STORED ENERGY CALCULATION *****            CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ISTOR = 0

            ISTOR =  0   :   STORED ENERGY CALCULATION IS NOT PERFORMED.
            ISTOR.LT.0   :   STORED ENERGY CALCULATION IS PERFORMED.                           REFER D- 700

***** HISTORY INPUT *****                        CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  NHIST = 0

            NHIST =  0   :   TIME DEPENDENT HISTORY.
            NHIST =  1   :   BURNUP DEPENDENT HISTORY.

***** CLADDING ELASTIC DEFORMATION *****         CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ICDF  =-1

            ICDF  =  0   :   ELASTIC CLAD DEFLECTION NOT TAKEN INTO ACCOUNT.
            ICDF .LT.0   :   ELASTIC CLAD DEFLECTION TAKEN INTO ACCOUNT.

***** FUEL SWELLING MODEL *****                  CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  ISWELL= 1

            ISWELL=  0   :   FUEL SWELLING IS NOT TAKEN INTO ACCOUNT.
            ISWELL=  1   :   GEITHOFF. ET AL. MODEL IS USED.          USED IN GAPCON ( CONSERVATIVE MODEL )
            ISWELL=  2   :   REVISED GAP CLOSURE MODEL IS USED.       USED IN GAPCON THERMAL-1 ( OPTIONAL )

***** FUEL THERMAL EXPANSION EQUATION *****      CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  NEXP  = 2
                                   ----THERMAL EXPANSION COEFF. AVERAGE   DELTA.L/L/(T2-T1)   25/2800  500/2800
                                                                                            ----(   /DEG-C)----
            NEXP  =  0   :   FUEL THERMAL EXPANSION IS NOT TAKEN INTO ACCOUNT.
            NEXP  =  1   :   ROTH AND HALTEMAN.       ( GAPCON )            REFER D-812      1.1145E-5 1.1430E-5
    *       NEXP  =  2   :   CONWAY.FINCEL AND HAIN  ( GAPCON THERMAL-1 )   REFER D-812      1.4978E-5 1.6354E-5

***** CALCULATE THE CALDDING-TO-COOLANT HEAT TRANSFER COEFFICIENT *****
                                                CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  SIGHF = -1.000

            SIGHF.GT.0.  :   COOLANT IS UNSPECIFIED AND THE FILM COEFFICIENT WILL BE SET TO SIGHF.
            SIGHF =  0.  :   COOLANT IS LIQUID SODIUM. ( PRESENTED HEDL-TME 71-32. JUNE 1971 ).
            SIGHF = -1.  :   COOLANT IS WATER.         ( DITTUS-BOELTER EQUATION ).            REFER D- 929
            SIGHF = -2.  :   COOLANT IS WATER.         ( JENS LOTTES EQUATION )                REFER D- 526
            SIGHF = -3.  :   SUBCOOL=DITTUS BOELTER.  SATURATE=JENS LOTTES

***** FUEL THERMAL EXPANSION MODEL *****         CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MEXP  = 4

            MEXP  =  1   :   GAPCON MODEL.     ( MOST CONSERVATIVE   )
            MEXP  =  2   :   PLASTIC MODEL.     ( AREA BALANCE TYPE   )
            MEXP  =  3   :   TWO REGION MODEL.  ( HALF CRACK TYPE     )
            MEXP  =  4   :   BRITTLE MODEL.     ( CONPLETE CRACK TYPE )

***** GAP CONDUCTANCE CONVERGENCE METHOD *****   CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MCONV = 0

            MCONV =  0   :   SIMILAR METHOD WHICH IS USED FOR GAPCON-THERMAL-1.
            MCONV =  1   :   NEWTON-RAPHSON METHOD.

***** GAP CONDUCTANCE EQUATION *****             CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MREV1 = 0
```

```
MREV1 = -1   :   RESAR-41 EQUATION
MREV1 =  1   :   ROSS AND STOUTE EQUATION

*****  FUEL DENSIFICATION MODEL  *****          CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MDEN  = 2

MDEN  =  0   :   DENSIFICATION IS NOT TAKEN INTO ACCOUNT.
MDEN  =  1   :   HALDEN DENSIFICATION MODEL.                                        REFER D- 946
MDEN  =  2   :   GAPCON THERMAL-2 DENSIFICATION MODEL

*****  FUEL RELOCATION MODEL  *****             CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MRELOC= 1

MRELOC=  0   :   RELOCATION IS NOT TAKEN INTO ACCOUNT.
MRELOC=  1   :   GAPCON THERMAL 2 RELOCATION MODEL                                  REFER D-1123

*****  TEMPERATURE DISTRIBUTION PRINTED  *****  CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  IIPROF= 1

IIPROF=  0   :   RADIAL TEMPERATURE PROFILE IS NOT PRINTED.
IIPROF=  1   :   RADIAL TEMPERATURE PROFILE IS PRINTED.

*****  RESTRUCTURING MODEL  *****               CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  MREST = 0

MREST =  0   :   RESTRUCTURING CALCULATION ISNOT PERFORMED.
MREST =  1   :   RESTRUCTURNIG CALCULATION IS PERFORMED.                            REFER D- 936

*****  FUEL CREEP  *****                        CONTROL SIGNAL...INPUT GROUP NO. 2  NAMELIST  /INPUT/  LCREP = 0

LCREP =  0   :   FUEL NOT CREEP.
LCREP =  1   :   FUEL CREEP.
```

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SAMPLE  PROBLEM     (TYPICAL PWR PIN)                                    76-09-09     9 HR 56 MINUTE

                                        ******************
                                        *  INPUT VALUES  *
                                        ******************
*****************************************************************************************************************
*                                                                                                               *
*        FUEL COMPOSITION                                                                                       *
*  ( 1)     0.0        WEIGHT FRACTION PU02                                                        FRPU02      *
*           0.0        WEIGHT FRACTION PU239                                                       FR39=1.-FR40-FR41 *
*  ( 2)     0.0        WEIGHT FRACTION PU240                                                       FR40        *
*  ( 3)     0.0        WEIGHT FRACTION PU241                                                       FR41        *
*           1.0000     WEIGHT FRACTION U02                                                         FRU02=1.-FRPU02 *
*  ( 4)     0.0300     WEIGHT FRACTION U235                                                        FR35        *
*           0.9700     WEIGHT FRACTION U238                                                        FR38=1.-FR35 *
*  ( 5)  FUEL DENSITY                          0.92700(FRACTION TD)      0.92700(FRACTION TD)      FRDEN       *
*  ( 6)  RESTRUCTURED FUEL DENSITY             0.96000(FRACTION TD)      0.96000(FRACTION TD)      FRSIN       *
*  ( 7)  PELLET DIAMETER                       0.93193( CM )             0.36690(INCHES)           DFS         *
*  ( 8)  INITIAL RESTRUCTURED FUEL DIAMETER    0.0    ( CM )             0.0    (INCHES)           DSINZ       *
*  ( 9)  INITIAL CENTER HOLE DIAMETER          0.0    ( CM )             0.0    (INCHES)           DVOIDZ      *
*  (  )  PELLET DISH DIAMETER                  0.18300( CM )             0.07205(INCHES)           DDISH       *
*  (  )  PELLET DISH DEPTH                     0.0    ( CM )             0.0    (INCHES)           HDISH       *
*        PELLET-TO-CLAD DIAMETRAL GAP          0.01651( CM )             0.00650(INCHES)           GAP=DCI-DFS *
*  (10)  CLAD INSIDE DIAMETER                  0.94844( CM )             0.37340(INCHES)           DCI         *
*  (11)  CLAD OUTSIDE DIAMETER                 1.07188( CM )             0.42200(INCHES)           DCO         *
*  (12)  FUEL LENGTH                         365.76000( CM )           144.00000(INCHES)           LFUEL(REAL) *
*  (13)  INITIAL CENTER VOID LENGTH            0.0    ( CM )             0.0    (INCHES)           LVOIDZ(REAL) *
*  (14)  SORBED GAS CONTENT                    0.01700(CC/GRAM)          0.01700(CC/GRAM)          S           *
*  (15)  FRACTION OF SORBED GAS WHICH IS H2    0.0                       0.0                       XX          *
*  (16)  PLENUM VOLUME                         7.17753(CU. CM)           0.43800(CU. IN.)          VPLENZ      *
*  (18)  AXIAL TEMPERATURE GRADIENT ACROSS CORE 36.00000(DEG C)          64.80000(DEG F)           DTEMP       *
*  (19)  COOLANT PASSAGE EQUIVALENT DIAMETER   1.40005( CM  )            0.55120(INCHES)           DE          *
*  (20)  COOLANT VELOCITY                      4.25897(M/SEC)           13.97300(FT/SEC)           V           *
*  (23)  FUEL SURFACE ROUGHNESS, ARITH. MEAN 0.10160E-03( CM )       0.40000E-04(INCHES)           ROUF        *
*  (24)  CLAD ID SURFACE ROUGHNESS ARITH. MEAN 0.50800E-04( CM )     0.20000E-04(INCHES)           ROUC        *
*  (35)  MELTING TEMPERATURE OF THE FUEL     2850.00000(DEG C)       5162.00000(DEG F)             TM          *
*  (36)  FILL GAS PRESSURE                     20.00000(ATMOSPHERES)     20.00000(ATMOSPHERES)     ATMOS       *
*        FILL GAS COMPOSITION                                                                                   *
*  (37)    1.0000     MOLE FRACTION HELIUM                                                        FRACHE      *
*  (38)    0.0        MOLE FRACTION ARGON                                                         FRACAR      *
*  (39)    0.0        MOLE FRACTION HYDROGEN                                                      FRACH       *
*  (40)    0.0        MOLE FRACTION NITROGEN                                                      FRACN       *
*  (41)    0.0        MOLE FRACTION KRYPTON                                                       FRACKR      *
*  (42)    0.0        MOLE FRACTION XENON                                                         FRACXE      *
*  (43)  COOLANT IS WATER  (DITTUS-BOELTER EQUATION)                                              SIGHF =  -1.00 *
*  (44)  THERMAL FLUX IRRADIATION                                                                 IFLUX =  1  *
*  (45)  FUEL THERMAL EXPANSION IS TAKEN INTO ACCOUNT.                                            NEXP  =  2  *
*  (55)  NUMBER OF AXIAL SEGMENTS  (LIMIT OF 20)                                                  NPOW  = 10  *
*  (  )  FUEL DENSIFICATION IS TAKEN INTO ACCOUNT.                                                MDEN  =  2  *
*  (  )  FUEL RELOCATION MODEL IS USED.                                                           MRELOC=  1  *
*  (  )  RESTRUCTURING CALCULATION IS PERFORMED                                                   MREST =  1  *
*  (57)  THE HYDROGEN IS ASSUMED TO REACT WITH THE CLADDING                                       NOH   =  1  *
*  (60)  ELASTIC CLAD DEFLECTION TAKEN INTO ACCOUNT.                                              ICDF  = -1  *
*  (  )  GEITHOFF. ET AL. MODEL IS USED.                                                          ISWELL=  1  *
*  (62)  STORED ENERGY CALCULATION IS NOT PERFORMED.                                              ISTOR =  0  *
*  (63)  A PEAK POWER NEEDS TO BE INPUT.                                                          IPEAK =  0  *
*  (65)  RADIUS TEMPERATURE PROFILE IN FUEL PIN IS PRINTED                                        IIPROF=  1  *
*  (  )  FUEL THERMAL EXPANSION IS TAKEN INTO ACCOUNT.                                            MEXP  =  4  *
*  (67)  GAPCON-THERMAL-1 ORIGINAL CONVERGENCE METHOD IS USED                                     MCONV =  0  *
*  (  )  YIELD STRENGTH IS USED FROM TABLE DATA WHICH IS ASSIGNED BY NCLAD                        IYIELD=  0  *
*  (  )  TIME DEPENDENT HISTORY                                                                   NHIST =  0  *
*  (  )  FISSION PRODUCTS YIELD PRINT OUT                                                         NUCLEI=  1  *
*                                                                                                               *
*****************************************************************************************************************
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(48) FUEL THERMAL CONDUCTIVITY VALUES DETERMINED FROM DATA OF LYONS , ET AL (NCON)= -4

TEMPERATURE (DEG C)	TEMPERATURE (DEG F)	THERMAL CONDUCTIVITY UNRESTRUCTURED FUEL (WATT/CM-C)	THERMAL CONDUCTIVITY UNRESTRUCTURED FUEL (BTU/HR-FT-F)	THERMAL CONDUCTIVITY RESTRUCTURED FUEL (WATT/CM-C)	THERMAL CONDUCTIVITY RESTRUCTURED FUEL (BTU/HR-FT-F)
0.	32.	0.092	5.301	0.097	5.578
300.	572.	0.053	3.043	0.055	3.202
600.	1112.	0.037	2.150	0.039	2.263
900.	1652.	0.029	1.693	0.031	1.781
1200.	2192.	0.025	1.440	0.026	1.516
1500.	2732.	0.023	1.312	0.024	1.380
1800.	3272.	0.022	1.273	0.023	1.339
2100.	3812.	0.023	1.309	0.024	1.377
2400.	4352.	0.024	1.414	0.026	1.488
2700.	4892.	0.027	1.585	0.029	1.668
3000.	5432.	0.032	1.825	0.033	1.920

(51) CLADDING IS ZIRCALOY-4 (NCLAD)= -4 IYIELD= 0

TEMPERATURE (DEG C)	THERMAL CONDUCTIVITY (W/CM/C)	YIELD STRENGTH (KG/CM2)	YOUNGS MODULUS (KG/CM2)	POISSONS RATIO	THERMAL EXPANSION COEFF. (/C)	MAYER HARDNESS (KG/CM2)
25.0	0.12900	3150.0	0.97200E+06	0.370	0.58300E-05	9470.0
100.0	0.13600	2450.0	0.91400E+06	0.400	0.62500E-05	7360.0
200.0	0.14300	2450.0	0.91400E+06	0.400	0.62500E-05	7360.0
300.0	0.15200	2450.0	0.91400E+06	0.400	0.62500E-05	7360.0
400.0	0.16400	2450.0	0.91400E+06	0.400	0.62500E-05	7360.0
500.0	0.18000	2450.0	0.91400E+06	0.400	0.62500E-05	7360.0

(54) FLUX DEPRESSION VALUES USED (NFLX)= 2

DIAMETER (CM)	DIAMETER (INCH)	FLUX RATIO
0.0	0.0	1.0000
0.9319	0.3669	1.0000

( ) AXIAL POWER DISTRIBUTION SEGMENT NO.= 10. NODAL POINT NO.= 11 POWER(11)

	INPUT VALUE	SEGMENT MEAN	.....AXIAL POWER DISTRIBUTION (SEGMENT MEAN)..... MIN.	AVG.	MAX.
TOP.....POWER(11)=	0.230000				
POWER(10)=	0.630000	0.433031	*		
POWER(9)=	0.960000	0.800604		*	
POWER(8)=	1.210000	1.092649		*	
POWER(7)=	1.350000	1.289023			*
POWER(6)=	1.400000	1.384693			*
POWER(5)=	1.350000	1.384693			*
POWER(4)=	1.210000	1.289023			*
POWER(3)=	0.960000	1.092649		*	
POWER(2)=	0.630000	0.800604		*	
BOTTOM....POWER(1)=	0.230000	0.433031	*		

(3)	LINEAR HEAT RATING(AVRAGE)	2,837 (KW/FT)	93,082 (WATT/CM)
(4)	BURNUP (PIN AVERAGE)	7,612 (MWD/MTU)	0.2565E+18 (FISSIONS/CC)
(5)	TIME IN REACTOR	1,000 (DAYS)	24,000 (HOURS)
(6)	COOLANT INLET TEMPERATURE	545,000 (DEG F)	285,000 (DEG C)
(7)	COOLANT OUTLET TEMPERATURE	609,800 (DEG F)	321,000 (DEG C)
(8)	COOLANT PRESSURE	2250,000 (PSI)	158,228 (KG/CM2)

(9) CUMULATED CP TIME 10,8440(SEC) COMPUTED TIME AT THIS STEP 7,6630(SEC)

(10) AXIAL SECTION NUMBER	(11) AXIAL DISTANCE (CM)	(INCH)	(12) LINEAR HEAT RATING (W/CM)	(KW/FT)	(13) BURNUP (MWD/MT)	(14) AVERAGE NEUTRON FLUX (NV)	(15) COOLANT TEMP. (DEG C)	(16) FILM COEFFICIENT BTU WATT/CM2-C	/HR-FT2-F	(17) CLAD OD SURFACE HEAT FLUX WATT / CM2	BTU/HR-FT2
1	18,29	7,20	40,3075	1,2286	3,30	4,845E+12	286,56	3,106	5470,923	11,962	37918,610
2	54,86	21,60	74,5219	2,2714	6,09	8,958E+12	289,44	3,096	5453,141	22,114	70101,682
3	91,44	36,00	101,7060	3,1000	8,32	1,223E+13	293,37	3,082	5428,721	30,179	95668,420
4	128,02	50,40	119,9850	3,6571	9,81	1,442E+13	298,02	3,070	5406,402	35,602	112856,953
5	164,59	64,80	128,8901	3,9286	10,54	1,549E+13	303,00	3,057	5384,042	38,242	121228,199
6	201,17	79,20	128,8901	3,9286	10,54	1,549E+13	307,98	3,049	5370,083	38,241	121224,430
7	237,74	93,60	119,9850	3,6571	9,81	1,442E+13	312,63	3,045	5363,277	35,598	112846,662
8	274,32	108,00	101,7060	3,1000	8,32	1,223E+13	316,56	3,043	5359,287	30,175	95654,576
9	310,90	122,40	74,5219	2,2714	6,09	8,958E+12	319,44	3,044	5361,862	22,110	70088,559
10	347,47	136,80	40,3075	1,2286	3,30	4,845E+12	321,00	3,044	5361,187	11,959	37910,461

AXIAL SECTION NUMBER	(18) CLAD OD TEMPERATURE (DEG C)	(DEG F)	(19) CLAD ID TEMPERATURE (DEG C)	(DEG F)	(20) CLAD THERMAL CONDUCTIVITY (WATT / CM2-C)	(BTU / HR-FT-F)	(21) GAP AVERAGE TEMPERATURE (DEG C)	(DEG F)	(22) FUEL SURFACE HEAT FLUX WATT / CM2	BTU/HR-FT2	(23) NO. OF GAP - CONDUCTANCE ITERATIONS 1	2	3	4	5
1	290,41	554,74	295,61	564,10	0,151368	8,749080	314,55	598,19	13,712	43467,90	2	5	2	2	0
2	296,58	565,85	306,15	583,08	0,152157	8,794700	337,89	640,21	25,326	80283,43	2	5	2	2	0
3	303,17	577,70	316,14	601,06	0,153150	8,852090	356,18	673,12	34,535	109477,11	2	4	2	2	0
4	309,61	589,30	324,83	616,70	0,154058	8,904551	369,35	696,83	40,718	129075,84	2	4	2	2	0
5	315,51	599,92	331,78	629,20	0,154828	8,949077	378,08	712,55	43,726	138610,68	2	3	2	2	0
6	320,53	608,95	336,73	638,12	0,155427	8,983661	382,71	720,88	43,723	138603,41	2	2	2	2	0
7	324,32	615,77	339,36	642,86	0,155812	9,005941	382,85	721,14	40,712	129056,88	2	2	2	2	0
8	326,48	619,66	339,22	642,60	0,155934	9,012976	377,91	712,24	34,527	109451,93	2	4	2	2	0
9	326,70	620,07	336,05	636,90	0,155759	9,002862	366,48	691,67	25,319	80260,43	2	4	2	2	0
10	324,93	616,87	330,00	626,00	0,155292	8,975862	348,03	658,46	13,708	43454,36	2	5	2	2	0

(24) ITERATION SUBTOTAL (THIS STEP)= 98
ITERATION TOTAL(UP TO THIS STEP)= 162

(10) AXIAL SECTION NUMBER	(25) GAP CONDUCTANCE(BTU/HR-FT2-F) SOLID -SOLID	GAS- CONDUCT	RADIANT	TOTAL	(26) GAS RELEASE RATE	(27) TEMP. JUMP DIST. MM	(28) INCREASE IN FUEL RADIUS(MM) THERMAL EXPANSION	SWELLING	TOTAL	(29) INCREASE IN CLAD RADIUS(MM) THERMAL EXPAN.	CREEP	PRESSURE	TOTAL	(30) RADIAL HOT GAP (MM)	(31)
1	0,0	630,10	5,97	636,07	0,00030	0,000281	0,013084	0,0	0,018755	0,00794	0,0	-0,00532	0,00263	0,06642	
2	0,0	693,10	6,72	699,82	0,00035	0,000294	0,016535	0,0	0,023508	0,00819	0,0	-0,00532	0,00288	0,06192	
3	0,0	750,59	7,35	757,94	0,00039	0,000304	0,019505	0,0	0,027439	0,00844	0,0	-0,00532	0,00312	0,05823	
4	0,0	795,34	7,83	803,17	0,00043	0,000312	0,021668	0,0	0,030227	0,00866	0,0	-0,00532	0,00334	0,05567	
5	0,0	821,70	8,15	829,85	0,00044	0,000316	0,022886	0,0	0,031746	0,00885	0,0	-0,00532	0,00353	0,05434	
6	0,0	826,92	8,33	835,25	0,00045	0,000319	0,023133	0,0	0,031993	0,00900	0,0	-0,00532	0,00368	0,05424	
7	0,0	809,80	8,33	818,13	0,00044	0,000319	0,022367	0,0	0,030926	0,00909	0,0	-0,00532	0,00378	0,05540	
8	0,0	772,22	8,14	780,35	0,00041	0,000316	0,020592	0,0	0,028526	0,00912	0,0	-0,00532	0,00381	0,05783	
9	0,0	718,74	7,71	726,45	0,00037	0,000310	0,017883	0,0	0,024856	0,00908	0,0	-0,00532	0,00376	0,06146	
10	0,0	657,40	7,05	664,45	0,00032	0,000300	0,014544	0,0	0,020216	0,00896	0,0	-0,00532	0,00365	0,06598	

AXIAL SECTION NUMBER	(32) FUEL SURFACE TEMP. (DEG C)	(33) FUEL CENTER TEMP. (DEG C)	(34) VOL. AVG FUEL TEMP. (DEG C)	FUEL CENTRAL VOID (MM)	(35) BOUNDARY 1700 DEG C (MM)	RADIUS (MM) 1350 DEG C (MM)	SURFACE (MM)	(36) PERCENT CHANGE ORIGINAL RADIUS FUEL OD (O/D)	CLAD OD (O/D)	(37) FILL GAS CONDUCTIVITY CAL/SEC -CM-C	BTU / HR-FT-F	(38) CONTACT PRESSURE (KG/CM2)	(39) CLAD ID THERMAL STRESS (KG/CM2)
1	333,488	400,058	366,305	0,0	0,0	0,0	4,67839	0,4025	0,0683	0,00057	0,13777	0,0	-25,784
2	369,634	503,520	434,839	0,0	0,0	0,0	4,68314	0,5045	0,0735	0,00058	0,14134	0,0	-47,422
3	396,208	530,641	490,005	0,0	0,0	0,0	4,68707	0,5889	0,0767	0,00060	0,14402	0,0	-64,302
4	413,867	652,751	528,388	0,0	0,0	0,0	4,68986	0,6467	0,0834	0,00060	0,14594	0,0	-75,411
5	424,385	686,636	549,735	0,0	0,0	0,0	4,69138	0,6813	0,0874	0,00061	0,14721	0,0	-80,605
6	428,689	692,245	554,669	0,0	0,0	0,0	4,69162	0,6866	0,0906	0,00061	0,14789	0,0	-80,295
7	426,343	668,727	542,557	0,0	0,0	0,0	4,69056	0,6637	0,0926	0,00061	0,14791	0,0	-74,562
8	416,597	615,823	512,720	0,0	0,0	0,0	4,68816	0,6122	0,0932	0,00061	0,14719	0,0	-63,154
9	396,911	535,408	464,369	0,0	0,0	0,0	4,68449	0,5334	0,0923	0,00060	0,14552	0,0	-46,326
10	366,064	435,536	400,314	0,0	0,0	0,0	4,67985	0,4339	0,0898	0,00059	0,14283	0,0	-25,132

(40)	PLENUM VOLUME	7.17753 (CM3)	0.43800 (INCH3)
(41)	PLENUM TEMPERATURE	326.55556 (DEG C)	619.80000 (DEG F)
(42)	COOLANT SATURATE TEMPERATURE	344.85963 (DEG C)	
(43)	INITIAL PLENUM PRESSURE	20.00000 (KG/CM2)	284.40000 (PSI)
(44)	INTERNAL GAS PRESSURE	50.50336 (KG/CM2)	718.15785 (PSI)
(45)	TOTAL GAS MOLES IN A PIN	0.13166E-01 (MOLES)	
(46)	GASES IN PLENUM	0.71290E-02 (MOLES)	
(47)	GASES IN A GAP OR CENTRAL VOID	0.60373E-02 (MOLES)	
(48)	FP GAS RELEASED RATE (PIN AVERAGE)	0.00039 (FRACTION)	

COMPOSITION OF PIN GAS (MOLES)

	(49) INITIAL FILL GAS	(50) GENERATED IN FUEL	(51) RELEASED GAS	(52) CUMULATED GAS	(53) FRACTION
HELIUM	0.0131655168	0.0	0.0	0.0131655168	0.999942
ARGON	0.0	0.0	0.0	0.0	0.0
HYDROGEN	0.0	0.0	0.0	0.0	0.0
NITROGEN	0.0	0.0	0.0000007511	0.0000007511	0.000057
KRYPTON	0.0	0.0000061397	0.0000000025	0.0000000025	0.000000
XENON	0.0	0.0000360169	0.0000000147	0.0000000147	0.000001
TOTAL	0.0131655168	0.0000421566	0.0000007683	0.0131662851	

STORED ENERGY

(10) AXIAL SECTION NUMBER	(54) NOMINAL HEAT CAPACITY CAL/K-MOLE	BTU/LB-F	(55) STORED ENERGY CAL/GRAM	BTU/LB	(56) VOLUME AVERAGE STORED ENERGY CAL/GRAM	BTU/LB	(57) STORED ENERGY PER UNIT LENGTH CAL/CM	BTU/FOOT
1	19.068	5148.368	22.351	40.232	22.535	40.563	156.312	18.906
2	19.369	5229.645	27.230	49.015	27.517	49.531	190.872	23.086
3	19.576	5285.587	31.210	56.177	31.599	56.879	219.187	26.511
4	19.707	5320.771	34.002	61.203	34.474	62.053	239.128	28.923
5	19.775	5339.246	35.563	64.013	36.083	64.950	250.290	30.273
6	19.790	5343.416	35.924	64.664	36.454	65.616	252.859	30.584
7	19.752	5333.114	35.037	63.067	35.533	63.960	246.476	29.812
8	19.655	5306.733	32.860	59.148	33.284	59.912	230.877	27.925
9	19.483	5260.466	29.355	52.839	29.680	53.425	205.877	24.901
10	19.224	5190.610	24.763	44.573	24.981	44.967	173.283	20.959

AXIAL VOLUME-TEMPERATURE AVERAGED (CONVERGENCE IN ITERATION)

ITER.	(58) TEMPERATURE (DEG. C)	(DEG. F)	(59) INNER PRESSURE (KG/CM2)	(PSI)
1	515.618	960.112	51.685	734.958
2	484.518	904.133	50.487	717.926
3	484.427	903.969	50.505	718.181
4	484.390	903.902	50.503	718.158

(60) CONVERGENCE RELATIVE ERROR (FRACTION) 0.00008 (CONVERGENCE CRITERION 0.005)

(10) AXIAL SECTION NO.	(61) DENSI-FICATION (MM)	(62) RELOCATION (MM)	(63) RESTRUCTURING RADIUS (MM)	TEMP. (DEG C)	(64) CENTRAL VOID RADIUS (MM)	LENGTH (MM)	(MOT) VOLUME (CUB MM)	(65) RADIUS FOR NEXT STEP (MM) CENTRAL VOID	PELLET SURFACE	CLAD INNER SURFACE	CLAD OUTER SURFACE
1	0.0	0.005672	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
2	0.0	0.006973	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
3	0.0	0.007934	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
4	0.0	0.008559	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
5	0.0	0.008859	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
6	0.0	0.008859	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
7	0.0	0.008559	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
8	0.0	0.007934	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
9	0.0	0.006973	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940
10	0.0	0.005672	0.0	1731.54	0.0	0.0	0.0	0.0	4.65963	4.74218	5.35940

AXIAL SECTION NO.	(66) PELLET ELONGATION LENGTH (CM) COLD	DISH SHOULDER	CENTER	(COLD - DISH)	(COLD - CENTER)	(67) DISH SHOULDER TEMP. (C)	PELLET DENSIFI-CATION	(68) AXIAL DENSIFICATION DENSIFIED LENGTH(CM)	DENSIFY + EXPANSION
1	36.5760	36.6852	36.6861	0.1092	0.1101	397.40	0.0	0.0	0.10924
2	36.5760	36.7198	36.7218	0.1438	0.1458	498.01	0.0	0.0	0.14380
3	36.5760	36.7505	36.7535	0.1745	0.1775	582.45	0.0	0.0	0.17445
4	36.5760	36.7732	36.7771	0.1972	0.2011	642.53	0.0	0.0	0.19719
5	36.5760	36.7859	36.7904	0.2099	0.2144	675.33	0.0	0.0	0.20992
6	36.5760	36.7881	36.7926	0.2121	0.2166	680.89	0.0	0.0	0.21210
7	36.5760	36.7793	36.7833	0.2033	0.2073	658.36	0.0	0.0	0.20330
8	36.5760	36.7598	36.7630	0.1838	0.1870	607.43	0.0	0.0	0.18381
9	36.5760	36.7311	36.7332	0.1551	0.1572	529.71	0.0	0.0	0.15513
10	36.5760	36.6971	36.6981	0.1211	0.1221	432.76	0.0	0.0	0.12115
(TOTAL)	365.7600	367.4701	367.4991	1.7101	1.7391			0.0	1.71009

GAS RELEASE MECHANISM INFORMATION

(10) AXIAL SECTION NUMBER	(69) GENERATED F.P. GAS (ATOMS PER UNIT LENGTH) KRYPTON	XENON	(70) GAS RELEASE RATE UNTIL NOW MAX. VALUE	THIS TIME STEP	(71) RELEASED GAS (ATOMS PER UNIT LENGTH) KRYPTON MAX. VALUE	KRYPTON IN THIS STEP	(72) XENON MAX. VALUE	XENON IN THIS STEP
1	0.43781E+16	0.24883E+17	0.000231	0.000295	0.0	0.12916E+13	0.0	0.73407E+13
2	0.80943E+16	0.47052E+17	0.000233	0.000350	0.0	0.28347E+13	0.0	0.16478E+14
3	0.11047E+17	0.64885E+17	0.000236	0.000395	0.0	0.43595E+13	0.0	0.25606E+14
4	0.13032E+17	0.76926E+17	0.000240	0.000426	0.0	0.55459E+13	0.0	0.32736E+14
5	0.14000E+17	0.82801E+17	0.000244	0.000443	0.0	0.61982E+13	0.0	0.36659E+14
6	0.14000E+17	0.82801E+17	0.000248	0.000447	0.0	0.62539E+13	0.0	0.36988E+14
7	0.13032E+17	0.76926E+17	0.000252	0.000437	0.0	0.56947E+13	0.0	0.33613E+14
8	0.11047E+17	0.64885E+17	0.000255	0.000413	0.0	0.45616E+13	0.0	0.26793E+14
9	0.80943E+16	0.47052E+17	0.000257	0.000374	0.0	0.30272E+13	0.0	0.17597E+14
10	0.43781E+16	0.24883E+17	0.000259	0.000322	0.0	0.14115E+13	0.0	0.80222E+13
(73) AXIAL SUM.	0.10110E+18	0.59309E+18	0.002455	0.003901	0.0	0.41179E+14	0.0	0.24183E+15
AXIAL AVG.	0.10110E+17	0.59309E+17	0.000245	0.000390	0.0	0.41179E+13	0.0	0.24183E+14
(74) TOTAL MOLES IN FUEL	0.61397E-05	0.36017E-04				0.25007E-08		0.14686E-07

(75) RELEASE RATE (BY VOLUME AVERAGE TEMP.)..... 0.00039

(76) RECALCULATED RELEASE RATE KR + XE 0.00041 0.00041

AXIAL PELLET LENGTH CHANGE	(77) PELLET STUCK LENGTH CHANGE (CM)	(78) PELLET VOLUME CHANGE BY ELONG-ATION (CM3)	(79) CHANGED PLENUM VOLUME (CM3)	(80) PLENUM PRESSURE INDUCED PELLET LENGTH CHANGE
DUE TO THERMAL EXPANSION	1.7100925	1.2081621	5.9693722	55.56790
DUE TO AXIAL DENSIFICATION	0.0	0.0	7.1775342	50.50336
DUE TO EXPANSION + DENSIFY	1.7100925	1.2081621	5.9693722	55.56790

(81) DETAIL TEMPERATURE DISTRIBUTION

AXIAL SECTION	NODE 1 RADI(CM)	TEMP(C)	NODE 2 RADI(CM)	TEMP(C)	NODE 3 RADI(CM)	TEMP(C)	NODE 4 RADI(CM)	TEMP(C)	NODE 5 RADI(CM)	TEMP(C)	NODE 6 RADI(CM)	TEMP(C)	NODE 7 RADI(CM)	TEMP(C)
COOLANT		286.6		289.4		293.4		298.0		303.0		308.0		312.6
CLAD OD	0.5362	290.4	0.5362	296.6	0.5363	303.2	0.5363	309.6	0.5363	315.5	0.5363	320.5	0.5363	324.3
CLAD ID	0.4745	295.6	0.4745	306.2	0.4745	316.1	0.4746	324.8	0.4746	331.8	0.4746	336.7	0.4746	339.4
GAP AVG. TEMP.		314.6		337.9		356.2		369.3		378.1		382.7		382.9
PELLET SURFACE	0.4678	333.5	0.4683	369.6	0.4687	396.2	0.4690	413.9	0.4691	424.4	0.4692	428.7	0.4691	426.3
RADIAL NODE 5	0.4211	345.7	0.4215	393.5	0.4218	430.0	0.4221	454.8	0.4222	469.0	0.4222	473.5	0.4222	467.9
10	0.3743	356.8	0.3747	415.4	0.3750	461.5	0.3752	493.1	0.3753	510.9	0.3753	515.6	0.3752	506.8
15	0.3275	366.7	0.3278	435.3	0.3281	490.2	0.3283	528.3	0.3284	549.5	0.3284	554.4	0.3283	542.5
20	0.2807	375.4	0.2810	452.9	0.2812	515.9	0.2814	559.9	0.2815	564.2	0.2815	589.3	0.2814	574.5
25	0.2339	382.9	0.2342	468.1	0.2344	538.1	0.2345	587.4	0.2346	614.5	0.2346	619.7	0.2345	602.4
30	0.1871	389.0	0.1873	480.7	0.1875	556.7	0.1876	610.5	0.1877	639.9	0.1877	645.3	0.1876	625.8
35	0.1404	393.8	0.1405	490.6	0.1406	571.4	0.1407	628.8	0.1407	660.1	0.1407	665.6	0.1407	644.4
40	0.0936	397.3	0.0937	497.8	0.0937	582.1	0.0938	642.0	0.0938	674.8	0.0938	680.3	0.0938	657.9
45	0.0468	399.4	0.0468	502.1	0.0469	588.5	0.0469	650.1	0.0469	683.7	0.0469	689.3	0.0469	666.0
PELLET CENTER	0.0	400.1	0.0	503.5	0.0	590.6	0.0	652.8	0.0	686.6	0.0	692.2	0.0	668.7

AXIAL SECTION	NODE 8 RADI(CM)	TEMP(C)	NODE 9 RADI(CM)	TEMP(C)	NODE 10 RADI(CM)	TEMP(C)
COOLANT		316.6		319.4		321.0
CLAD OD	0.5363	326.5	0.5363	326.7	0.5363	324.9
CLAD ID	0.4746	339.2	0.4746	336.1	0.4746	330.0
GAP AVG. TEMP.		377.9		366.5		348.0
PELLET SURFACE	0.4688	416.6	0.4684	396.9	0.4680	366.1
RADIAL NODE 5	0.4219	451.3	0.4216	421.6	0.4212	378.8
10	0.3751	483.5	0.3748	444.3	0.3744	390.4
15	0.3282	513.0	0.3279	464.9	0.3276	400.8
20	0.2813	539.2	0.2811	483.1	0.2808	409.9
25	0.2344	562.0	0.2342	498.7	0.2340	417.6
30	0.1875	581.1	0.1874	511.8	0.1872	424.0
35	0.1406	596.1	0.1405	522.1	0.1404	429.0
40	0.0938	607.0	0.0937	529.4	0.0936	432.6
45	0.0469	613.6	0.0468	533.9	0.0468	434.8
PELLET CENTER	0.0	615.8	0.0	535.4	0.0	435.5

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CASE   2     AXIAL SEGMENT  1  OF  10                    76-09-09    9 HR 56 MINUTE 29 SEC  71

  *****      (82)     SAMPLE  PROBLEM     (TYPICAL PWR PIN)                                  *****

400. 0.0   0-----PELLET CENTER----------------1000-----------------------------------2000-----------------------------------3000
400. 0.09  |              *                   |                                    |                                    |
400. 0.19  |             *                    |                                    |                                    |
400. 0.28  |             *                    |                                    |                                    |
400. 0.37  |             *                    |                                    |                                    |
399. 0.47  |             *                    |                                    |                                    |
399. 0.56  |             *                    |                                    |                                    |
399. 0.65  |             *                    |                                    |                                    |
398. 0.75  |             *                    |                                    |                                    |
398. 0.84  |             *                    |                                    |                                    |
397. 0.94  |             *                    |                                    |                                    |
397. 1.03  |             *                    |                                    |                                    |
396. 1.12  |             *                    |                                    |                                    |
395. 1.22  |             *                    |                                    |                                    |
395. 1.31  |             *                    |                                    |                                    |
394. 1.40  |             *                    |                                    |                                    |
393. 1.50  |             *                    |                                    |                                    |
392. 1.59  |             *                    |                                    |                                    |
391. 1.68  |             *                    |                                    |                                    |
390. 1.78  |             *                    |                                    |                                    |
389. 1.87  |             *                    |                                    |                                    |
388. 1.96  |             *                    |                                    |                                    |
387. 2.06  |             *                    |                                    |                                    |
385. 2.15  |             *                    |                                    |                                    |
384. 2.25  |             *                    |                                    |                                    |
383. 2.34  |             *                    |                                    |                                    |
381. 2.43  |             *                    |                                    |                                    |
380. 2.53  |             *                    |                                    |                                    |
379. 2.62  |             *                    |                                    |                                    |
377. 2.71  |             *                    |                                    |                                    |
375. 2.81  |             *                    |                                    |                                    |
374. 2.90  |            *                     |                                    |                                    |
372. 2.99  |            *                     |                                    |                                    |
370. 3.09  |            *                     |                                    |                                    |
369. 3.18  |            *                     |                                    |                                    |
367. 3.27  |            *                     |                                    |                                    |
365. 3.37  |            *                     |                                    |                                    |
363. 3.46  |            *                     |                                    |                                    |
361. 3.56  |            *                     |                                    |                                    |
359. 3.65  |            *                     |                                    |                                    |
357. 3.74  |            *                     |                                    |                                    |
355. 3.84  |            *                     |                                    |                                    |
353. 3.93  |            *                     |                                    |                                    |
350. 4.02  |            *                     |                                    |                                    |
348. 4.12  |           *                      |                                    |                                    |
346. 4.21  |           *                      |                                    |                                    |
343. 4.30  |           *                      |                                    |                                    |
341. 4.40  |           *                      |                                    |                                    |
339. 4.49  |           *                      |                                    |                                    |
336. 4.58  |           *                      |                                    |                                    |
333. 4.68  |----------+-----------------------|------------- THERE IS A GAP,  GAP CONDUCTANCE IS  633.8 BTU/HR/FT2/DEG F

296.       |----------+-----------------------|            CLAD INNER SURFACE

290.       |----------+-----------------------|            CLAD OUTER SURFACE

287.       |          C                                    COOLANT

           |          C
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CASE   2     AXIAL SEGMENT  5  OF  10                    76-09-09    9 HR 56 MINUTE 30 SEC 690

  *****      (82)     SAMPLE  PROBLEM     (TYPICAL PWR PIN)                                  *****

687. 0.0   0-----PELLET CENTER----------*-------1000-----------------------------------2000-----------------------------------3000
687. 0.09  |                          *       |                                    |                                    |
686. 0.19  |                          *       |                                    |                                    |
686. 0.28  |                          *       |                                    |                                    |
685. 0.38  |                          *       |                                    |                                    |
684. 0.47  |                          *       |                                    |                                    |
682. 0.56  |                          *       |                                    |                                    |
681. 0.66  |                          *       |                                    |                                    |
679. 0.75  |                          *       |                                    |                                    |
677. 0.84  |                          *       |                                    |                                    |
675. 0.94  |                         *        |                                    |                                    |
672. 1.03  |                         *        |                                    |                                    |
670. 1.13  |                         *        |                                    |                                    |
667. 1.22  |                         *        |                                    |                                    |
664. 1.31  |                         *        |                                    |                                    |
660. 1.41  |                         *        |                                    |                                    |
657. 1.50  |                         *        |                                    |                                    |
653. 1.60  |                         *        |                                    |                                    |
649. 1.69  |                        *         |                                    |                                    |
644. 1.78  |                        *         |                                    |                                    |
640. 1.88  |                        *         |                                    |                                    |
635. 1.97  |                        *         |                                    |                                    |
630. 2.06  |                        *         |                                    |                                    |
625. 2.16  |                        *         |                                    |                                    |
620. 2.25  |                       *          |                                    |                                    |
614. 2.35  |                       *          |                                    |                                    |
609. 2.44  |                       *          |                                    |                                    |
603. 2.53  |                       *          |                                    |                                    |
597. 2.63  |                      *           |                                    |                                    |
591. 2.72  |                      *           |                                    |                                    |
584. 2.81  |                      *           |                                    |                                    |
578. 2.91  |                      *           |                                    |                                    |
571. 3.00  |                     *            |                                    |                                    |
564. 3.10  |                     *            |                                    |                                    |
557. 3.19  |                     *            |                                    |                                    |
549. 3.28  |                    *             |                                    |                                    |
542. 3.38  |                    *             |                                    |                                    |
534. 3.47  |                    *             |                                    |                                    |
527. 3.57  |                    *             |                                    |                                    |
519. 3.66  |                   *              |                                    |                                    |
511. 3.75  |                   *              |                                    |                                    |
503. 3.85  |                   *              |                                    |                                    |
494. 3.94  |                  *               |                                    |                                    |
486. 4.03  |                  *               |                                    |                                    |
478. 4.13  |                  *               |                                    |                                    |
469. 4.22  |                 *                |                                    |                                    |
460. 4.32  |                 *                |                                    |                                    |
451. 4.41  |                 *                |                                    |                                    |
443. 4.50  |                *                 |                                    |                                    |
433. 4.60  |                *                 |                                    |                                    |
424. 4.69  |----------------*-----------------|------------- THERE IS A GAP,  GAP CONDUCTANCE IS  827.7 BTU/HR/FT2/DEG F

332.       |----------+-----------------------|            CLAD INNER SURFACE

316.       |----------+-----------------------|            CLAD OUTER SURFACE

303.       |          C                                    COOLANT

           |          C
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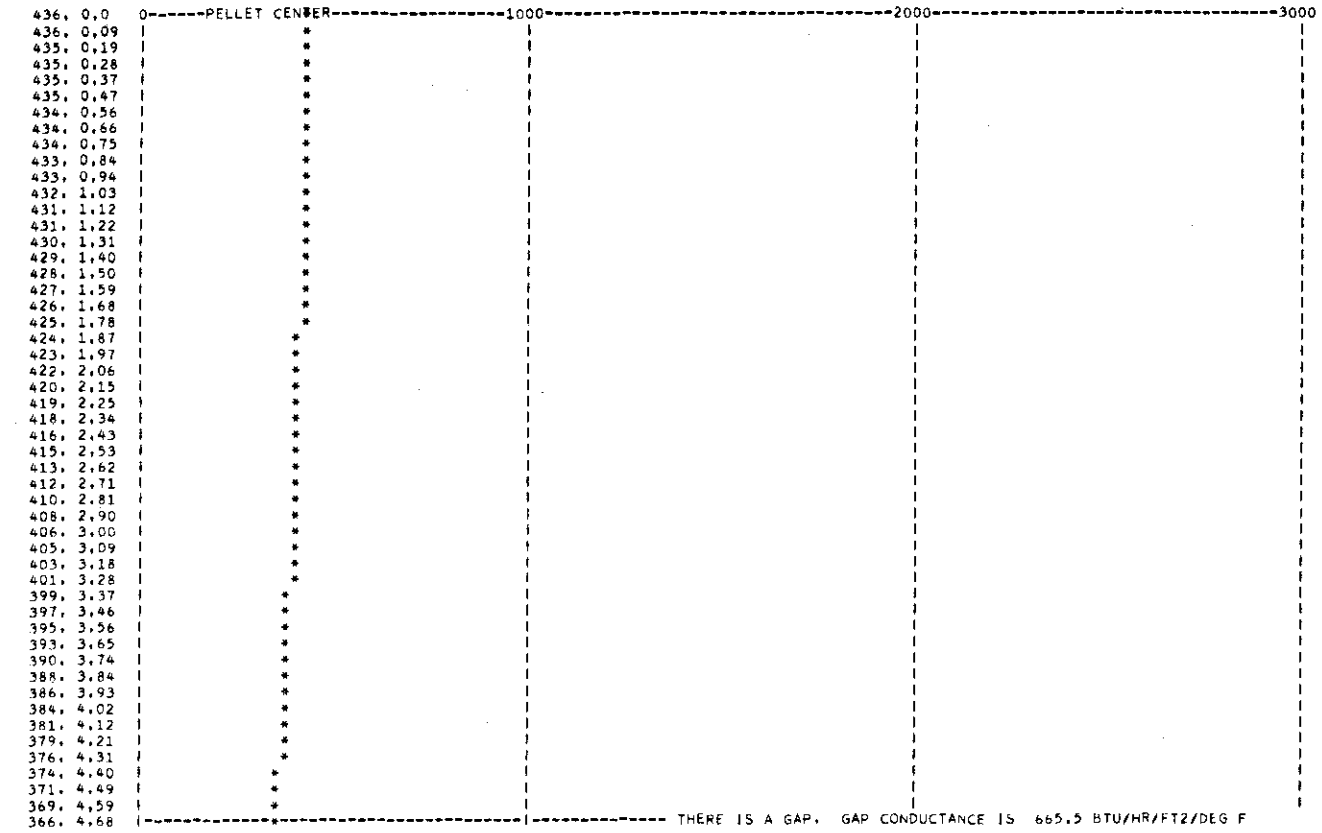
CASE 2 AXIAL SEGMENT 10 OF 10 76-09-09 9 HR 56 MINUTE 33 SEC 41

***** (82) SAMPLE PROBLEM (TYPICAL PWR PIN) *****



STEP 2 SAMPLE PROBLEM (TYPICAL PWR PIN) PAGE 7/ 16

(83) RADIO-ACTIVITY OF ISOTOPE

AXIAL NODE	83 KR	84 KR	85M KR	85 KR	86 KR	131M TE	131 TE	131 I	131 XE	132 TE
DECAY CONST (1/SEC)	0.0	0.0	4.3750E-05	2.0420E-09	0.0	6.6840E-06	4.6200E-04	9.9640E-07	0.0	2.4680E-06
NO. OF ATOMS										
1	2.0698E+16	3.8613E+16	1.3377E+16	1.0618E+16	7.6825E+16	1.3305E+16	2.5476E+15	1.0348E+17	8.9080E+15	1.5522E+17
2	3.8266E+16	7.1392E+16	2.4733E+16	1.9631E+16	1.4204E+17	2.4599E+16	4.7102E+15	1.9131E+17	1.6469E+16	2.8698E+17
3	5.2224E+16	9.7437E+16	3.3754E+16	2.6792E+16	1.9385E+17	3.3572E+16	6.4283E+15	2.6110E+17	2.2477E+16	3.9166E+17
4	6.1609E+16	1.1495E+17	3.9821E+16	3.1607E+16	2.2869E+17	3.9606E+16	7.5837E+15	3.0802E+17	2.6516E+16	4.6206E+17
5	6.6181E+16	1.2348E+17	4.2776E+16	3.3953E+16	2.4566E+17	4.2545E+16	8.1465E+15	3.3088E+17	2.8484E+16	4.9635E+17
6	6.6181E+16	1.2348E+17	4.2776E+16	3.3953E+16	2.4566E+17	4.2545E+16	8.1465E+15	3.3088E+17	2.8484E+16	4.9635E+17
7	6.1609E+16	1.1495E+17	3.9821E+16	3.1607E+16	2.2869E+17	3.9606E+16	7.5837E+15	3.0802E+17	2.6516E+16	4.6206E+17
8	5.2224E+16	9.7437E+16	3.3754E+16	2.6792E+16	1.9385E+17	3.3572E+16	6.4283E+15	2.6110E+17	2.2477E+16	3.9166E+17
9	3.8266E+16	7.1392E+16	2.4733E+16	1.9631E+16	1.4204E+17	2.4599E+16	4.7102E+15	1.9131E+17	1.6469E+16	2.8698E+17
10	2.0698E+16	3.8613E+16	1.3377E+16	1.0618E+16	7.6825E+16	1.3305E+16	2.5476E+15	1.0348E+17	8.9080E+15	1.5522E+17
SUB-TOTAL	4.7796E+17	8.9175E+17	3.0892E+17	2.4520E+17	1.7741E+18	3.0725E+17	5.8833E+16	2.3896E+18	2.0571E+17	3.5845E+18
CURIE										
1	0.0	0.0	1.5818E+01	5.8600E-04	0.0	2.4035E+00	3.1811E+01	2.7866E+00	0.0	1.0354E+01
2	0.0	0.0	2.9245E+01	1.0834E-03	0.0	4.4437E+00	5.8813E+01	5.1519E+00	0.0	1.9142E+01
3	0.0	0.0	3.9912E+01	1.4786E-03	0.0	6.0647E+00	8.0267E+01	7.0313E+00	0.0	2.6125E+01
4	0.0	0.0	4.7086E+01	1.7444E-03	0.0	7.1547E+00	9.4693E+01	8.2949E+00	0.0	3.0820E+01
5	0.0	0.0	5.0580E+01	1.8738E-03	0.0	7.6857E+00	1.0172E+02	8.9106E+00	0.0	3.3108E+01
6	0.0	0.0	5.0580E+01	1.8738E-03	0.0	7.6857E+00	1.0172E+02	8.9106E+00	0.0	3.3108E+01
7	0.0	0.0	4.7086E+01	1.7444E-03	0.0	7.1547E+00	9.4693E+01	8.2949E+00	0.0	3.0820E+01
8	0.0	0.0	3.9912E+01	1.4786E-03	0.0	6.0647E+00	8.0267E+01	7.0313E+00	0.0	2.6125E+01
9	0.0	0.0	2.9245E+01	1.0834E-03	0.0	4.4437E+00	5.8813E+01	5.1519E+00	0.0	1.9142E+01
10	0.0	0.0	1.5818E+01	5.8600E-04	0.0	2.4035E+00	3.1811E+01	2.7866E+00	0.0	1.0354E+01
SUB-TOTAL	0.0	0.0	3.6528E+02	1.3532E-02	0.0	5.5505E+01	7.3461E+02	6.4351E+01	0.0	2.3910E+02

STEP 2 SAMPLE PROBLEM (TYPICAL PWR PIN) PAGE 8/ 17

(83)

AXIAL NODE	132 I	132 XE	133 I	133 XE	134 XE	135 I	135M XE	135 XE	136 XE	NODE SUB-TOTAL
DECAY CONST (1/SEC)	8.3700E-05	0.0	9.1670E-06	1.5220E-06	0.0	2.8730E-05	7.2190E-04	2.0920E-05	0.0	
NO. OF ATOMS										
1	4.5736E+15	3.3075E+16	1.8394E+17	1.3651E+17	3.1527E+17	9.0675E+16	1.0826E+15	7.4225E+16	3.4104E+17	1.6240E+18
2	8.4558E+15	6.1151E+16	3.4008E+17	2.5237E+17	5.8290E+17	1.6764E+17	2.0016E+15	1.0702E+17	6.9905E+17	3.0408E+18
3	1.1540E+16	8.3458E+16	4.6413E+17	3.4443E+17	7.9555E+17	2.2880E+17	2.7317E+15	1.2351E+17	1.0011E+18	4.1745E+18
4	1.3614E+16	9.8458E+16	5.4754E+17	4.0632E+17	9.3855E+17	2.6992E+17	3.2226E+15	1.3177E+17	1.2088E+18	4.9387E+18
5	1.4625E+16	1.0577E+17	5.8818E+17	4.3647E+17	1.0082E+18	2.8995E+17	3.4618E+15	1.3520E+17	1.3109E+18	5.3113E+18
6	1.4625E+16	1.0577E+17	5.8818E+17	4.3647E+17	1.0082E+18	2.8995E+17	3.4618E+15	1.3520E+17	1.3109E+18	5.3113E+18
7	1.3614E+16	9.8458E+16	5.4754E+17	4.0632E+17	9.3855E+17	2.6992E+17	3.2226E+15	1.3177E+17	1.2088E+18	4.9387E+18
8	1.1540E+16	8.3458E+16	4.6413E+17	3.4443E+17	7.9555E+17	2.2880E+17	2.7317E+15	1.2351E+17	1.0011E+18	4.1745E+18
9	8.4558E+15	6.1151E+16	3.4008E+17	2.5237E+17	5.8290E+17	1.6764E+17	2.0016E+15	1.0702E+17	6.9905E+17	3.0408E+18
10	4.5736E+15	3.3075E+16	1.8394E+17	1.3651E+17	3.1527E+17	9.0675E+16	1.0826E+15	7.4225E+16	3.4104E+17	1.6240E+18
SUB-TOTAL	1.0562E+17	7.6381E+17	4.2477E+18	3.1522E+18	7.2810E+18	2.0940E+18	2.5001E+16	1.1434E+18	9.1218E+18	3.8178E+19
CURIE										
1	1.0346E+01	0.0	4.5573E+01	5.6153E+00	0.0	7.0408E+01	2.1122E+01	4.1967E+01	0.0	2.5820E+02
2	1.9128E+01	0.0	8.4256E+01	1.0381E+01	0.0	1.3017E+02	3.9052E+01	6.0507E+01	0.0	4.6030E+02
3	2.6106E+01	0.0	1.1499E+02	1.4168E+01	0.0	1.7766E+02	5.3297E+01	6.9833E+01	0.0	6.1546E+02
4	3.0798E+01	0.0	1.3566E+02	1.6714E+01	0.0	2.0959E+02	6.2876E+01	7.4503E+01	0.0	7.1819E+02
5	3.3084E+01	0.0	1.4573E+02	1.7954E+01	0.0	2.2514E+02	6.7543E+01	7.6443E+01	0.0	7.6790E+02
6	3.3084E+01	0.0	1.4573E+02	1.7954E+01	0.0	2.2514E+02	6.7543E+01	7.6443E+01	0.0	7.6790E+02
7	3.0798E+01	0.0	1.3566E+02	1.6714E+01	0.0	2.0959E+02	6.2876E+01	7.4503E+01	0.0	7.1819E+02
8	2.6106E+01	0.0	1.1499E+02	1.4168E+01	0.0	1.7766E+02	5.3297E+01	6.9833E+01	0.0	6.1546E+02
9	1.9128E+01	0.0	8.4256E+01	1.0381E+01	0.0	1.3017E+02	3.9052E+01	6.0507E+01	0.0	4.6030E+02
10	1.0346E+01	0.0	4.5573E+01	5.6153E+00	0.0	7.0408E+01	2.1122E+01	4.1967E+01	0.0	2.5820E+02
SUB-TOTAL	2.3893E+02	0.0	1.0524E+03	1.2967E+02	0.0	1.6259E+03	4.8778E+02	6.4651E+02	0.0	5.6401E+03

********** INVENTORY FP GAS SUMMARY

STEP 2 SAMPLE PROBLEM (TYPICAL PWR PIN) PAGE 10/ 19

(84)

AXIAL NODE	132 I	132 XE	133 I	133 XE	134 XE	135 I	135M XE	135 XE	136 XE	NODE SUB-TOTAL
DECAY CONST (1/SEC)	8.3700E-05	0.0	9.1670E-06	1.5220E-06	0.0	2.8730E-05	7.2190E-04	2.0920E-05	0.0	
NO. OF ATOMS										
1	1.3493E+12	9.7575E+12	5.4264E+13	4.0271E+13	9.3009E+13	2.6750E+13	3.1938E+11	2.1897E+13	1.0061E+14	4.7909E+14
2	2.9613E+12	2.1415E+13	1.1910E+14	8.8383E+13	2.0414E+14	5.8710E+13	7.0096E+11	3.7478E+13	2.4481E+14	1.0649E+15
3	4.5542E+12	3.2935E+13	1.8316E+14	1.3592E+14	3.1395E+14	9.0291E+13	1.0780E+12	4.8741E+13	3.9507E+14	1.6474E+15
4	5.7936E+12	4.1898E+13	2.3301E+14	1.7291E+14	3.9940E+14	1.1486E+14	1.3714E+12	5.6074E+13	5.1440E+14	2.1016E+15
5	6.4750E+12	4.6827E+13	2.6041E+14	1.9324E+14	4.4638E+14	1.2837E+14	1.5327E+12	5.9859E+13	5.8040E+14	2.3515E+15
6	6.5331E+12	4.7247E+13	2.6275E+14	1.9498E+14	4.5038E+14	1.2952E+14	1.5464E+12	6.0396E+13	5.8561E+14	2.3726E+15
7	5.9489E+12	4.3022E+13	2.3925E+14	1.7754E+14	4.1011E+14	1.1794E+14	1.4082E+12	5.7578E+13	5.2820E+14	2.1580E+15
8	4.7653E+12	3.4462E+13	1.9165E+14	1.4222E+14	3.2851E+14	9.4477E+13	1.1280E+12	5.1001E+13	4.1338E+14	1.7238E+15
9	3.1624E+12	2.2870E+13	1.2718E+14	9.4385E+13	2.1800E+14	6.2697E+13	7.4856E+11	4.0023E+13	2.6144E+14	1.1372E+15
10	1.4745E+12	1.0663E+13	5.9303E+13	4.4010E+13	1.0164E+14	2.9234E+13	3.4903E+11	2.3930E+13	1.0995E+14	5.2357E+14
SUB-TOTAL	4.3018E+13	3.1110E+14	1.7301E+15	1.2839E+15	2.9655E+15	8.5286E+14	1.0183E+13	4.5698E+14	3.7339E+15	1.5560E+16
CURIE										
1	3.0522E-03	0.0	1.3444E-02	1.6566E-03	0.0	2.0771E-02	6.2313E-03	1.2381E-02	0.0	7.6173E-02
2	6.6989E-03	0.0	2.9507E-02	3.6356E-03	0.0	4.5587E-02	1.3676E-02	2.1190E-02	0.0	1.6120E-01
3	1.0302E-02	0.0	4.5379E-02	5.5912E-03	0.0	7.0110E-02	2.1033E-02	2.7558E-02	0.0	2.4288E-01
4	1.3106E-02	0.0	5.7729E-02	7.1126E-03	0.0	8.9189E-02	2.6757E-02	3.1705E-02	0.0	3.0562E-01
5	1.4648E-02	0.0	6.4519E-02	7.9491E-03	0.0	9.9679E-02	2.9904E-02	3.3844E-02	0.0	3.3998E-01
6	1.4779E-02	0.0	6.5098E-02	8.0204E-03	0.0	1.0057E-01	3.0172E-02	3.4148E-02	0.0	3.4303E-01
7	1.3457E-02	0.0	5.9277E-02	7.3033E-03	0.0	9.1581E-02	2.7474E-02	3.2555E-02	0.0	3.1382E-01
8	1.0780E-02	0.0	4.7483E-02	5.8504E-03	0.0	7.3360E-02	2.2008E-02	2.8836E-02	0.0	2.5414E-01
9	7.1538E-03	0.0	3.1511E-02	3.8825E-03	0.0	4.8683E-02	1.4605E-02	2.2629E-02	0.0	1.7215E-01
10	3.3356E-03	0.0	1.4693E-02	1.8104E-03	0.0	2.2700E-02	6.8099E-03	1.3530E-02	0.0	8.3245E-02
SUB-TOTAL	9.7313E-02	0.0	4.2864E-01	5.2812E-02	0.0	6.6223E-01	1.9867E-01	2.5838E-01	0.0	2.2922E+00

********** RELEASED FP GAS SUMMARY

(84) RADIO-ACTIVITY OF ISOTOPE

..... RELEASED FP GAS .....

AXIAL NODE	83 KR	84 KR	85M KR	85 KR	86 KR	131M TE	131 TE	131 I	131 XE	132 TE
DECAY CONST (1/SEC)	0.0	0.0	4.3750E-05	2.0420E-09	0.0	6.6840E-06	4.6200E-04	9.9640E-07	0.0	2.4680E-06
NO. OF ATOMS										
1	6.1062E+12	1.1391E+13	3.9465E+12	3.1324E+12	2.2664E+13	3.9251E+12	7.5158E+11	3.0527E+13	2.6280E+12	4.5792E+13
2	1.3401E+13	2.5002E+13	8.6615E+12	6.8748E+12	4.9742E+13	8.6146E+12	1.6495E+12	6.6998E+13	5.7676E+12	1.0050E+14
3	2.0609E+13	3.8452E+13	1.3321E+13	1.0573E+13	7.6500E+13	1.3249E+13	2.5368E+12	1.0304E+14	8.8700E+12	1.5456E+14
4	2.6217E+13	4.8917E+13	1.6946E+13	1.3450E+13	9.7318E+13	1.6854E+13	3.2272E+12	1.3108E+14	1.1284E+13	1.9663E+14
5	2.9301E+13	5.4671E+13	1.8939E+13	1.5032E+13	1.0876E+14	1.8836E+13	3.6068E+12	1.4649E+14	1.2611E+13	2.1975E+14
6	2.9564E+13	5.5162E+13	1.9109E+13	1.5167E+13	1.0974E+14	1.9005E+13	3.6392E+12	1.4781E+14	1.2724E+13	2.2173E+14
7	2.6920E+13	5.0229E+13	1.7400E+13	1.3811E+13	9.9928E+13	1.7306E+13	3.3137E+12	1.3459E+14	1.1588E+13	2.0190E+14
8	2.1565E+13	4.0234E+13	1.3938E+13	1.1063E+13	8.0046E+13	1.3863E+13	2.6544E+12	1.0781E+14	9.2812E+12	1.6173E+14
9	1.4311E+13	2.6700E+13	9.2497E+12	7.3417E+12	5.3120E+13	9.1996E+12	1.7615E+12	7.1548E+13	6.1593E+12	1.0733E+14
10	6.6731E+12	1.2449E+13	4.3129E+12	3.4232E+12	2.4768E+13	4.2895E+12	8.2136E+11	3.3361E+13	2.8719E+12	5.0044E+13
SUB-TOTAL	1.9467E+14	3.6321E+14	1.2582E+14	9.9869E+13	7.2259E+14	1.2514E+14	2.3962E+13	9.7326E+14	8.3783E+13	1.4600E+15
CURIE										
1	0.0	0.0	4.6664E-03	1.7288E-07	0.0	7.0907E-04	9.3846E-03	8.2207E-04	0.0	3.0545E-03
2	0.0	0.0	1.0242E-02	3.7942E-07	0.0	1.5562E-03	2.0597E-02	1.8042E-03	0.0	6.7037E-03
3	0.0	0.0	1.5751E-02	5.8351E-07	0.0	2.3933E-03	3.1676E-02	2.7748E-03	0.0	1.0310E-02
4	0.0	0.0	2.0037E-02	7.4231E-07	0.0	3.0447E-03	4.0296E-02	3.5299E-03	0.0	1.3116E-02
5	0.0	0.0	2.2394E-02	8.2961E-07	0.0	3.4028E-03	4.5036E-02	3.9451E-03	0.0	1.4658E-02
6	0.0	0.0	2.2595E-02	8.3706E-07	0.0	3.4333E-03	4.5440E-02	3.9805E-03	0.0	1.4790E-02
7	0.0	0.0	2.0574E-02	7.6221E-07	0.0	3.1263E-03	4.1377E-02	3.6245E-03	0.0	1.3467E-02
8	0.0	0.0	1.6481E-02	6.1056E-07	0.0	2.5043E-03	3.3145E-02	2.9034E-03	0.0	1.0788E-02
9	0.0	0.0	1.0937E-02	4.0518E-07	0.0	1.6619E-03	2.1996E-02	1.9268E-03	0.0	7.1590E-03
10	0.0	0.0	5.0997E-03	1.8893E-07	0.0	7.7490E-04	1.0256E-02	8.9840E-04	0.0	3.3380E-03
SUB-TOTAL	0.0	0.0	1.4878E-01	5.5117E-06	0.0	2.2607E-02	2.9920E-01	2.6210E-02	0.0	9.7383E-02

STEP 3 (2) SAMPLE PROBLEM (TYPICAL PWR PIN) PAGE 1/ 20

(3)	LINEAR HEAT RATING(AVRAGE)	5,674 (KW/FT)	186,164 (WATT/CM)
(4)	BURNUP (PIN AVERAGE)	30,448 (MWD/MTU)	0.1026E+19 (FISSIONS/CC)
(5)	TIME IN REACTOR	2.000 (DAYS)	48.000 (HOURS)
(6)	COOLANT INLET TEMPERATURE	545.000 (DEG F)	285.000 (DEG C)
(7)	COOLANT OUTLET TEMPERATURE	609.800 (DEG F)	321.000 (DEG C)
(8)	COOLANT PRESSURE	2250.000 (PSI)	158.228 (KG/CM2)

(9) CUMULATED CP TIME 14.6920(SEC) COMPUTED TIME AT THIS STEP 3.8480(SEC)

(10) AXIAL SECTION NUMBER	(11) AXIAL DISTANCE (CM)	(INCH)	(12) LINEAR HEAT RATING (W/CM)	(KW/FT)	(13) BURNUP (MWD/MT)	(14) AVERAGE NEUTRON FLUX (NV)	(15) COOLANT TEMP. (DEG C)	(16) FILM COEFFICIENT WATT/CM2-C	BTU /HR-FT2-F	(18) CLAD TEMPERATURE OD (DEG C)	(19) ID (DEG C)
1	18.29	7.20	80.6149	2.4571	13.19	9.693E+12	286.56	3.102	5463.850	294.270	304.638
2	54.86	21.60	149.0439	4.5429	24.38	1.793E+13	289.44	3.088	5438.129	303.763	322.728
3	91.44	36.00	203.4121	6.2000	33.27	2.447E+13	293.37	3.071	5408.094	313.028	338.658
4	128.02	50.40	239.9700	7.3143	39.25	2.887E+13	298.02	3.056	5381.952	321.312	351.305
5	164.59	64.80	257.7803	7.8571	42.16	3.101E+13	303.00	3.048	5368.076	328.089	360.117
6	201.17	79.20	257.7803	7.8571	42.16	3.101E+13	307.98	3.043	5360.195	333.110	365.017
7	237.74	93.60	239.9700	7.3143	39.25	2.887E+13	312.63	3.047	5366.049	335.989	365.652
8	274.32	108.00	203.4121	6.2000	33.27	2.447E+13	316.56	3.050	5372.268	336.341	361.521
9	310.90	122.40	149.0439	4.5429	24.38	1.793E+13	319.44	3.050	5371.381	333.938	352.469
10	347.47	136.80	80.6149	2.4571	13.19	9.693E+12	321.00	3.047	5366.341	328.849	338.944

AXIAL SECTION NUMBER	(25) GAP CONDUCTANCE(BTU/HR-FT2-F) SOLID -SOLID	GAS-CONDUCT	RADIANT	TOTAL	(28)(61)(62) INCREASE IN FUEL RADIUS(MM) THERMAL EXPANSION	SWELLING	DENSI-FICATION	RE-LOCATION	TOTAL	(29) INCREASE IN CLAD RADIUS(MM) THERMAL EXPAN.	CREEP	PRESSURE	TOTAL	(30) RADIAL HOT GAP (MM)	(31)
1	0.0	709.75	6.73	716.49	0.016989	0.0	0.0	0.008103	0.025092	0.00813	0.0	-0.00511	0.00303	0.06049	
2	0.0	824.96	8.09	833.05	0.024663	0.0	-0.003564	0.010863	0.031963	0.00854	0.0	-0.00511	0.00344	0.05402	
3	0.0	905.19	9.25	914.43	0.032000	0.0	-0.009163	0.012915	0.035751	0.00892	0.0	-0.00511	0.00381	0.05061	
4	0.0	987.34	10.01	997.35	0.037392	0.0	-0.012139	0.014251	0.039503	0.00923	0.0	-0.00511	0.00412	0.04717	
5	0.0	1040.78	10.46	1051.16	0.040278	0.0	-0.013428	0.014892	0.041741	0.00946	0.0	-0.00511	0.00435	0.04516	
6	0.0	1048.30	10.65	1058.95	0.040576	0.0	-0.013428	0.014892	0.042039	0.00960	0.0	-0.00511	0.00450	0.04501	
7	0.0	1007.72	10.56	1018.28	0.038235	0.0	-0.012139	0.014251	0.040347	0.00966	0.0	-0.00511	0.00455	0.04675	
8	0.0	933.76	10.10	943.86	0.033281	0.0	-0.009163	0.012915	0.037032	0.00960	0.0	-0.00511	0.00449	0.05001	
9	0.0	857.28	9.15	866.43	0.026193	0.0	-0.003564	0.010863	0.033493	0.00943	0.0	-0.00511	0.00432	0.05338	
10	0.0	740.19	7.87	748.06	0.018553	0.0	0.0	0.008103	0.026656	0.00916	0.0	-0.00511	0.00405	0.05994	

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(10) AXIAL SECTION NUMBER	(32) FUEL SURFACE TEMP. (DEG C)	(33) FUEL CENTER TEMP. (DEG C)	(34) VOL. AVG FUEL TEMP. (DEG C)	(54) NOMINAL HEAT CAPACITY CAL/K-MOLE	BTU/LB-F	(55) STORED ENERGY AT VOLUMETRIC AVERAGE TEMP. CAL/GRAM	BTU/LB	(56) STORED ENERGY VOLUME AVERAGE CAL/GRAM	BTU/LB	(57) STORED ENERGY PER UNIT LENGTH CAL/CM	BTU/FOOT	(38) CONTACT PRESSURE (KG/CM2)
1	371.852	518.047	442.897	19.401	5238.273	27.809	50.056	28.123	50.621	195.072	23.594	0.0
2	429.333	740.896	577.237	19.859	5362.045	37.581	67.646	38.145	68.661	264.590	32.003	0.0
3	471.178	942.072	690.982	20.174	5446.932	46.016	82.828	46.815	84.267	324.732	39.277	0.0
4	494.467	1044.141	766.994	20.361	5497.550	51.722	93.099	52.736	94.924	365.799	44.244	0.0
5	506.083	1157.510	805.884	20.452	5522.158	54.661	98.390	55.804	100.447	387.082	46.819	0.0
6	509.793	1143.487	810.701	20.464	5525.157	55.026	99.047	56.183	101.130	389.713	47.137	0.0
7	505.418	1101.358	780.990	20.394	5506.491	52.778	95.000	53.830	96.895	373.393	45.163	0.0
8	489.408	969.196	713.499	20.231	5462.333	47.700	85.861	48.553	87.396	336.789	40.735	0.0
9	454.528	774.996	606.722	19.946	5385.379	39.755	71.559	40.375	72.675	280.059	33.874	0.0
10	402.984	554.897	476.816	19.529	5272.842	30.255	54.458	30.615	55.107	212.360	25.685	0.0

(40)	PLENUM VOLUME	7.17753 (CM3)	0.43800 (INCH3)
(41)	PLENUM TEMPERATURE	326.55556 (DEG C)	619.80000 (DEG F)
(42)	COOLANT SATURATE TEMPERATURE	344.85963 (DEG C)	
(43)	INITIAL PLENUM PRESSURE	20.00000 (KG/CM2)	284.40000 (PSI)
(44)	INTERNAL GAS PRESSURE	55.19862 (KG/CM2)	784.92442 (PSI)
(45)	TOTAL GAS MOLES IN A PIN	0.13168E-01 (MOLES)	
(46)	GASES IN PLENUM	0.77918E-02 (MOLES)	
(47)	GASES IN A GAP OR CENTRAL VOID	0.53766E-02 (MOLES)	
(48)	FP GAS RELEASED RATE (PIN AVERAGE)	0.00136 (FRACTION)	

COMPOSITION OF PIN GAS (MOLES)	HELIUM	ARGON	HYDROGEN	NITROGEN	KRYPTON	XENON
FRACTION	0.999784	0.0	0.0	0.000199	0.000002	0.000014

AXIAL VOLUME-TEMPERATURE AVERAGED (CONVERGENCE IN ITERATION)

ITER.	(58) TEMPERATURE (DEG. C)	(DEG. F)	(59) INNER PRESSURE (KG/CM2)	(PSI)
1	731.155	1348.078	57.706	820.574
2	667.747	1233.944	55.167	784.480
3	667.398	1233.317	55.204	785.003
4	667.273	1233.091	55.199	784.924

(60) CONVERGENCE RELATIVE ERROR (FRACTION) 0.00019 (CONVERGENCE CRITERION 0.005)

Table B-1　計算結果出力の説明

(1)　入力された運転履歴の時間ステップ数

(2)　タイトル（入力）

(3)　線出力密度（燃料棒平均）　参照(12)（各軸方向セグメントの値）

(4)　燃焼度（燃料棒平均）　参照(13)（各軸方向セグメントの値）

(5)　積算照射時間

(6)　冷却材入口温度

(7)　冷却材出口温度

(8)　冷却材圧力（均一）

(9)　計算時間（CPUタイム）

(10)　軸方向セグメント番号（制限20）　番号1は燃料棒最下部セグメントに対応

(11)　等分割された燃料棒セグメト中心の底からの高さ

(12)　軸方向線出力密度分布

(13)　線出力密度及び照射時間より計算された燃焼度

(14)　線出力密度より計算された熱中性子束

(15)　冷却材温度分布。もし KOOL＞0（すなわち被覆内面温度を冷却温度と等しくする）の場合は被覆内面温度と等しい温度がプリントされる。

(16)　冷却材ー被覆管熱伝達係数。もし KOOL＞0 の場合は 0.0 とプリントされる。

(17)　被覆管外表面熱流束　$q''_{co} = p / (\pi \times (D_{co} + 2 \cdot \triangle r_{co}))$　p＝線出力密度

(18)　被覆管外表面温度

(19)　被覆管内表面温度

(20)　被覆管平均熱伝導率　被覆管内外表面の平均温度によって決められた熱伝導率

(21)　ギャップ平均温度　$T_{gap} = (T_{ci} + T_{fs}) / 2$

(22)　燃料ペレット表面熱流束　$q''_{fs} = p / \pi \times (D_{fs} + 2 \cdot \triangle r_{fs}))$

(23)　ギャップ・コンダクタンス収斂計算中の繰返し計算回数
燃料体積平均温度を繰返し計算で求めているため((58)　参照，打切5回)
1セグメント当り数回のギャップ・コンダクタンス収斂計算が行なわれる。

(24)　収斂計算の繰返し回数の総計　今回のステップの合計((23)を合計)及び最初からの積算

(25)　ギャップ・コンダクタンス　接触熱伝達，ガス熱伝導，輻射及び合計
もし，MREV1＞0（すなわち RESAR－41ギャップ・コンダクタンス評価式で計算）の場合，全ギャップ・コンダクタンスが与えられるため，接触熱伝導，輻射の項は0.0とプリントされる。

(26)　体積平均温度((34))を用いて決められたガス放出率

(27)　Temperature Jump Distance

(28)　ペレット変位量　熱膨張，スウェリング及びそれらとRelocation((61))，Densification((62))を加算した全変位量（$=\triangle r_{fuel}$）

(29)　被覆管変位量　熱膨張，クリープひずみ内外圧力差による弾性変位およびそれらの合計（$=\triangle r_{clad}$）

(30)　ホット・ギャップ　$r^{h}_{gap} = r^{o}_{gap} + \triangle r_{clad} - \triangle r_{fuel}$　r^{o}_{gap}＝初期ギャップ

(31) 被覆管ーペレットの接触状態を示すサイン

もし MREV1≧0の場合，接触の条件（r^h_{gap}＜平均表面粗さ）が満されていればスター（＊）がプリントされ，満されていなければブランク（空白）となる。

もし MREV1＜0の場合，接触状態によりA，B，C，D，Eの文字がプリントされる。それぞれの定義は別表（Table B－2）に示す。

(32) 燃料ペレット外表面温度

(33) 燃料ペレット中心温度

(34) 燃料ペレット体積平均温度

(35) 燃料ペレット内領域境界半径（中心孔半径，柱軸晶領域半径，等軸晶領域半径，外表面半径），中心孔半径は中心孔がなければ0.0，柱軸晶及び等軸晶領域は温度によって判定するため（1700℃及び1350℃），温度が低ければ各領域は重なり同じ半径がプリントされる。

(36) 燃料ペレット外表面，被覆管外表面での円周方向歪（$\Delta r / r_0$）

(37) ギャップ・ガスの熱伝導率

(38) 燃料ペレットー被覆管接触圧力（被覆管Yield Stressは越えない）

(39) 被覆管内面円周方向熱応力

(40) プレナム体積（入力値）

(41) プレナム平均温度（入力値）

(42) 冷却材飽和温度（SIGHF＜0以外のときはプリントされない）

(43) 初期プレナム圧力（入力値）

(44) 照射時プレナム圧力

(45) 燃料棒内（プレナム，ギャップ，中心孔）に存在するガスの全モル数

(46) (45)のガス中プレナム内に存在するモル数

(47) (45)のガス中ギャップ及び中心孔内に存在するモル数

(48) 燃料棒体積平均温度を用いて決められたF.P.ガス放出率（(75)と同じ）

(49) 初期封入ガス中に含まれていた各ガス成分のモル数

(50) 燃料ペレット内で生成された各ガス成分のモル数

(51) 燃料ペレットより放出（放出率は(70)）された各ガス成分のモル数

(52) プレナム，ギャップ内に初期から蓄積された各ガス成分のモル数（(49)＋(51)）

(53) プレナム，ギャップ内に存在している各ガス成分のモル分率

(54) 定圧比熱

(55) 蓄積エネルギー　$E(cal/g-UO_2) = \{\sum_{i=1}^{N} m_i \int_{298}^{T1} c_p(T)\,dT/m\} / 270g/mole\ UO_2$

(56) 体積平均温度での蓄積エネルギー　$\overline{E}(cal/g-UO_2) = \int_{298}^{\bar{T}} c_p(T)\,dT / 270g/mole\ UO_2$

(57) 単位長当りの蓄積エネルギー

(58) 燃料棒の体積平均温度収斂計算中の温度収斂状況

(59) 収斂計算中の内圧収斂状況

(60) 収斂時の相対誤差（収斂判定条件は体積平均温度の各繰返し計算中の相対誤差が0.005以下）

(61) Densificationによる変位量

(62) Relocationによる変位量（もしこの変位を考慮することによって接触条件となるような場合，接触しないという条件を満すまでこの変位量は減じられる）

(63) 再組織化する温度及び半径（初期燃料密度と再組織化密度（各々入力値）が等しい場合は再組織化は起さないので各々0.0とプリントされる）

(64) 再組織化によって生ずる中心孔の半径，高さ，及びその体積
但し，高さは常に1セグメント長と同じである。

(65) 次のタイム・ステップを計算するための形状寸法
但し，中心孔半径は(64)の半径を室温（25°C）での半径に計算したものであり，ペレット表面半径，被覆管内外半径は現Versionでは初期入力値と同じである。中心孔がある場合，この内半径を用いて次のステップの計算が行なわれ，この内半径が小さくなることはない。

(66) 燃料スタック長の変化　初期セグメント長，ディッシュ肩に相当する半径での温度を用いた軸方向熱膨張量，ペレット中心での温度を用いた軸方向熱膨張量，及び初期セグメント長との各々の差，ディッシュ半径が入力されていない場合は0.0，すなわち中心（中心孔のある場合は内半径）で計算される。

(67) ディッシュ肩に相当する半径での温度，半径が入力されていない場合はペレット中心温度となる。

(68) 軸方向Densification考慮による軸方向長さ変化量
Densificationによる"ちぢみ"量及びDensificationと熱膨張の双方を考慮したときのスタック長変化。Densification率は半径方向と同じ値を用いた。

(69) 各軸方向セグメント内で生成された各分裂生成ガス（Kr, Xe）の単位長さ当りの原子数

(70) 各軸方向セグメント体積平均温度によって決定されたガス放出率
このステップ以前までの最大放出率，及びこのステップで計算された放出率がプリントされており，もしこのステップでの放出率が最大放出率より大きくなった場合は置換が行なわれ，次ステップで使われる。もしこのステップでの放出率が最大放出率より小さい場合は，最大放出率を用いて放出量が計算される。

(71) 生成量及び放出率によって計算された放出されたクリプトン量
(70)と同様に常に最大量が計算に用いられるようになっている。

(72) (71)と同様なキセノン量

(73) 軸方向の総計と平均

(74) (69),(71)及び(72)の各々の量に軸方向セグメント長を掛けて合計された燃料ピン中の総量

(75) GAPCON－THERMAL－1 Original Versionで計算されるガス放出率
（燃料ピン全体の体積平均温度によって与えられた放出率）

(76) (74)の各項を用いて計算された（全放出量）／（全生成量）

(77) 熱膨張，Densification及びそれらの重ね合せによる，ペレット・スタック長変化量，熱膨張量はディッシュ肩相当半径での温度(67)を用いて計算される。もしディッシュ半径の入力がなければ中心で行なう。

(78) (77)で計算された長さ変化×πr_{ci}^2，　r_{ci}＝被覆管内面半径

(79) 初期プレナム体積より(78)を差し引いたプレナム体積

(80)　(79)で計算されたプレナム体積を用いて，計算した燃料棒内圧。
ここで計算された内圧は，他の計算に一際影響しない。

(81)　軸方向セグメント毎の半径方向温度分布。半径は変形後の値である。このプリントアウトは照射履歴に対応したHistory dataを与える際の各タイム・ステップに依存したコントロール・シグナル（入力説明参照）によって行なわれる。

(82)　(81)と同様詳細な温度分布をライン・プリンターによって図示してある。この場合(81)と同様なコントロール・シグナルとIIPROF＝1の入力が必要である。左端よりメッシュ温度，半径及びプロットされた温度であり通常（＊）によって示されているが，融点（入力）を超えた場合は（M）によって示される。

(83)　FPガスの各軸方向セグメント毎の原子数及び放射能。
(69)でプリントした値は単位長当りの数値である。

(84)　プレナム及びギャップへ放出されたFPガスの原子数及び放射能(83)及び(84)はNUCLEI＝1の入力によって計算，プリントアウトされる。

Table B-2　接触圧力のgrade区分

被覆管内面変位＝熱膨張＋内外圧による弾性変形＋クリープ

最大ギャップ巾＝初期ギャップ＋被覆管内面変位－ペレット・デンシィフィケーション　（＝GAP9）

IGRADE	1	2	3	4	5
Print Out Symbol	A	B	C	D	E
名　　称	HARD CONTACT－1	HARD CONTACT－2	MEDIUM	SOFT	OPEN
ペレット変位（＝DELRSM）	（保守的な熱膨張）＋（保守的なスウェリング）	（保守的なスウェリング）＋（使用者指定の熱膨張モデル及び線熱膨張係数計算式）	（使用者指定のスウェリングモデル）＋（IGRADE＝2のときと同じ熱膨張）	（IGRADE＝3と同じ変位）＋（リロケーション）	IGRADE＝4と同じ 但し GAP9＞DELRSM
HOT GAP	CEE(*)×RESGAP(**)	CEE×RESGAP	CEE×RESGAP 但し CEE＝1	CEE×RESGAP 但し CEE＝1	GAP9－DELRSM
接触圧力（＝PFACE）	被覆管－ペレット相互干渉量（RINT）より薄肉円筒弾性変形理論によって計算。	170(max)(kg/cm^2) 76＋94×COEF(***)	76(max)(kg/cm^2) 76×COEF	0.0	0.0

（＊）　CEE＝接触圧力に依存するGap Correration factor　（＝exp(－0.00125×PFACE)）

（＊＊）　RESGAP＝2×（ペレット表面粗さ＋被覆管表面粗さ）＋1×10^{-5}（cm）

（＊＊＊）　COEF＝相互干渉量（RINT＝DELRSM－GAP9）／最大相互干渉可能量

各GRADE（IGRADE）の選択法

最大ギャップ巾（GAP9）に対して，IGRADE＝1より遂時ペレット変位（DELRSM）を計算，比較しDELRSM＞GAP9となったとき，接触のGRADEとする。