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AN ASSESSMENT OF THE COMPUTER CODE COBRA/CFTL

by
C. B. BAXI and C. J. BURHOP

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General Atomic Company
under Subcontract No. 40X-92304C
for Oak Ridge National Laboratory
Oak Ridge, Tennessee 37830
Operated by Union Carbide Corporation
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ABSTRACT

The COBRA/CFTL code has been developed by Oak Ridge National Laboratory (ORNL) for thermal-hydraulic analysis of simulated gas-cooled fast breeder reactor (GCFR) core assemblies to be tested in the core flow test loop (CFTL). The COBRA/CFTL code was obtained by modifying the General Atomic code COBRA*GCFR.

This report discusses these modifications, compares the two code results for three cases which represent conditions from fully rough turbulent flow to laminar flow. Case 1 represented fully rough turbulent flow in the bundle. For this case, the agreement between the two code results for the pressure drop and coolant temperature calculations was within 1%. The agreement for the interior channel rod temperatures was within 3%. However, the wall channel rod and shroud temperatures differed by up to 8.5% and 23%, respectively. Cases 2 and 3 represented laminar and transition flow regimes. For these cases, the agreement between the pressure drop and coolant temperature calculations was within 5%. However, the rod surface temperatures varied by as much as 25% due to different spacer enhancement correlations and a different definition of start of heating location in the two cases. The reasons for the differences are discussed in detail in the report.

The required input for the COBRA/CFTL code, a sample problem input/output and the code listing are included in the Appendices.

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NOMENCLATURE

AD	function defined by Eqs. 19 and 21
AH	slope of the temperature profile, Eq. 2
AR	slope of the velocity profile, Eq. 1
CG(1) to CG(7)	constants, Eqs. 9 through 11
CR(1) to CR(8)	constants, Eqs. 3 through 6
D_H	hydraulic diameter
f	friction factor
$G(h^+)$	function, Eq. 2
h^+	roughness cavity Reynolds number
h_R	rib height
K	function defined by Eqs. 24 and 26
$K(Re)$	function defined by Eq. 18
m	exponent, Eqs. 23 and 25
Nu	Nusselt number
Nu^*	multiplier on the Nusselt number due to spacer effect, Eqs. 16 and 22
Pr	Prandtl number
Re	Reynolds number
$R(h^+)$	function, Eq. 1
r_0	radius of zero shear
r_1	volumetric radius of rough rod
r_2	radius of equivalent annulus

SH	spacer length
St_1	Stanton number for the inner zone or interior channel
T	temperature
t^+	nondimensional temperature
u^+	nondimensional velocity
x	axial distance
y	radial distance
y_L	length of the velocity profile
α	radius ratio
ϵ	ratio of spacer area to free flow area in a channel

Subscripts

B	bulk temperature
w	wall temperature
MAX	maximum value
1	inner zone or interior channel

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1. INTRODUCTION

The COBRA/CFTL code was developed by the Oak Ridge National Laboratory (ORNL) for thermal-hydraulic analysis of gas-cooled fast breeder reactor (GCFR) simulated core assemblies to be tested in the core flow test loop (CFTL) (Ref. 1) under construction at ORNL. The COBRA/CFTL code is essentially a modified version of the COBRA*GCFR code (Ref. 2) developed by General Atomic Company (GA). These modifications (1) simplify the code for specific application to CFTL test bundles, (2) incorporate a new correlation method developed for rough surfaces by ORNL (Refs. 3 through 5), (3) incorporate new thermal-hydraulic correlations, (4) convert the code to metric units, and (5) incorporate new input and output formats. This report describes only these modifications to the COBRA*GCFR code. The report is intended as a supplement to Ref. 2. Together, these two reports provide a complete description and user's manual for the COBRA/CFTL code.

To evaluate the effect of the code modifications, calculation results of the COBRA/CFTL and COBRA*GCFR codes are compared with each other for three problems that cover all flow regimes. This report discusses these comparisons.

A set of input instructions, a sample input and output, and the listing for the COBRA/CFTL code are included in the Appendices.

2. MODIFICATIONS

This section describes modifications made to the COBRA*GCFR code to obtain the COBRA/CFTL code. These changes were made to obtain a computer code that was simpler for specific application to thermal-hydraulic analysis of test bundles in the CFTL (Ref. 1). In addition, some changes were made to include correlations that were not available when development of the COBRA*GCFR code was stopped in February 1980.

2.1 REMOVAL OF UNNECESSARY ROUTINES

The COBRA/CFTL code is expected to be used at ORNL for specific application to CFTL with helium coolant. Hence, a number of subroutines related to coolants other than helium were removed from the COBRA*GCFR code. In addition, subroutines related to rod conduction and radiation heat transfer calculations were modified (Ref. 6). Table 1 lists the subroutines that were removed from the COBRA*GCFR code and the subroutines that were added.

2.2 USE OF MODIFIED $R(h^+)$ AND $G(h^+)$ FUNCTIONS

As discussed in Refs. 3 through 5, the COBRA/CFTL code uses the following velocity and temperature profiles in the rough portion of the bundle:

$$u^+ = AR \ln(Y/h_R) + R(h^+) \quad (1)$$

$$t^+ = AH \ln(Y/h_R) + G(h^+) \quad (2)$$

The correlations for the $R(h^+)$ and $G(h^+)$ functions and the slopes of the velocity and temperature profiles are of the form

$R(h^+)$ and AR

1. Fully Rough Flow: $[h_w^+ > CR(3)]$

$$R(h^+) = CR(1) \quad (3)$$

$$AR = CR(2) \quad (4)$$

2. Transition Flow:

$$R(h^+) = CR(4) - CR(5)\ln(h^+) \quad (5)$$

$$AR = CR(6) - CR(7)\ln(h^+) + CR(8)[\ln(h^+)]^2 \quad (6)$$

3. Hydraulically Smooth Flow:

$$\left[R(h^+) + (AR - 2.5) \right] \ln \frac{Y_L}{h_R} - 0.5 - \frac{1}{2 + \frac{Y_L}{r_1}} \left. \right] > \left[2.5 \ln(h_B^+) + 5.5 \right]$$

$$R(h^+) = 5.5 + 2.5 \ln(h_B^+) \quad (7)$$

$$AR = 2.5 \quad (8)$$

$G(h^+)$ and AH

For $h_w^+ \geq CG(6)$:

$$G(h^+) = CG(1) * (h_w^+)^{CG(2)} * Pr^{CG(4)} * (T_w/T_B)^{CG(5)} \quad (9)$$

For $h_w^+ < CG(6)$:

$$G(h^+) = CG(7) \quad (10)$$

$$AH = CG(3) \quad (11)$$

The coefficients CR(1) to CR(8) and CG(1) to CG(7) in Eqs. 3 to 11 depend on the roughness geometry as given in Refs. 3 through 5 and are input to the code.

2.3 STANTON NUMBER IN INTERIOR CHANNELS

The COBRA*GCFR code calculates the Stanton number in the interior channel (see Fig. 1) from Eqs. 1 and 2 by using the Dipprey-Saberskey heat

transfer similarity law (Ref. 7). This has been replaced in the COBRA/CFTL code by the relation obtained by solving the equation

$$\frac{\sqrt{f_1/2}}{St_1} = AH \left[\ln(Y_L/h_R) - 0.5 - 1/(2 + Y_L/r_1) \right] + G(h^+) \quad (12)$$

2.4 MODIFICATIONS FOR VARIABLE SLOPES AR AND AH

In the COBRA*GCFR code (Ref. 2), it is assumed that

$$AR = AH = 2.5 \quad (13)$$

However, as discussed above, in the COBRA/CFTL code AR and AH are calculated from input quantities. Hence, a number of modifications were made to subroutines BASIC and IDDT to accommodate this change.

2.5 SI (METRIC) UNITS

A number of appropriate changes have been made so that all the input, the internal calculations, and the output are in SI units.

2.6 LAMINAR NUSSELT NUMBERS

In the COBRA*GCFR code, correlations for laminar heat transfer coefficients are part of the input. This has been modified and the following correlations from Ref. 8 have been made part of the coding in the COBRA/CFTL code for laminar flow calculations.

Interior Channels

$$Nu = \frac{\alpha}{1 + \alpha} \left[14.12 + 4.13 \ln \left(\frac{0.95}{\alpha - 1} \right) \right] \quad (14)$$

Wall and Corner Channels

$$Nu = 4.07 + \frac{1.24}{(\alpha)^{0.803}} \quad (15)$$

where $\alpha = r_1/r_2$ for wall and corner channels

$= r_1/r_0$ for interior channels.

2.7 SHROUD TEMPERATURE DURING LAMINAR FLOW

The COBRA*GCFR code calculates shroud temperatures only when $R(h^+)$ and $G(h^+)$ functions are used for friction factor and heat transfer coefficient calculations. In the COBRA/CFTL code, a method of the SAGAPO code (Ref. 8) has been incorporated to calculate the shroud temperatures during laminar flow. However, there seems to be an error in the programming of this calculation. Results of the test Cases 2 and 3 (presented in later in this report) indicate that the COBRA/CFTL code calculates the shroud temperature to be less than the inlet coolant temperature at a number of locations during laminar flow. This is possible only when there is a heat loss from the shroud. In these test cases, no such heat loss was considered.

2.8 EFFECT OF SPACERS ON HEAT TRANSFER DURING LAMINAR AND TRANSITION FLOW

The correlations for this effect were not available when development work on the COBRA*GCFR code was stopped in February 1980. These correlations from Ref. 9 have been included in the COBRA/CFTL code.

Upstream and Under-Space Effect ($-1 \leq \frac{x}{D_H} < AD$)

$$Nu^* = 1 + \frac{Nu_{\max}^* - 1}{AD + 1} \left(\frac{x}{D_H} + 1 \right) \quad (16)$$

For Rough Surface: $Nu_{\max}^* = 1 + K(Re)\epsilon^2 \quad (17)$

$$\text{where } K(Re) = \begin{cases} .174 Re^{.5} & Re < 2653 \\ 3.3 + 72700 Re^{-1.2} & Re > 2653 \end{cases} \quad (18)$$

$$AD = \frac{SH/2}{D_H} \quad (19)$$

For Smooth Surface:

$$Nu_{\max}^* = \text{Min} \begin{cases} 1. + .174 Re^{.5} \epsilon^2 \\ 1. + (6.38 + 4550 Re^{-0.8}) \epsilon^{2.4} \end{cases} \quad (20)$$

$$AD = \begin{cases} \frac{SH/2}{D_H} & Re < 3000 \\ SH/D_H & Re > 3000 \end{cases} \quad (21)$$

Downstream of Spacer ($\frac{x}{D_H} > AD$)

$$Nu^* = K * \left(\frac{x/D_H}{RePr} \right)^m \quad (22)$$

For Rough Surface:

$$m = \begin{cases} 1.1855 \times 10^{-3} Re \epsilon^2 & Re < 3000 \\ (1 + 4.9 \times 10^4 Re^{-1.2}) \epsilon^2 & Re > 3000 \end{cases} \quad (23)$$

$$m > -4\epsilon^2, \quad m = -4\epsilon^2$$

$$K = \begin{cases} 4.42 - 1.05 \log_{10}(Re) - 2.25\epsilon & Re < 3000 \\ -0.1298 [\log_{10}(Re)]^2 + 1.2466 [\log_{10}(Re)] - 1.8478 - 2.25\epsilon; & Re > 3000 \end{cases} \quad (24)$$

$$K < .885 - 2.25\epsilon, \quad K = .885 - 2.25\epsilon$$

For Smooth Surface:

$$m = \begin{cases} -1.855 \times 10^{-3} Re \epsilon^2 & Re < 3000 \\ -30.34 Re^{-0.253} \epsilon^2 & Re > 3000 \end{cases} \quad (25)$$

$$m < -4\epsilon^2, \quad m = -4\epsilon^2$$

$$K = \begin{cases} 4.42 - 1.05 \log_{10}(\text{Re}) - 2.25\epsilon & \text{Re} < 3000 \\ .426 + .113 \log_{10}(\text{Re}) - 2.25\epsilon & \text{Re} > 3000 \end{cases} \quad (26)$$

$$K < .895 - 2.25\epsilon, \quad K = .885 - 2.25\epsilon$$

2.9 INPUT/OUTPUT CHANGES

A number of changes in input and output have been made for convenience. Appendix A describes the input instructions and Appendices B and C show sample input/output from the COBRA/CFTL code.

2.10 SEARCH FOR STEP CHANGE IN HEAT FLUX

In the COBRA*GCFR code, a search for a step change in heat flux between nodes consists essentially of a change from zero to a non-zero value or vice-versa. This was modified such that the test in COBRA/CFTL is for a factor of three increase or decrease in heat flux at adjacent nodes. If the test is positive, the distance between nodes is subdivided into 20 parts for accurate calculation of the energy added. Also, this modification has altered the definition of "location of the start of heating." In the COBRA*GCFR code, the heating is assumed to start whenever heat flux is non-zero. However, COBRA/CFTL defines the start of heating when heat flux has a factor of three increase, as explained above. This difference in the definition of "location of start of heating" leads to significant differences in laminar heat transfer coefficients in the developing region.

2.11 CORRECTION FOR SMOOTH GEOMETRY

Since the more important calculations in the codes are in the rough portion of the bundle, the geometry of the rough part of the bundle (i.e., flow area, wetted perimeter, etc.) is an input to the codes. The flow area and wetted perimeter for the smooth part of the bundle differ from those of the rough part of the bundle. The flow area can be correctly accounted for by using the axial flow area variation option in the codes. Programming has been provided in the COBRA/CFTL code to reduce the hydraulic diameter by 1.7% whenever the flow area variation factor is less than 0.99. The 1.7% correction to the hydraulic diameter represents the average for the CFTL test bundles.

2.12 PROPERTY TABLE RANGE

The subroutine SETUP was modified to permit setting up minimum temperatures in the property table in the event that individual subchannel temperatures and enthalpies are read in.

2.13 TEST FOR LAMINAR FRICTION FACTOR

Changes were made to subroutines PROP, SETUP, and SETUP2 to test the turbulent friction factor value (FSP(I)) against the laminar friction factor value (FLAM) whenever the index LAMNF > 0. If FLAM < FSP(I), the flow is assumed to be turbulent.

2.14 IMPOSITION OF LAMINAR FLOW CALCULATIONS

When the laminar option (Card 2A) is selected, the COBRA/CFTL code checks whether the flow is laminar or turbulent in a given channel by calculating and comparing the laminar and turbulent friction factors. In some instances the flow rate is low enough that this test is unnecessary. The code has been modified to permit the user to select an option so that only laminar calculations are performed (LAMNF = 2).

2.15 CORRECTION FOR AXIAL FLOW WHEN ROD CONDUCTION CALCULATIONS ARE MADE

The heat fluxes computed in the subroutine RODCON (see Ref. 6) are at the midpoint between the nodes. However, the clad temperature in the COBRA/CFTL code are at the nodes. The code has been modified to adjust the flux values to the node locations for clad temperature calculations. This adjustment is required only for the case in which rod conduction calculations are made.

2.16 CORRECTION TO BUNDLE-AVERAGED RESULTS

In the COBRA/CFTL and the COBRA*GCFR codes, heat transfer to and from the bundle is modeled by creating a dummy flow channel outside the bundle. In the COBRA*GCFR code, the parameters of the dummy channel are included in the bundle-averaged results. However, in the COBRA/CFTL code an option has been added such that the dummy channel can be excluded from the bundle-average calculation by specifying that it is of a type greater than NFT (Card 4B).

2.17 SYMMETRY OPTION

The symmetry option in the COBRA*GCFR code consisted of making the adjacent channel number (LC(I,J)) in group 4 negative at the symmetry lines. This adjusted the cross flow and conduction through the coolant to 50% of the actual values. This option has been removed in the COBRA/CFTL code.

2.18 REMOVAL OF UNNECESSARY OPTIONS

The following options, which were considered unnecessary for the CFTL calculations or for the ORNL computer, were removed from the COBRA* GCFR code.

1. COBRA-IV fuel rod model
2. Roll option
3. Restart option
4. Coolant properties other than helium

3. COMPARISON OF COBRA*GCFR AND COBRA/CFTL RESULTS

To investigate the effect of various changes discussed in Section 2, calculation results of the COBRA*GCFR and the COBRA/CFTL codes were compared for three tests which covered the turbulent flow, transition flow, hydraulically smooth, and laminar flow regimes. The test section considered was a sixth section (Fig. 1) of the AG-1 bundle designed for testing in the CFTL (Ref. 1). The test conditions are summarized in Table 2.

3.1 TEST 1

The flow conditions for Test 1 (Table 2) are fully turbulent rough flow in all channels. The results of the two codes are likely to be affected by different forms of $R(h^+)$ and $G(h^+)$ functions.

Figures 2 through 7 show the comparison of results for this test. The pressure drop and coolant temperature calculations in all channels agree very closely. The maximum deviation in these quantities is less than 1%. Similarly, there is a close agreement in rod surface temperatures of interior and corner channels.

However, rod and shroud temperatures in the wall channel (Figs. 4 and 5) differ by as much as 20°C (out of a film drop of 200°C). The procedure of inverse transformation used for calculating the Stanton numbers in the wall channel (Ref. 4) indicates that this difference is likely to be due to different forms of $R(h^+)$ and $G(h^+)$ functions used in the two codes. The difference in the calculated shroud temperatures is also due to different forms of the $R(h^+)$ and $G(h^+)$ functions.

3.2 TEST 2

The flow conditions for Test 2 are such that the flow is hydraulically smooth in the interior channel and laminar in the corner and wall channels. Figures 8 through 13 show the comparison of the results obtained by the two codes.

The pressure drop results (Fig. 8) are within 5%. The slight difference is due to the difference in the calculated friction factors in the interior channels. Similarly, there is close agreement in coolant temperature (Figs. 9 through 13) in all channels. This indicates that the flow distribution calculated by the two codes was quite close.

However, there is substantial disagreement in the rod surface temperatures in all channels. This is due to the different correlations for the

$R(h^+)$ and $G(h^+)$ functions used by the two codes in this flow regime and different correlations for space enhancement of heat transfer. The correlations used in COBRA/CFTL are based on published results which were not available when development of COBRA*GCFR code was stopped.

Another difference in the two codes which affects the heat transfer coefficients is the definition of the start of heating point. For the axial heat flux under consideration, COBRA*GCFR calculates the start of heating at $x = 0$, whereas COBRA/CFTL calculates the start of heating at $x = 939$ mm. This affects the laminar heat transfer coefficient, since this coefficient is a function of distance from the start of heating point (Ref. 2).

There is a large disagreement in the shroud temperatures calculated by the two codes (Fig. 11). However, shroud temperatures calculated by COBRA/CFTL are obviously in error since some of the shroud temperatures are lower than the inlet temperatures. This must have been due to some programming error in implementing the methods of the SAGAPO code.

3.3 TEST 3

The flow conditions for Test 3 are such that the flow is in the transition regime in all channels. Figures 14 through 19 show the comparison of results.

Similar to Test 2, the results from the two codes for pressure drop and coolant temperatures agree well. Also, there is a close agreement in the rod surface temperatures for the interior channels. However, rod surface temperature for wall and corner channels differ because of different $R(h^+)$ and $G(h^+)$ functions and different spacer enhancement correlations.

The remarks about shroud temperature calculations for Test 2 also apply to the results of this test.

3.4 SUMMARY OF CODE COMPARISON

The results of the code comparison have shown that the pressure drop and coolant temperature calculations agree closely for all flow conditions. The close agreement in the interior channel rod temperature for fully turbulent rough flow is not surprising. Because although the form of $R(h^+)$ and $G(h^+)$ functions used in the two codes is different, the correlations are such that the values of the $R(h^+)$ and $G(h^+)$ functions for fully turbulent flow are equal. The codes predict different results for rod surface temperatures and duct temperatures, especially during laminar and transition flow due to different correlations for the $R(h^+)$ and $G(h^+)$ functions, different definitions for the start of heating point, a programming error in the COBRA/CFTL code in laminar shroud temperature calculations, and different spacer enhancement correlations. Table 3 summarizes these comparison results.

4. COST COMPARISONS

Table 4 compares costs and standard units of processing (SUP) time on the COBRA/CFTL and COBRA*GCFR codes. For Test 1, costs and SUP times are very close. For Tests 2 and 3, costs on the COBRA*GCFR code are about 70% of those on the COBRA/CFTL code. The reason for this may be that the COBRA/CFTL code used $R(h^+)$ and $G(h^+)$ functions for Tests 2 and 3, where as COBRA*GCFR uses input correlations for Tests 2 and 3. Use of $R(h^+)$ and $G(h^+)$ functions result in added iteration for convergence and, hence, added costs.

Interestingly, reducing the size of the code by removing a number of subroutines (Table 1) did not reduce the time or computation cost of the code on the Univac computer at GA. However, the shortened code does provide substantial benefit when run on the IBM computer at ORNL.

5. SUMMARY AND CONCLUSIONS

The COBRA/CFTL code has been developed for thermal-hydraulic analysis of simulated GCFR core assemblies to be tested in the CFTL. The code was obtained by modification of the COBRA*GCFR code. These modifications consisted of:

1. Removing of unnecessary routines.
2. Changing velocity and temperature profile correlations.
3. Changing the method of calculating Stanton number in the interior channels.
4. Converting to SI units.
5. Building-in laminar Nusselt number correlations.
6. Including shroud temperature calculation during laminar flow.
7. Incorporating effect of spacer on heat transfer coefficient during laminar flow.
8. Incorporating changes in input/output.
9. Changing the method for step change in heat flux.
10. Correcting for smooth geometry.

Some of the above changes were made for convenience; others were made to include more up-to-date information in the code. Comparing the calculations of the two codes shows that

1. Pressure drop calculations for all flow conditions agree well.
2. Coolant temperatures and flow distributions also agree well for all flow conditions.
3. The rod and shroud temperatures in the wall channel during fully turbulent rough and transition flow differ because of different forms of $R(h^+)$ and $G(h^+)$ functions.
4. The rod temperatures during laminar flow differ because of code differences in the spacer enhancement correlation and in the definition of the start of heating point.

5. Shroud temperatures during the laminar flow differ because the COBRA/CFTL code uses the method from the SAGAPO code for this calculation, whereas the COBRA*GCFR code assumes the shroud temperature to be equal to the coolant temperature during laminar flow. The difference in this result seems to be due to a programming error in the COBRA/CFTL code.

Some of the modifications incorporated in the COBRA/CFTL code are clearly improvements over the COBRA*GCFR code (e.g., laminar space enhancement, correction for smooth region, shroud temperature calculation during laminar flow, method for step change in heat flux). Other changes connected with the new form of $R(h^+)$ and $G(h^+)$ functions and variable slopes of the velocity and temperature profiles are based on the development work done at ORNL over the last three years. The procedure suggested has been supported to some extent by recent experiments at KfK. Unfortunately, because of the termination of the GCFR program, comparison of both code calculations with same bundle experiment has not been done.

6. REFERENCES

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TABLE 1

SUBROUTINES REMOVED FROM AND ADDED TO THE
COBRA*GCFR CODE TO OBTAIN THE COBRA/CFTL CODE

Routines Removed	Routines Added
APF; BVOID; CHAIN; CHECK; CHF; CHFCOR; CHF1; CHF2; CIRCON; CLEAR; CO2; DFAULT; DRIFT (dummy); DUMPIT; ELAP; ERRORS; FILES; GAUSS; GROUP9; HCOOL; HTCOR; IAD; ISWAP; LESCON; LOADER; LOADL; LOCATE; LOCATR; LOOP; MOVEAB; NAMTAB; NEWTAB; PBOUND; READ; RESLTM; RESTRT; REWIND; ROLLIT; SCAN; SCQUAL; SIGN2,3,4,5,7,8; SREAD; SRITE; STEAM; SIREAD; SIRITE; TEMP; TERM; TODS; TRIDAG; VOID; XSCHM.	BLOCKDATA; CONROD; ELAPI; ERROR; RODCON; SAXPY; SDOT; SPBFA; SPBSL; ZEROIT; ZERSET.

TABLE 2

TEST CONDITIONS FOR CODE COMPARISONS

Test No.	Bundle Average Re	Interior Channels		Wall Channels		Corner Channel	
		Re	Flow	Re	Flow	Re	Flow
1	83,100.	100,400.	Fully Turbulent Rough	63,600.	Fully Turbulent Rough	44,800.	Fully Turbulent Rough
2	3,310.	4,120.	Hydraulically smooth	2,484	Hydraulically smooth/laminar	1,720.	Hydraulically smooth/laminar
3	6,000.	7,420.	Transition	4,420.	Transition hydraulically smooth	3,100.	Transition hydraulically smooth

TABLE 3
SUMMARY OF CODE COMPARISON

	Difference in Pressure Drop (%)	% Difference in Calculated Temperatures ^(a)				
		Coolant	Interior Channel Rod	Wall Channel Rod	Corner Channel Rod	Wall Channel Shroud
Test 1 Fully turbulent rough flow	0.45	0.41	3.0	8.5	2.4	23.0
Test 2 Hydraulically smooth/laminar flow	4.8	5.5	10.6	25.4	22.3	_(b)
Test 3 Transition/ hydraulically smooth flow	1.	2.5	14.3	17.7	24.5	_(b)

(a)
$$\% \text{ difference} = - \frac{T_1 - T_2}{T_1 - T_I} \times 100.$$

(b) For these cases, COBRA/CFTL code calculates the shroud temperatures less than the inlet temperatures.

where,

T_1 = temperature calculated by COBRA*GCFR code.

T_2 = temperature calculated by COBRA/CFTL code.

T_I = inlet temperature.

TABLE 4
COMPARISON OF COMPUTER TIMES AND COSTS

Test No.	COBRA/CFTL at GA		COBRA*GCFR at GA	
	SUP Time (Sec)	Cost (\$)	SUP Time (Sec)	Cost (\$)
1	290	34.39	269	32.13
2	152	19.05	103	13.43
3	155	19.36	102	13.43

Types of Channels

- ① Interior
- ② Wall
- ③ Corner
- ④ Interior
- ⑤ Interior

Figure 1. Subchannel and Rod Identification Numbers for the Test Bundle.

Figure 2. Comparison of COBRA*GCFL and COBRA/CFTL Results - Test 1: Pressure Drop

Figure 3. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 1:
Coolant and Rod Surface Temperatures in Interior Channel.

Figure 4. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 1:
Coolant and Rod Surface Temperatures in Wall Channel.

Figure 5. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 1:
Shroud Temperatures in Wall Channel.

Figure 6. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 1:
Coolant and Rod Surface Temperatures in Corner Channel.

Figure 7. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 1:
Coolant Temperatures in Channel Next to Hanger Rod.

Figure 8. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 2: Pressure Drop.

Figure 9. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 2: Coolant and Rod Surface Temperatures in Interior Channel.

Figure 10. Comparison of COBRA*GC=R and COBRA/CFTL Results - Test 2:
Coolant and Rod Surface Temperatures in Wall Channel.

Figure 11. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 2:
Shroud Temperatures in Wall Channel.

Figure 12. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 2: Coolant and Rod Surface Temperatures in Corner Channel.

Figure 13. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 2:
Coolant Temperatures in Channel Next to Hanger Rod.

Figure 14. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 3: Pressure Drop.

Figure 15. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 3: Coolant and Rod Surface Temperatures in Interior Channel.

Figure 16. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 3:
Coolant and Rod Surface Temperatures in Wall Channel.

Figure 17. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 3:
Shroud Temperatures in Wall Channel.

Figure 18. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 3: Coolant and Rod Surface Temperatures in Corner Channel.

Figure 19. Comparison of COBRA*GCFR and COBRA/CFTL Results - Test 3:
Coolant Temperatures in Channel Next to Hanger Rod.

APPENDIX A
INPUT DATA CARD DESCRIPTIONS FOR COBRA/CFTL CODE

CØBRA/3FTL INPUT

WORD	1
COLUMN	1-5
FORMAT	I 5
0A	Time Limit allowed for problem Default = 1000, if MAXT read in as zero.
SYMBOL	MAXT

Read in CØBRA

WORD	1	2
COLUMN	1-5	6-71
FORMAT	I 5	16 A 4, A 2
0B	Read case number if < 1, program stop	Output text for problem identification
SYMBOL	KASE	TEXT

Read this and
all remaining
cards in SETUP

Case Control

WORD	1	2	3
COLUMN	1-5	6-10	11-20
FORMAT	I 5	I 5	5X, I 5
1A	Group number (= 1)	Number of values in property table	Property range = 0, calculates NPRØP properties from (inlet temperature -1) to 750°C = 1, calculates NPRØP properties over temper- ature specified in DTMAX (Card 1B)
SYMBOL	NGRØUP	N1 = NPRØP	N3

Property Table

CØBRA/CFTL INPUT

WORD	1
COLUMN	1-5
FORMAT	F5.3
1B	Temperature range over which the properties are to be calculated.
SYMBOL	DTMAX

Read if
N3 = 1

WORD	1	2
COLUMN	1-5	6-30
FORMAT	I 5	20X, I 5
2A	Group Number (= 2)	Laminar friction factor = 0, no laminar correlation = 1, read in up to NFT sets of laminar friction factor correlation constants = 2, laminar solution imposed (Card 2C)
SYMBOL	NGRØUP	N5 = LAMNF

Friction and
Nusselt
Correlations

WORD	3	4	5
COLUMN	31-35	36-40	41-45
FORMAT	I 5	I 5	I 5
2A (Cont.)	Rod-to-coolant single phase heat transfer = 0, use Dittus-Boelter correlation > 0, read a user-supplied Nusselt correlation (Card 2D)	Friction and heat transfer correlations (see below)	Number of friction or Stanton correlation types to read if NFH > 0.
SYMBOL	N6	N7 = NFH	N8 = NFT

CØBRA/CFTL INPUT

NFH	$F = AAL(Re)^{BBL} + CCL$ (Card 2C)	$F = AA(Re)^{BB} + CC$ (Card 2B)	$F_r = AAR(Re)^{BBR} + CCR$ (Card 2E)	$Nu = k$ - functions (Card Group 13)	$St_s = \frac{(AH(1)Re)^{AH(2)} p_r^{AH(3)} + AH(4))}{(Card 2D)}$	$St_s = HAA(Re)^{HBB} + HCC$ (Card 2F)	$St_r = \text{Petukov-Roizen method.}$ (Card 2G)	$Nu_I = \alpha / (1 + \alpha) * (14.12 + 4.13 \ln \frac{(-.95}{803^\alpha} - 1))$	$Nu_{c,w} = 4.07 + 1.24 / (\alpha)^{803^\alpha} - 1))$
0	X	X		X					
1	X	X	X		X		X	X	
2	X	X		X	X			X	
3	X	X	X			X	X	X	
4	X	X		X		X		X	

Subscripts:

c - corner subchannel
 I - interior subchannel
 r - rough section
 s - smooth section
 w - wall subchannel

For $LAMNF > 0$, $F = \text{Maximum of } \begin{cases} AAL(Re)^{BBL} + CCL \\ F \text{ for turbulent flow} \end{cases}$

WORD	1-12
COLUMN	1-60
FORMAT	6E10.5
2B*	Turbulent friction factor correlation coefficients. If NFH>0, this is for the axially smooth section; otherwise, it is used for the entire axial length. $f = AA(Re)^{BB} + CC$ [I = subchannel type]
SYMBOL	AA(I), BB(I), CC(I), I = 1, NFT

Read if
NFH = 0

WORD	1-12
COLUMN	1-60
FORMAT	6E10.5
2C	Laminar friction factor correlation coefficients $f_L = AAL(Re)^{BBL} + CCL$
SYMBOL	AAL(I), BBL(I), CCL(I), I = 1, NFT

Read if
LAMNF>0

WORD	1-4
COLUMN	1-20
FORMAT	4F5.3
2D	Single phase Nusselt number correlation coefficients $h = \frac{k}{D} [AH(1)Re^{AH(2)}Pr^{AH(3)} + AH(4)]$
SYMBOL	AH(I), I = 1,4

Read if
N6>0

*Put this card here after card 2D if LAMNF>0 and NFH>0. Coefficients are for the smooth section only.

CØBRA/3FTL INPUT

WORD	1-6
COLUMN	1-60
FORMAT	6E10.5
2E	Friction factor correlation coefficients for axially rough section. $F_R = AAR(Re)^{BBR} + CCR \quad (I = \text{subchannel type})$
SYMBOL	AAR(I), BBR(I), CCR(I), I = 1, NFT

Read if
NFH=1,3

WORD	1-6
COLUMN	1-60
FORMAT	6E10.5
2F	Stanton number correlation coefficients for axially smooth section $St_s = HAA(Re)^{HBB} + HCC \quad (I = \text{subchannel type})$
SYMBOL	HAA(I), HBB(I), HCC(I), I = 1, NFT

Read if
NFH=1,2

WORD	1-6
COLUMN	1-60
FORMAT	6E10.5
2G	Stanton number correlation coefficients for axially rough section $St_R = HAAR(Re)^{HBBR} + HCCR \quad (I = \text{subchannel type})$
SYMBOL	HAAR(I), HBBR(I), HCCR(I), I = 1, NFT

Read if
NFH=1,3

WORD	1	2	3	4
COLUMN	1-5	6-10	11-15	16-20
FORMAT	I 5	I 5	I 5	I 5
3A	Group Number (=3)	No. of entries in axial heat flux table.	Radiation heat transfer model = 0, no radiation = 1, radiation	Logical unit for reading Hottel's radiation exchange factors when IRAD = 1
SYMBOL	NGRØUP	N1 = NAX	N2 = IRAD	N3

Axial Heat
Flux

WORD	1-12			
COLUMN	1-60			
FORMAT	12F5.3			
3B	Axial heat flux table Y = relative position (X/L) AXIAL = relative heat flux (local/average)			
SYMBOL	Y(I), AXIAL(I), I = 1, NAX			

NOTE: Y(1) must be = 0.0
Y(NAX) must be = 1.0

WORD	1	2	3	4	5
COLUMN	1-5	6-10	11-15	16-20	21-25
FORMAT	I 5	I 5	I 5	I 5	I 5
4A	Group number (=4)	No. of subchannel data cards to be read	Total no. of sub-channels	=0, no directed crossflows >0, the number of gaps for which directed cross-flows are specified (Card 4D)	=0, no thermal connections >0, number of thermal connections (Card 4C)
SYMBOL	NGRØUP	N1	N2=NCHANL	N3 = NS	N4 = NWK

Subchannel Data

WORD	6	7
COLUMN	26-30	31-35
FORMAT	I 5	I 5
4A (Cont.)	Logical unit for reading subchannel geometry data = 0, read from cards > 0, number of logical unit	Logical unit for reading directed crossflow data = 0, read from cards > 0, number of logical unit
SYMBOL	N5	N6

WORD	1	2	3	4
COLUMN	1	2-5	6-10	11-15
FORMAT	I 1	I 4	E5.2	E5.2
4B	Subchannel type number (1-5)	Subchannel number	Subchannel nominal flow area (mm ²)	Subchannel nominal wetted perimeter (mm)
SYMBOL	N	I	AC(I)	PW(I)

† If a dummy channel, read in as a number greater than NFI. Then the dummy channel will be treated as a type 1 channel, but will be excluded from bundle averaging.

WORD	5-16
COLUMN	16-80
FORMAT	5X, 4(I5, 2E5.2)
4B (Cont.)	LC = adjacent subchannel number GAPS = nominal gap width (mm) DIST = centroid-to-centroid distance (mm) Note: DIST required only if in Group 10 N1 = 3 or N3 = 1.
SYMBOL	LC(I,L), GAPS(I,L), DIST(I,L), L = 1,4

A-8

Read N1
cards

CØBRA/CFTL INPUT

WORD	1	2	3	4	5
COLUMN	3-5	6-10	11-15	16-20	21-25
FORMAT	I 5	E5.2	E5.2	I 5	E5.2
4C	Thermal connection number	Wall heat capacity parameter (KJ/m ² -K)	Width of wall [heat conduction] area = WIDTH*DX (mm)	Subchannel no. adjacent to wall	Conductive resistance of wall associated with IKW subchannel $\left(\frac{m^2}{kW}\right)$
SYMBOL	KW	RHØLCP	WIDTH	IKW	RWALL(1,KW)

Read if
NWK>0

WORD	6	7
COLUMN	26-30	31-35
FORMAT	I 5	E5.2
4C (Cont.)	Subchannel number adjacent to wall	Conductive resistance of wall associated with JKW subchannel $\left(\frac{m^2}{kW}\right)$
SYMBOL	JKW	RWALL(2,KW)

WORD	1 - 10
COLUMN	1 - 50
FORMAT	5(I5, F5.0)
4D	Gap number for which directed crossflow is specified
	Relative direction of positive crossflow thru gap K
SYMBOL	K(I)
	ANGLE(I), I = 1, NS

Read if
NS>0

CØBRA/CFTL INPUT

WORD	1	2	3	4
COLUMN	1-5	6-10	11-15	16-20
FORMAT	I 5	I 5	I 5	I 5
5A	Group number (= 5)	Number of subchannels with area variations	Number of axial locations for area variations	Number of iterations for gradual insertion of area variations (Default = 1)
SYMBOL	NGRØUP	N1=NAFACT	N2=NAXL	N3=NARAMP

Area variation

WORD	1 - 2
COLUMN	1 - 60
FORMAT	12F5.2
5B	Relative axial locations (X/L) where subchannel area variations are being specified
SYMBOL	AXL(I), I = 1, NAXL

Read if
NAXL>0

WORD	1	1-12
COLUMN	1-5	1-60
FORMAT	I 5	12F5.3
5C 5D	Subchannel number	Relative subchannel area (A_i/A_{nominal}) at each axial location (AXL)
SYMBOL	I	AFACT

Read if
NAXL>0Read NAXL
values for
each sub-
channel.

A-10

CØBRA/CFTL INPUT

WORD	1	2	3
COLUMN	1-5	6-10	11-15
FORMAT	I 5	I 5	I 5
6A	Group number (= 6)	Number of gaps for which gap variation tables are to be read	Number of axial locations for gap variation
SYMBOL	NGRØUP	N1 = NGAPS	N2 = NGXL

Gap Size
Variation

WORD	1 - 12
COLUMN	1 - 60
FORMAT	12F5.3
6B	Relative axial locations (X/L) where gap variations are being specified.
SYMBOL	GAPXL(I), I = 1, NGXL

Read if
NGXL>0

WORD	1	1 - 12
COLUMN	1-5	1 - 60
FORMAT	I 5	12F5.3
6C 6D	Gap number	Relative gap length ($GAP_i / GAP_{nominal}$) at each axial location (GAPXL)
SYMBOL	K	GFACT

Read if
NGXL>0

Read NGXL
values for
each gap.

WORD	1	2	3	4	5
COLUMN	1-5	6-10	11-15	16-20	21-25
FORMAT	I 5	I 5	I 5	I 5	I 5
7A	Group number (=7)	=1, wire wrap input only =2, grid spacer input only =3, both wire wrap and grid spacer input (loss coefficients) =0, no wire wrap or spacers	No. of gaps for which wire wrap crossing data is supplied	No. of axial locations for grid spacers	No. of grid types for which data will be supplied
SYMBOL	NGRØUP	N1 = J6	N2	N3=NGRID	N4=NGRIDT

Wire Wrap
and
Spacer Data

WORD	6	7	8
COLUMN	26-30	31-35	36-40
FORMAT	I 5	I 5	I 5
7A (Cont.)	Number of iterations over which grid loss terms are to be ramped into the solution. [Default = 1]	Logical unit for reading wrap crossing data and wrap inventory =0, read from cards >0, number of logical unit	Number of channels for which wire wrapping information is to be read (Default = NCHANL)
SYMBOL	N5 = NRAMP	N6	N7

WORD	1	2	3
COLUMN	1-10	11-20	21-30
FORMAT	E10.5	E10.5	E10.5
7B	Wire wrap pitch (mm)	Rod or cladding outer diameter (mm)	Wire wrap diameter (mm)
SYMBOL	PITCH	DIA	THICK

Read if
J6 = 1,3

Wire Wrap
Specifications

CØBRA/CFTL INPUT

WORD	1	2	3 & 4
COLUMN	1-5	6-10	11-20
FORMAT	I 5	E5.2	2E5.2
7C	Gap number	Effective fraction of pitch length for forced cross flow $= \frac{\text{axial node length}}{\text{wire wrap pitch}}$	Wire wrap crossing angle-positive if wire moving from lower to higher subchannel number $= \frac{\theta \text{ between gap \& wire at inlet}}{360}$
SYMBOL	K	DUR	XCRØSS(K,L), L = 1,2

Read if
J6 = 1,3
Read N2 cards

Wire Wrap
Crossing Data

WORD	1-10
COLUMN	1-50
FORMAT	10 I 5
7D	Number of wires initially in each subchannel (at bundle inlet) Wire on gap boundary assumed to be in subchannel into which it is proceeding
SYMBOL	NWRAPS(I), I = 1, N7

Read if
J6 = 1,3

Wire
Inventory

WORD	1-12	
COLUMN	1-60	
FORMAT	6(E5.2, I 5)	
7E1	Relative location (X/L) of grid spacers	Grid Type
SYMBOL	GRIDXL(I)	IGRID(I), I = 1, NGRID

Read if
J6 = 2,3

Grid Spacer
Specifications

WORD	1-4
COLUMN	1-40
FORMAT	4E10.5
7E2	Equation for spacer loss coefficients $COEF = CD(J, I) ** CDC1(I) * \left(CDC2(I) + \frac{CDC3(I)}{Re^{CDC4(I)}} \right)$ <p>where CD(J, I) is read on Card 7F</p>
SYMBOL	CDC1(I), CDC2(I), CDC3(I), CDC4(I), I = 1, NGRIDT

Read if
J6 = 2,3Read NGRIDT
cards

WORD	1	2	3
COLUMN	1-10	11-20	21-30
FORMAT	E10.5	E10.5	E10.5
7E3	Spacer height (mm)	Rough spacer coefficient $YST = 1 + RSC * CD^2 * F(X)$	Smooth spacer coefficient $YST = 1 + SSC * CD^2 * F(X)$
SYMBOL	SH	RSC	SSC

Read if
J6 = 2,3

WORD	1	2	3	4
COLUMN	1-5	6-10	11-15	16-20
FORMAT	I 5	E5.2	I 5	E5.2
7F	Subchannel number	Solidity for grid type I in subchannel J ($A_{spacer}/A_{channel}$)	Gap associated with J thru which forced diversion crossflow is specified	Fraction of axial flow diverted thru gap K for grid type I
SYMBOL	J	CD(J,I)	K	FXFLOW(K,I)

Read if
J6 = 2,3Read NGRIDT
sets of
NCHANL cards

CØBRA/CFTL INPUT

WORD	1	2	3	4
COLUMN	1-5	6-10	11-15	16-20
FORMAT	I 5	I 5	I 5	I 5
8A	Group number (= 8)	Number of cards of rod data	Total number of rods	NC = 0, fuel properties not read >0, fuel properties read
SYMBOL	NGRØUP	N1	N2=NRØD	N3 = NC

Rod Data

WORD	5	6
COLUMN	21-35	36-50
FORMAT	10X, I 5	10X, I 5
8A (Cont.)	Additional fuel model options = 0, no additional options = 4, circumferential rod conduction	Logical unit from which rod input data to be read = 0, read from cards > 0, number of logical unit
SYMBOL	N6 = NQAX	N9

WORD	7
COLUMN	51-55
FORMAT	I 5
8A (Cont.)	Maximum number of subchannels connected to a rod (Default = 6) 7 for CFTL with Hanger Channels
SYMBOL	N10 = MSC

CØBRA/C=TL INPUT

WORD	1	2	3	4-15	
COLUMN	1-5	6-10	11-15	16-75	
FORMAT	I 5	E5.2	E5.2	6(I 5, E5.2)	
8B	Rod number	Cladding outer diameter (mm)	Radial power factor	Subchannel number adjacent to rod	Fraction of total power to subchannel
SYMBOL	I	DR	RADIAL	(LR(I,L), PHI(I,L), L = 1,6)	

Read N1 sets
of cards 8B
and 8BB

WORD	1	
COLUMN	16-25	
FORMAT	15X, I5, E5.2	
8BB	Subchannel number adjacent to rod	Fraction of total power to subchannel
SYMBOL	LR(I, L), PHI(I, L), L = 7, MSC	

Read if
MSC > 6

WORD	1-5
COLUMN	1-50
FORMAT	5F10.0
8C1	Fuel zonal radii
SYMBOL	RF(J), J = 1, 5

Read if
NC > 0

CØBRA/CFTL INPUT

WORD	1-5
COLUMN	1-50
FORMAT	5F10.0
8C2	Fuel conductivity
	XKF(J), J = 1,5

Read if
NC > 0

WORD	1-4
COLUMN	1-40
FORMAT	4F10.0
8C3	Fuel-gap conductance
SYMBOL	HGAP(J), J = 1,4

Read if
NC > 0

WORD	1-5
COLUMN	1-50
FORMAT	5F10.0
8C4	Fuel specific heat
	CPF(J), J = 1,5

Read if
NC > 0

WORD	1-5
COLUMN	1-50
FORMAT	5F10.0
8C5	Fuel power fraction
SYMBOL	QPFrac(J), J = 1,5

Read if
NC > 0

WORD	1-5
COLUMN	1-50
FORMAT	5F10.0
8C6	Fuel density
SYMBOL	RHOF(J), J = 1,5

Read if
NC > 0

WORD	1
COLUMN	1-5
FORMAT	I 5
8D1	Rods for calculating circumferential conduction = 0, all rods > 0, read NCONR rods for conduction (Card 8D2)
SYMBOL	NCONR

Read if
N6 = 4

CØBRA/CFTL INPUT

WORD	1-11
COLUMN	1-55
FORMAT	11(I5)
8D2	Rod numbers for circumferential conduction
SYMBOL	ICONR(I), I = 1, NCONR

Read if
NCONR > 0.

Read as many
cards as
necessary.

WORD	1	2	3
COLUMN	1-5	6-10	11-15
FORMAT	I 5	I 5	I 5
9A	Group number (= 9)	Output print option = 0 or 1, print all axial levels > 1, print every NSKIPX axial level	Output print option = 0 or 1, print all time steps > 1, print every NSKIPT time steps
SYMBOL	NGRØUP	N1 = NSKIPX	N2 = NSKIPT

Calculational
Variables

WORD	4
COLUMN	16-40
FORMAT	20X, I5
9A (Cont.)	= 0, let code calculate equal axial node locations = 1, read axial node locations (Card 9CC)
SYMBOL	N7

CØBRA/CFTL INPUT

WORD	1	2	3	4	5
COLUMN	1-5	6-10	11-15	16-20	21-25
FORMAT	E5.0	E5.0	E5.0	E5.0	E5.0
9B	Total axial length (mm)	Total transient time (sec.)	External crossflow convergence factor (Default = 0.1)	Internal crossflow convergence factor (Default = 0.001)	External axial flow convergence factor (Default = 0.01)
SYMBOL	Z	TTIME	WERRX	WERRY	FERRØR

WORD	6	7	8	9	10
COLUMN	26-30	31-35	36-40	41-45	46-50
FORMAT	E5.0	E5.0	E5.0	E5.0	E5.0
9B (Cont.)	Turbulent crossflow resistance factor (Default = 0.5)	Transverse momentum factor (Default=0.5)	Turbulent momentum factor (Default=0.0)	Bundle orientation from vertical [0=up](deg.)	Contribution of velocity from donor and receiver subchannels in U* calculations $0 \leq \text{USDØN} \leq 1$ (Default = 0.0)
SYMBOL	KIJ	SL	FTM	THETA	USDØN

WORD	11	12	13
COLUMN	51-55	56-60	61-65
FORMAT	E5.0	E5.0	E5.0
9B (Cont.)	Damping factor for iterative SP term (Default = 0.8)	Crossflow solution accelerator (Default = 1.5)	Damping factor for iterative axial flow (Default = 1.0)
SYMBOL	DAMPNG	ACCELY	ACCELF

CØBRA/CFTL INPUT

WORD	1	2	3	4	5
COLUMN	1-5	6-10	11-15	16-20	21-25
FORMAT	I 5	I 5	I 5	I 5	I 5
9C	Number of axial nodes	Total number of time steps allowed $DT = \frac{TTIME}{NDT}$	Max. number of external iterations allowed (implicit scheme) (Default = 20)	Max. number of internal iterations allowed (implicit scheme) (Default = max. of 20 or 2* no. gaps)	Min. number of iterations in internal crossflow solution (implicit scheme) (Default = 5)
SYMBOL	NDX	NDT	NTRIES	ITRY	ITRYM

WORD	6	7
COLUMN	26-30	31-35
FORMAT	E5.0	E5.0
9C (Cont.)	Distance from inlet where roughening begins (mm)	Distance from inlet where roughening ends (mm)
SYMBOL	LENSMØ	LENRØU

WORD	1-6
COLUMN	1-60
FORMAT	6E10.5
9CC	Axial node locations beginning with zero (mm) Do <u>not</u> include a node at the bundle exit. This is automatically done.
SYMBOL	X(J), J = 1, NDX

Read if
N7 = 1

WORD	1	2
COLUMN	1-5	6-10
FORMAT	I 5	I 5
10A	Group number (= 10)	Single phase mixing option = 0, $w' = ABETA * (S_K \bar{G})$ = 1, $w' = ABETA * Re^{**} BBETA * (S_K \bar{G})$ = 2, $w' = ABETA * Re^{**} BBETA * (\bar{DG})$ = 3, $w' = ABETA * Re^{**} BBETA * (\frac{S_K}{Z_K}) (\bar{DG})$ = 4, $w' = ABETA * (\bar{DG}) \sqrt{F/8}$
SYMBOL	NGRØUP	N1 = NSCBC

Turbulent
Mixing
Correlation

WORD	3
COLUMN	11-20
FORMAT	5X, I 5
10A (Cont.)	Radial thermal conduction mixing = 0, no thermal conduction = 1, read thermal conduction factor GK (Card 10C)
SYMBOL	N3 = J5

WORD	1	2
COLUMN	1-5	6-10
FORMAT	F5.3	F5.3
10B	Turbulent mixing correlation constant (see Card 10A)	Turbulent mixing correlation constant (See Card 10A) (omit if NSCBC = 0 or 4)
SYMBOL	ABETA	BBETA

CØBRA/CFTL INPUT

WORD	1
COLUMN	1-5
FORMAT	F5.3
10C	Geometry factor for radial thermal conduction mixing
SYMBOL	GK

Read if
J5 = 1

WORD	1	2	3
COLUMN	1-5	6-10	11-15
FORMAT	I 5	I 5	I 5
11A	Group number (= 11)	Inlet enthalpy or temp. option = 0, inlet h = HIN = 1, inlet T = HIN = 2, read inlet h for each subchannel = 3, read inlet T for each subchannel	Inlet mass flux option = 0, inlet G=GIN for each subchannel = 1, equal $\Delta P/\Delta X$ across first axial node = 2, flow split by flow fractions given in Card 11D
SYMBOL	NGRØUP	N1 = IH	N2 = IG

Operating
Conditions

WORD	4	5	6	7
COLUMN	16-20	21-25	26-30	31-35
FORMAT	I 5	I 5	I 5	I 5
11A (Cont.)	Transient forcing function for system pressure (Card 11E)	Transient forcing function for inlet h or T (Card 11F)	Transient forcing function for inlet G or ΔP (Card 11G)	Transient forcing function for average heat flux (Card 11H)
SYMBOL	N3 = NP	N4 = NH	N5 = NG	N6 = NQ

WORD	1	2	3	4
COLUMN	1-10	11-20	21-30	31-40
FORMAT	F10.0	F10.0	F10.0	F10.0
11B	System Pressure (KPa)	Inlet h or T depending on IH (KJ/Kg or °C)	Inlet mass flux $\left(\frac{\text{g}}{\text{s-mm}^2}\right)$	Average heat flux $\left(\frac{\text{KW}}{\text{m}^2}\right)$
SYMBOL	PEXIT	HIN	GIN	AFLUX

WORD	1-12
COLUMN	1-50
FORMAT	12E5.0
11C	Inlet enthalpy (IH = 2) or inlet temperature (IH = 3) for each subchannel. $\left(\frac{\text{KJ}}{\text{Kg}} \text{ or } ^\circ\text{C}\right)$
SYMBOL	HINLET(I), I = 1, NCHANL

Read if
IH = 2, 3

WORD	1-2
COLUMN	1-60
FORMAT	12E5.0
11D	Individual subchannel inlet flow fraction F(I)/FTOTAL
SYMBOL	FINLET(I), I = 1, NCHANL

Read if
IG = 2

CØBRA/CFTL INPUT

WORD	1-12	
COLUMN	1-60	
FORMAT	12E5.0	
11E	Pressure Transient Table	
	Transient time when factor is applied	Fraction of SS system pressure
SYMBOL	YP(I)	FP(I), I = 1, NP

Read if
NP>1

WORD	1-12	
COLUMN	1-60	
FORMAT	12E5.0	
11F	Enthalpy or Temperature Transient Table	
	Transient time when factor applied	Fraction of inlet enthalpy (IH = 0 or 2) or inlet temperature (IH = 1 or 3)
SYMBOL	YH(I)	FH(I), I = 1, NH

Read if
NH>1

WORD	1-12	
COLUMN	1-60	
FORMAT	12E5.0	
11G	Inlet Flow Boundary Condition Transient Table	
	Transient time when factor is applied	Fraction of SS inlet flow
SYMBOL	YG(I)	FG(I), I = 1, NG

Read if
NG>1

CØBRA, CFTL INPUT

WORD	1-12	
COLUMN	1-60	
FORMAT	2E5.0	
11H	Heat Flux Transient Table	
	Transient time when factor is applied	Fraction of SS heat flux
SYMBOL	YQ(I)	FQ(I), I = 1, NQ

Read if
NQ>1

WORD	1	2
COLUMN	1-5	6-10
FORMAT	I 5	I 5
12A	Group number (= 12)	= 10, subchannel data only = 11, subchannel data and crossflows = 12, subchannel data, fuel rod and duct temperatures = 13, subchannel data, crossflows, fuel rod, and duct temperatures
SYMBOL	NGRØUP	N1 = NØUT

Output
Options

WORD	3	4	5
COLUMN	11-15	16-20	20-30
FORMAT	I 5	I 5	5X, I 5
12A (Cont.)	= 0, print all subchannel data > 0, read NPCHAN subchannel numbers for printing (Card 12B)	= 0, print data for all rods > 0, read NPRØD rod numbers for printing (Card 12C)	= 0, print crossflows for all gaps > 0, read NPGAP gap numbers for printing (Card 12D)
SYMBOL	N2 = NPCHAN	N3 = NPRØD	N5 = NPGAP

CØBRA/CFTL INPUT

WORD	1-24
COLUMN	1-72
FORMAT	24I3
12B	Numbers of NPCHAN subchannels to be printed
SYMBOL	PRINTC (I), I = 1, NPCHAN

Read if
NPCHAN>0

WORD	1-24
COLUMN	1-72
FORMAT	24I3
12C	Indices of NPRØD rods to be printed (heat flux and temperature) Note: If use RODCON, <u>must</u> print for rod #1.
SYMBOL	PRINTR (I), I = NPRØD

Read if
NPRØD>0

WORD	1-24
COLUMN	1-72
FORMAT	24I3
12D	Number of NPGAP gaps to be printed (crossflow)
SYMBOL	PRINTG (I), I = 1, NPGAP

Read if
NPGAP>0

WORD	1
COLUMN	1-5
FORMAT	I 5
13A	Group number (= 13)
SYMBOL	NGRØUP

Read this
group only if
NFH = 2 or 4
in Group 2.

WORD	1-6
COLUMN	1-60
FORMAT	6F10.0
13B	Tube radius for subchannel types I (equivalent tube radii for wall and corner channels.) (mm) (Should be zero for central and hanger channels.)
SYMBOL	R2(I), I = 1, NFT

WORD	1-6
COLUMN	1-60
FORMAT	6F10.0
13C	Radius of zero shear for subchannel Types I. <u>Must</u> be read in as zero for (mm) wall and corner channels.
SYMBOL	RZS(I), I = 1, NFT

CØBRA/CFTL INPUT

WORD	1
COLUMN	1-60
FORMAT	6F10.0
13D	Rod radius for subchannel types I (mm)
SYMBOL	RR(I), I = 1, NFT

WORD	1
COLUMN	1-10
FORMAT	F10.0
13E	Roughness rib height (mm)
SYMBOL	HRIB

WORD	1
COLUMN	1-10
FORMAT	E10.5
13F	Biot cefficient
SYMBOL	BIØTC

CØBR3/CFTL INPUT

WORD	1-3
COLUMN	1-30
FORMAT	3E10.5
13G	R-function coefficients. Fully rough flow: $(H + > CR(3)), R(H^+) = CR(1), A = CR(2)$ Transition region: $R(H^+) = CR(4) - CR(5) \ln(H^+)$ $A = CR(6) - CR(7) \ln(H^+) + CR(8) [\ln(H^+)]^2$
SYMBOL	CR(I), I = 1, 8

WORD	1-2
COLUMN	1-80
FORMAT	3E10.5
13H	G-function coefficients. $G(HW^+) = CG(1)[HW^+]^{CG(2)} * [PR]^{CG(4)} * [TWTB]^{CG(5)}, AH = CG(3)$ If $H + < CG(6), 3(HW^+) = CG(7), CG(8) = 0$, a spare for now.
SYMBOL	CG(I), I = 1, 8

WORD	
COLUMN	
FORMAT	
	B L A N K indicates end of data, begin execution
SYMBOL	

CØBRA/CFTL INPUT

WORD	
COLUMN	
FORMAT	
	<p>B L A N K</p> <p>indicates no additional cases; stop</p>
SYMBOL	

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APPENDIX B

SAMPLE INPUT FOR COBRA/CFTL CODE

56. 00 8
 57. 00 .973 .973 1.0 1.0 .973 .973
 58. 00 9
 59. 00 .973 .973 1.0 1.0 .973 .973
 60. 00 10
 61. 00 .973 .973 1.0 1.0 .973 .973
 62. 00 11
 63. 00 .967 .967 1.0 1.0 .967 .967
 64. 00 12
 65. 00 .967 .967 1.0 1.0 .967 .967
 66. 00 13
 67. 00 .973 .973 1.0 1.0 .973 .973
 68. 00 14
 69. 00 .9836.9836 1.0 1.0 .9836.9836
 70. 00 15
 71. 00 .9836.9836 1.0 1.0 .9836.9836
 72. 00 16
 73. 00 .973 .973 1.0 1.0 .973 .973
 74. 00 17
 75. 00 .9836.9836 1.0 1.0 .9836.9836
 76. 00 18
 77. 00 .9845.9845 1.0 1.0 .9845.9845
 78. 00 19
 79. 00 .9836.9836 1.0 1.0 .9836.9836
 80. 00 20
 81. 00 .973 .973 1.0 1.0 .973 .973
 82. 00 21
 83. 00 .9836.9836 1.0 1.0 .9836.9836
 84. 00 22
 85. 00 .9836.9836 1.0 1.0 .9836.9836
 86. 00 23
 87. 00 .973 .973 1.0 1.0 .973 .973
 88. 00 24
 89. 00 .964 .964 1.0 1.0 .964 .964
 90. 00 25
 91. 00 .964 .964 1.0 1.0 .964 .964
 92. 00 26
 93. 00 .964 .964 1.0 1.0 .964 .964
 94. 00 27
 95. 00 .964 .964 1.0 1.0 .964 .964
 96. 00 7 2 0 12 2 0 0. 0
 97. 00 .1372 1.2421 1.3469 2.4170 2.4869 2.5568 2
 98. 00 .6268 2.6967 2.7666 1.8365 1.9065 1.9939 1
 99. 00 2.0 5.14 828. 0.5
 100. 00 2.0 8.82 761. 0.5
 101. 00 15.0 3.35 5.55
 102. 00 1 .182 0 0.0
 103. 00 2 .182 0 0.0
 104. 00 3 .182 0 0.0
 105. 00 4 .182 0 0.0
 106. 00 5 .182 0 0.0
 107. 00 6 .182 0 0.0
 108. 00 7 .182 0 0.0
 109. 00 8 .182 0 0.0
 110. 00 9 .182 0 0.0
 111. 00 10 .182 0 0.0
 112. 00 11 .182 0 0.0

113.	00	12 .182	0 0.0					
114.	00	13 .248	0 0.0					
115.	00	14 .323	0 0.0					
116.	00	15 .469	0 0.0					
117.	00	16 .180	0 0.0					
118.	00	17 .364	0 0.0					
119.	00	18 .425	0 0.0					
120.	00	19 .364	0 0.0					
121.	00	20 .180	0 0.0					
122.	00	21 .469	0 0.0					
123.	00	22 .323	0 0.0					
124.	00	23 .248	0 0.0					
125.	00	24 .434	0 0.0					
126.	00	25 .434	0 0.0					
127.	00	26 .434	0 0.0					
128.	00	27 .434	0 0.0					
129.	00	1 .176	0 0.0					
130.	00	2 .176	0 0.0					
131.	00	3 .176	0 0.0					
132.	00	4 .176	0 0.0					
133.	00	5 .176	0 0.0					
134.	00	6 .176	0 0.0					
135.	00	7 .176	0 0.0					
136.	00	8 .176	0 0.0					
137.	00	9 .176	0 0.0					
138.	00	10 .176	0 0.0					
139.	00	11 .176	0 0.0					
140.	00	12 .176	0 0.0					
141.	00	13 .242	0 0.0					
142.	00	14 .318	0 0.0					
143.	00	15 .463	0 0.0					
144.	00	16 .175	0 0.0					
145.	00	17 .359	0 0.0					
146.	00	18 .418	0 0.0					
147.	00	19 .359	0 0.0					
148.	00	20 .175	0 0.0					
149.	00	21 .463	0 0.0					
150.	00	22 .318	0 0.0					
151.	00	23 .242	0 0.0					
152.	00	24 .419	0 0.0					
153.	00	25 .419	0 0.0					
154.	00	26 .419	0 0.0					
155.	00	27 .419	0 0.0					
156.	00	8 8 8 0	0			0	7	
157.	00	17.836 1.0	1.0833	2.0833				
158.	00							
159.	00	27.836 1.0	1.1667	2.1667	3.1667	4.1667	5.1667	6.1667
160.	00							
161.	00	37.836 1.0	5.1667	6.0833	7.0833	8.1667		
162.	00							
163.	00	49.436 0.0	24.0833	25.1667	26.1667	27.0833		
164.	00							
165.	00	57.836 1.0	4.1667	5.1667	8.1667	9.1667	10.1667	11.1667
166.	00							
167.	00	67.836 1.0	7.1667	8.1667	9.1667	20.0833	21.1667	22.1667
168.	00		23.0833					
169.	00	77.836 1.0	9.1667	10.1667	16.0833	17.1667	18.1667	19.1667

170.	CO			20.0833									
171.	CO	87.836	1.0	10.1667	11.1667	12.1667	13.0833	14.1667	15.1667				
172.	CO			16.0833									
173.	CO	9	0	0		1							
174.	CO	2860.	0.0	0.05	.001	.01	0.6	0.5	1.0	0.	0.0	0.8	0.6
175.	CO	24	0	20	0	5	930.	2150.					
176.	CO	0.0		186.58	430.02	554.78	714.62	805.85					
177.	CO	991.21		1071.99	1191.21	1271.98	1391.21	1471.99					
178.	CO	1591.21		1671.98	1791.21	1871.98	1991.21	2071.98					
179.	CO	2179.07		2267.93	2402.77	2544.23	2636.34	2742.28					
180.	CO	10	4	0									
181.	CO	.04	0.										
182.	CO	11	1	0	0	0	0	0	0				
183.	CO	9000.		325.	.27553		1146.866						
184.	CO	12	13	0	0								
185.	CO	13											
186.	CO	0.		8.5954	7.5159	0.	0.						
187.	CO	6.300		0.	0.	6.081	6.721						
188.	CO	3.918		3.918	3.918	3.918	4.718						
189.	CO	0.13											
190.	CO	1.2											
191.	CO	4.37		2.00	50.	5.23	0.218	6.209	2.007	0.238			
192.	CO	6.27		0.25	2.05	0.44	0.350	30.0	13.64				
193.	CO	0											
194.	CO	0											

END ELT. ERRORS: NONE. TIME: 1.164 SEC. IMAGE COUNT: 194

3XQT COBRA*CFIL-PLOT.ABS

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APPENDIX C
SAMPLE OUTPUT FOR COBRA/CFTL CODE

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THIS IS THE OAK RIDGE NATIONAL LABORATORY VERSION OF THE

COBRA-IV THERMAL/HYDRAULIC ANALYSIS COMPUTER CODE

ADAPTED FROM THE BNWL PROGRAM COBRA-IV-I WITH UPDATES THROUGH FX 15 DATED 062480.

COBRA DIMENSION PARAMETERS

MA =	28	SUBCHANNELS WITH AREA VARIATIONS	GRP 5
MC =	28	SUBCHANNELS	GRP 4
ME =	30	(=MX)	GRP 9
MG =	41	SUBCHANNEL GAP CONNECTIONS	GRP 4
MI =	7	CONNECTIONS TO A CHANNEL(THERMAL+FLOW)	GRP 0
MK =	6	GRID SPACER TYPES	GRP 7
ML =	6	AXIAL LOCATIONS FOR GAP AREA VARIATIONS	GRP 5
MO =	7	WIDTH OF AAA ARRAY(TRIANGLE=5,HANGAR=7)	GRP 0
MP =	20	CARDS IN COOLANT PROPERTY TABLE	GRP 1
MR =	8	RODS	GRP 8
MS =	39	GAPS WITH GAP SPACING VARIATIONS	GRP 6
MT =	9	CORRELATIONS	GRP 2
MW =	12	THERMAL CONNECTIONS	GRP 4
MX =	30	AXIAL NODES PLUS ONE	GRP 9
MY =	5	RADIAL ROD DIVISIONS	GRP 8
MZ =	12	AXIAL LOCATIONS FOR GRID SPACERS	GRP 7
NU =	55	SURFACES	GRP 3

INPUT FOR CASE

1

CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81

TIME 11:21:28

SUMMARY OF INPUT OPTIONS

GROUP	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10
1	20	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	4	5	0	0
3	15	0	0	0	0	0	0	0	0	0
4	27	27	0	0	0	0	0	0	0	0
5	27	6	0	0	0	0	0	0	0	0
7	2	0	12	2	0	0	0	0	0	0
8	8	8	0	0	0	0	0	0	0	7
9	0	0	0	0	0	0	1	0	0	0
10	4	0	0	0	0	0	0	0	0	0
11	1	0	0	0	0	0	0	0	0	0
12	13	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0

HELIUM PROPERTIES AT 9000.00 KPA

T	H	CP	V	VISC	K	PR
DEG C	KJ/KG	KJ/KG-K	CU M/KG	KG/M-S	KW/M-K	
324.0	3135.7	5.188	.1405	.0000319	.000245	.676
332.4	3179.0	5.188	.1424	.0000322	.000247	.676
340.7	3222.3	5.188	.1443	.0000325	.000250	.676
349.1	3265.7	5.188	.1462	.0000328	.000252	.676
374.1	3395.7	5.188	.1520	.0000337	.000259	.675
399.2	3525.6	5.188	.1578	.0000346	.000266	.675
424.2	3655.6	5.187	.1635	.0000355	.000273	.674
449.3	3785.6	5.187	.1693	.0000364	.000280	.674
474.4	3915.6	5.187	.1750	.0000372	.000287	.674
499.4	4045.6	5.187	.1808	.0000381	.000293	.674
524.5	4175.6	5.187	.1866	.0000389	.000300	.673
549.5	4305.6	5.187	.1923	.0000398	.000307	.673
574.6	4435.6	5.187	.1981	.0000406	.000313	.673
599.6	4565.6	5.187	.2039	.0000414	.000320	.672
624.7	4695.6	5.187	.2096	.0000422	.000326	.672
649.8	4825.6	5.187	.2154	.0000431	.000332	.672
674.8	4955.5	5.188	.2212	.0000439	.000339	.672
699.9	5085.5	5.188	.2269	.0000446	.000345	.671
724.9	5215.5	5.188	.2327	.0000454	.000351	.671
750.0	5345.5	5.188	.2385	.0000462	.000357	.671

FRICTION FACTOR CORRELATION

SMOOTH SECTION

CHANNEL TYPE 1	FRICT=	.52000+00*RE**(-.3200+00) +	.58240-02
CHANNEL TYPE 2	FRICT=	.52000+00*RE**(-.3200+00) +	.58240-02
CHANNEL TYPE 3	FRICT=	.52000+00*RE**(-.3200+00) +	.58240-02
CHANNEL TYPE 4	FRICT=	.52000+00*RE**(-.3200+00) +	.58240-02
CHANNEL TYPE 5	FRICT=	.52000+00*RE**(-.3200+00) +	.58240-02

ROUGH SECTION

CHANNEL TYPE 1	FRICT=	R-FUNCTION CORRELATION
CHANNEL TYPE 2	FRICT=	R-FUNCTION CORRELATION
CHANNEL TYPE 3	FRICT=	R-FUNCTION CORRELATION
CHANNEL TYPE 4	FRICT=	R-FUNCTION CORRELATION
CHANNEL TYPE 5	FRICT=	R-FUNCTION CORRELATION

STANTON NUMBER CORRELATION

SMOOTH SECTION

CHANNEL TYPE 1-5 STN = PETUKHOV-ROIZEN METHOD

ROUGH SECTION

CHANNEL TYPE 1-5 STN = G-FUNCTION CORRELATION

HEAT FLUX DISTRIBUTION

X/L RELATIVE FLUX

.0000 .0330
 .3283 .0330

BEGINNING OF HEATING = 938.94 MM

.3287	.4980
.3670	.6560
.4100	.8000
.4520	.9080
.4940	.9760
.5380	1.0000
.5790	.9800
.6210	.9150
.6640	.8100
.7060	.6690
.7480	.4980
.7481	.0000
1.0000	.0000

SUBCHANNEL INPUT DATA

CHANNEL NO.	TYPE	AREA (SQ-MM)	WETTED PERIM. (MM)	HYDRAULIC DIAMETER (MM)	(ADJACENT CHANNEL NO., SPACING, CENTROID DISTANCE)
1	1	19.10	6.15	12.423	(2,4.170,4.320)(6,2.080,6.860)(0, .000, .000)(0, .000, .000)
2	1	19.10	6.15	12.423	(3,2.080,6.860)(0, .000, .000)(0, .000, .000)(0, .000, .000)
3	4	11.48	4.10	11.200	(4,1.680,5.590)(24,3.450,2.540)(0, .000, .000)(0, .000, .000)
4	4	22.90	8.20	11.171	(5,4.170,6.850)(11,1.680,6.860)(25,6.930,2.290)(0, .000, .000)
5	1	38.26	12.31	12.432	(6,4.170,6.100)(8,4.170,6.860)(0, .000, .000)(0, .000, .000)
6	1	19.10	6.15	12.423	(0, .000, .000)(0, .000, .000)(0, .000, .000)(0, .000, .000)
7	1	19.10	6.15	12.423	(8,4.170,6.100)(23,2.080,4.570)(0, .000, .000)(0, .000, .000)
8	1	38.26	12.31	12.432	(9,4.170,6.860)(0, .000, .000)(0, .000, .000)(0, .000, .000)
9	1	38.26	12.31	12.432	(10,4.170,6.860)(20,4.170,5.080)(0, .000, .000)(0, .000, .000)
10	1	38.26	12.31	12.432	(11,4.170,6.850)(16,4.170,5.080)(0, .000, .000)(0, .000, .000)
11	4	22.90	8.20	11.171	(12,1.680,6.100)(26,6.930,2.290)(0, .000, .000)(0, .000, .000)
12	4	11.48	4.10	11.200	(13,2.080,4.570)(27,3.730,2.540)(0, .000, .000)(0, .000, .000)
13	1	6.39	2.05	12.468	(14,3.020,3.810)(0, .000, .000)(0, .000, .000)(0, .000, .000)
14	2	24.77	10.10	9.810	(15,3.280,6.100)(0, .000, .000)(0, .000, .000)(0, .000, .000)
15	2	24.77	10.10	9.810	(16,3.020,4.060)(17,3.730,7.110)(0, .000, .000)(0, .000, .000)
16	1	12.45	4.10	12.146	(17,3.020,4.060)(0, .000, .000)(0, .000, .000)(0, .000, .000)
17	2	24.77	10.10	9.810	(18,3.280,6.100)(0, .000, .000)(0, .000, .000)(0, .000, .000)
18	3	21.87	12.40	7.055	(19,3.280,6.100)(0, .000, .000)(0, .000, .000)(0, .000, .000)
19	2	24.77	10.10	9.810	(20,3.020,4.060)(21,3.730,7.110)(0, .000, .000)(0, .000, .000)
20	1	12.45	4.10	12.146	(21,3.020,4.060)(0, .000, .000)(0, .000, .000)(0, .000, .000)
21	2	24.77	10.10	9.810	(22,3.280,6.100)(0, .000, .000)(0, .000, .000)(0, .000, .000)
22	2	24.77	10.10	9.810	(23,3.020,3.810)(0, .000, .000)(0, .000, .000)(0, .000, .000)
23	1	6.39	2.05	12.468	(0, .000, .000)(0, .000, .000)(0, .000, .000)(0, .000, .000)
24	5	6.06	2.47	9.814	(25,1.680,5.590)(0, .000, .000)(0, .000, .000)(0, .000, .000)
25	5	12.13	4.94	9.822	(26,1.680,5.590)(0, .000, .000)(0, .000, .000)(0, .000, .000)
26	5	12.13	4.94	9.822	(27,1.680,5.590)(0, .000, .000)(0, .000, .000)(0, .000, .000)
27	5	6.06	2.47	9.814	(0, .000, .000)(0, .000, .000)(0, .000, .000)(0, .000, .000)

X/L AREA VARIATION FACTORS FOR SUBCHANNEL (1)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
.0000	.9730	.9730	.9670	.9670	.9730	.9730	.9730	.9730	.9730	.9730
.3248	.9730	.9730	.9670	.9670	.9730	.9730	.9730	.9730	.9730	.9730
.3252	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.7518	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.7521	.9730	.9730	.9670	.9670	.9730	.9730	.9730	.9730	.9730	.9730
1.0000	.9730	.9730	.9670	.9670	.9730	.9730	.9730	.9730	.9730	.9730

X/L AREA VARIATION FACTORS FOR SUBCHANNEL (1)

	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
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.0000	.9670	.9670	.9730	.9836	.9836	.9730	.9836	.9845	.9836	.9730
.3248	.9670	.9670	.9730	.9836	.9836	.9730	.9836	.9845	.9836	.9730
.3252	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.7518	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.7521	.9670	.9670	.9730	.9836	.9836	.9730	.9836	.9845	.9836	.9730
1.0000	.9670	.9670	.9730	.9836	.9836	.9730	.9836	.9845	.9836	.9730

X/L	AREA VARIATION FACTORS FOR SUBCHANNEL (I)							
	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
.0000	.9836	.9836	.9730	.9640	.9640	.9640	.9640	.9640
.3248	.9836	.9836	.9730	.9640	.9640	.9640	.9640	.9640
.3252	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.7518	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
.7521	.9836	.9836	.9730	.9640	.9640	.9640	.9640	.9640
1.0000	.9836	.9836	.9730	.9640	.9640	.9640	.9640	.9640

SPACER DATA

SPACER TYPE NO.	1	1	2	2	2	2	2	2	1	1	1	1
LOCATION (X/L)	.137	.242	.347	.417	.487	.557	.627	.697	.767	.836	.906	.994

SPACER LOSS COEFFICIENT

SPACER TYPE 1 COEF = $CD^{**} .20000 + 01 * (.51400 + 01 + .82800 + 03 / RE^{**} .50000 + 00)$

SPACER TYPE 2 COEF = $CD^{**} .20000 + 01 * (.38200 + 01 + .76100 + 03 / RE^{**} .50000 + 00)$

SPACER WIDTH = 15.00 MM

HEAT TRANSFER COEFFICIENT ENHANCEMENT DUE TO SPACERS

ROUGH BUNDLE - $YST = 1 + 3.350 * CD^{**2} * F(X)$ SMOOTH BUNDLE - $YST = 1 + 5.550 * CD^{**2} * F(X)$

SPACER TYPE 1

CHANNEL		CHANNEL		CHANNEL		CHANNEL	
NO.	SOLIDITY	NO.	SOLIDITY	NO.	SOLIDITY	NO.	SOLIDITY
1	.1820	2	.1820	3	.1820	4	.1820
5	.1820	6	.1820	7	.1820	8	.1820
9	.1820	10	.1820	11	.1820	12	.1820
13	.2480	14	.3230	15	.4690	16	.1800
17	.3640	18	.4250	19	.3640	20	.1800
21	.4690	22	.3230	23	.2480	24	.4340
25	.4340	26	.4340	27	.4340		

SPACER TYPE 2

CHANNEL		CHANNEL		CHANNEL		CHANNEL	
NO.	SOLIDITY	NO.	SOLIDITY	NO.	SOLIDITY	NO.	SOLIDITY
1	.1760	2	.1760	3	.1760	4	.1760
5	.1760	6	.1760	7	.1760	8	.1760
9	.1760	10	.1760	11	.1760	12	.1760
13	.2420	14	.3180	15	.4630	16	.1750
17	.3590	18	.4180	19	.3590	20	.1750
21	.4630	22	.3180	23	.2420	24	.4190
25	.4190	26	.4190	27	.4190		

ROD INPUT DATA

ROD NO.	DIA (MM)	RADIAL POWER FACTOR	FRACTION OF POWER TO ADJACENT CHANNELS (ADJ. CHANNEL NO.)									
1	7.836	1.0000	.0833(1)	.0833(2)	.0000(0)	.0000(0)	.0000(0)	.0000(0)	.0000(0)	.0000(0)	.0000(0)	
2	7.836	1.0000	.1667(1)	.1667(2)	.1667(3)	.1667(4)	.1667(5)	.1667(6)	.0000(0)	.0000(0)	.0000(0)	
3	7.836	1.0000	.1667(5)	.0833(6)	.0833(7)	.1667(8)	.0000(0)	.0000(0)	.0000(0)	.0000(0)	.0000(0)	

4	9.436	.0000	.0833(24)	.1667(25)	.1667(26)	.0833(27)	.0000(0)	.0000(0)	.0000(0)
5	7.836	1.0000	.1667(4)	.1667(5)	.1667(8)	.1667(9)	.1667(10)	.1667(11)	.0000(0)
6	7.836	1.0000	.1667(7)	.1667(8)	.1667(9)	.0833(20)	.1667(21)	.1667(22)	.0833(23)
7	7.836	1.0000	.1667(9)	.1667(10)	.0833(16)	.1667(17)	.1667(18)	.1667(19)	.0833(20)
8	7.836	1.0000	.1667(10)	.1667(11)	.1667(12)	.0833(13)	.1667(14)	.1667(15)	.0833(16)

IMPLICIT SOLUTION WITH INLET FLOWS SPECIFIED

CALCULATION PARAMETERS

LATERAL RESISTANCE FACTOR .6000
 (S/L) PARAMETER .5000
 TURBULENT MOMENTUM FACTOR 1.0000

CHANNEL LENGTH 2860.00 MM
 NUMBER OF AXIAL NODES 24
 ROUGHENING BEGINS 930.0 MM
 ROUGHENING ENDS 2150.0 MM
 TOTAL TRANSIENT TIME .0000 SECONDS
 NUMBER OF TIME STEPS 0
 NOMINAL TIME STEP .1000+11 SECONDS

CHANNEL ORIENTATION .0000 DEGREES

DATA FOR IMPLICIT SOLUTION

EXTERNAL ITERATION LIMIT 20
 INTERNAL ITERATION LIMIT 72
 CONVERGENCE FACTORS
 EXTERNAL (DW/W) .0500
 INTERNAL (DW/W) .0010
 FLOW (DF/F) .0100

MINIMUM INTERNAL ITERATIONS 5
 FRACTION DONOR CELL USTAR .0000
 ACCELERATION FACTORS
 CROSSFLOW SOLUTION .8000
 LATERAL DELTA-P .8000
 FLOW .6000

AXIAL NODE LOCATIONS (MM)

.0	186.6	430.0	554.8	714.6	805.8	991.2	1072.0	1191.2	1272.0
1391.2	1472.0	1591.2	1672.0	1791.2	1872.0	1991.2	2072.0	2179.1	2267.9
2402.8	2544.2	2636.3	2742.3	2860.0					

MIXING CORRELATIONS

$$WP = .0400 \cdot DAVG \cdot GAVG \cdot SQRT(F/8)$$

OPERATING CONDITIONS

SYSTEM PRESSURE = 9000.00 KPA
 INLET ENTHALPY = 3140.8 KJ/KG
 INLET MASS FLUX = .27553 G/S-MM2
 INLET TEMPERATURE = 325.0 DEGREES C
 MAX. HEAT FLUX = 1146.87 KW/M2

UNIFORM INLET TEMPERATURE

UNIFORM INLET MASS VELOCITY

SUBCHANNEL TYPES

	1	2	3	4	5
TUBE RADIUS (MM)	.000	8.595	7.516	.000	.000
RADIUS OF ZERO SHEAR (MM)	6.300	.000	.000	6.081	6.721
POD RADIUS (MM)	3.918	3.918	3.918	3.918	4.718
ROUGHNESS RIB HEIGHT=	.130 MM				
PIOT COEFFICIENT	1.20				

FULLY ROUGH FLOW ($H+ > 50$): $R(H+) = 4.37$

SLOPE $A = 2.00$

TRANSITION REGION: $R(H+) = 5.23 - .2180 \ln(H+)$

$A = 6.209 - 2.0070 \ln(H+) + .2380 \ln(H+))^{**2}$

HYDRAULICALLY SMOOTH: $R(H+) = 5.5 + 2.5 \ln(HB+)$

$A = 2.50$

$G(HW+) = 6.27 * (HW+)^{**} .25 * PR^{**} .44 * (TW/TB)^{**} .35$

FOR $H+ < 30.0$ $G(HW+) = 13.64$

ELAPSED TIME UPON ENTERING SUBROUTINE SCHEME IS 2 SECONDS.

DATA FROM ITERATIVE SOLUTION

ITERATION NO.	TOTAL INTERNAL ITERATIONS	LAST NODE OUT OF CONVERGENCE W F	MAXIMUM ERROR INTERNAL EXTERNAL	FLOW	ENTHALPY	TIME
1	1412	25 25	333.7152 .9962	.1535	.0609	21
2	1139	25 25	24.1977 .7945	.0740	.0529	39
3	1440	25 25	7.5051 .5706	.0425	.0036	58
4	1684	25 25	6.6605 .1422	.0230	.0015	77
5	1679	24 25	5.1748 .1212	.0130	.0013	96
6	1675	23 0	3.4874 .1030	.0082	.0009	115
7	1618	23 0	4.3545 .0935	.0057	.0009	134
8	1594	23 0	2.2465 .0830	.0039	.0008	153
9	1594	23 0	2.9870 .0718	.0026	.0008	171
10	1594	23 0	4.1880 .0614	.0018	.0010	190
11	1594	23 0	4.5777 .0565	.0016	.0012	209
12	1594	18 0	2.5438 .0520	.0017	.0010	228
13	1529	0 0	.1717 .0477	.0016	.0009	246

CHANNEL EXIT SUMMARY RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY POUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

MASS BALANCE - -

MASS FLOW IN .14581 KG/SEC
 MASS FLOW OUT .14581 KG/SEC
 MASS FLOW ERROR -.74506-08 KG/SEC

ENERGY BALANCE - -

FLOW ENERGY IN 457.95291 KW
 ENERGY ADDED 163.13234 KW
 FLOW ENERGY OUT 621.08381 KW
 ENERGY ERROR -.14305-02 KW OR -.001 PCT.

CHANNEL (NO.)	ENTHALPY (KJ/KG)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	MASS FLUX (G/S-MM2)
1	4389.87	565.9	5.027	.00620	.3247
2	4364.52	561.0	5.056	.00614	.3215
3	4307.96	550.1	5.122	.00347	.3022
4	4262.30	541.3	5.177	.00689	.3009
5	4334.07	555.1	5.091	.01240	.3242
6	4378.77	563.7	5.040	.00621	.3254
7	4307.68	550.0	5.122	.00627	.3283
8	4290.01	546.6	5.143	.01251	.3270
9	4236.66	536.3	5.208	.01218	.3184
10	4196.27	528.5	5.257	.01198	.3131
11	4214.33	532.0	5.235	.00652	.2847
12	4193.68	528.0	5.261	.00294	.2561
13	4138.86	517.5	5.330	.00163	.2549
14	4118.35	513.5	5.356	.00554	.2238
15	4141.18	517.9	5.327	.00453	.1827
16	4158.25	521.2	5.305	.00320	.2574
17	4157.76	521.1	5.306	.00470	.1896
18	4191.35	527.6	5.264	.00378	.1728
19	4223.66	533.8	5.224	.00523	.2111
20	4238.65	536.7	5.205	.00335	.2687
21	4261.44	541.1	5.178	.00453	.1829
22	4292.08	547.0	5.141	.00628	.2537
23	4308.17	550.1	5.122	.00203	.3178
24	4302.98	549.1	5.128	.00132	.2184
25	4279.04	544.5	5.156	.00250	.2064
26	4256.91	540.2	5.183	.00235	.1937
27	4238.15	536.6	5.206	.00110	.1822

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

BUNDLE AVERAGED RESULTS

DISTANCE (MM)	DELTA-P (KPA)	ENTHALPY (KJ/KG)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	VELOCITY (M/S)	AREA (SQ-MM)
.0	.000	3140.84	325.1	7.107	.1458	91899.	38.769	529.2
186.6	-1.877	3147.60	326.4	7.091	.1458	91761.	38.855	529.2
430.0	-7.439	3156.42	328.1	7.070	.1458	91583.	38.974	529.2
554.8	-8.633	3160.93	329.0	7.057	.1458	91492.	39.044	529.2
714.6	-13.233	3166.72	330.1	7.043	.1458	91376.	39.122	529.2
805.8	-14.050	3170.03	330.7	7.033	.1458	91310.	39.176	529.2
991.2	-17.452	3204.84	337.4	6.956	.1458	90619.	38.622	542.7
1072.0	-25.242	3260.68	348.2	6.837	.1458	89539.	39.290	542.7
1191.2	-30.427	3359.07	367.1	6.631	.1458	87708.	40.514	542.7
1272.0	-38.711	3434.67	381.7	6.489	.1458	86364.	41.399	542.7
1391.2	-44.254	3556.36	405.2	6.257	.1458	84301.	42.936	542.7
1472.0	-53.080	3643.19	421.9	6.115	.1458	82898.	43.930	542.7
1591.2	-58.978	3773.84	447.1	5.890	.1458	80896.	45.612	542.7
1672.0	-68.362	3861.07	463.9	5.766	.1458	79625.	46.591	542.7
1791.2	-74.580	3983.94	487.6	5.572	.1458	77914.	48.212	542.7
1872.0	-84.470	4060.84	502.4	5.476	.1458	76887.	49.059	542.7
1991.2	-90.943	4161.82	521.9	5.326	.1458	75587.	50.439	542.7
2072.0	-101.235	4219.55	533.0	5.261	.1458	74871.	51.062	542.7
2179.1	-106.694	4259.67	540.8	5.197	.1458	74381.	53.016	529.2
2267.9	-112.300	4259.66	540.8	5.206	.1458	74381.	52.927	529.2
2402.8	-118.291	4259.67	540.8	5.206	.1458	74381.	52.927	529.2
2544.2	-120.040	4259.67	540.8	5.200	.1458	74381.	52.990	529.2
2636.3	-125.434	4259.67	540.8	5.199	.1458	74381.	52.996	529.2
2742.3	-126.705	4259.66	540.8	5.195	.1458	74381.	53.040	529.2
2860.0	-132.390	4259.67	540.8	5.193	.1458	74381.	53.063	529.2

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 1

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.005121	102448.	18.58	.01878	.00295	4.221	.0	.00	.0
186.6	-1.879	326.6	7.087	.005216	104165.	18.58	.01872	.00294	4.281	.0	.00	.0
430.0	-7.430	328.7	7.061	.005767	114914.	18.58	.01832	.00287	4.625	.0	.00	.0
554.8	-8.639	329.7	7.047	.005709	113624.	18.58	.01836	.00288	4.589	.0	.00	.0
714.6	-13.218	330.9	7.031	.006043	120103.	18.58	.01814	.00284	4.865	.0	.00	.0
805.8	-14.047	331.5	7.021	.005947	118105.	18.58	.01821	.00285	4.735	.0	.00	.0
991.2	-17.474	338.8	6.939	.005565	111492.	19.10	.04911	.00535	8.243	129.6	4.37	2.0
1072.0	-25.201	351.2	6.800	.005759	113812.	19.10	.10808	.00536	7.853	111.7	4.37	2.0
1191.2	-30.486	372.3	6.577	.005265	101694.	19.10	.10761	.00549	8.056	97.3	4.37	2.0
1272.0	-38.653	389.9	6.401	.005612	106415.	19.10	.10698	.00545	7.808	98.4	4.37	2.0
1391.2	-44.318	416.6	6.154	.005184	95666.	19.10	.10693	.00557	8.066	88.3	4.37	2.0
1472.0	-53.015	437.0	5.976	.005564	100641.	19.10	.10666	.00551	7.856	91.5	4.37	2.0
1591.2	-59.047	465.6	5.744	.005151	90684.	19.10	.10696	.00563	8.121	83.8	4.37	2.0
1672.0	-68.292	485.9	5.588	.005539	95702.	19.10	.10701	.00557	7.911	88.7	4.37	2.0
1791.2	-74.654	512.6	5.397	.005134	86621.	19.10	.10756	.00568	8.163	82.7	4.37	2.0
1872.0	-84.397	530.2	5.276	.005524	91798.	19.10	.10788	.00561	7.954	89.1	4.37	2.0
1991.2	-91.022	551.8	5.135	.005125	83637.	19.10	.10857	.00571	8.200	84.2	4.37	2.0
2072.0	-101.157	564.4	5.054	.005517	89102.	19.10	.10910	.00563	7.979	92.3	4.37	2.0
2179.1	-106.785	572.3	5.004	.005190	81868.	18.58	.08494	.00291	4.321	85.4	4.37	2.0
2267.9	-112.260	571.3	5.006	.005722	90347.	18.58	.01932	.00284	4.542	.0	.00	.0
2402.8	-118.268	570.0	5.011	.006020	95145.	18.58	.01910	.00281	4.930	.0	.00	.0
2544.2	-120.073	568.9	5.015	.005873	92913.	18.58	.01920	.00283	4.634	.0	.00	.0
2636.3	-125.401	567.9	5.019	.006136	97153.	18.58	.01901	.00280	4.793	.0	.00	.0
2742.3	-126.726	567.0	5.022	.006002	95096.	18.58	.01910	.00281	4.712	.0	.00	.0
2860.0	-132.389	565.9	5.027	.006201	98347.	18.58	.01896	.00279	4.952	.0	.00	.0

C-12

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 2

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.005121	102448.	18.58	.01878	.00295	4.221	.0	.00	.0
186.6	-1.879	326.6	7.087	.005205	103956.	18.58	.01872	.00294	4.274	.0	.00	.0
430.0	-7.432	328.6	7.062	.005712	113823.	18.58	.01836	.00288	4.591	.0	.00	.0
554.8	-8.638	329.6	7.048	.005642	112297.	18.58	.01841	.00289	4.547	.0	.00	.0
714.6	-13.220	330.7	7.033	.005957	118422.	18.58	.01820	.00285	4.812	.0	.00	.0
805.8	-14.047	331.4	7.023	.005855	116292.	18.58	.01827	.00286	4.678	.0	.00	.0
991.2	-17.472	338.7	6.940	.005475	109702.	19.10	.04915	.00537	8.144	127.4	4.37	2.0
1072.0	-25.205	351.0	6.801	.005684	112345.	19.10	.10804	.00538	7.778	110.0	4.37	2.0
1191.2	-30.482	372.1	6.579	.005199	100436.	19.10	.10757	.00550	7.981	95.9	4.37	2.0
1272.0	-38.658	389.3	6.407	.005548	105263.	19.10	.10693	.00546	7.742	97.1	4.37	2.0
1391.2	-44.314	415.8	6.161	.005125	94651.	19.10	.10688	.00558	7.997	87.1	4.37	2.0
1472.0	-53.020	435.5	5.988	.005506	99732.	19.10	.10661	.00552	7.793	90.4	4.37	2.0
1591.2	-59.043	464.0	5.756	.005097	89870.	19.10	.10690	.00564	8.056	82.8	4.37	2.0
1672.0	-68.298	483.5	5.606	.005485	94987.	19.10	.10696	.00558	7.851	87.8	4.37	2.0
1791.2	-74.650	510.2	5.413	.005083	85955.	19.10	.10751	.00569	8.099	81.8	4.37	2.0
1872.0	-84.403	526.9	5.297	.005474	91222.	19.10	.10783	.00562	7.896	88.3	4.37	2.0
1991.2	-91.017	548.6	5.155	.005077	83071.	19.10	.10853	.00572	8.138	83.5	4.37	2.0
2072.0	-101.164	560.5	5.078	.005470	88619.	19.10	.10906	.00564	7.922	91.6	4.37	2.0
2179.1	-106.779	568.6	5.026	.005143	81386.	18.58	.08493	.00291	4.292	84.7	4.37	2.0
2267.9	-112.265	566.5	5.034	.005669	89849.	18.58	.01934	.00285	4.510	.0	.00	.0
2402.8	-118.272	565.0	5.040	.005965	94666.	18.58	.01912	.00282	4.896	.0	.00	.0
2544.2	-120.070	564.2	5.043	.005814	92325.	18.58	.01922	.00283	4.599	.0	.00	.0
2636.3	-125.407	562.8	5.049	.006080	96658.	18.58	.01903	.00280	4.760	.0	.00	.0
2742.3	-126.725	562.3	5.050	.005940	94483.	18.58	.01913	.00282	4.676	.0	.00	.0
2860.0	-132.390	561.0	5.056	.006141	97783.	18.58	.01898	.00280	4.916	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA

DATA FOR CHANNEL 3

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H*	R(H*)	AR
.0	.000	325.1	7.107	.003059	91794.	11.10	.01925	.00300	4.290	.0	.00	.0
186.6	-1.878	326.5	7.088	.003065	91818.	11.10	.01925	.00300	4.296	.0	.00	.0
430.0	-7.434	328.3	7.065	.003233	96677.	11.10	.01903	.00296	4.476	.0	.00	.0
554.8	-8.637	329.2	7.052	.003182	95033.	11.10	.01910	.00297	4.421	.0	.00	.0
714.6	-13.225	330.3	7.038	.003311	98780.	11.10	.01894	.00295	4.600	.0	.00	.0
805.8	-14.047	331.0	7.028	.003253	96961.	11.10	.01902	.00296	4.496	.0	.00	.0
991.2	-17.466	338.2	6.945	.003067	92224.	11.48	.05159	.00559	7.923	123.8	4.37	2.0
1072.0	-25.215	349.9	6.813	.003168	94045.	11.48	.11369	.00560	7.533	105.8	4.37	2.0
1191.2	-30.471	370.8	6.593	.002907	84354.	11.48	.11319	.00574	7.752	92.5	4.37	2.0
1272.0	-38.670	386.3	6.435	.003098	88447.	11.48	.11248	.00569	7.501	93.5	4.37	2.0
1391.2	-44.302	412.7	6.188	.002875	79887.	11.48	.11245	.00581	7.784	84.4	4.37	2.0
1472.0	-53.034	430.6	6.029	.003084	84194.	11.48	.11212	.00575	7.562	87.4	4.37	2.0
1591.2	-59.030	459.2	5.793	.002867	76160.	11.48	.11247	.00587	7.856	80.5	4.37	2.0
1672.0	-68.313	476.8	5.655	.003079	80454.	11.48	.11249	.00580	7.625	85.2	4.37	2.0
1791.2	-74.636	503.8	5.457	.002864	73043.	11.48	.11313	.00591	7.906	79.9	4.37	2.0
1872.0	-84.419	518.8	5.350	.003077	77447.	11.48	.11343	.00584	7.673	86.0	4.37	2.0
1991.2	-91.003	541.0	5.203	.002863	70730.	11.48	.11422	.00594	7.949	81.8	4.37	2.0
2072.0	-101.180	551.4	5.133	.003078	75375.	11.48	.11477	.00586	7.702	89.6	4.37	2.0
2179.1	-106.762	560.0	5.076	.002888	69036.	11.10	.08929	.00301	4.144	82.6	4.37	2.0
2267.9	-112.276	556.5	5.094	.003183	76310.	11.10	.02007	.00294	4.372	.0	.00	.0
2402.8	-118.278	553.6	5.109	.003378	81165.	11.10	.01979	.00290	4.755	.0	.00	.0
2544.2	-120.063	553.2	5.109	.003302	79383.	11.10	.01989	.00292	4.498	.0	.00	.0
2636.3	-125.418	551.8	5.116	.003433	82616.	11.10	.01971	.00289	4.635	.0	.00	.0
2742.3	-126.721	551.6	5.115	.003364	80962.	11.10	.01980	.00290	4.563	.0	.00	.0
2860.0	-132.392	550.1	5.122	.003469	83605.	11.10	.01966	.00288	4.761	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 4

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.006101	91555.	22.14	.01926	.00300	4.290	.0	.00	.0
186.6	-1.878	326.6	7.088	.006111	91532.	22.14	.01926	.00300	4.294	.0	.00	.0
430.0	-7.435	328.4	7.064	.006504	97229.	22.14	.01900	.00296	4.505	.0	.00	.0
554.8	-8.636	329.3	7.051	.006384	95325.	22.14	.01909	.00297	4.440	.0	.00	.0
714.6	-13.226	330.4	7.037	.006676	99578.	22.14	.01890	.00294	4.637	.0	.00	.0
805.8	-14.048	331.1	7.027	.006536	97404.	22.14	.01900	.00295	4.521	.0	.00	.0
991.2	-17.464	338.5	6.942	.006116	91935.	22.90	.05160	.00560	7.927	123.4	4.37	2.0
1072.0	-25.219	350.6	6.806	.006362	94356.	22.90	.11372	.00560	7.575	106.3	4.37	2.0
1191.2	-30.464	371.7	6.583	.005791	83934.	22.90	.11319	.00574	7.750	92.1	4.37	2.0
1272.0	-38.676	387.6	6.423	.006229	88796.	22.90	.11253	.00568	7.550	94.1	4.37	2.0
1391.2	-44.294	413.8	6.178	.005728	79496.	22.90	.11246	.00581	7.784	84.0	4.37	2.0
1472.0	-53.041	431.5	6.021	.006202	84585.	22.90	.11217	.00575	7.612	88.0	4.37	2.0
1591.2	-59.021	459.6	5.790	.005713	75859.	22.90	.11247	.00587	7.855	80.2	4.37	2.0
1672.0	-68.320	476.5	5.657	.006195	80970.	22.90	.11253	.00580	7.676	85.9	4.37	2.0
1791.2	-74.627	502.6	5.465	.005710	72902.	22.90	.11312	.00591	7.906	79.7	4.37	2.0
1872.0	-84.427	516.5	5.366	.006195	78128.	22.90	.11345	.00583	7.726	86.8	4.37	2.0
1991.2	-90.993	537.6	5.224	.005714	70775.	22.90	.11421	.00594	7.950	81.7	4.37	2.0
2072.0	-101.189	545.8	5.161	.006201	76211.	22.90	.11478	.00585	7.755	90.6	4.37	2.0
2179.1	-106.751	554.3	5.111	.005767	69253.	22.14	.08927	.00301	4.148	82.8	4.37	2.0
2267.9	-112.279	549.2	5.139	.006425	77481.	22.14	.02000	.00293	4.413	.0	.00	.0
2402.8	-118.281	545.1	5.161	.006786	82120.	22.14	.01974	.00290	4.782	.0	.00	.0
2544.2	-120.059	543.8	5.167	.006574	79632.	22.14	.01987	.00292	4.493	.0	.00	.0
2636.3	-125.421	542.7	5.171	.006864	83224.	22.14	.01968	.00289	4.645	.0	.00	.0
2742.3	-126.718	542.3	5.172	.006663	80818.	22.14	.01981	.00291	4.540	.0	.00	.0
2860.0	-132.392	541.3	5.177	.006890	83648.	22.14	.01965	.00289	4.747	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 5

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.010257	102525.	37.23	.01878	.00295	4.221	.0	.00	.0
186.6	-1.879	326.6	7.087	.010438	104149.	37.23	.01872	.00294	4.278	.0	.00	.0
430.0	-7.433	328.7	7.061	.011511	114591.	37.23	.01833	.00288	4.613	.0	.00	.0
554.8	-8.638	329.6	7.048	.011384	113195.	37.23	.01838	.00288	4.573	.0	.00	.0
714.6	-13.222	330.8	7.032	.012040	119563.	37.23	.01816	.00285	4.845	.0	.00	.0
805.8	-14.048	331.5	7.022	.011841	117496.	37.23	.01823	.00286	4.713	.0	.00	.0
991.2	-17.469	338.7	6.939	.011069	110800.	38.26	.04912	.00536	8.199	128.8	4.37	2.0
1072.0	-25.211	351.2	6.800	.011479	113333.	38.26	.10807	.00537	7.823	111.1	4.37	2.0
1191.2	-30.471	372.3	6.577	.010480	101127.	38.26	.10759	.00550	8.017	96.7	4.37	2.0
1272.0	-38.668	389.8	6.403	.011199	106097.	38.26	.10697	.00545	7.784	98.1	4.37	2.0
1391.2	-44.302	416.3	6.156	.010324	95209.	38.26	.10691	.00557	8.030	87.7	4.37	2.0
1472.0	-53.032	436.2	5.982	.011109	100463.	38.26	.10664	.00552	7.834	91.3	4.37	2.0
1591.2	-59.030	464.6	5.751	.010265	90361.	38.26	.10693	.00563	8.087	83.3	4.37	2.0
1672.0	-68.309	484.1	5.601	.011067	95691.	38.26	.10699	.00557	7.893	88.6	4.37	2.0
1791.2	-74.636	510.5	5.411	.010236	86453.	38.26	.10753	.00568	8.131	82.4	4.37	2.0
1872.0	-84.415	526.9	5.297	.011047	91974.	38.26	.10785	.00561	7.938	89.1	4.37	2.0
1991.2	-91.002	548.1	5.158	.010227	83635.	38.26	.10854	.00571	8.170	84.1	4.37	2.0
2072.0	-101.176	559.3	5.085	.011044	89478.	38.26	.10907	.00563	7.965	92.5	4.37	2.0
2179.1	-106.762	566.9	5.035	.010363	82034.	37.23	.08492	.00291	4.311	85.4	4.37	2.0
2267.9	-112.270	564.1	5.048	.011460	90924.	37.23	.01929	.00284	4.542	.0	.00	.0
2402.8	-118.274	561.3	5.062	.012057	95885.	37.23	.01906	.00281	4.931	.0	.00	.0
2544.2	-120.064	559.9	5.069	.011743	93505.	37.23	.01917	.00283	4.629	.0	.00	.0
2636.3	-125.409	557.9	5.078	.012289	98001.	37.23	.01897	.00280	4.794	.0	.00	.0
2742.3	-126.721	557.0	5.082	.011998	95759.	37.23	.01907	.00282	4.707	.0	.00	.0
2860.0	-132.390	555.1	5.091	.012404	99151.	37.23	.01892	.00279	4.949	.0	.00	.0

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CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 6

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	PEYNOlds NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.005121	102448.	18.58	.01878	.00295	4.221	.0	.00	.0
186.6	-1.879	326.6	7.087	.005216	104178.	18.58	.01872	.00294	4.281	.0	.00	.0
430.0	-7.431	328.7	7.061	.005772	115003.	18.58	.01831	.00287	4.628	.0	.00	.0
554.8	-8.640	329.7	7.047	.005715	113751.	18.58	.01836	.00288	4.593	.0	.00	.0
714.6	-13.219	330.9	7.031	.006051	120260.	18.58	.01814	.00284	4.870	.0	.00	.0
805.8	-14.047	331.6	7.021	.005956	118291.	18.58	.01820	.00285	4.741	.0	.00	.0
991.2	-17.473	338.8	6.938	.005575	111704.	19.10	.04910	.00535	8.254	129.9	4.37	2.0
1072.0	-25.203	351.2	6.799	.005767	113970.	19.10	.10808	.00536	7.861	111.8	4.37	2.0
1191.2	-30.482	372.3	6.577	.005271	101806.	19.10	.10762	.00549	8.062	97.4	4.37	2.0
1272.0	-38.656	390.0	6.400	.005619	106527.	19.10	.10699	.00545	7.814	98.6	4.37	2.0
1391.2	-44.315	416.7	6.153	.005188	95736.	19.10	.10694	.00557	8.071	88.4	4.37	2.0
1472.0	-53.019	437.1	5.975	.005569	100730.	19.10	.10667	.00551	7.861	91.6	4.37	2.0
1591.2	-59.043	465.8	5.743	.005155	90736.	19.10	.10696	.00563	8.126	83.8	4.37	2.0
1672.0	-68.296	486.0	5.587	.005544	95790.	19.10	.10702	.00557	7.917	88.8	4.37	2.0
1791.2	-74.650	512.7	5.396	.005137	86679.	19.10	.10757	.00568	8.167	82.7	4.37	2.0
1872.0	-84.401	530.1	5.277	.005530	91911.	19.10	.10788	.00561	7.961	89.2	4.37	2.0
1991.2	-91.017	551.6	5.136	.005130	83721.	19.10	.10857	.00571	8.205	84.3	4.37	2.0
2072.0	-101.162	563.9	5.057	.005525	89260.	19.10	.10910	.00563	7.986	92.4	4.37	2.0
2179.1	-106.779	571.8	5.007	.005195	81989.	18.58	.08494	.00291	4.324	85.5	4.37	2.0
2267.9	-112.262	570.2	5.013	.005733	90593.	18.58	.01931	.00284	4.548	.0	.00	.0
2402.8	-118.270	568.4	5.020	.006032	95460.	18.58	.01908	.00281	4.937	.0	.00	.0
2544.2	-120.071	567.4	5.024	.005885	93208.	18.58	.01918	.00283	4.641	.0	.00	.0
2636.3	-125.403	566.0	5.030	.006150	97513.	18.58	.01899	.00280	4.802	.0	.00	.0
2742.3	-126.725	565.2	5.033	.006015	95436.	18.58	.01908	.00281	4.720	.0	.00	.0
2860.0	-132.390	563.7	5.040	.006215	98736.	18.58	.01894	.00279	4.961	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 7

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.005121	102448.	18.58	.01878	.00295	4.221	.0	.00	.0
186.6	-1.877	326.6	7.088	.005211	104070.	18.58	.01872	.00294	4.278	.0	.00	.0
430.0	-7.436	328.5	7.063	.005685	113291.	18.58	.01837	.00288	4.574	.0	.00	.0
554.8	-8.635	329.4	7.050	.005617	111813.	18.58	.01843	.00289	4.532	.0	.00	.0
714.6	-13.229	330.6	7.034	.005916	117627.	18.58	.01822	.00286	4.787	.0	.00	.0
805.8	-14.050	331.2	7.025	.005818	115587.	18.58	.01829	.00287	4.656	.0	.00	.0
991.2	-17.458	338.5	6.941	.005482	109860.	19.10	.04914	.00537	8.152	127.6	4.37	2.0
1072.0	-25.232	350.6	6.805	.005698	112666.	19.10	.10805	.00537	7.791	110.3	4.37	2.0
1191.2	-30.438	371.5	6.585	.005227	101042.	19.10	.10758	.00550	8.011	96.5	4.37	2.0
1272.0	-38.700	387.5	6.424	.005590	106262.	19.10	.10695	.00545	7.781	98.1	4.37	2.0
1391.2	-44.267	413.8	6.179	.005168	95643.	19.10	.10690	.00557	8.043	88.1	4.37	2.0
1472.0	-53.067	431.6	6.020	.005563	101143.	19.10	.10662	.00551	7.845	91.7	4.37	2.0
1591.2	-58.993	460.1	5.786	.005149	91110.	19.10	.10691	.00562	8.110	84.0	4.37	2.0
1672.0	-68.347	477.8	5.648	.005551	96622.	19.10	.10696	.00556	7.910	89.3	4.37	2.0
1791.2	-74.597	504.6	5.451	.005141	87357.	19.10	.10751	.00567	8.159	83.2	4.37	2.0
1872.0	-84.454	519.9	5.343	.005544	92952.	19.10	.10782	.00559	7.960	90.0	4.37	2.0
1991.2	-90.962	541.7	5.198	.005140	84583.	19.10	.10853	.00570	8.202	85.0	4.37	2.0
2072.0	-101.217	552.9	5.124	.005543	90372.	19.10	.10906	.00562	7.989	93.4	4.37	2.0
2179.1	-106.715	560.9	5.071	.005206	82908.	18.58	.08490	.00291	4.334	86.3	4.37	2.0
2267.9	-112.295	559.4	5.077	.005748	91649.	18.58	.01926	.00284	4.560	.0	.00	.0
2402.8	-118.282	556.8	5.089	.006072	97024.	18.58	.01901	.00281	4.965	.0	.00	.0
2544.2	-120.048	554.5	5.101	.005926	94860.	18.58	.01911	.00282	4.669	.0	.00	.0
2636.3	-125.426	553.3	5.106	.006196	99284.	18.58	.01892	.00279	4.832	.0	.00	.0
2742.3	-126.709	551.7	5.114	.006057	97189.	18.58	.01901	.00281	4.749	.0	.00	.0
2860.0	-132.390	550.0	5.122	.006271	100756.	18.58	.01885	.00279	4.997	.0	.00	.0

C-18

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 8

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.010257	102525.	37.23	.01878	.00295	4.221	.0	.00	.0
186.6	-1.878	326.6	7.087	.010448	104253.	37.23	.01871	.00294	4.281	.0	.00	.0
430.0	-7.435	328.6	7.061	.011543	114909.	37.23	.01832	.00287	4.622	.0	.00	.0
554.8	-8.637	329.6	7.048	.011418	113541.	37.23	.01837	.00288	4.583	.0	.00	.0
714.6	-13.226	330.8	7.032	.012085	120010.	37.23	.01815	.00284	4.859	.0	.00	.0
805.8	-14.049	331.4	7.022	.011886	117945.	37.23	.01821	.00285	4.727	.0	.00	.0
991.2	-17.463	338.7	6.940	.011126	111377.	38.26	.04911	.00535	8.230	129.5	4.37	2.0
1072.0	-25.223	351.0	6.801	.011542	113974.	38.26	.10808	.00536	7.854	111.8	4.37	2.0
1191.2	-30.452	372.1	6.579	.010535	101676.	38.26	.10761	.00549	8.047	97.3	4.37	2.0
1272.0	-38.686	389.3	6.407	.011274	106861.	38.26	.10699	.00544	7.821	98.9	4.37	2.0
1391.2	-44.282	415.7	6.162	.010385	95832.	38.26	.10692	.00557	8.064	88.4	4.37	2.0
1472.0	-53.052	435.0	5.992	.011192	101334.	38.26	.10666	.00551	7.875	92.1	4.37	2.0
1591.2	-59.009	463.1	5.763	.010332	91073.	38.26	.10694	.00562	8.124	84.1	4.37	2.0
1672.0	-68.331	481.8	5.618	.011158	96681.	38.26	.10700	.00556	7.936	89.5	4.37	2.0
1791.2	-74.613	508.0	5.428	.010310	87265.	38.26	.10754	.00567	8.170	83.2	4.37	2.0
1872.0	-84.437	523.4	5.320	.011147	93087.	38.26	.10786	.00559	7.986	90.2	4.37	2.0
1991.2	-90.979	544.4	5.181	.010309	84565.	38.26	.10855	.00570	8.213	85.0	4.37	2.0
2072.0	-101.200	554.6	5.113	.011154	90720.	38.26	.10908	.00561	8.016	93.8	4.37	2.0
2179.1	-106.734	562.1	5.064	.010451	83062.	37.23	.08491	.00291	4.340	86.5	4.37	2.0
2267.9	-112.283	558.1	5.084	.011588	92395.	37.23	.01922	.00284	4.582	.0	.00	.0
2402.8	-118.279	553.7	5.108	.012179	97467.	37.23	.01899	.00281	4.970	.0	.00	.0
2544.2	-120.056	551.6	5.119	.011852	95015.	37.23	.01910	.00282	4.664	.0	.00	.0
2636.3	-125.418	549.7	5.128	.012407	99622.	37.23	.01890	.00279	4.832	.0	.00	.0
2742.3	-126.715	548.7	5.133	.012103	97261.	37.23	.01900	.00281	4.740	.0	.00	.0
2860.0	-132.390	546.6	5.143	.012512	100724.	37.23	.01886	.00279	4.983	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY POUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 9

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AP
.0	.000	325.1	7.107	.010257	102525.	37.23	.01878	.00295	4.221	.0	.00	.0
186.6	-1.877	326.6	7.088	.010438	104151.	37.23	.01872	.00294	4.278	.0	.00	.0
430.0	-7.438	328.5	7.063	.011426	113757.	37.23	.01836	.00288	4.586	.0	.00	.0
554.8	-8.634	329.4	7.049	.011283	112221.	37.23	.01841	.00289	4.542	.0	.00	.0
714.6	-13.231	330.6	7.034	.011897	118167.	37.23	.01821	.00285	4.801	.0	.00	.0
805.8	-14.051	331.2	7.025	.011691	116042.	37.23	.01828	.00286	4.667	.0	.00	.0
991.2	-17.455	338.5	6.941	.010984	109969.	38.26	.04914	.00537	8.152	127.7	4.37	2.0
1072.0	-25.238	350.8	6.804	.011450	113093.	38.26	.10806	.00537	7.808	110.8	4.37	2.0
1191.2	-30.431	371.8	6.582	.010475	101130.	38.26	.10758	.00550	8.013	96.6	4.37	2.0
1272.0	-38.707	387.9	6.421	.011233	106641.	38.26	.10696	.00544	7.798	98.5	4.37	2.0
1391.2	-44.258	413.9	6.177	.010354	95715.	38.26	.10690	.00557	8.043	88.1	4.37	2.0
1472.0	-53.076	431.2	6.024	.011178	101592.	38.26	.10662	.00550	7.861	92.2	4.37	2.0
1591.2	-58.982	458.8	5.796	.010321	91353.	38.26	.10690	.00562	8.110	84.1	4.37	2.0
1672.0	-68.357	474.9	5.669	.011166	97368.	38.26	.10695	.00555	7.929	89.9	4.37	2.0
1791.2	-74.584	500.3	5.481	.010319	87935.	38.26	.10749	.00566	8.163	83.6	4.37	2.0
1872.0	-84.465	513.2	5.388	.011173	94137.	38.26	.10780	.00558	7.983	91.0	4.37	2.0
1991.2	-90.948	533.7	5.249	.010333	85537.	38.26	.10850	.00568	8.210	85.8	4.37	2.0
2072.0	-101.229	541.9	5.192	.011190	91989.	38.26	.10903	.00560	8.016	94.9	4.37	2.0
2179.1	-106.698	549.2	5.142	.010475	84144.	37.23	.08486	.00291	4.350	87.5	4.37	2.0
2267.9	-112.295	544.3	5.169	.011539	93072.	37.23	.01919	.00284	4.570	.0	.00	.0
2402.8	-118.289	540.6	5.189	.012010	97177.	37.23	.01901	.00282	4.920	.0	.00	.0
2544.2	-120.042	539.1	5.196	.011625	94181.	37.23	.01914	.00284	4.597	.0	.00	.0
2636.3	-125.430	537.8	5.202	.012153	98559.	37.23	.01895	.00281	4.757	.0	.00	.0
2742.3	-126.706	537.1	5.205	.011808	95821.	37.23	.01907	.00283	4.653	.0	.00	.0
2860.0	-132.390	536.3	5.208	.012182	98925.	37.23	.01893	.00281	4.884	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 10

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H MM/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.010257	102525.	37.23	.01878	.00295	4.221	.0	.00	.0
186.6	-1.876	326.6	7.088	.010426	104034.	37.23	.01872	.00294	4.274	.0	.00	.0
430.0	-7.438	326.5	7.063	.011375	113257.	37.23	.01838	.00288	4.570	.0	.00	.0
554.8	-8.633	329.4	7.050	.011204	111435.	37.23	.01844	.00289	4.517	.0	.00	.0
714.6	-13.232	330.5	7.035	.011804	117258.	37.23	.01824	.00286	4.772	.0	.00	.0
805.8	-14.051	331.2	7.026	.011570	114844.	37.23	.01832	.00287	4.630	.0	.00	.0
991.2	-17.454	338.5	6.942	.010826	108401.	38.26	.04917	.00538	8.066	125.8	4.37	2.0
1072.0	-25.240	350.8	6.803	.011352	112120.	38.26	.10803	.00538	7.760	109.7	4.37	2.0
1191.2	-30.429	371.8	6.582	.010355	99974.	38.26	.10755	.00551	7.945	95.3	4.37	2.0
1272.0	-38.708	387.8	6.421	.011167	106014.	38.26	.10694	.00545	7.764	97.9	4.37	2.0
1391.2	-44.256	413.4	6.182	.010259	94882.	38.26	.10686	.00558	7.987	87.2	4.37	2.0
1472.0	-53.078	430.3	6.031	.011128	101216.	38.26	.10660	.00551	7.834	91.7	4.37	2.0
1591.2	-58.979	457.1	5.809	.010237	90753.	38.26	.10686	.00563	8.059	83.4	4.37	2.0
1672.0	-68.359	472.6	5.686	.011128	97238.	38.26	.10693	.00555	7.905	89.7	4.37	2.0
1791.2	-74.581	497.1	5.504	.010245	87556.	38.26	.10744	.00567	8.115	83.0	4.37	2.0
1872.0	-84.468	509.1	5.416	.011148	94265.	38.26	.10777	.00558	7.964	91.0	4.37	2.0
1991.2	-90.943	528.6	5.281	.010269	85371.	38.26	.10845	.00569	8.165	85.4	4.37	2.0
2072.0	-101.232	535.9	5.230	.011177	92351.	38.26	.10900	.00559	8.000	95.1	4.37	2.0
2179.1	-106.693	542.8	5.182	.010417	84127.	37.23	.08484	.00291	4.333	87.3	4.37	2.0
2267.9	-112.294	536.8	5.216	.011538	93654.	37.23	.01916	.00284	4.571	.0	.00	.0
2402.8	-118.291	532.4	5.241	.011949	97360.	37.23	.01900	.00282	4.902	.0	.00	.0
2544.2	-120.041	531.0	5.247	.011432	93251.	37.23	.01918	.00285	4.540	.0	.00	.0
2636.3	-125.431	529.6	5.255	.012012	98109.	37.23	.01897	.00282	4.717	.0	.00	.0
2742.3	-126.706	529.3	5.254	.011586	94645.	37.23	.01912	.00284	4.587	.0	.00	.0
2860.0	-132.390	528.5	5.257	.011981	97937.	37.23	.01897	.00282	4.824	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 11

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	PEYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.006101	91555.	22.14	.01926	.00300	4.290	.0	.00	.0
186.6	-1.877	326.6	7.088	.006110	91521.	22.14	.01926	.00300	4.294	.0	.00	.0
430.0	-7.437	328.4	7.064	.006508	97291.	22.14	.01900	.00296	4.507	.0	.00	.0
554.8	-8.634	329.3	7.051	.006358	94944.	22.14	.01910	.00297	4.427	.0	.00	.0
714.6	-13.230	330.3	7.038	.006655	99274.	22.14	.01892	.00294	4.626	.0	.00	.0
805.8	-14.050	330.9	7.028	.006477	96548.	22.14	.01903	.00296	4.490	.0	.00	.0
991.2	-17.458	338.3	6.944	.006028	90631.	22.90	.05164	.00561	7.842	121.6	4.37	2.0
1072.0	-25.231	350.6	6.806	.006337	93980.	22.90	.11371	.00561	7.552	105.8	4.37	2.0
1191.2	-30.446	371.1	6.589	.005728	83075.	22.90	.11315	.00575	7.687	90.9	4.37	2.0
1272.0	-38.693	387.1	6.428	.006240	88994.	22.90	.11253	.00568	7.558	94.4	4.37	2.0
1391.2	-44.273	411.8	6.196	.005685	79064.	22.90	.11241	.00582	7.738	83.3	4.37	2.0
1472.0	-53.060	428.9	6.044	.006225	85123.	22.90	.11216	.00574	7.628	88.6	4.37	2.0
1591.2	-58.998	454.4	5.831	.005678	75754.	22.90	.11240	.00587	7.810	79.8	4.37	2.0
1672.0	-68.340	470.5	5.702	.006226	81829.	22.90	.11250	.00578	7.695	86.7	4.37	2.0
1791.2	-74.601	493.8	5.527	.005680	73083.	22.90	.11303	.00591	7.861	79.5	4.37	2.0
1872.0	-84.448	507.0	5.430	.006232	79263.	22.90	.11341	.00581	7.746	87.9	4.37	2.0
1991.2	-90.964	525.7	5.300	.005686	71141.	22.90	.11412	.00594	7.903	81.8	4.37	2.0
2072.0	-101.211	534.5	5.239	.006240	77490.	22.90	.11474	.00583	7.772	91.9	4.37	2.0
2179.1	-106.716	540.8	5.194	.005729	69570.	22.14	.08921	.00301	4.129	82.8	4.37	2.0
2267.9	-112.284	536.2	5.220	.006452	78669.	22.14	.01993	.00293	4.430	.0	.00	.0
2402.8	-118.288	532.7	5.239	.006644	81244.	22.14	.01978	.00291	4.707	.0	.00	.0
2544.2	-120.046	532.0	5.241	.006270	76726.	22.14	.02004	.00295	4.335	.0	.00	.0
2636.3	-125.428	531.7	5.241	.006616	80967.	22.14	.01980	.00291	4.517	.0	.00	.0
2742.3	-126.708	531.8	5.239	.006304	77150.	22.14	.02002	.00295	4.353	.0	.00	.0
2860.0	-132.390	532.0	5.235	.006521	79784.	22.14	.01986	.00292	4.552	.0	.00	.0

C-22

CHANNEL RESULTS

CASE 1

CF1L BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81

TIME 11:21:28

TIME = .00000 SECONDS

PRESSURE = 9000.0 KPA

DATA FOR CHANNEL 12

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H*	RIH*)	AR
.0	.000	325.1	7.107	.003059	91794.	11.10	.01925	.00300	4.290	.0	.00	.0
186.6	-1.876	326.5	7.089	.003060	91678.	11.10	.01925	.00300	4.290	.0	.00	.0
430.0	-7.439	323.1	7.067	.003190	95388.	11.10	.01908	.00297	4.429	.0	.00	.0
554.8	-8.633	329.0	7.055	.003104	92732.	11.10	.01921	.00299	4.337	.0	.00	.0
714.6	-13.233	329.9	7.042	.003214	95922.	11.10	.01906	.00297	4.495	.0	.00	.0
805.8	-14.050	333.5	7.033	.003114	92869.	11.10	.01920	.00299	4.348	.0	.00	.0
991.2	-17.453	337.4	6.954	.002932	88257.	11.48	.05170	.00564	7.665	118.2	4.37	2.0
1072.0	-25.239	349.2	6.820	.003096	91977.	11.48	.11361	.00563	7.405	103.1	4.37	2.0
1191.2	-30.434	367.9	6.622	.002821	82108.	11.48	.11305	.00577	7.577	89.4	4.37	2.0
1272.0	-38.703	382.5	6.472	.003074	88096.	11.48	.11242	.00569	7.450	92.9	4.37	2.0
1391.2	-44.260	404.3	6.263	.002815	78903.	11.48	.11228	.00583	7.652	82.6	4.37	2.0
1472.0	-53.072	420.0	6.119	.003076	84863.	11.48	.11202	.00574	7.531	87.7	4.37	2.0
1591.2	-58.984	443.1	5.921	.002817	75987.	11.48	.11226	.00587	7.729	79.5	4.37	2.0
1672.0	-68.354	458.0	5.798	.003081	81932.	11.48	.11234	.00578	7.599	86.1	4.37	2.0
1791.2	-74.585	480.0	5.626	.002819	73449.	11.48	.11288	.00591	7.777	79.3	4.37	2.0
1872.0	-84.462	492.3	5.533	.003083	79455.	11.48	.11326	.00581	7.645	87.5	4.37	2.0
1991.2	-90.946	511.3	5.396	.002818	71401.	11.48	.11400	.00593	7.810	81.6	4.37	2.0
2072.0	-101.225	519.5	5.336	.003082	77527.	11.48	.11462	.00583	7.661	91.4	4.37	2.0
2179.1	-106.694	528.0	5.276	.002821	69283.	11.10	.08914	.00303	4.076	82.1	4.37	2.0
2267.9	-112.287	523.0	5.305	.003125	77070.	11.10	.02002	.00296	4.317	.0	.00	.0
2402.8	-118.291	522.9	5.303	.003082	76021.	11.10	.02008	.00297	4.440	.0	.00	.0
2544.2	-120.036	525.4	5.284	.002861	70404.	11.10	.02044	.00302	4.033	.0	.00	.0
2636.3	-125.433	525.5	5.281	.003039	74781.	11.10	.02016	.00298	4.225	.0	.00	.0
2742.1	-126.700	527.4	5.267	.002849	69996.	11.10	.02047	.00302	4.020	.0	.00	.0
2860.0	-132.389	528.0	5.261	.002940	72193.	11.10	.02032	.00300	4.198	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 13

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.001713	102823.	6.22	.01877	.00295	4.221	.0	.00	.0
186.6	-1.875	326.4	7.090	.001724	103310.	6.22	.01875	.00295	4.241	.0	.00	.0
430.0	-7.441	327.9	7.070	.001730	103501.	6.22	.01874	.00295	4.961	.0	.00	.0
554.8	-8.631	328.7	7.058	.001711	102297.	6.22	.01879	.00295	4.307	.0	.00	.0
714.6	-13.238	329.6	7.045	.001713	102301.	6.22	.01879	.00295	5.138	.0	.00	.0
805.8	-14.052	330.3	7.036	.001696	101163.	6.22	.01884	.00296	4.425	.0	.00	.0
991.2	-17.446	337.3	6.955	.001660	99914.	6.39	.04940	.00547	8.128	186.0	4.37	2.0
1072.0	-25.253	348.1	6.832	.001713	101915.	6.39	.10786	.00548	7.498	98.8	4.37	2.0
1191.2	-30.412	367.0	6.630	.001648	96027.	6.39	.10768	.00555	8.209	92.2	4.37	2.0
1272.0	-38.726	378.3	6.513	.001730	99602.	6.39	.10676	.00552	7.632	91.1	4.37	2.0
1391.2	-44.236	401.6	6.288	.001665	93554.	6.39	.10703	.00559	8.361	86.7	4.37	2.0
1472.0	-53.098	413.1	6.180	.001744	96879.	6.39	.10639	.00556	7.751	86.8	4.37	2.0
1591.2	-58.957	438.4	5.959	.001675	90796.	6.39	.10701	.00563	8.482	84.1	4.37	2.0
1672.0	-68.381	448.9	5.869	.001753	94041.	6.39	.10670	.00559	7.839	85.7	4.37	2.0
1791.2	-74.557	473.3	5.676	.001684	88309.	6.39	.10756	.00565	8.558	84.3	4.37	2.0
1872.0	-84.491	481.7	5.609	.001760	91555.	6.39	.10756	.00561	7.902	87.4	4.37	2.0
1991.2	-90.917	502.9	5.453	.001691	86324.	6.39	.10855	.00567	8.622	86.8	4.37	2.0
2072.0	-101.256	508.3	5.411	.001764	89614.	6.39	.10884	.00563	7.935	91.5	4.37	2.0
2179.1	-106.660	518.5	5.338	.001697	84017.	6.22	.08479	.00293	4.374	86.9	4.37	2.0
2267.9	-112.303	513.1	5.371	.001750	87078.	6.22	.01948	.00291	4.679	.0	.00	.0
2402.8	-118.299	512.8	5.370	.001716	85384.	6.22	.01956	.00292	5.419	.0	.00	.0
2544.2	-120.028	514.7	5.355	.001647	81827.	6.22	.01975	.00295	4.169	.0	.00	.0
2636.3	-125.442	515.0	5.350	.001666	82745.	6.22	.01970	.00294	4.745	.0	.00	.0
2742.3	-126.696	516.7	5.337	.001613	79967.	6.22	.01985	.00296	4.108	.0	.00	.0
2860.0	-132.391	517.5	5.330	.001629	80709.	6.22	.01981	.00296	5.040	.0	.00	.0

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CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 14

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.006713	81781.	24.36	.01975	.00267	3.920	.0	.00	.0
186.6	-1.875	325.9	7.096	.006618	80549.	24.36	.01982	.00268	3.778	.0	.00	.0
430.0	-7.443	327.1	7.079	.006141	74634.	24.36	.02017	.00273	4.956	.0	.00	.0
554.8	-8.629	327.9	7.068	.006144	74613.	24.36	.02017	.00273	3.878	.0	.00	.0
714.6	-13.242	328.8	7.055	.005848	70944.	24.36	.02040	.00276	5.173	.0	.00	.0
805.8	-14.053	329.4	7.046	.005873	71200.	24.36	.02039	.00275	3.989	.0	.00	.0
991.2	-17.439	335.2	6.979	.006457	79088.	24.77	.02793	.00462	7.704	108.8	4.41	2.0
1072.0	-25.267	343.1	6.887	.006463	78469.	24.77	.04255	.00465	6.523	87.1	4.42	2.0
1191.2	-30.390	359.2	6.711	.007212	86025.	24.77	.04253	.00456	8.429	98.7	4.42	2.0
1272.0	-38.748	369.4	6.601	.006793	80137.	24.77	.04213	.00465	6.850	83.8	4.40	2.0
1391.2	-44.212	389.3	6.403	.007398	85471.	24.77	.04231	.00458	8.681	94.8	4.42	2.0
1472.0	-53.122	401.2	6.286	.006891	78640.	24.77	.04194	.00466	6.974	80.3	4.42	2.0
1591.2	-58.932	423.0	6.088	.007465	83350.	24.77	.04240	.00460	8.826	92.4	4.41	2.0
1672.0	-68.407	435.5	5.978	.006931	76457.	24.77	.04218	.00469	7.052	79.5	4.42	2.0
1791.2	-74.530	456.7	5.803	.007498	81046.	24.77	.04272	.00462	8.889	92.5	4.41	2.0
1872.0	-84.518	468.2	5.709	.006952	74334.	24.77	.04268	.00471	7.101	81.4	4.42	2.0
1991.2	-90.889	486.5	5.569	.007513	78998.	24.77	.04321	.00464	8.952	95.0	4.40	2.0
2072.0	-101.285	495.9	5.497	.006958	72553.	24.77	.04335	.00472	7.121	85.9	4.42	2.0
2179.1	-106.630	504.9	5.430	.007405	75310.	24.36	.03711	.00259	4.354	92.2	4.42	2.0
2267.9	-112.321	506.7	5.414	.006572	66735.	24.36	.02069	.00266	4.626	.0	.00	.0
2402.8	-118.305	508.4	5.399	.006011	60946.	24.36	.02113	.00271	5.832	.0	.00	.0
2544.2	-120.022	509.9	5.387	.005935	60101.	24.36	.02120	.00272	3.769	.0	.00	.0
2636.3	-125.451	511.0	5.377	.005693	57592.	24.36	.02141	.00274	4.564	.0	.00	.0
2742.3	-126.693	512.1	5.368	.005683	57432.	24.36	.02142	.00274	3.651	.0	.00	.0
2860.0	-132.391	513.5	5.356	.005544	55959.	24.36	.02155	.00276	5.166	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 15

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.006713	81781.	24.36	.01975	.00267	3.820	.0	.00	.0
186.6	-1.874	325.9	7.096	.006615	80513.	24.36	.01982	.00268	3.777	.0	.00	.0
430.0	-7.445	327.1	7.079	.005331	64789.	24.36	.02083	.00281	3.193	.0	.00	.0
554.8	-8.628	328.0	7.067	.005655	68668.	24.36	.02056	.00278	3.343	.0	.00	.0
714.6	-13.244	328.9	7.054	.004791	58114.	24.36	.02136	.00288	2.940	.0	.00	.0
805.8	-14.052	329.6	7.044	.005181	62796.	24.36	.02098	.00283	3.123	.0	.00	.0
991.2	-17.434	335.9	6.970	.006218	76104.	24.77	.02810	.00465	9.347	106.0	4.42	2.0
1072.0	-25.275	343.9	6.878	.005271	63942.	24.77	.04284	.00486	5.156	66.0	4.41	2.0
1191.2	-30.378	362.2	6.680	.006820	81085.	24.77	.04309	.00461	10.043	97.3	4.41	2.0
1272.0	-38.759	372.1	6.574	.005496	64648.	24.77	.04224	.00486	5.377	61.8	4.41	2.0
1391.2	-44.200	394.7	6.351	.006927	79578.	24.77	.04296	.00464	10.281	92.9	4.40	2.0
1472.0	-53.134	405.9	6.244	.005543	62957.	24.77	.04214	.00490	5.463	58.6	4.40	2.0
1591.2	-58.919	430.8	6.022	.006959	77109.	24.77	.04298	.00466	10.423	89.8	4.42	2.0
1672.0	-68.419	442.0	5.925	.005562	60967.	24.77	.04234	.00492	5.509	58.0	4.42	2.0
1791.2	-74.517	466.3	5.729	.006969	74655.	24.77	.04329	.00469	10.466	89.1	4.42	2.0
1872.0	-84.530	476.0	5.651	.005572	59156.	24.77	.04294	.00494	5.543	60.0	4.42	2.0
1991.2	-90.876	496.9	5.495	.006970	72612.	24.77	.04373	.00471	10.542	90.5	4.42	2.0
2072.0	-101.299	504.1	5.440	.005575	57710.	24.77	.04377	.00495	5.556	64.5	4.42	2.0
2179.1	-106.617	514.0	5.368	.006812	68729.	24.36	.03754	.00263	4.456	84.7	4.41	2.0
2267.9	-112.329	513.8	5.366	.005257	53054.	24.36	.02182	.00279	3.127	.0	.00	.0
2402.8	-118.306	514.2	5.360	.004652	46933.	24.36	.02246	.00287	2.845	.0	.00	.0
2544.2	-120.017	515.3	5.350	.005281	53221.	24.36	.02181	.00279	3.137	.0	.00	.0
2636.3	-125.455	515.7	5.346	.004533	45668.	24.36	.02261	.00289	2.788	.0	.00	.0
2742.3	-126.690	516.8	5.336	.005088	51204.	24.36	.02201	.00281	3.048	.0	.00	.0
2860.0	-132.390	517.9	5.327	.004526	45509.	24.36	.02263	.00289	2.785	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 16

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.003338	100168.	12.11	.01888	.00295	4.221	.0	.00	.0
186.6	-1.875	326.4	7.090	.003358	100610.	12.11	.01886	.00295	4.240	.0	.00	.0
430.0	-7.443	327.9	7.070	.003374	100939.	12.11	.01885	.00295	4.256	.0	.00	.0
554.8	-8.630	328.8	7.057	.003327	99408.	12.11	.01891	.00295	4.209	.0	.00	.0
714.6	-13.240	329.7	7.044	.003370	100585.	12.11	.01886	.00295	4.290	.0	.00	.0
805.8	-14.053	330.5	7.033	.003323	99106.	12.11	.01892	.00295	4.205	.0	.00	.0
991.2	-17.441	337.9	6.948	.003309	99553.	12.45	.04939	.00548	7.728	115.2	4.37	2.0
1072.0	-25.264	348.8	6.825	.003474	103240.	12.45	.10785	.00547	7.446	100.0	4.37	2.0
1191.2	-30.395	369.3	6.608	.003316	96374.	12.45	.10750	.00555	7.872	91.7	4.37	2.0
1272.0	-38.744	381.0	6.487	.003479	99872.	12.45	.10673	.00552	7.539	91.2	4.37	2.0
1391.2	-44.219	406.6	6.243	.003324	92941.	12.45	.10681	.00560	7.976	85.2	4.37	2.0
1472.0	-53.117	418.0	6.137	.003485	96345.	12.45	.10636	.00556	7.627	86.2	4.37	2.0
1591.2	-58.939	445.7	5.900	.003333	89683.	12.45	.10680	.00564	8.069	82.1	4.37	2.0
1672.0	-68.401	455.7	5.815	.003495	93154.	12.45	.10667	.00560	7.705	84.7	4.37	2.0
1791.2	-74.538	481.4	5.616	.003347	87106.	12.45	.10737	.00567	8.139	82.3	4.37	2.0
1872.0	-84.512	489.4	5.553	.003506	90590.	12.45	.10754	.00563	7.765	86.3	4.37	2.0
1991.2	-90.899	510.4	5.402	.003361	85233.	12.45	.10839	.00569	8.197	85.0	4.37	2.0
2072.0	-101.279	515.7	5.362	.003514	88704.	12.45	.10882	.00564	7.797	90.5	4.37	2.0
2179.1	-106.641	524.3	5.300	.003376	83162.	12.11	.08479	.00292	4.317	85.9	4.37	2.0
2267.9	-112.319	519.1	5.331	.003447	85289.	12.11	.01957	.00290	4.284	.0	.00	.0
2402.8	-118.303	517.6	5.337	.003317	82191.	12.11	.01973	.00293	4.319	.0	.00	.0
2544.2	-120.027	518.3	5.330	.003124	77363.	12.11	.02000	.00297	3.972	.0	.00	.0
2636.3	-125.449	518.9	5.324	.003267	80853.	12.11	.01981	.00294	4.110	.0	.00	.0
2742.3	-126.697	519.9	5.316	.003129	77382.	12.11	.02000	.00297	3.976	.0	.00	.0
2860.0	-132.391	521.2	5.305	.003205	79156.	12.11	.01990	.00295	4.128	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 17

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.006713	81791.	24.36	.01975	.00267	3.820	.0	.00	.0
186.6	-1.875	325.9	7.096	.006588	80133.	24.36	.01984	.00268	3.765	.0	.00	.0
430.0	-7.445	327.2	7.078	.005844	71028.	24.36	.02040	.00276	4.782	.0	.00	.0
554.8	-8.628	327.9	7.067	.005893	71559.	24.36	.02036	.00275	3.512	.0	.00	.0
714.6	-13.244	328.9	7.054	.005441	65994.	24.36	.02074	.00280	5.005	.0	.00	.0
805.8	-14.053	329.5	7.044	.005532	67048.	24.36	.02067	.00279	3.610	.0	.00	.0
991.2	-17.434	335.7	6.973	.006264	76633.	24.77	.02808	.00465	8.002	105.9	4.40	2.0
1072.0	-25.277	343.9	6.878	.006026	73097.	24.77	.04276	.00472	6.273	80.3	4.41	2.0
1191.2	-30.376	360.9	6.693	.007005	83399.	24.77	.04273	.00459	8.752	96.7	4.41	2.0
1272.0	-38.762	371.4	6.581	.006322	74421.	24.77	.04223	.00471	6.574	76.8	4.42	2.0
1391.2	-44.198	392.1	6.376	.007152	82335.	24.77	.04254	.00461	8.987	92.5	4.41	2.0
1472.0	-53.138	404.3	6.258	.006386	72646.	24.77	.04215	.00474	6.680	73.2	4.41	2.0
1591.2	-58.917	426.8	6.056	.007193	80019.	24.77	.04265	.00464	9.118	89.8	4.40	2.0
1672.0	-68.423	439.4	5.946	.006404	70359.	24.77	.04242	.00477	6.738	72.2	4.41	2.0
1791.2	-74.514	461.4	5.766	.007207	77558.	24.77	.04287	.00466	9.154	89.3	4.42	2.0
1872.0	-84.535	473.0	5.673	.006406	68199.	24.77	.04294	.00479	6.770	73.9	4.41	2.0
1991.2	-90.873	492.1	5.529	.007205	75332.	24.77	.04336	.00468	9.209	91.3	4.42	2.0
2072.0	-101.304	501.3	5.459	.006396	66377.	24.77	.04365	.00481	6.773	77.9	4.41	2.0
2179.1	-106.613	510.5	5.392	.007047	71315.	24.36	.03734	.00261	4.277	87.2	4.41	2.0
2267.9	-112.331	511.8	5.380	.005950	60149.	24.36	.02119	.00272	4.117	.0	.00	.0
2402.8	-118.307	513.8	5.362	.005188	52351.	24.36	.02189	.00280	5.450	.0	.00	.0
2544.2	-120.017	516.0	5.345	.005130	51670.	24.36	.02196	.00281	3.073	.0	.00	.0
2636.3	-125.456	517.4	5.334	.004881	49102.	24.36	.02222	.00284	3.955	.0	.00	.0
2742.3	-126.689	518.9	5.323	.004885	49073.	24.36	.02223	.00284	2.953	.0	.00	.0
2860.0	-132.390	521.1	5.306	.004697	47094.	24.36	.02244	.00286	4.634	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 18

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.005932	58867.	21.53	.02130	.00277	3.760	.0	.00	.0
186.6	-1.875	325.9	7.095	.005513	54650.	21.53	.02167	.00282	3.741	.0	.00	.0
430.0	-7.446	327.2	7.077	.004489	44438.	21.53	.02276	.00295	3.192	.0	.00	.0
554.6	-8.628	328.0	7.066	.004535	44847.	21.53	.02271	.00294	3.216	.0	.00	.0
714.6	-13.245	329.1	7.052	.004023	39741.	21.53	.02337	.00303	2.933	.0	.00	.0
805.8	-14.054	329.7	7.042	.004141	40876.	21.53	.02322	.00301	2.999	.0	.00	.0
991.2	-17.432	336.3	6.966	.004839	48213.	21.87	.03223	.00519	8.617	92.1	4.41	2.0
1072.0	-25.281	345.5	6.860	.004487	44254.	21.87	.05044	.00534	5.448	64.4	4.39	2.0
1191.2	-30.370	362.8	6.674	.005470	52944.	21.87	.05049	.00512	9.445	86.3	4.42	2.0
1272.0	-38.769	373.8	6.557	.004716	45109.	21.87	.04960	.00533	5.708	61.0	4.41	2.0
1391.2	-44.192	394.4	6.355	.005580	52233.	21.87	.05029	.00514	9.699	82.6	4.42	2.0
1472.0	-53.145	406.9	6.235	.004764	44032.	21.87	.04962	.00537	5.813	58.1	4.39	2.0
1591.2	-58.911	429.3	6.035	.005613	50736.	21.87	.05042	.00517	9.853	80.2	4.41	2.0
1672.0	-68.431	441.9	5.925	.004785	42721.	21.87	.04981	.00539	5.865	57.5	4.40	2.0
1791.2	-74.508	463.9	5.747	.005627	49204.	21.87	.05078	.00520	9.897	79.8	4.41	2.0
1872.0	-84.543	475.3	5.656	.004794	41481.	21.87	.05034	.00541	5.894	59.2	4.42	2.0
1991.2	-90.867	494.7	5.511	.005627	47839.	21.87	.05131	.00523	9.970	81.3	4.41	2.0
2072.0	-101.312	503.6	5.444	.004792	40420.	21.87	.05126	.00542	5.904	63.2	4.42	2.0
2179.1	-106.608	513.3	5.373	.005524	45426.	21.53	.04354	.00279	3.854	75.2	4.41	2.0
2267.9	-112.338	514.1	5.364	.004476	36781.	21.53	.02381	.00292	3.153	.0	.00	.0
2402.8	-118.309	517.0	5.341	.003984	32650.	21.53	.02451	.00300	2.882	.0	.00	.0
2544.2	-120.014	520.7	5.314	.004216	34444.	21.53	.02419	.00296	3.010	.0	.00	.0
2636.3	-125.460	522.4	5.301	.003835	31283.	21.53	.02477	.00303	2.798	.0	.00	.0
2742.3	-126.688	524.8	5.284	.004029	32802.	21.53	.02448	.00299	2.906	.0	.00	.0
2860.0	-132.391	527.6	5.264	.003779	30695.	21.53	.02488	.00304	2.766	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 19

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.006713	81781.	24.36	.01975	.00267	3.920	.0	.00	.0
186.6	-1.875	325.9	7.096	.006588	80185.	24.36	.01984	.00268	3.765	.0	.00	.0
430.0	-7.444	327.2	7.078	.005821	70747.	24.36	.02042	.00276	4.768	.0	.00	.0
554.8	-8.628	327.9	7.067	.005887	71483.	24.36	.02037	.00275	3.509	.0	.00	.0
714.6	-13.243	328.9	7.054	.005421	65752.	24.36	.02076	.00280	4.992	.0	.00	.0
805.8	-14.053	329.5	7.044	.005530	67024.	24.36	.02067	.00279	3.609	.0	.00	.0
991.2	-17.434	335.8	6.971	.006297	77078.	24.77	.02806	.00464	8.033	106.4	4.40	2.0
1072.0	-25.276	343.9	6.878	.006041	73270.	24.77	.04276	.00472	6.285	80.5	4.42	2.0
1191.2	-30.377	361.3	6.688	.007019	83534.	24.77	.04273	.00459	8.766	96.9	4.41	2.0
1272.0	-38.761	371.6	6.579	.006337	74578.	24.77	.04223	.00471	6.586	77.0	4.42	2.0
1391.2	-44.200	393.4	6.363	.007167	82448.	24.77	.04255	.00461	9.003	92.7	4.41	2.0
1472.0	-53.136	405.2	6.250	.006406	72806.	24.77	.04215	.00474	6.697	73.4	4.41	2.0
1591.2	-58.920	429.7	6.031	.007215	80031.	24.77	.04266	.00464	9.144	90.0	4.40	2.0
1672.0	-68.421	441.8	5.926	.006433	70526.	24.77	.04242	.00477	6.764	72.6	4.41	2.0
1791.2	-74.518	466.3	5.729	.007236	77514.	24.77	.04289	.00466	9.191	89.5	4.42	2.0
1872.0	-84.533	477.3	5.641	.006444	68334.	24.77	.04295	.00479	6.806	74.3	4.41	2.0
1991.2	-90.878	499.2	5.479	.007241	75283.	24.77	.04339	.00468	9.256	91.4	4.42	2.0
2072.0	-101.302	507.9	5.414	.006442	66461.	24.77	.04366	.00481	6.818	78.2	4.41	2.0
2179.1	-106.621	519.4	5.332	.007112	71415.	24.36	.03735	.00261	4.306	87.6	4.41	2.0
2267.9	-112.335	520.5	5.322	.006078	60980.	24.36	.02113	.00270	4.186	.0	.00	.0
2402.8	-118.306	523.3	5.300	.005498	55024.	24.36	.02164	.00276	5.687	.0	.00	.0
2544.2	-120.015	527.2	5.272	.005723	57085.	24.36	.02145	.00274	3.377	.0	.00	.0
2636.3	-125.459	528.9	5.259	.005304	52831.	24.36	.02184	.00279	4.226	.0	.00	.0
2742.3	-126.688	531.3	5.241	.005504	54712.	24.36	.02167	.00276	3.274	.0	.00	.0
2860.0	-132.390	533.8	5.224	.005229	51866.	24.36	.02194	.00279	5.028	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 20

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.003338	100168.	12.11	.01888	.00295	4.221	.0	.00	.0
186.6	-1.875	326.4	7.090	.003359	100640.	12.11	.01886	.00295	4.241	.0	.00	.0
430.0	-7.442	327.9	7.070	.003401	101730.	12.11	.01881	.00294	4.281	.0	.00	.0
554.8	-8.630	328.9	7.056	.003353	100181.	12.11	.01888	.00295	4.234	.0	.00	.0
714.6	-13.239	329.8	7.043	.003411	101829.	12.11	.01881	.00294	4.331	.0	.00	.0
805.8	-14.053	330.5	7.033	.003368	100453.	12.11	.01887	.00295	4.249	.0	.00	.0
991.2	-17.441	339.0	6.948	.003342	100515.	12.45	.04937	.00547	7.783	116.4	4.37	2.0
1072.0	-25.263	348.8	6.825	.003486	103618.	12.45	.10786	.00547	7.466	100.5	4.37	2.0
1191.2	-30.395	369.2	6.608	.003329	96773.	12.45	.10751	.00555	7.896	92.1	4.37	2.0
1272.0	-38.742	381.0	6.487	.003482	99965.	12.45	.10673	.00552	7.544	91.3	4.37	2.0
1391.2	-44.220	406.9	6.239	.003330	93071.	12.45	.10682	.00560	7.987	85.4	4.37	2.0
1472.0	-53.115	418.7	6.131	.003486	96302.	12.45	.10636	.00557	7.629	86.2	4.37	2.0
1591.2	-58.941	447.6	5.885	.003334	89529.	12.45	.10681	.00564	8.073	82.1	4.37	2.0
1672.0	-68.399	458.0	5.797	.003491	92827.	12.45	.10668	.00560	7.701	84.5	4.37	2.0
1791.2	-74.541	486.2	5.581	.003338	86483.	12.45	.10740	.00568	8.131	81.8	4.37	2.0
1872.0	-84.509	494.3	5.519	.003492	89834.	12.45	.10756	.00563	7.750	85.7	4.37	2.0
1991.2	-90.902	518.6	5.347	.003342	84133.	12.45	.10842	.00570	8.175	84.0	4.37	2.0
2072.0	-101.277	523.6	5.309	.003491	87528.	12.45	.10884	.00565	7.772	89.4	4.37	2.0
2179.1	-106.647	535.3	5.229	.003352	81794.	12.11	.08483	.00292	4.291	84.6	4.37	2.0
2267.9	-112.323	530.2	5.259	.003430	84060.	12.11	.01963	.00290	4.265	.0	.00	.0
2402.8	-118.302	530.4	5.254	.003387	83003.	12.11	.01969	.00291	4.386	.0	.00	.0
2544.2	-120.022	532.6	5.238	.003316	81110.	12.11	.01979	.00293	4.155	.0	.00	.0
2636.3	-125.451	533.6	5.229	.003375	82467.	12.11	.01972	.00291	4.211	.0	.00	.0
2742.3	-126.693	534.8	5.219	.003306	80718.	12.11	.01981	.00293	4.146	.0	.00	.0
2860.0	-132.390	536.7	5.205	.003346	81544.	12.11	.01977	.00292	4.263	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 21

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	RI(H+)	AR
.0	.000	325.1	7.107	.006713	81781.	24.36	.01975	.00267	3.320	.0	.00	.0
186.6	-1.875	325.9	7.096	.006617	80535.	24.36	.01982	.00268	3.777	.0	.00	.0
430.0	-7.444	327.1	7.078	.005356	65099.	24.36	.02081	.00281	3.205	.0	.00	.0
554.8	-8.628	328.0	7.066	.005683	69003.	24.36	.02053	.00277	3.356	.0	.00	.0
714.6	-13.243	328.9	7.053	.004830	58581.	24.36	.02132	.00288	2.958	.0	.00	.0
805.8	-14.052	329.6	7.043	.005231	63396.	24.36	.02094	.00283	3.146	.0	.00	.0
991.2	-17.435	335.8	6.972	.006253	76540.	24.77	.02811	.00465	9.395	106.8	4.40	2.0
1072.0	-25.275	343.8	6.879	.005284	64106.	24.77	.04284	.00486	5.166	66.2	4.41	2.0
1191.2	-30.380	361.7	6.684	.006852	81509.	24.77	.04308	.00461	10.075	97.9	4.41	2.0
1272.0	-38.758	371.8	6.578	.005509	64824.	24.77	.04223	.00486	5.387	62.0	4.41	2.0
1391.2	-44.204	394.1	6.357	.006967	80092.	24.77	.04294	.00463	10.322	93.5	4.40	2.0
1472.0	-53.133	405.7	6.245	.005559	63157.	24.77	.04214	.00489	5.475	58.8	4.40	2.0
1591.2	-58.925	430.9	6.022	.007006	77622.	24.77	.04296	.00466	10.472	90.5	4.42	2.0
1672.0	-68.418	442.9	5.918	.005577	61081.	24.77	.04244	.00492	5.529	58.2	4.40	2.0
1791.2	-74.524	468.2	5.714	.007019	75055.	24.77	.04328	.00469	10.523	89.7	4.42	2.0
1872.0	-84.529	479.2	5.627	.005581	59077.	24.77	.04296	.00494	5.553	60.0	4.42	2.0
1991.2	-90.885	502.2	5.458	.007016	72749.	24.77	.04374	.00471	10.603	90.8	4.42	2.0
2072.0	-101.298	511.1	5.393	.005573	57342.	24.77	.04382	.00496	5.562	64.2	4.42	2.0
2179.1	-106.629	523.9	5.302	.006838	68396.	24.36	.03758	.00263	4.467	84.6	4.41	2.0
2267.9	-112.336	525.2	5.291	.005240	52360.	24.36	.02189	.00279	3.117	.0	.00	.0
2402.8	-118.307	529.8	5.258	.004622	46000.	24.36	.02257	.00287	2.829	.0	.00	.0
2544.2	-120.016	534.9	5.223	.005402	53529.	24.36	.02178	.00277	3.190	.0	.00	.0
2636.3	-125.462	536.5	5.210	.004540	44929.	24.36	.02270	.00289	2.789	.0	.00	.0
2742.3	-126.689	539.1	5.192	.005190	51242.	24.36	.02200	.00280	3.092	.0	.00	.0
2860.0	-132.391	541.1	5.178	.004530	44659.	24.36	.02273	.00289	2.784	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 22

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.006713	81781.	24.36	.01975	.00267	3.320	.0	.00	.0
186.6	-1.875	325.9	7.096	.006621	80583.	24.36	.01982	.00268	3.779	.0	.00	.0
430.0	-7.442	327.2	7.078	.006148	74720.	24.36	.02016	.00273	4.960	.0	.00	.0
554.8	-8.630	327.9	7.067	.006175	74979.	24.36	.02015	.00272	3.894	.0	.00	.0
714.6	-13.240	328.9	7.054	.005881	71342.	24.36	.02038	.00275	5.194	.0	.00	.0
805.8	-14.053	329.5	7.045	.005941	72018.	24.36	.02033	.00275	4.024	.0	.00	.0
991.2	-17.440	335.5	6.976	.006566	80401.	24.77	.02786	.00460	7.799	110.7	4.41	2.0
1072.0	-25.265	343.3	6.885	.006515	79087.	24.77	.04263	.00465	6.571	88.0	4.40	2.0
1191.2	-30.391	360.1	6.701	.007275	86684.	24.77	.04252	.00456	8.484	99.6	4.42	2.0
1272.0	-38.746	370.3	6.593	.006831	80509.	24.77	.04212	.00464	6.880	84.3	4.40	2.0
1391.2	-44.217	392.6	6.371	.007424	85473.	24.77	.04233	.00458	8.710	95.0	4.42	2.0
1472.0	-53.119	404.5	6.257	.006913	78633.	24.77	.04196	.00466	6.996	80.5	4.42	2.0
1591.2	-58.939	431.2	6.019	.007452	82546.	24.77	.04246	.00461	8.831	91.8	4.41	2.0
1672.0	-68.402	443.4	5.913	.006932	75875.	24.77	.04224	.00469	7.063	79.2	4.42	2.0
1791.2	-74.540	471.4	5.690	.007444	79366.	24.77	.04284	.00464	8.871	91.0	4.40	2.0
1872.0	-84.513	482.6	5.602	.006925	73085.	24.77	.04278	.00472	7.099	80.5	4.42	2.0
1991.2	-90.902	508.7	5.414	.007422	76523.	24.77	.04327	.00467	8.905	92.3	4.42	2.0
2072.0	-101.280	517.5	5.349	.006908	70678.	24.77	.04349	.00475	7.109	84.1	4.41	2.0
2179.1	-106.648	532.9	5.244	.007323	72691.	24.36	.03729	.00259	4.311	89.4	4.42	2.0
2267.9	-112.330	533.6	5.237	.006574	65219.	24.36	.02080	.00265	4.623	.0	.00	.0
2402.8	-118.303	538.8	5.200	.006298	62203.	24.36	.02103	.00268	6.025	.0	.00	.0
2544.2	-120.020	543.6	5.168	.006625	65171.	24.36	.02080	.00265	4.102	.0	.00	.0
2636.3	-125.457	544.5	5.160	.006205	60991.	24.36	.02112	.00269	4.859	.0	.00	.0
2742.3	-126.692	546.2	5.148	.006513	63926.	24.36	.02090	.00266	4.057	.0	.00	.0
2860.0	-132.391	547.0	5.141	.006285	61645.	24.36	.02107	.00268	5.641	.0	.00	.0

CHANNEL RESULTS

CASE 1

CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81

TIME 11:21:28

TIME = .00000 SECONDS

PRESSURE = 9000.0 KPA

DATA FOR CHANNEL 23

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.001713	102E23.	6.22	.01877	.00295	4.221	.0	.00	.0
186.6	-1.876	326.4	7.090	.001731	103163.	6.22	.01873	.00295	4.255	.0	.00	.0
430.0	-7.440	328.0	7.069	.001758	105162.	6.22	.01868	.00293	5.020	.0	.00	.0
554.8	-8.632	329.0	7.055	.001768	105E46.	6.22	.01866	.00293	4.415	.0	.00	.0
714.6	-13.235	330.0	7.042	.001775	105468.	6.22	.01865	.00293	5.272	.0	.00	.0
805.8	-14.052	330.7	7.031	.001793	106504.	6.22	.01861	.00292	4.616	.0	.00	.0
991.2	-17.448	337.9	6.948	.001772	106606.	6.39	.04924	.00540	8.528	124.2	4.37	2.0
1072.0	-25.249	348.6	6.827	.001779	105763.	6.39	.10797	.00544	7.709	103.2	4.37	2.0
1191.2	-30.413	369.2	6.609	.001725	100310.	6.39	.10785	.00550	8.494	97.2	4.37	2.0
1272.0	-38.722	381.3	6.484	.001773	101748.	6.39	.10687	.00550	7.776	93.6	4.37	2.0
1391.2	-44.240	408.4	6.227	.001718	95910.	6.39	.10720	.00556	8.571	89.8	4.37	2.0
1472.0	-53.092	421.5	6.106	.001774	97757.	6.39	.10653	.00555	7.865	88.2	4.37	2.0
1591.2	-58.964	452.5	5.846	.001713	91555.	6.39	.10720	.00562	8.645	85.7	4.37	2.0
1672.0	-68.374	465.1	5.742	.001773	93698.	6.39	.10687	.00559	7.934	86.1	4.37	2.0
1791.2	-74.566	495.9	5.512	.001708	87729.	6.39	.10776	.00566	8.684	84.6	4.37	2.0
1872.0	-84.482	506.7	5.432	.001771	90120.	6.39	.10774	.00563	7.980	86.8	4.37	2.0
1991.2	-90.928	533.2	5.252	.001703	84634.	6.39	.10873	.00569	8.719	86.0	4.37	2.0
2072.0	-101.247	541.4	5.195	.001769	87356.	6.39	.10900	.00565	8.003	90.0	4.37	2.0
2179.1	-106.679	553.9	5.113	.001716	82432.	6.22	.08493	.00292	4.404	85.9	4.37	2.0
2267.9	-112.314	550.8	5.129	.001787	86052.	6.22	.01953	.00289	4.746	.0	.00	.0
2402.8	-116.294	552.7	5.114	.001924	92523.	6.22	.01921	.00284	5.879	.0	.00	.0
2544.2	-120.030	552.7	5.112	.001989	95668.	6.22	.01907	.00282	4.811	.0	.00	.0
2636.3	-125.441	551.9	5.115	.001958	94257.	6.22	.01914	.00283	5.342	.0	.00	.0
2742.3	-126.699	551.2	5.117	.002019	97227.	6.22	.01900	.00281	4.873	.0	.00	.0
2860.0	-132.390	550.1	5.122	.002031	97884.	6.22	.01898	.00281	5.905	.0	.00	.0

CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS PRESSURE = 9000.0 KPA DATA FOR CHANNEL 24

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.001610	80183.	5.84	.01984	.00301	4.303	.0	.00	.0
186.6	-1.878	325.6	7.100	.001590	79147.	5.84	.01990	.00302	4.262	.0	.00	.0
430.0	-7.436	326.7	7.084	.001384	68803.	5.84	.02055	.00312	3.830	.0	.00	.0
554.8	-8.635	327.6	7.071	.001475	73279.	5.84	.02025	.00307	4.023	.0	.00	.0
714.5	-13.228	328.5	7.059	.001309	64945.	5.84	.02082	.00316	3.669	.0	.00	.0
805.3	-14.047	329.3	7.047	.001426	70690.	5.84	.02042	.00309	3.919	.0	.00	.0
991.2	-17.461	334.1	6.991	.001469	73679.	6.06	.05461	.00586	10.412	122.7	4.37	2.0
1072.0	-25.222	340.1	6.920	.001288	64154.	6.06	.12434	.00603	6.405	106.9	4.37	2.0
1191.2	-30.462	357.4	6.729	.001375	67219.	6.06	.12434	.00597	9.936	112.0	4.37	2.0
1272.0	-38.679	368.3	6.611	.001260	60876.	6.06	.12434	.00609	6.338	101.4	4.37	2.0
1391.2	-44.292	393.9	6.355	.001369	64353.	6.06	.12434	.00603	10.018	107.2	4.37	2.0
1472.0	-53.044	407.4	6.230	.001259	58404.	6.06	.12434	.00615	6.380	97.3	4.37	2.0
1591.2	-59.019	437.7	5.965	.001369	61600.	6.06	.12434	.00608	10.149	102.6	4.37	2.0
1672.0	-68.323	451.8	5.846	.001258	55866.	6.06	.12434	.00621	6.424	93.0	4.37	2.0
1791.2	-74.624	482.4	5.609	.001367	59006.	6.06	.12434	.00614	10.211	98.3	4.37	2.0
1872.0	-84.429	495.2	5.512	.001256	53583.	6.06	.12434	.00626	6.463	89.2	4.37	2.0
1991.2	-90.991	522.2	5.324	.001365	56883.	6.06	.12434	.00619	10.313	94.7	4.37	2.0
2072.0	-101.192	531.9	5.256	.001254	51823.	6.06	.12434	.00630	6.491	86.3	4.37	2.0
2179.1	-106.747	547.0	5.156	.001361	54602.	5.84	.09647	.00309	4.242	90.9	4.37	2.0
2267.9	-112.282	548.0	5.146	.001207	48384.	5.84	.02230	.00318	3.410	.0	.00	.0
2402.8	-118.282	549.8	5.132	.001258	50328.	5.84	.02210	.00315	3.519	.0	.00	.0
2544.2	-120.054	550.6	5.125	.001487	59447.	5.84	.02125	.00303	4.002	.0	.00	.0
2636.3	-125.426	550.0	5.126	.001283	51342.	5.84	.02199	.00314	3.574	.0	.00	.0
2742.3	-126.714	549.9	5.125	.001485	59424.	5.84	.02125	.00303	3.999	.0	.00	.0
2860.0	-132.392	549.1	5.128	.001323	52981.	5.84	.02183	.00311	3.659	.0	.00	.0

CHANNEL RESULTS

CASE 1

CFTL BUNDLE - ONE SIXTH SECTION - FULLY POUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS

PRESSURE = 9000.0 KPA

DATA FOR CHANNEL 25

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.003222	80250.	11.69	.01984	.00301	4.303	.0	.00	.0
186.6	-1.877	325.4	7.101	.003176	79080.	11.69	.01990	.00302	4.256	.0	.00	.0
430.0	-7.437	326.4	7.087	.002703	67223.	11.69	.02066	.00313	3.759	.0	.00	.0
554.8	-8.634	327.2	7.075	.002875	71441.	11.69	.02037	.00309	3.941	.0	.00	.0
714.6	-13.230	328.0	7.064	.002521	62581.	11.69	.02100	.00318	3.562	.0	.00	.0
805.8	-14.047	328.8	7.053	.002735	67839.	11.69	.02061	.00313	3.793	.0	.00	.0
991.2	-17.458	333.2	7.001	.002864	71892.	12.13	.05468	.00589	10.217	119.7	4.37	2.0
1072.0	-25.226	338.2	6.940	.002505	62531.	12.13	.12434	.00606	6.259	104.1	4.37	2.0
1191.2	-30.455	354.2	6.763	.002693	66045.	12.13	.12434	.00599	9.771	110.0	4.37	2.0
1272.0	-38.684	364.0	6.656	.002461	59710.	12.13	.12434	.00612	6.209	99.4	4.37	2.0
1391.2	-44.285	388.6	6.409	.002686	63490.	12.13	.12434	.00604	9.861	105.7	4.37	2.0
1472.0	-53.049	401.1	6.288	.002462	57454.	12.13	.12434	.00617	6.253	95.7	4.37	2.0
1591.2	-59.011	430.7	6.023	.002688	60895.	12.13	.12434	.00610	9.993	101.4	4.37	2.0
1672.0	-68.328	443.8	5.910	.002461	55043.	12.13	.12434	.00622	6.296	91.7	4.37	2.0
1791.2	-74.615	474.3	5.668	.002685	58375.	12.13	.12434	.00615	10.053	97.2	4.37	2.0
1872.0	-84.435	486.3	5.576	.002455	52785.	12.13	.12434	.00628	6.331	87.9	4.37	2.0
1991.2	-90.980	513.6	5.380	.002680	56252.	12.13	.12434	.00620	10.150	93.7	4.37	2.0
2072.0	-101.197	523.0	5.313	.002448	50956.	12.13	.12434	.00633	6.351	84.9	4.37	2.0
2179.1	-106.735	538.9	5.206	.002664	53796.	11.69	.09649	.00311	4.173	89.6	4.37	2.0
2267.9	-112.282	540.5	5.193	.002340	47178.	11.69	.02244	.00321	3.327	.0	.00	.0
2402.8	-118.283	543.2	5.172	.002381	47905.	11.69	.02235	.00319	3.372	.0	.00	.0
2544.2	-120.048	544.6	5.162	.002845	57174.	11.69	.02144	.00306	3.868	.0	.00	.0
2636.3	-125.428	544.8	5.159	.002442	49053.	11.69	.02223	.00317	3.437	.0	.00	.0
2742.3	-126.709	544.8	5.157	.002812	56496.	11.69	.02150	.00307	3.832	.0	.00	.0
2860.0	-132.391	544.5	5.156	.002503	50306.	11.69	.02210	.00316	3.504	.0	.00	.0

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CHANNEL RESULTS

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS

PRESSURE = 9000.0 KPA

DATA FOR CHANNEL 26

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	PEYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.003222	80250.	11.69	.01984	.00301	4.303	.0	.00	.0
186.6	-1.877	325.4	7.101	.003176	79079.	11.69	.01990	.00302	4.256	.0	.00	.0
430.0	-7.438	326.4	7.087	.002712	67446.	11.69	.02064	.00313	3.768	.0	.00	.0
554.8	-8.633	327.1	7.076	.002868	71261.	11.69	.02038	.00309	3.933	.0	.00	.0
714.6	-13.232	327.9	7.065	.002521	62594.	11.69	.02100	.00318	3.562	.0	.00	.0
805.8	-14.048	328.6	7.055	.002709	67198.	11.69	.02066	.00313	3.764	.0	.00	.0
991.2	-17.455	332.6	7.007	.002829	71057.	12.13	.05472	.00590	10.127	118.3	4.37	2.0
1072.0	-25.233	337.9	6.944	.002501	62431.	12.13	.12434	.00606	6.249	104.0	4.37	2.0
1191.2	-30.446	352.0	6.786	.002670	65619.	12.13	.12434	.00600	9.705	109.3	4.37	2.0
1272.0	-38.693	362.8	6.668	.002472	60038.	12.13	.12434	.00611	6.228	100.0	4.37	2.0
1391.2	-44.274	384.1	6.452	.002668	63358.	12.13	.12434	.00604	9.803	105.5	4.37	2.0
1472.0	-53.060	397.8	6.317	.002474	57917.	12.13	.12434	.00616	6.273	96.5	4.37	2.0
1591.2	-58.999	423.5	6.084	.002668	60879.	12.13	.12434	.00610	9.923	101.4	4.37	2.0
1672.0	-68.340	438.0	5.957	.002472	55602.	12.13	.12434	.00621	6.313	92.6	4.37	2.0
1791.2	-74.602	464.8	5.740	.002663	58408.	12.13	.12434	.00615	9.972	97.3	4.37	2.0
1872.0	-84.448	478.2	5.635	.002464	53387.	12.13	.12434	.00626	6.342	88.9	4.37	2.0
1991.2	-90.966	502.9	5.454	.002654	56230.	12.13	.12434	.00620	10.055	93.7	4.37	2.0
2072.0	-101.212	513.5	5.376	.002453	51484.	12.13	.12434	.00631	6.352	85.7	4.37	2.0
2179.1	-106.718	528.6	5.272	.002626	53490.	11.69	.09650	.00312	4.128	89.1	4.37	2.0
2267.9	-112.286	530.7	5.255	.002340	47574.	11.69	.02239	.00321	3.328	.0	.00	.0
2402.8	-118.289	535.2	5.223	.002291	46398.	11.69	.02252	.00322	3.274	.0	.00	.0
2544.2	-120.043	538.4	5.200	.002672	53963.	11.69	.02174	.00311	3.685	.0	.00	.0
2636.3	-125.433	538.9	5.195	.002331	47071.	11.69	.02245	.00321	3.318	.0	.00	.0
2742.3	-126.705	539.8	5.189	.002628	53026.	11.69	.02183	.00312	3.639	.0	.00	.0
2860.0	-132.391	540.2	5.183	.002349	47378.	11.69	.02241	.00320	3.337	.0	.00	.0

CHANNEL RESULTS

CASE 1

CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS

PRESSURE = 9000.0 KPA

DATA FOR CHANNEL 27

DISTANCE (MM)	DELTA-P (KPA)	TEMPERATURE (DEG-C)	DENSITY (KG/M3)	FLOW (KG/S)	REYNOLDS NUMBER	AREA (MM2)	FRICTION FACTOR	STANTON NUMBER	FILM H KW/M2-C	H+	R(H+)	AR
.0	.000	325.1	7.107	.001610	80183.	5.84	.01984	.00301	4.303	.0	.00	.0
186.6	-1.877	325.6	7.100	.001589	79123.	5.84	.01990	.00302	4.261	.0	.00	.0
430.0	-7.439	326.6	7.084	.001388	69009.	5.84	.02053	.00311	3.838	.0	.00	.0
554.8	-8.633	327.3	7.074	.001459	72505.	5.84	.02030	.00308	3.990	.0	.00	.0
714.6	-13.233	328.2	7.061	.001299	64490.	5.84	.02085	.00316	3.648	.0	.00	.0
805.8	-14.048	328.8	7.053	.001384	68665.	5.84	.02056	.00312	3.831	.0	.00	.0
991.2	-17.454	333.1	7.002	.001424	71482.	6.06	.05470	.00589	10.183	119.1	4.37	2.0
1072.0	-25.236	339.5	6.927	.001276	63597.	6.06	.12434	.00604	6.356	105.9	4.37	2.0
1191.2	-30.441	353.6	6.769	.001344	65939.	6.06	.12434	.00599	9.762	109.8	4.37	2.0
1272.0	-38.699	365.6	6.640	.001264	61221.	6.06	.12434	.00609	6.347	102.0	4.37	2.0
1391.2	-44.269	385.4	6.439	.001341	63628.	6.06	.12434	.00604	9.853	106.0	4.37	2.0
1472.0	-53.067	399.8	6.299	.001263	59039.	6.06	.12434	.00613	6.386	98.3	4.37	2.0
1591.2	-58.993	423.3	6.086	.001339	61123.	6.06	.12434	.00609	9.957	101.8	4.37	2.0
1672.0	-68.348	438.3	5.955	.001261	56706.	6.06	.12434	.00619	6.419	94.4	4.37	2.0
1791.2	-74.595	462.7	5.756	.001334	58653.	6.06	.12434	.00614	9.990	97.7	4.37	2.0
1872.0	-84.457	476.4	5.648	.001255	54476.	6.06	.12434	.00624	6.440	90.7	4.37	2.0
1991.2	-90.959	499.0	5.481	.001327	56446.	6.06	.12434	.00619	10.057	94.0	4.37	2.0
2072.0	-101.221	509.7	5.402	.001247	52519.	6.06	.12434	.00629	6.438	87.5	4.37	2.0
2179.1	-106.708	523.5	5.305	.001308	53534.	5.84	.09650	.00313	4.120	89.2	4.37	2.0
2267.9	-112.289	525.3	5.290	.001175	48008.	5.84	.02234	.00320	3.343	.0	.00	.0
2402.8	-118.292	529.6	5.259	.001103	44893.	5.84	.02270	.00325	3.183	.0	.00	.0
2544.2	-120.041	533.7	5.231	.001256	50965.	5.84	.02203	.00315	3.518	.0	.00	.0
2636.3	-125.437	534.2	5.225	.001119	45359.	5.84	.02265	.00324	3.217	.0	.00	.0
2742.3	-126.705	535.8	5.213	.001234	49979.	5.84	.02213	.00317	3.470	.0	.00	.0
2860.0	-132.391	536.6	5.206	.001104	44685.	5.84	.02273	.00325	3.185	.0	.00	.0

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DIVERSION CROSSFLOW BETWEEN ADJACENT CHANNELS, W(I,J), (KG/SEC-M).

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS

AXIAL ZONE	W(1, 2)	W(1, 6)	W(2, 3)	W(3, 4)	W(3, 24)	W(4, 5)	W(4, 11)	W(4, 25)	W(5, 6)	W(5, 8)
.0 - 186.6	-.00031	-.00020	-.00076	-.00057	-.00023	.00091	-.00109	-.00044	.00071	-.00078
186.6 - 430.0	-.00117	-.00110	-.00325	-.00266	-.00128	.00349	-.00513	-.00264	.00338	-.00430
430.0 - 554.8	.00054	-.00008	.00111	.00014	.00138	-.00106	.00039	.00178	-.00038	.00034
554.8 - 714.6	-.00103	-.00106	-.00301	-.00256	-.00126	.00332	-.00518	-.00253	.00316	-.00395
714.6 - 805.8	.00115	-.00010	.00227	.00020	.00271	-.00208	.00079	.00303	-.00093	.00103
805.8 - 991.2	.00086	.00120	.00291	.00235	.00156	-.00166	.00359	.00268	-.00325	.00575
991.2 - 1072.0	-.00175	-.00066	-.00435	-.00260	-.00300	.00488	-.00558	-.00495	.00304	-.00324
1072.0 - 1191.2	.00188	.00227	.00594	.00402	.00411	-.00314	.00683	.00513	-.00643	.01166
1191.2 - 1272.0	-.00221	-.00209	-.00654	-.00582	-.00308	.00591	-.01251	-.00464	.00640	-.00939
1272.0 - 1391.2	.00198	.00162	.00552	.00232	.00508	-.00247	.00278	.00621	-.00522	.01009
1391.2 - 1472.0	-.00215	-.00256	-.00686	-.00706	-.00238	.00651	-.01542	-.00402	.00727	-.01048
1472.0 - 1591.2	.00218	.00128	.00560	.00139	.00603	-.00221	.00018	.00752	-.00475	.00962
1591.2 - 1672.0	-.00209	-.00270	-.00689	-.00765	-.00186	.00681	-.01701	-.00340	.00752	-.01065
1672.0 - 1791.2	.00219	.00120	.00556	.00058	.00679	-.00166	-.00220	.00850	-.00461	.00992
1791.2 - 1872.0	-.00207	-.00276	-.00690	-.00830	-.00123	.00729	-.01877	-.00282	.00763	-.01036
1872.0 - 1991.2	.00220	.00114	.00553	-.00026	.00758	-.00098	-.00471	.00946	-.00450	.01039
1991.2 - 2072.0	-.00196	-.00289	-.00683	-.00911	-.00037	.00783	-.02091	-.00205	.00779	-.01008
2072.0 - 2179.1	.00227	.00079	.00532	-.00137	.00847	-.00039	-.00693	.01000	-.00387	.00985
2179.1 - 2267.9	-.00252	-.00347	-.00844	-.01064	-.00111	.00975	-.02459	-.00319	.00952	-.01212
2267.9 - 2402.8	.00033	-.00254	-.00187	-.00862	.00531	.00537	-.02238	.00571	.00476	-.00381
2402.8 - 2544.2	.00182	-.00078	.00289	-.00439	.00781	.00054	-.01382	.01039	-.00026	.00301
2544.2 - 2636.3	-.00132	-.00153	-.00421	-.00688	.00126	.00695	-.01677	-.00020	.00442	-.00339
2636.3 - 2742.3	.00189	-.00063	.00321	-.00481	.00867	.00069	-.01301	.00941	-.00064	.00407
2742.3 - 2860.0	-.00044	-.00126	-.00215	-.00677	.00374	.00625	-.01903	.00408	.00297	-.00016

DIVERSION CROSSFLOW BETWEEN ADJACENT CHANNELS, W(I,J), (KG/SEC-M).

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS

AXIAL ZONE	W(7, 8)	W(7, 23)	W(8, 9)	W(9, 10)	W(9, 20)	W(10, 11)	W(10, 16)	W(11, 12)	W(11, 26)	W(12, 13)
.0 - 186.6	.00033	-.00082	-.00147	-.00074	-.00170	.00037	-.00202	-.00059	-.00017	-.00072
186.6 - 430.0	.00165	-.00359	-.00715	-.00324	-.00796	.00211	-.00925	-.00301	-.00164	-.00359
430.0 - 554.8	-.00127	.00182	.00007	-.00072	.00193	-.00061	.00126	.00020	.00079	.00089
554.8 - 714.6	.00092	-.00280	-.00720	-.00356	-.00747	.00158	-.00889	-.00346	-.00201	-.00352
714.6 - 805.8	-.00261	.00369	.00060	-.00094	.00379	-.00107	.00270	.00051	.00116	.00189
805.8 - 991.2	-.00448	.00629	.00537	-.00012	.00931	-.00532	.00922	.00089	-.00020	.00413
991.2 - 1072.0	.00234	-.00502	-.00605	-.00143	-.01040	.00197	-.00991	-.00421	-.00322	-.00483
1072.0 - 1191.2	-.00926	.01321	.01085	.00044	.01859	-.00982	.01863	.00266	-.00054	.00937
1191.2 - 1272.0	.00515	-.00964	-.01340	-.00168	-.02112	.00944	-.02117	-.00873	-.00068	-.01253
1272.0 - 1391.2	-.01128	.01482	.00626	-.00166	.01529	-.00808	.01404	-.00031	-.00034	.00771
1391.2 - 1472.0	.00324	-.00813	-.01723	-.00384	-.02360	.01026	-.02486	-.01111	-.00074	-.01397
1472.0 - 1591.2	-.01442	.01789	.00242	-.00463	.01424	-.00864	.01147	-.00308	-.00078	.00678
1591.2 - 1672.0	.00125	-.00623	-.01963	-.00566	-.02443	.00979	-.02648	-.01310	-.00091	-.01495
1672.0 - 1791.2	-.01699	.02043	.00004	-.00638	.01352	-.00905	.01008	-.00565	-.00102	.00579
1791.2 - 1872.0	-.00076	-.00423	-.02148	-.00686	-.02519	.00958	-.02761	-.01496	-.00137	-.01569
1872.0 - 1991.2	-.01968	.02307	-.00226	-.00792	.01271	-.00926	.00872	-.00814	-.00125	.00488
1991.2 - 2072.0	-.00335	-.00165	-.02389	-.00841	-.02608	.00943	-.02909	-.01696	-.00138	-.01629
2072.0 - 2179.1	-.02168	.02483	-.00527	-.00982	.01122	-.00935	.00663	-.01008	-.00143	.00418
2179.1 - 2267.9	-.00485	-.00125	-.02976	-.01159	-.03015	.01055	-.03477	-.02065	-.00154	-.01981
2267.9 - 2402.8	-.01923	.01683	-.02743	-.01773	-.01320	.00201	-.02280	-.02024	-.00156	-.01024
2402.8 - 2544.2	-.02149	.02253	-.01616	-.01512	.00169	-.00380	-.00766	-.01526	.00027	-.00390
2544.2 - 2636.3	-.01044	.00751	-.01986	-.01029	-.01531	.00031	-.01690	-.01607	-.00417	-.00934
2636.3 - 2742.3	-.02062	.02193	-.01369	-.01200	.00156	-.00348	-.00451	-.01405	.00046	-.00301
2742.3 - 2860.0	-.01835	.01654	-.02199	-.01402	-.01115	-.00188	-.01551	-.01892	-.00386	-.00827

DIVERSION CROSSFLOW BETWEEN ADJACENT CHANNELS, W(I,J), (KG/SEC-M).

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS

AXIAL ZONE	W(12, 27)	W(13, 14)	W(14, 15)	W(15, 16)	W(15, 17)	W(16, 17)	W(17, 18)	W(18, 19)	W(19, 20)	W(19, 21)
.0 - 186.6	.00013	-.00078	-.00027	.00125	-.00100	-.00087	-.00120	.00195	.00148	.00024
186.6 - 430.0	.00004	-.00362	-.00166	.00619	-.00257	-.00313	-.00264	.00157	.00600	-.00129
430.0 - 554.8	-.00000	.00104	.00102	-.00070	-.00088	.00094	-.00033	-.00070	-.00077	-.00045
554.8 - 714.6	-.00063	-.00354	-.00169	.00582	-.00209	-.00335	-.00261	.00059	.00560	-.00209
714.6 - 805.8	-.00028	.00209	.00181	-.00140	-.00105	.00181	-.00023	-.00152	-.00152	-.00119
805.8 - 991.2	-.00226	.00433	.00118	-.00670	.00228	.00259	.00093	-.00283	-.00657	-.00040
991.2 - 1072.0	-.00140	-.00550	-.00558	.00556	.00058	-.00638	-.00285	.00150	.00601	-.00134
1072.0 - 1191.2	-.00440	.00992	.00364	-.01276	.00341	.00720	.00240	-.00584	-.01225	-.00180
1191.2 - 1272.0	.00067	-.01355	-.00835	.00884	-.00080	-.01435	-.00670	.00264	.01179	-.00070
1272.0 - 1391.2	-.00586	.00826	.00319	-.01249	.00367	.00285	-.00044	-.00768	-.01059	-.00406
1391.2 - 1472.0	-.00037	-.01495	-.00867	.00923	-.00077	-.01763	-.00893	.00117	.01325	-.00265
1472.0 - 1591.2	-.00769	.00736	.00255	-.01350	.00416	-.00075	-.00337	-.01049	-.01036	-.00691
1591.2 - 1672.0	-.00142	-.01591	-.00929	.00796	.00004	-.02053	-.01073	-.00047	.01314	-.00393
1672.0 - 1791.2	-.00925	.00637	.00163	-.01589	.00572	-.00457	-.00559	-.01266	-.01110	-.00829
1791.2 - 1872.0	-.00255	-.01662	-.00985	.00611	.00133	-.02347	-.01224	-.00192	.01275	-.00487
1872.0 - 1991.2	-.01079	.00545	.00076	-.01836	.00739	-.00842	-.00774	-.01472	-.01176	-.00964
1991.2 - 2072.0	-.00394	-.01719	-.01032	.00453	.00241	-.02646	-.01405	-.00372	.01269	-.00651
2072.0 - 2179.1	-.01183	.00481	.00064	-.01891	.00900	-.01099	-.00907	-.01591	-.01102	-.01115
2179.1 - 2267.9	-.00428	-.02041	-.01103	.00302	.00344	-.03256	-.01679	-.00500	.01384	-.00720
2267.9 - 2402.8	-.00969	-.00999	-.00582	-.00751	.00617	-.02935	-.01753	-.01388	.00342	-.01300
2402.8 - 2544.2	-.00981	-.00341	-.00288	-.01533	.00801	-.02161	-.01320	-.01484	-.00627	-.01015
2544.2 - 2636.3	-.00869	-.00955	-.00692	-.00486	.00608	-.02332	-.01455	-.01040	.00392	-.00977
2636.3 - 2742.3	-.00928	-.00251	-.00242	-.01590	.00826	-.01913	-.01094	-.01276	-.00550	-.00913
2742.3 - 2860.0	-.01145	-.00841	-.00723	-.01135	.00889	-.02753	-.01705	-.01492	.00015	-.01271

DIVERSION CROSSFLOW BETWEEN ADJACENT CHANNELS, $W(I,J)$, (KG/SEC-M).

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81

TIME 11:21:28

TIME = .00000 SECONDS

AXIAL ZONE	W(20, 21)	W(21, 22)	W(22, 23)	W(24, 25)	W(25, 26)	W(26, 27)	W(27, 28)
.0 - 186.6	-.00033	.00042	.00091	-.00012	-.00031	-.00024	
186.6 - 430.0	-.00213	.00176	.00370	-.00044	-.00114	-.00087	
430.0 - 554.8	.00155	-.00152	-.00173	.00064	.00104	.00058	
554.8 - 714.6	-.00223	.00101	.00284	-.00022	-.00053	-.00037	
714.6 - 805.8	.00275	-.00284	-.00350	.00142	.00211	.00121	
805.8 - 991.2	.00288	-.00303	-.00640	.00133	.00331	.00247	
991.2 - 1072.0	-.00618	.00448	.00511	-.00076	-.00127	-.00043	
1072.0 - 1191.2	.00766	-.00729	-.01366	.00337	.00693	.00497	
1191.2 - 1272.0	-.01122	.00472	.01022	-.00165	-.00342	-.00166	
1272.0 - 1391.2	.00599	-.01031	-.01528	.00417	.00850	.00651	
1391.2 - 1472.0	-.01229	.00249	.00882	-.00102	-.00226	-.00060	
1472.0 - 1591.2	.00516	-.01388	-.01840	.00511	.01074	.00833	
1591.2 - 1672.0	-.01323	.00053	.00698	-.00049	-.00107	.00045	
1672.0 - 1791.2	.00370	-.01668	-.02098	.00588	.01249	.00987	
1791.2 - 1872.0	-.01435	-.00141	.00502	.00015	.00019	.00157	
1872.0 - 1991.2	.00221	-.01947	-.02364	.00666	.01423	.01139	
1991.2 - 2072.0	-.01525	-.00390	.00247	.00101	.00184	.00295	
2072.0 - 2179.1	.00150	-.02145	-.02532	.00747	.01545	.01240	
2179.1 - 2267.9	-.01719	-.00641	.00204	.00063	.00112	.00279	
2267.9 - 2402.8	-.00946	-.01787	-.01582	.00494	.01035	.00916	
2402.8 - 2544.2	-.00408	-.01975	-.02206	.00619	.01331	.01090	
2544.2 - 2636.3	-.01204	-.01245	-.00786	.00347	.00768	.00721	
2636.3 - 2742.3	-.00329	-.01853	-.02138	.00677	.01271	.01037	
2742.3 - 2860.0	-.01133	-.01843	-.01645	.00511	.01183	.01035	

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 1 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP- 2 (DEG-C)	CLADDING TEMPERATURES (DEG-C)		HEAT FLUXES (KW/M2) FOR SUBCHANNEL NUMBER	
			1	2	1	2
.0	37.847	9.0	334.0	334.0		
186.6	37.847	8.9	335.5	335.5		
430.0	37.847	8.2	336.9	336.8		
554.8	37.847	8.3	337.9	337.9		
714.6	37.847	7.9	338.7	338.6		
805.8	37.847	8.1	339.5	339.5		
991.2	655.718	80.5	418.3	419.2		
1072.0	782.385	100.6	450.8	451.6		
1191.2	936.682	117.4	488.6	489.5		
1272.0	1019.968	131.8	520.6	521.1		
1391.2	1105.298	138.2	553.6	554.0		
1472.0	1132.279	145.3	581.1	580.8		
1591.2	1136.591	141.1	605.6	605.1		
1672.0	1113.974	141.9	626.7	625.4		
1791.2	1034.548	127.7	639.4	637.9		
1872.0	955.458	121.0	650.3	647.9		
1991.2	804.880	98.9	649.9	647.5		
2072.0	681.017	86.0	649.8	646.4		
2179.1	.000	.0	572.3	568.6		
2267.9	.000	.0	571.3	566.5		
2402.8	.000	.0	570.0	565.0		
2544.2	.000	.0	568.9	564.2		
2636.3	.000	.0	567.9	562.8		
2742.3	.000	.0	567.0	562.3		
2860.0	.000	.0	565.9	561.0		

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CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 2 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP- 6 (DEG-C)	CLADDING TEMPERATURES (DEG-C)						HEAT FLUXES (KW/M2)					
			FOR SUBCHANNEL NUMBER						FOR SUBCHANNEL NUMBER					
			1	2	3	4	5	6	1	2	3	4	5	6
.0	37.847	9.0	334.0	334.0	333.8	333.8	334.0	334.0						
186.6	37.847	8.8	335.5	335.5	335.3	335.4	335.5	335.5						
430.0	37.847	8.2	336.9	336.8	336.7	336.8	336.9	336.9						
554.8	37.847	8.2	337.9	337.9	337.8	337.9	337.9	337.9						
714.6	37.847	7.8	338.7	338.6	338.5	338.5	338.6	338.7						
805.8	37.847	8.0	339.5	339.5	339.4	339.4	339.5	339.6						
991.2	655.718	79.4	418.3	419.2	421.0	421.2	418.7	418.2						
1072.0	782.385	99.6	450.8	451.6	453.8	453.9	451.2	450.8						
1191.2	936.682	116.2	488.6	489.5	491.6	492.6	489.2	488.5						
1272.0	1019.968	130.5	520.6	521.1	522.3	522.7	520.8	520.6						
1391.2	1105.298	137.0	553.6	554.0	554.7	555.9	554.0	553.7						
1472.0	1132.279	144.0	581.1	580.8	580.3	580.3	580.8	581.1						
1591.2	1136.591	139.9	605.6	605.1	603.9	604.3	605.2	605.6						
1672.0	1113.974	140.7	626.7	625.4	622.9	621.6	625.3	626.7						
1791.2	1034.548	126.7	639.4	637.9	634.7	633.5	637.7	639.4						
1872.0	955.458	120.0	650.3	647.9	643.3	640.2	647.3	650.1						
1991.2	804.880	98.1	649.9	647.5	642.2	638.8	646.6	649.7						
2072.0	681.017	85.3	649.8	646.4	639.8	634.7	644.8	649.2						
2179.1	.000	.0	572.3	568.6	560.0	554.3	566.9	571.8						
2267.9	.000	.0	571.3	566.5	556.5	549.2	564.2	570.2						
2402.8	.000	.0	570.0	565.0	553.6	545.1	561.3	568.4						
2544.2	.000	.0	568.9	564.2	553.2	543.8	559.9	567.4						
2636.3	.000	.0	567.9	562.8	551.8	542.7	557.9	566.0						
2742.3	.000	.0	567.0	562.3	551.6	542.3	557.0	565.2						
2860.0	.000	.0	565.9	561.0	550.1	541.3	555.1	563.7						

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CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 3 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP- 8 (DEG-C)	CLADDING TEMPERATURES (DEG-C)				HEAT FLUXES (KW/M2) FOR SUBCHANNEL NUMBER			
			5	6	7	8	5	6	7	8
.0	37.847	9.0	334.0	334.0	334.0	334.0				
186.6	37.847	8.8	335.5	335.5	335.4	335.5				
430.0	37.847	8.2	336.9	336.9	336.8	336.8				
554.8	37.847	8.3	337.9	337.9	337.8	337.9				
714.6	37.847	7.8	338.6	338.7	338.5	338.6				
805.8	37.847	8.0	339.5	339.6	339.4	339.5				
991.2	655.718	79.7	418.7	418.2	419.0	418.4				
1072.0	782.385	99.6	451.2	450.8	451.1	450.7				
1191.2	936.682	116.4	489.1	488.5	488.5	488.5				
1272.0	1019.968	130.4	520.8	520.6	518.6	519.7				
1391.2	1105.298	137.1	554.0	553.7	551.2	552.8				
1472.0	1132.279	143.8	580.7	581.1	576.0	578.8				
1591.2	1136.591	139.9	605.2	605.6	600.3	603.1				
1672.0	1113.974	140.4	625.2	626.7	618.6	622.2				
1791.2	1034.548	126.6	637.7	639.4	631.5	634.6				
1872.0	955.458	119.6	647.3	650.1	640.0	643.1				
1991.2	804.880	98.0	646.6	649.7	639.9	642.4				
2072.0	681.017	85.0	644.8	649.2	638.2	639.6				
2179.1	.000	.0	566.9	571.8	560.9	562.1				
2267.9	.000	.0	564.1	570.2	559.4	558.1				
2402.8	.000	.0	561.3	568.4	556.8	553.7				
2544.2	.000	.0	559.9	567.4	554.5	551.6				
2636.3	.000	.0	557.9	566.0	553.3	549.7				
2742.3	.000	.0	557.0	565.2	551.7	548.7				
2860.0	.000	.0	555.1	563.7	550.0	546.6				

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CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 4 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP-27 (DEG-C)	CLADDING TEMPERATURES (DEG-C)				HEAT FLUXES (KW/M2)			
			FOR SUBCHANNEL NUMBER				FOR SUBCHANNEL NUMBER			
			24	25	26	27	24	25	26	27
.0	.000	.0	325.1	325.0	325.0	325.0				
186.6	.000	.0	325.6	325.4	325.4	325.6				
430.0	.000	.0	326.7	326.4	326.4	326.6				
554.8	.000	.0	327.6	327.2	327.1	327.3				
714.6	.000	.0	328.5	328.0	327.9	328.2				
805.8	.000	.0	329.3	328.8	328.6	328.8				
991.2	.000	.0	334.1	333.2	332.6	333.1				
1072.0	.000	.0	340.1	338.2	337.9	339.5				
1191.2	.000	.0	357.4	354.2	352.0	353.6				
1272.0	.000	.0	368.3	364.1	362.8	365.6				
1391.2	.000	.0	393.9	388.6	384.1	385.4				
1472.0	.000	.0	407.4	401.1	397.8	399.8				
1591.2	.000	.0	437.7	430.7	423.5	423.3				
1672.0	.000	.0	451.8	443.8	438.0	438.3				
1791.2	.000	.0	482.4	474.3	464.9	462.7				
1872.0	.000	.0	495.2	486.3	478.2	476.4				
1991.2	.000	.0	522.2	513.6	502.9	499.0				
2072.0	.000	.0	531.9	523.0	513.5	509.7				
2179.1	.000	.0	547.0	538.9	528.6	523.5				
2267.9	.000	.0	548.0	540.5	530.7	525.3				
2402.8	.000	.0	549.8	543.2	535.2	529.6				
2544.2	.000	.0	550.6	544.6	538.5	533.7				
2636.3	.000	.0	550.0	544.8	538.9	534.2				
2742.3	.000	.0	549.9	544.8	539.8	535.8				
2860.0	.000	.0	549.1	544.5	540.2	536.6				

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DATE 052781

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CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 5 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP-11 (DEG-C)	CLADDING TEMPERATURES (DEG-C)						HEAT FLUXES (KW/M2)					
			FOR SUBCHANNEL NUMBER						FOR SUBCHANNEL NUMBER					
			4	5	8	9	10	11	4	5	8	9	10	11
.0	37.847	8.8	333.9	334.0	334.0	334.0	334.0	333.8						
186.6	37.847	8.8	335.4	335.5	335.5	335.5	335.5	335.4						
430.0	37.847	8.4	336.8	336.9	336.8	336.8	336.7	336.8						
554.8	37.847	8.5	337.8	337.9	337.9	337.8	337.8	337.8						
714.6	37.847	8.2	338.5	338.6	338.6	338.5	338.4	338.5						
805.8	37.847	8.4	339.4	339.5	339.5	339.3	339.3	339.4						
991.2	655.718	83.6	421.2	418.7	418.4	419.0	419.8	421.9						
1072.0	782.385	103.6	453.9	451.2	450.7	451.0	451.7	454.2						
1191.2	936.682	121.9	492.6	489.2	488.5	488.7	489.7	493.0						
1272.0	1019.968	135.0	522.7	520.8	519.7	518.7	519.2	522.1						
1391.2	1105.298	142.9	555.8	554.0	552.8	551.3	551.8	554.7						
1472.0	1132.279	148.4	580.2	580.8	578.8	575.2	574.9	577.3						
1591.2	1136.591	145.5	604.3	605.2	603.1	598.9	598.2	599.9						
1672.0	1113.974	144.8	621.6	625.3	622.2	615.4	613.5	615.2						
1791.2	1034.548	131.6	633.5	637.7	634.6	627.1	624.6	625.4						
1872.0	955.458	123.3	640.2	647.3	643.1	632.9	629.1	630.3						
1991.2	804.880	101.8	638.8	646.6	642.4	631.7	627.2	627.6						
2072.0	681.017	87.6	634.6	644.8	639.6	626.8	621.0	622.1						
2179.1	.000	.0	554.3	566.9	562.1	549.2	542.8	540.8						
2267.5	.000	.0	549.2	564.2	558.1	544.3	536.8	536.2						
2402.8	.000	.0	545.1	561.3	553.7	540.6	532.4	532.7						
2544.2	.000	.0	543.8	559.9	551.6	539.1	531.0	532.0						
2636.3	.000	.0	542.7	557.9	549.7	537.9	529.6	531.7						
2742.3	.000	.0	542.3	557.0	548.7	537.1	529.3	531.8						
2860.0	.000	.0	541.3	555.1	546.6	536.3	528.5	532.0						

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CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 6 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP-23 (DEG-C)	CLADDING TEMPERATURES (DEG-C)							HEAT FLUXES (KW/M2) FOR SUBCHANNEL NUMBER					
			7	8	9	20	21	22	23	7	8	9	20	21	23
.0	37.847	9.0	334.0	334.0	334.0	334.0	334.9	334.9	334.0						
186.6	37.847	8.9	335.4	335.5	335.5	335.3	335.9	335.9	335.3						
430.0	37.847	7.5	336.8	336.8	336.8	336.7	339.0	334.8	335.5						
554.8	37.847	8.6	337.8	337.9	337.8	337.8	339.3	337.6	337.5						
714.6	37.847	7.2	338.5	338.6	338.5	338.5	341.7	336.1	337.1						
805.8	37.847	8.2	339.4	339.5	339.3	339.5	341.6	338.9	338.9						
991.2	655.718	76.9	419.0	418.4	419.0	422.2	405.6	419.5	414.8						
1072.0	782.385	101.5	451.0	450.7	451.0	453.6	495.3	462.4	450.2						
1191.2	936.682	110.3	488.5	488.5	488.7	487.9	454.7	470.5	479.5						
1272.0	1019.968	131.2	518.6	519.7	518.7	516.2	561.2	518.6	512.5						
1391.2	1105.298	129.0	551.2	552.8	551.3	545.3	501.2	519.5	537.3						
1472.0	1132.279	144.0	576.0	578.8	575.2	567.1	612.6	566.4	565.5						
1591.2	1136.591	131.5	600.3	603.1	598.9	588.4	539.4	559.8	583.9						
1672.0	1113.974	140.4	618.6	622.2	615.4	602.7	644.4	601.2	605.6						
1791.2	1034.548	119.1	631.4	634.6	627.1	613.5	566.5	588.0	615.0						
1872.0	955.458	119.7	640.0	643.1	632.9	617.6	651.3	617.2	626.5						
1991.2	804.880	92.3	639.9	642.4	631.7	617.1	578.1	599.1	625.5						
2072.0	681.017	85.1	638.2	639.6	626.8	611.2	633.5	613.3	626.5						
2179.1	.000	.0	560.9	562.1	549.2	535.3	523.9	532.9	553.9						
2267.9	.000	.0	559.4	558.1	544.3	530.2	525.2	533.6	550.8						
2402.8	.000	.0	556.8	553.7	540.6	530.4	529.8	538.8	552.7						
2544.2	.000	.0	554.5	551.6	539.1	532.6	534.9	543.6	552.8						
2636.3	.000	.0	553.3	549.7	537.9	533.6	536.5	544.5	551.9						
2742.3	.000	.0	551.7	548.7	537.1	534.8	539.1	546.2	551.2						
2860.0	.000	.0	550.0	546.6	536.3	536.7	541.1	547.0	550.1						

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CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 7 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP-20 (DEG-C)	CLADDING TEMPERATURES (DEG-C)								HEAT FLUXES (KW/M2) FOR SUBCHANNEL NUMBER					
			FOR SUBCHANNEL NUMBER								FOR SUBCHANNEL NUMBER					
			9	10	16	17	18	19	20	9	10	16	17	18	19	20
.0	37.847	9.0	334.0	334.0	334.0	334.9	334.6	334.9	334.0							
186.6	37.847	8.9	335.5	335.5	335.3	336.0	336.1	336.0	335.3							
430.0	37.847	8.8	336.8	336.7	336.8	335.1	339.1	335.1	336.7							
554.8	37.847	8.9	337.8	337.8	337.8	338.7	339.8	338.7	337.8							
714.6	37.847	8.7	338.5	338.4	338.6	336.5	342.0	336.5	338.5							
805.8	37.847	8.9	339.3	339.3	339.5	340.0	342.3	340.0	339.5							
991.2	655.718	84.3	419.0	419.8	422.8	417.6	412.4	417.5	422.2							
1072.0	782.385	104.8	451.0	451.7	453.9	468.6	489.2	468.5	453.6							
1191.2	936.582	118.6	488.7	489.7	488.3	468.0	461.9	468.2	487.8							
1272.0	1019.968	135.2	518.7	519.2	516.3	526.6	552.5	526.5	516.2							
1391.2	1105.298	138.4	551.3	551.8	545.2	515.1	508.3	516.2	545.3							
1472.0	1132.279	148.4	575.2	574.9	566.5	573.9	601.7	574.4	567.1							
1591.2	1136.591	140.8	598.9	598.2	586.6	551.4	544.6	554.0	588.4							
1672.0	1113.974	144.7	615.3	613.5	600.3	604.8	631.9	606.6	602.7							
1791.2	1034.548	127.2	627.1	624.6	608.5	574.5	568.4	578.9	613.5							
1872.0	955.458	123.3	632.9	629.1	612.5	614.2	637.4	617.7	617.6							
1991.2	804.880	98.4	631.7	627.2	608.6	579.5	575.4	586.1	617.1							
2072.0	681.017	87.6	626.8	621.0	603.0	601.9	618.9	607.8	611.2							
2179.1	.000	.0	549.2	542.8	524.3	510.5	513.3	519.5	535.3							
2267.9	.000	.0	544.3	536.8	519.1	511.8	514.1	520.5	530.2							
2402.8	.000	.0	540.6	532.4	517.6	513.8	517.0	523.3	530.4							
2544.2	.000	.0	539.1	531.0	518.3	516.0	520.7	527.2	532.6							
2636.3	.000	.0	537.8	529.6	518.9	517.4	522.4	528.9	533.6							
2742.3	.000	.0	537.1	529.3	519.9	518.9	524.8	531.3	534.8							
2860.0	.000	.0	536.3	528.5	521.2	521.1	527.6	533.8	536.7							

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CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81 TIME 11:21:28

TIME = .00000 SECONDS TEMPERATURE DATA FOR ROD 8 (FUEL TYPE - CYLINDER)

DISTANCE (MM)	AVG FLUX (KW/M2)	FILM DROP-16 (DEG-C)	CLADDING TEMPERATURES (DEG-C)								HEAT FLUXES (KW/M2) FOR SUBCHANNEL NUMBER							
			10	11	12	13	14	15	16	10	11	12	13	14	15	16		
.0	37.847	9.0	334.0	333.8	333.8	334.0	334.9	334.9	334.0									
186.6	37.847	8.9	335.5	335.4	335.3	335.3	335.9	335.9	335.3									
430.0	37.847	8.9	336.7	336.8	336.7	335.5	334.8	339.0	336.8									
554.8	37.847	9.0	337.8	337.8	337.7	337.5	337.6	339.3	337.8									
714.6	37.847	8.8	338.4	338.5	338.4	337.0	336.1	341.8	338.6									
805.8	37.847	9.0	339.3	339.4	339.2	338.8	338.9	341.7	339.5									
991.2	655.718	84.9	419.8	421.9	423.0	418.0	420.3	406.1	422.8									
1072.0	782.385	105.1	451.7	454.2	454.9	452.5	463.1	495.7	454.0									
1191.2	936.682	119.0	489.7	493.0	491.5	481.1	470.3	455.4	488.3									
1272.0	1019.968	135.3	519.2	522.1	519.4	512.0	518.3	561.8	516.3									
1391.2	1105.298	138.6	551.8	554.7	548.8	533.8	516.6	502.2	545.1									
1472.0	1132.279	148.5	574.8	577.3	570.4	559.2	563.6	613.2	566.5									
1591.2	1136.591	140.8	598.2	599.9	590.1	572.4	551.8	539.9	586.5									
1672.0	1113.974	144.6	613.5	615.2	604.6	591.0	593.5	644.2	600.3									
1791.2	1034.548	127.1	624.6	625.4	613.0	594.3	573.1	565.1	608.5									
1872.0	955.458	123.1	629.1	630.3	617.3	602.6	602.8	648.4	612.5									
1991.2	804.880	98.2	627.2	627.6	614.3	596.3	576.4	573.2	608.6									
2072.0	681.017	87.4	621.0	622.1	608.4	594.1	591.6	626.7	603.0									
2179.1	.000	.0	542.8	540.8	528.0	518.5	504.9	514.0	524.3									
2267.9	.000	.0	536.8	536.2	523.0	513.1	506.7	513.8	519.1									
2402.8	.000	.0	532.4	532.7	522.9	512.8	508.4	514.2	517.6									
2544.2	.000	.0	531.0	532.0	525.4	514.7	509.9	515.3	518.3									
2636.3	.000	.0	529.6	531.7	525.5	515.0	511.0	515.7	518.9									
2742.3	.000	.0	529.3	531.8	527.4	516.7	512.1	516.8	519.9									
2860.0	.000	.0	528.5	532.0	528.0	517.5	513.5	517.9	521.2									

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DUCT TEMPERATURE RESULTS (DEG-C)

CASE 1 CFTL BUNDLE - ONE SIXTH SECTION - FULLY ROUGH FLOW - 1/13/81

DATE 27 MAY 81

TIME 11:21:28

TIME = .00000 SECONDS

DISTANCE (MM)	CHANNEL (14)	CHANNEL (15)	CHANNEL (17)	CHANNEL (18)	CHANNEL (19)	CHANNEL (21)	CHANNEL (22)	CHANNEL (	CHANNEL	CHANNEL	CHANNEL	CHANNEL
991.2	326.0	320.6	324.7	319.8	325.0	320.6	326.6					
1072.0	331.9	345.2	330.4	335.8	330.5	345.1	331.6					
1191.2	324.6	302.8	319.1	300.5	319.5	302.6	325.8					
1272.0	355.1	374.4	354.3	361.9	354.6	374.1	355.5					
1391.2	347.5	322.7	341.5	319.0	342.9	322.3	351.2					
1472.0	385.1	408.5	385.0	393.5	386.1	408.3	387.8					
1591.2	378.6	354.0	372.8	349.0	375.9	354.4	386.9					
1672.0	419.5	444.5	420.3	428.5	422.9	445.3	426.9					
1791.2	415.5	395.0	411.3	389.5	416.4	397.3	430.3					
1872.0	454.1	478.1	456.3	463.4	460.7	481.2	468.1					
1991.2	452.7	438.3	450.9	433.5	458.2	444.0	474.8					
2072.0	485.3	505.7	488.9	494.7	495.6	512.6	506.8					

ITERATIONS = 13

SPECIFIED NUMBER OF TIME STEPS COMPLETED

TOTAL ELAPSED TIME IS 284 SECONDS.

EXIT LOC034727

aFIN

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APPENDIX D
LISTING OF COBRA/CFTL CODE*

*

The enclosed listing is for the COBRA/CFTL code after it was made operational on the GA's UNIVAC computer and contains calls to the following GA system subroutines.

DATGT2(A): current date

GTIME(T): current time

TICKER(X): elapsed SUP time

When using the COBRA/CFTL code on other computing systems, call to above routines must be replaced by the call to equivalent routines.

COBRA+CFTL(1).COMDEK

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1  SPEC1  PROC
2      COMMON/INTGR1/ IK(41),JK(41),IKW(12),JKW(12),NAX,I3,I2,IERROR,
3          1      ITERAT,K11,K12,NWR,ITRY,ITRYM,NAA1,NAAAP1,NAAH,NAAMP1,
4          2      END1
5      COMMON/REALS1/ ANGLE(41),AXIAL(20),X(30),Y(20),THH(28),
6          1  WIDTH(12),UWCP(2,12),UWALL(2,12),RWALL(2,12),RHOLCP(12),AFLUX,Z,
7          2  THETA,PI,ATOTAL,JAX,ELEV,FERROR,SLOX,DTGC,DXGC,GC,SL,DX,DX2,DT,
8          3  PEXIT,DXI,SLDT,SLDT2,SLGC,DXIDT,WERRX,ACCELY,ACCELF,DAMPNG,
9          4  HININ,USDON,XH,WERRY,KIJ,IDTGC,LENSMO,LENROU,LENGTH(41),END2
10     COMMON/LOOP1/ NCHANL,NK,NDXP1,NWK,NROD,NDX,END3
11     COMMON/LARGE1/SAVEAL(99001),PW(28),PH(28),DC(28),V(28),VPA(28),
12     1  VISC(28),VISCW(28),HFILM(28),CON(28),CP(28),FSP(28),PERIM(28),
13     2  WP(41),AAA(7,41),P(28,30),H(28,30),F(28,30),RHO(28,30),
14     3  HOLD(28,30),FOLD(28,30),RHOLD(28,30),A(28,30),DHYD(28,30),
15     4  STNO(28,30),RENO(28,30),GAP(41,30),TWALL(12,30),TWOLD(12,30),END4
16  END
17  SPEC2  PROC
18      COMMON/LARGE3/ AN(28),DHYDN(28),LOCA(8,41),MWRAP(28),NWRAPS(28),
19      1  T(28),ILOCS(9,28),END5
20  END
21  SPEC3  PROC
22      COMMON/BGRID/ GRIDXL(12),CD(28,6),FDIV(41),FXFLOW(41,6),DUR(41),
23      1  PITCH,WBAR(30),XCROSS(41,2),CDC1(6),CDC2(6),CDC3(6),
24      2  CDC4(6),S4,RSC,SSC,THICK,DIA,IGRID(12),NGRID,NGRIDT,J6,NGTYPE,
25      3  NRAMP,GRID,END6
26  END
27  SPEC4  PROC
28      COMMON/BAREA/ AFACT(6,28),GFACT(6,39),AXL(6),GAPXL(6),NARAMP,
29      1  NAFAC,NAXL,NGXL,NGAPS,NCH(28),NGAP(39),END7
30  END
31  SPEC5  PROC
32      COMMON/PROP1/ AA(9),BB(9),CC(9),HGPT(20),TPCUT(20),CPPOUT(20),
33      1  KPOUT(20),UPOUT(20),VPOUT(20),DTMAX,PREFOL,AAL(9),
34      2  BBL(9),CCL(9),AAR(9),BBR(9),CCR(9),HAA(9),
35      3  HBB(9),HCC(9),HAAR(9),HBBR(9),HCCR(9),NFH,CT,NFT,
36      4  NPROP,NTYPE(28),LAMNF,PREF,TF,AH(4),END8
37  END
38  SPEC6  PROC
39      COMMON/FUEL/RF(5),XKF(5),HGAP(5),CPF(5),QPFRAC(5),RHO(5),
40      1  FLX(55,30),PHI(8,7),RADIAL(8),D(8),POWER,TREF,MSC,LR(8,7),
41      2  END9
42  END
43  SPEC7  PROC
44      COMMON/INMAIN/OUTPUT(13),TEXT(17),DATE(2),TIMNOW(2),
45      1  TTIME,ETIME,YP(20),FP(20),YG(20),FG(20),YH(20),FH(20),YQ(20),
46      2  FQ(20),FHX(20),YHX(20),HOUT,HIN,TIN,GIN,ZZ,DX,XX,NHX,NOUT,NPCHAN,
47      3  NPGAP,NPROD,NSKIPT,NSKIPX,MR,MC,MG,MP,MX,MW,MY,ME,MZ,HK,MS,MA,
48      4  M1,MT,ML,MU,NP,NG,NQ,NH,IM(39),JM(39),MAXT,IMP(10),JMP(10),IH,
49      5  IG,K10,NOT,NDTP1,KASE,NTRIES,PRINT(13),MI,END10
50  END
51  SPEC8  PROC
52      COMMON/LARGE2/ PRINTC(28),PRINTG(41),PRINTR(8),END11
53  END
54  SPEC9  PROC
55      COMMON/LARGE4/ GAPN(41),IDAREA(28),IDGAP(41),END12
56  END

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57 SPEC10 PROC
58 COMMON/MIX1/ ABETA,BBETA,GK,FTM,JS,NSCBC,END13
59 END
60 SPEC11 PROC
61 COMMON/EOFIX/ GAPS(28,4),END14
62 END
63 SPEC12 PROC
64 COMMON/RADV/ NSF,IRAD,ICON,NCONR,IFL,IJM,END15
65 END
66 SPEC13 PROC
67 COMMON/GRP13A/ R2(9),RZS(9),RR(9),HRIB,TWTB,BIOTC,BIOT,END16
68 END
69 SPEC14 PROC
70 COMMON/GRP13B/ LREFF,LREFST,AR,AHS,GPRIME,HPLUS,END17
71 END
72 SPEC15 PROC
73 COMMON/GRP13C/ CR(8),CG(8),END18
74 END
75 SPEC16 PROC
76 COMMON/ICONR/ ICONR(8),END19
77 END
78 SPEC17 PROC
79 COMMON/PR/ PR,END20
80 END
81 SPEC19 PROC
82 COMMON/QPRI/ QPRIM(28),END21
83 END
84 SPEC20 PROC
85 COMMON/SIZES/ AC(28),OR(8),HINLET(28),TINLET(28),
86 1 FINLET(28),DIST(28,4),LC(28,4),END22
87 END
88 SPEC21 PROC
89 COMMON/RAD/QR(55,30),TSF(55),HFA(550),IIS(550),JJS(550),END23
90 END
91 SPEC22 PROC
92 COMMON/HFLX/ FLUX(8,30),END28
93 END
94 SPEC23 PROC
95 COMMON/LAHNAR/LAHARK(28),TETA(28),END24
96 END
97 SPEC24 PROC
98 COMMON/RUFF/HPW(28,30),RHPLS(28,30),END25
99 END
100 SPEC25 PROC
101 COMMON/ERROR1/ISAVT,ISOUT,QIM,QGM,END26
102 END
103 SPEC26 PROC
104 COMMON/ICONT/ICOUNT,END27
105 END
106 SPEC51 PROC
107 DIMENSION UB(330,30),STUM(330,30),AP(330,30)
108 END
109 SPEC52 PROC
110 DIMENSION W(330,30),WOLD(330,30),BETA(330,30),BSAVE(330,30),
111 1 PSI(330,30),TRF(330,30)
112 END
113 SPEC53 PROC

```

```

114      DIMENSION US(330,30),USW(330,30),TERM1(28),TERM2(28),
115      1      DPK(28),APP(330,30),FLOW(28),B(41),CIJ(41),
116      2      MARK(330,30),SP(330,30),DPWP(28),IFDIV(41),
117      3      ISTA(41),AAH(287),ILOCS(252),WPP(41),PSHIFT(28)
118      END
119      SPEC55 PROC
120      DIMENSION HFILMS(28)
121      END
122      SPEC56 PROC
123      DIMENSION DPOX(28),DHDX(28),DFDX(28),CONK(41)
124      END
125      SPEC57 PROC
126      DIMENSION AAAPRM(287),WPRM(9900),LOCA1(328)
127      DIMENSION USWPRM(41),USPRM(41),BETPRM(41),SPPRM(41),
128      1      WOLDPM(41),UBPRM(28),APPPRM(28),WSAVE(41),
129      2      DTII(41),DTJJ(41)
130      END
131      SPEC58 PROC
132      DIMENSION QRAD(24)
133      END
134      SPEC59 PROC
135      DIMENSION TFLX(55,30)
136      END
137      SPEC71 PROC
138      EQUIVALENCE (UB(1,1),SAVEAL(247)),(STUW(1,1),SAVEAL(275)),
139      1      (AP(1,1),SAVEAL(303))
140      END
141      SPEC72 PROC
142      EQUIVALENCE (W(1,1),SAVEAL(1)),(WOLD(1,1),SAVEAL(42)),
143      1      (BETA(1,1),SAVEAL(83)),(BSAVE(1,1),SAVEAL(124)),
144      2      (PSI(1,1),SAVEAL(165)),
145      3      (TRF(1,1),SAVEAL(206))
146      END
147      SPEC73 PROC
148      EQUIVALENCE (US(1,1),USW(1,1),PSI(1,1)),(TERM1(1),VISCW(1)),
149      1      (TERM2(1),STUW(1,1)),(DPK(1),STUW(1,2)),
150      2      (APP(1,1),AP(1,1)),(FLOW(1),STUW(1,3)),
151      3      (B(1),WP(1),CIJ(1),WPP(1)),(MARK(1,1),BETA(1,1)),
152      4      (SP(1,1),TRF(1,1)),(AAH(1),AAA(1,1)),
153      5      (ILOCS(1),ILOCS(1,1)),(CPWP(1),FSP(1)),
154      6      (PSHIFT(1),TMHI(1)),(ISTAR(1),IFDIV(1),FDIV(1))
155      END
156      SPEC76 PROC
157      EQUIVALENCE (DHDX(1),CP(1)),(DFDX(1),FSP(1)),(DPOX(1),CON(1)),
158      1      (CONK(1),AAA(1,1))
159      END
160      SPEC77 PROC
161      EQUIVALENCE (AAA(1,1),AAAPRM(1)),(W(1,1),WPRM(1)),
162      1      (LOCA(1,1),LOCA1(1))
163      EQUIVALENCE (WSAVE(1),BSAVE(1,3)),(DTII(1),BSAVE(1,1)),
164      1      (DTJJ(1),BSAVE(1,2)),(USWPRM(1),USW(1,1)),
165      2      (USPRM(1),US(1,1)),(BETPRM(1),BETA(1,1)),
166      3      (SPPRM(1),SP(1,1)),(WOLDPM(1),WOLD(1,1)),
167      4      (UBPRM(1),UB(1,1)),(APPPRM(1),APP(1,1))
168      END
169      SPEC60 PROC
170      MC=28

```

* C O M D E K *

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```
171      MG=41
172      MX=30
173      MR=8
174      ME=30
175      MF=20
176      ML=6
177      MZ=12
178      MW=12
179      MY=5
180      MO=7
181      NI=8
182      NI=9
183      MI=7
184      MK=6
185      MA=28
186      MT=9
187      MS=39
188      NU=55
189      MI=330
190      END
191      SPEC61 PROC
192          COMMON/SIG/ SIGNAL(14),END28
193          REAL*8 SIGNAL
194      END
```

@HDG

* A R E A *

```
@PRT,S      COBRA*CFIL.AREA
FURPUR 23R1 GA-B E35 S74711 05/26/81 17:36:53
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COBRA*CFIL(1),AREA

```

1      SUBROUTINE AREA (J,JX)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC3,LIST
5      INCLUDE SPEC4,LIST
6      INCLUDE SPEC9,LIST
7      INCLUDE SPEC51,LIST
8      INCLUDE SPEC52,LIST
9      INCLUDE SPEC53,LIST
10     INCLUDE SPEC71,LIST
11     INCLUDE SPEC72,LIST
12     INCLUDE SPEC73,LIST
13     LOGICAL GRID
14     REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
15     ICROSS(K)=IFIX(EINTEG*PITCH*ABS(XCROSS(K,L)))
16     IXC(K)=((IXJX-ICROSS(K))/IPITCH)*IPITCH+ICROSS(K)
17
18     C      FFS = FF                                203500
19     JM1=J-1                                         203600
20     JXM1=JX-1                                       203700
21     IF (J.NE.1) GO TO 100                          203800
22     PL=0                                            204100
23     JXM1=1                                          204000
24     JM1=1                                           204100
25     100 CONTINUE                                    204200
26     C      EINTEG REDUCED TO 1.0E9 TO AVOID FIXED POINT OVERFLOW 204300
27     EINTEG = 1.0E9                                  204400
28     IXJX=IFIX(EINTEG*X(JX))                        204500
29     IXJXM1=IFIX(EINTEG*X(JXM1))                    204600
30     IPITCH=IFIX(EINTEG*PITCH)                      204700
31     C      CALCULATE CHANNEL AREA IF REQUIRED.        204800
32     DO 110 I=1,NCHANL                               204900
33     A(I,J)=AN(I)                                    205000
34     DHYD(I,J)=DHYDN(I)                             205100
35     110 CONTINUE                                    205200
36     IF (NAXL.EQ.0) GO TO 130                        205300
37     DO 120 I=1,NCHANL                               205400
38     JJ=IDAREA(I)                                    205500
39     IF (JJ.LT.1) GO TO 120                          205600
40     CALL CURVE (FF,X(JX)/Z,AFAC(I,JJ),AXL,NAXL,IERROR,1) 205700
41     IF (IERROR.GT.1) GO TO 240                      205800
42     DUMY=FLOAT(ITERAT)/FLOAT(NARAMP)                205900
43     DUMY=AMIN1(DUMY,1.)                             206000
44     IF (FF.LE.0.) GO TO 240                         206100
45     FF=1.-(1.-FF)*DUMY                             206200
46     A(I,J)=AN(I)*FF                                206300
47     C      FF DECREASED IN SMOOTH SECTION TO ACCOUNT FOR PW EFFECT ON DHYD
48     IF(FF.LT.0.99)FF=FF/1.0171
49     DHYD(I,J)=DHYDN(I)*FF                            206400
50     120 CONTINUE                                    206500
51     130 IF(J6.NE.1.AND.J6.NE.3) GO TO 210          206600
52     IF(INK.EQ.0) GO TO 231                          206700
53     IF (JX.NE.1) GO TO 150                          206800
54     DO 140 I=1,NCHANL                               206900
55     140 NWRAP(I)=NWRAPS(I)                         207000
56     150 CONTINUE                                    207100

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* A P E A *

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57      DUMY=FLOAT(ITERAT)/FLOAT(NARAMP)                207200
58      DUMY=AMIN1(DUMY,1.)                             207300
59      WPMW=PI*THICK*DUMY                             207400
60      AWW=WPMW*THICK*0.25                             207500
61      C PL IS THE PITCH LENGTH CONTAINING X(J).        207600
62      C FIND THE WRAP CROSSINGS IN DX.                 207700
63      IF (JX.EQ.1.OR.JX.EQ.NDXP1) GO TO 190            207800
64      DO 180 K=1,NK                                    207900
65      II=IK(K)                                          208000
66      JJ=JK(K)                                          208100
67      DO 180 L=1,2                                     208200
68      IF (XCROSS(K,L).EQ.0.) GO TO 180                 208300
69      IF (IXC(K).LE.JXJXM1.OR.IXC(K).GT.IXJX) GO TO 180 208400
70      C ADD AND SUBTRACT WIRE WRAPS FROM SUBCHANNEL AT EACH WRAP CROSSING 208500
71      IF (XCROSS(K,L)) 160,180,170                    208600
72      160 NWRAP(II)=NWRAP(II)+1                        208700
73      NWRAP(JJ)=NWRAP(JJ)-1                            208800
74      GO TO 180                                         208900
75      170 NWRAP(II)=NWRAP(II)-1                        209000
76      NWRAP(JJ)=NWRAP(JJ)+1                            209100
77      180 CONTINUE                                     209200
78      190 CONTINUE                                     209300
79      C MODIFY AREA AND HYDRAULIC DIAMETER FOR WIRE WRAPS IN SUBCHANNELS. 209400
80      DO 200 I=1,NCHANL                                209500
81      A(I,J)=A(I,J)-FLOAT(NWRAP(II))*AWW              209600
82      200 DHYD(I,J)=4.*A(I,J)/(PERIM(II)+FLOAT(NWRAP(II))*WPMW) 209700
83      C                                                 209800
84      C CALCULATE GAP SPACING IF REQUIRED.               209900
85      210 IF(NK.EQ.0) GO TO 231                        210000
86      DO 220 K=1,NK                                    210100
87      220 GAP(K,J)=GAPN(K)                             210200
88      IF(NGXL.EQ.0) GO TO 231                          210300
89      DO 230 K=1,NK                                    210400
90      L=IDGAP(K)                                        210500
91      IF (L.LT.1) GO TO 230                            210600
92      CALL CURVE (FF,X(JX)/Z,GFACT(I,L),GAPXL,NGXL,IERROR,1) 210700
93      IF (IERROR.GT.1) GO TO 240                       210800
94      IF (FF.LE.0.) GO TO 240                          210900
95      GAP(K,J)=GAPN(K)*FF                              211000
96      230 CONTINUE                                     211100
97      231 IF(IJ.EQ.1) GO TO 233                        211200
98      DO 232 I=1,NCHANL                                211300
99      232 APP(I,J)=.5*(A(I,J)+A(I,JM1))                211400
100     233 CONTINUE                                     211500
101     FF = FFS                                          211600
102     RETURN                                           211700
103     240 IERROR=9                                       211800
104     FF = FFS                                          211900
105     RETURN
106     END

```

@H06

* B A S I C *

@PRT,S COBRA*CFIL.BASIC
FURPUR 28R1 GA-B E35 574T11 05/26/81 17:35:53

COBRA*CFIL(1).BASIC

```

1      SUBROUTINE BASIC (RO,R1,HR,RE,TR,F,ST,I,J)
2      C      SUBROUTINE TO CALCULATE FRICTION FACTOR AND STANTON NUMBER FROM R    95900
3      C      AND G FUNCTIONS                                                    96000
4      C      CH = RELAXATION PARAMETER                                          96100
5      C      DH = HYDRAULIC DIAMETER                                           96200
6      C      F = FRICTION FACTOR                                               96300
7      C      FI = STARTING VALUE OF THE FRICTION FACTOR                       96400
8      C      GH = FUNCTION IN THE TEMPERATURE PROFILE                         96500
9      C      HR = RIB HEIGHT                                                    96600
10     C      REW = REYNOLDS NUMBER AT WALL                                    96800
11     C      RH = FUNCTION IN THE VELOCITY PROFILE                             96900
12     C      RO = RADIUS OF ZERO SHEAR                                          97000
13     C      R1 = RADIUS OF ROD                                                 97100
14     C      ST = STANTON NUMBER                                                97200
15     C      YH = RO-R1                                                         97300
16     C                                                                           97400
17     C                                                                           97500
18     INCLUDE SPEC14,LIST
19     INCLUDE SPEC15,LIST
20     INCLUDE SPEC17,LIST
21     INCLUDE SPEC24,LIST
22     CH = .7                                                                    97800
23     IF (TR .LT. 1.) TR=1.                                                    97900
24     REW = RE*TR**(-1.67)                                                       98000
25     YH = RO - R1                                                              98200
26     DH = 2.*(RO*RO - R1*R1)/R1                                                98300
27     FI = .1                                                                    98500
28     C                                                                           98600
29     DO 9 IT=1,20
30     HW = HR/DH*REW*SQRT(FI/8.)                                                98900
31     RH = CR(1)
32     AR=CR(2)
33     IF(HW.GT.CR(3))GO TO 11
34     RH=CR(4)-CR(5)*ALOG(HW)
35     AR=CR(6)-ALOG(HW)*(CR(7)-CR(8)*ALOG(HW))
36     HH = HW*TR**1.67                                                         99300
37     RHSM = 5.5 + 2.5*ALOG(HH)
38     TEST=RH*(AR-2.50)*(ALOG(YH/HR)-.5-1./(2.+YH/R1))
39     C      IF (TEST > RHSM FLOW IS HYDRAULICALLY SMOOTH
40     IF (TEST.LT.RHSM) GO TO 11
41     RH=RHSM
42     AR=2.50
43     11 C4 = AR*ALOG(YH/HR)
44     C5 = AR*(1.50 + 0.50*RO/R1)/(1.+RO/R1)                                  99700
45     C6I=1./(C4-C5*RH)
46     F = (C6I**2)*8.
47     F = (1.-CH)*FI + CH*F                                                    100000
48     IF (ABS(F-FI) .LT. .001) GO TO 10                                       100100
49     FI = F                                                                    100200
50     9 CONTINUE                                                                100300
51     PPINT 100                                                                100400
52     100 FORMAT('O BASIC NOT CONVERGED.')                                     100500
53     RETURN                                                                    100600
54     C                                                                           100700
55     10 CONTINUE                                                                100800
56     HPW(I,J)=HW

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```
57      RHPLS(I,J)=RH
58      C7 = CG(1)*HW**CG(2)
59      IF(HW.LT.CG(6))C7=CG(7)
60      C8 = PR**CG(4)
61      C9 = TR**CG(5)
62      GH = C7*C9*C9
63      AHS=CG(3)
64      ST =C6I/(AHS/AR*(C4-C5)+GH)
65      RETURN
66      END
```

101200

101600

101700

@MDG

* B E F *

@PRT,S COBRA*CFIL.BEF
FURPUR 29R1 GA-B E35 S74T11 05/26/81 17:36:53

COBRA*CFIL(1).BEF

1	SUBROUTINE BEF(AL,RE,F,AS,AR)	
2	C INNER AND OUTER ZONE DENSITIES AND VISCOSITIES ASSUMED EQUAL	
3	R1=1.	
4	R2=1.	
5	ET1=1.	
6	ET2=1.	
7	RETURN	300
8	ENTRY BEF1(B,Y)	
9	WF = SQRT(2.0/F)	500
10	B2 = 1.0 - B*B	600
11	A1 = 1.0 - AL	700
12	A2 = 1.0 - AL*AL	800
13	BA = B*B - AL*AL	900
14	BAA = BA/AL/A1	1000
15	GA = B/AL	1100
16	WBA = SQRT(B2*AL/BA)	1200
17	S2 = AS/2.0*(3.0 + B)/(1.0 + B)	
18	G1 = AR*(1.50 + 0.50*GA)/(1.0 + GA)	
19	AA = AS*ALOG ((1.0 - B)/2.0/A1*SQRT(B2/A1)*RE/WF*ET2/R2) + 5.5	1700
20	Y = (AA*R1/R2*WBA - G1)*R1*SQRT(BAA)*BA/A2	
21	1 + (AA - G2)*R2*SQRT(B2/A1)*B2/A2 - WF	1900
22	RETURN	2000
23	ENTRY BEF4 (F1,F2,RE1,RE2)	2100
24	F1 = 2.0/(AA*WBA*R1/R2 - G1)**2	2200
25	F2 = 2.0/(AA - G2)**2	2300
26	RE1 = BAA*SQRT(BAA)/R1*ET1*SQRT(F/F1)*RE	2400
27	RE2 = B2/A1*SQRT(B2/A1)/R2*ET2*SQRT(F/F2)*RE	2500
28	RETURN	2600
29	END	2700

ENDG * B E T A F *

@PRT,S COBRA*CFIL.BETAF
FURPUR 28R1 GA-B E35 574T11 05/26/81 17:36:54

* B E T A F *

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COBRA*CFTL(1).BETAF

1	SUBROUTINE BETAF(BETA,A,*)	
2	C BESTIMMUNG DER TAU-0-LINIE (REGULA FALSI)	3100
3	I = 1	3200
4	B = 0.995	3300
5	CALL BEF1(B,Y)	
6	1 BB = B - 0.025	3500
7	IF(BB.LT.A) GO TO 10	3600
8	CALL BEF1(BB,YY)	
9	IF((Y*YY).LT.0.0) GO TO 2	3800
10	B = BB	3900
11	Y = YY	4000
12	GO TO 1	4100
13	2 I = I + 1	4200
14	IF(I.GT.100) GO TO 10	4300
15	B2 = B - Y*(BB - B)/(Y - Y)	4400
16	CAL BEF1(B2,Y2)	
17	IF(ABS(Y2).LT.1.0E-4) GO TO 4	4600
18	IF(ABS(B2-BV).LT.1.0E-5) GO TO 4	4700
19	BV = B2	4800
20	IF((Y*Y2).GT.0.0) GO TO 3	4900
21	YY = Y2	5000
22	BB = B2	5100
23	GO TO 2	5200
24	3 Y = Y2	5300
25	B = B2	5400
26	GO TO 2	5500
27	4 BETA = B2	5600
28	RETURN	5700
29	10 WRITE(6,11) I	5800
30	RETURN	5900
31	11 FORMAT(/,30X,'BETA ITERATION FAILED I = ',I3)	6000
32	END	6100

@HOG

* B L O C K D A T A *

@PRT,S

COBRA*CFTL.BLOCKDATA

FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:54

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COBRA*CFIL(1).BLOCKDATA

```

1      BLOCK DATA
2      INCLUDE SPEC61,LIST
3      DATA SIGNAL/' COBRA ',' DIFFER ',' DIVERT ',' MIX ','
4      1 ' SCHEME ',' FORCE ',' VOID ',' SPLIT ',' AREA ','
5      2 ' CURVE ',' PROP ',' XSCHM ',' SUMUP ',' HEAT '/'
6      END

```

331000

@HDG * C L D T M P *

@PRT,S COBRA*CFIL,CLDTMP
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:54

COBRA*CFIL(1),CLDTMP

```

1      SUBROUTINE CLDTMP(JX,N)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC5,LIST
5      INCLUDE SPEC6,LIST
6      INCLUDE SPEC7,LIST
7      INCLUDE SPEC12,LIST
8      INCLUDE SPEC59,LIST
9      LOGICAL PRINT
10     REAL KPOUT
11     REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
12     C   THIS ROUTINE CALCULATES THE CLADDING SURFACE TEMPERATURES.
13     DIMENSION ISUB(7), TCOLD(7)
14     C
15     J = JX
16     IF(JX.GT. NSKIPX) GO TO 20
17     C   FIND SURFACE NUMBER NS
18     NS=0
19     N1 = N-1
20     IF(N1.LT.1) GO TO 16
21     DO 15 I=1,N1
22     DO 15 II=1,MSC
23     IF(LR(I,II).GT.0) NS=NS+1
24     15 CONTINUE
25     16 CONTINUE
26     LD = MSC
27     DO 10 L=1,MSC
28     ISUB(L) = LR(1,L)
29     IF(ISUB(L).GT.0) GO TO 10
30     LD = LD - 1
31     10 CONTINUE
32     WRITE(6,959)ISUB(LD),(ISUB(L),L=1,LD)
33     WRITE(6,101)(ISUB(L),L=1,LD)
34     WRITE(6,282)
35     20 CONTINUE
36     C
37     XJ = X(JX)*1000.
38     IF(IFL.EQ.0.OR.JX.EQ.1)GO TO 48
39     DX=X(JX)-X(JX-1)
40     CALL CURVE(QX1,X(JX-1)/Z,AXIAL,Y,NAX,IERROR,1)
41     CALL CURVE(QX2,X(JX)/Z,AXIAL,Y,NAX,IERROR,1)
42     TEST=(QX2+1.E-5)/(QX1+1.E-5)
43     IF(TEST.LT.3..AND.TEST.GT.0.33)GO TO 17
44     QXSUM=(QX1+QX2)/2.
45     DXF=DX/20.
46     XF=X(JX-1)
47     DO 11 IDXF=1,19
48     XF=XF+DXF
49     CALL CURVE(QX,XF/Z,AXIAL,Y,NAX,IERROR,1)
50     11 QXSUM=QXSUM+QX
51     QX=QXSUM/20.
52     GO TO 48
53     17 XDUMY=(X(JX)-DX/2.)/Z
54     CALL CURVE(QX,XDUMY,AXIAL,Y,NAX,IERROR,1)
55     48 CALL CURVE(QAX,X(JX)/Z,AXIAL,Y,NAX,IERROR,1)
56     DFLUX = AFLUX*QAX*RADIAL(N)*POWER

```

258300
258400
258600
258700
258800
258900
259000
259100
259200
259300
259400
259500
259600
259700
259800
259900
260000
260100
260400
260500
260600
260700

260900

```

57      FLXTOT=0.
58      PRMTOT=0.
59      DO 50 L=1,LD
60      I = ISUP(L)
61      CALL CURVE(THCL,HI,I,J),TPOUT,HGPT,NPROP,IERFOR,I)
62      CALL PROP(2,J,JX,I,I)
63      IF(IFL.EQ.0)GO TO 49
64      QRAD=1.
65      IF(JX.GT.1.AND.QX.GT.0.001)QRAD=QAX/QX
66      IF(QRAD.EQ.0.1GO TO 46
67      TFLX(NS+L,JX)=FLX(NS+L,JX)*QRAD
68      DFLUX=TFLX(NS+L,JX)
69      GO TO 47
70      46 CALL PROP(2,J,JX,1,NCHANL)
71      CALL RODCONINROD,JX,T,HFILM,0.,DT)
72      IF(IRAD.GT.0)CALL RADIAT(JX)
73      TFLX(NS+L,JX)=FLX(NS+L,JX)
74      DFLUX=TFLX(NS+L,JX)
75      47 FLXTOT=FLXTOT+DFLUX*PHI(N,L)
76      PRMTOT=PRMTOT+PHI(N,L)
77      49 DTFLM = DFLUX/HFILM(I)
78      TCLO(L) = THCL + DTFLM
79      50 CONTINUE
80      IF(IFL.EQ.1)DFLUX=FLXTOT/PRMTOT
81      WRITE(6,280) XJ,DFLUX,DTFLM,(TCLO(L),L=1,LD)
82      C PRINT HEAT FLUXES FOR EACH SURFACE OF THE ROD
83      IF(IFL.EQ.0)RETURN
84      DO 466 L=1,LD
85      466 OUTPUT(L) = TFLX(NS+L,JX)
86      WRITE(6,963) (OUTPUT(L),L=1,LD)
87      RETURN
88      C
89      101 FORMAT(1H+,79X,7I7)
90      280 FORMAT(F7.1,F13.3,F9.1,1X,7F7.1)
91      282 FORMAT(1H )
92      959 FORMAT(/,41X,'CLADDING TEMPERATURES (DEG-C)',/,24X,4HFILM,
93      .68X,32HHEAT FLUXES (KW/M2) ,/,
94      .28H DISTANCE AVG FLUX DROP-,12,15X,21HFOR SUBCHANNEL NUMBER,
95      .29X,21HFOR SUBCHANNEL NUMBER,/,
96      .30H (MM) (KW/M2) (DEG-C),15,6I7)
97      963 FORMAT(1H+,79X,7F7.2)
98      END

```

262100
262200
262300

262600

263200

264500

264700

265000

265100

265200

265800

265900

266100

266400

266500

266600

266700

266900

QHDG

* C O B R A *

QPR,T,S

COBRA*CFIL,COBRA

FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:55

COBRA*CFIL(1).COBRA

1	INCLUDE SPEC1,LIST	
2	INCLUDE SPEC2,LIST	
3	INCLUDE SPEC3,LIST	
4	INCLUDE SPEC4,LIST	
5	INCLUDE SPEC5,LIST	
6	INCLUDE SPEC6,LIST	
7	INCLUDE SPEC7,LIST	
8	INCLUDE SPEC20,LIST	
9	INCLUDE SPEC52,LIST	
10	INCLUDE SPEC72,LIST	
11	INCLUDE SPEC61,LIST	
12	LOGICAL GRID	
13	REAL KPOUT	
14	REAL KF	
15	REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU	
16	C	
17	C	
18	C	
19	INCLUDE SPEC60,LIST	
20	C	
21	C	
22	C	
23	C	
24	C	
25	C	
26	C	
27	C	
28	C	
29	C	
30	C	
31	C	
32	C	
33	C	
34	C	
35	C	
36	C	
37	C	
38	C	
39	C	
40	C	
41	C	
42	C	
43	C	
44	C	
45	C	
46	C	
47	C	
48	C	
49	C	
50	C	
51	C	
52	C	
53	C	
54	C	
55	C	
56	C	

CALL ZEROIT
 GA-MAR81
 INCLUDE SPEC60,LIST
 UNITS 12,13, AND 18 ARE THE INPUT, OUTPUT, AND SAVE TAPE UNITS
 MP - MAXIMUM NUMBER OF CARDS IN PROPERTY TABLE.
 MC - MAXIMUM NUMBER OF SUBCHANNELS,
 MG - MAXIMUM NUMBER OF SUBCHANNEL GAP CONNECTIONS,
 ML - MAXIMUM NUMBER OF AXIAL LOCATIONS FOR GAP AND AREA VARIATION
 MX - MAXIMUM NUMBER OF AXIAL NODES PLUS ONE.
 MN - EQUAL TO 1
 MT - MAXIMUM NUMBER OF FRICTION AND HEAT TRANSFER CORRELATIONS
 MR - MAXIMUM NUMBER OF FUEL RODS.
 ME - EQUAL TO MX
 MZ - MAXIMUM NUMBER OF AXIAL LOCATIONS FOR GRID SPACERS
 MK - MAXIMUM NUMBER OF GRID SPACER TYPES
 MA - MAXIMUM NUMBER OF SUBCHANNELS THAT CAN HAVE AREA VARIATIONS.
 MS - MAXIMUM NUMBER OF GAPS THAT CAN HAVE GAP SPACING VARIATIONS,
 MW - MAXIMUM NUMBER OF WALL CONNECTIONS
 MY - MAXIMUM NUMBER OF RADIAL FUEL ROD DIVISIONS
 MO - MAXIMUM WIDTH OF AAA ARRAY (5 FOR HEX, 7 FOR HANGAR GEOMETRY)
 MI - MAXIMUM NUMBER OF CONNECTIONS TO A CHANNEL (THERMAL+ FLOW)
 NU - MAXIMUM NUMBER OF SURFACES FOR RADIATIVE HEAT TRANSFER
 CALL ELAPI
 NAAA=MO
 NAAAP1=NI
 NAAHP1=N1
 NAAH=MI+1
 NWR=M1
 I2=E
 I3=E
 WRITE(I3,664)
 WRITE(I3,665) MA,MC,ME,MG,MI,MK,ML,MO,MP,MR,MS,MT,MW,MX,MY,MZ,NU
 PI=355./113.
 GC=1.
 JUMP=0
 ISAVE=0
 READ (I2,680) MAXT
 IF (MAXT.EQ.0) MAXT=1000
 READ INPUT DATA WITH SETUP SUBROUTINE

GA-MAR81

283300

284000

284100

284200

284300

284400

284700

285000

285100

285200

285300

285700

287200

287300

287400

287500

288600

288700

289200

289500

289300

290200

290600

290700

292300

292900

D-16

57	C		293000
58		110 CALL SETUP	293100
59	C		293300
60		IF (IERROR.GT.0.OR.KASE.LT.1) STOP	293500
61		SAVEDT=DT	
62		NDTP1=NDT+1	293800
63	C		293900
64	C	START TIME LOOP	294000
65	C		294100
66		DO 650 NT=1,NDTP1	
67		IERROR=0	294600
68		IF (NT.EQ.1) DT=1.E+10	295300
69		DO 140 I=1,NCHANL	295500
70		AN(I)=AC(I)	
71		DHYDN(I)=DC(I)	
72	140	PERIM(I)=PW(I)	
73		IF (NT.NE.2) GO TO 150	
74		NRAMP=1	296200
75		NARAMP=1	296300
76		DT=AMIN1(DT,SAVEDT)	
77	150	CONTINUE	296500
78		ETIME=ETIME+DT	296600
79		IF (NT.EQ.1) ETIME=0.	296700
80	C	ESTABLISH CHANNEL BOUNDARY CONDITIONS AND FORCING FUNCTION VALUES.	296800
81		DUMY=1.	296900
82		IF (INP.GT.1) CALL CURVE (DUMY,ETIME,FP,YP,NP,IERROR,1)	297000
83		IF (IERROR.GT.1) GO TO 660	297100
84		PREF=DUMY*PEXIT	297200
85		DUM=ABS(PREF-PREFOL)/PREF	297800
86		IF (DUM.LT..001) GO TO 160	297900
87		PREFOL=PREF	298000
88		TF = TIN-5.	
89		CALL PROP (1,1,1,1,NCHANL)	298200
90	160	CONTINUE	298300
91		IF (IERROR.GT.1) GO TO 660	298400
92		DUMY=1.	298500
93		IF (INH.GT.1) CALL CURVE (DUMY,ETIME,FH,YH,NH,IERROR,1)	298600
94		IF (IERROR.GT.1) GO TO 660	298700
95		DO 170 I=1,NCHANL	298800
96		HOLD(I,1)=H(I,1)	298900
97		H(I,1)=HINLET(I)*DUMY	299000
98		IF (IH.NE.1.AND.IH.NE.3) GO TO 170	299100
99		VIN=TINLET(I)*DUMY	299200
100		CALL CURVE (VOUT,VIN,HGPT,TPOUT,NPROP,IERROR,1)	
101		H(I,1)=VOUT	299500
102	170	HI=H(I,1)	299600
103		CALL CURVE (VOUT,HI,TPOUT,HGPT,NPROP,IERROR,1)	300400
104		CALL CURVE (VI,HI,VPOUT,HGPT,NPROP,IERROR,2)	300500
105		T(I)=VOUT	300600
106		RHO(I,1)=1./VI	300700
107	190	CONTINUE	301100
108	220	DUMY=1.	302200
109		IF (ING.GT.1) CALL CURVE (DUMY,ETIME,FG,YG,NG,IERROR,1)	302300
110		IF (IERROR.GT.1) GO TO 660	302400
111		DO 300 I=1,NCHANL	304000
112	300	F(I,1)=FINLET(I)*DUMY	304100
113		DUMY=1.	304600

* C O B R A *

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114	IF (NQ.GT.1) CALL CURVE (DUMY,ETIME,FQ,YQ,NQ,IERROR,1)	304700
115	IF (IERROR.GT.1) GO TO 660	304800
116	POWER=DUMY	304900
117	IDTGC=1./(DT*GC)	308500
118	DTGC=DT*GC	308600
119	SLDT=SL/DT	308700
120	SLDT2=SLDT/DT	308800
121	C IMPLICIT SOLUTION	309300
122	CALL SCHEME (NTRIES,JUMP,MAXT)	
123	IF (IERROR.GT.1) GO TO 530	310100
124	IF (JUMP.LT.1.OR.JUMP.GT.3) GO TO 660	310900
125	IF (JUMP.GE.2) GO TO 530	311000
126	WRITE (I3,670) NTRIES	311100
127	IERROR=1	311300
128	530 DO 620 J=1,NDXP1	
129	IF (J.EQ.1) FININ=F(1,J)	
130	IF (J.EQ.NDXP1) FINOUT=F(1,J)	
131	IF (NK.EQ.0) GO TO 570	319300
132	DO 560 K=1,NK	319400
133	560 WOLD(K,J)=W(K,J)	319500
134	570 CONTINUE	319600
135	IF (J.EQ.1) MININ=H(1,1)	
136	DO 580 I=1,NCHANL	319800
137	FOLD(I,J)=F(I,J)	
138	HOLD(I,J)=H(I,J)	320000
139	RHOLD(I,J)=RHO(I,J)	320100
140	580 CONTINUE	320300
141	IF (NWK.EQ.0) GO TO 600	320400
142	DO 590 K=1,NWK	320500
143	590 TWOLD(K,J)=TWALL(K,J)	320600
144	600 CONTINUE	320700
145	620 CONTINUE	321300
146	ISAVE=IERROR	322000
147	IERROR=0	322100
148	C	322200
149	C	323300
150	C PRINT RESULTS WITH SUBROUTINE RESULT(NT)	323400
151	C	323500
152	C CALL RESULT(NT)	323600
153	C	323700
154	C IF (IERROR.GT.0.OR.ISAVE.GT.0) GO TO 660	323800
155	C	
156	650 CONTINUE	
157	C	
158	WRITE (I3,720)	325200
159	660 IF (IERROR.GT.0) WRITE (I3,690) SIGNAL(IERROR)	325500
160	IF (ISAVE.GT.0) WRITE (I3,690) SIGNAL(ISAVE)	325600
161	CALL ELAP(ETIME)	
162	WRITE(I3,740) MTIME	
163	GO TO 110	326700
164	C	326800
165	C	
166	664 FORMAT(1H1,15X,20I' * '),//,34X,'THIS IS THE OAK RIDGE NATIONAL	
167	LABORATORY VERSION OF THE',//,38X,49HCOBRA-IV THERMAL/	
168	.HYDRAULIC ANALYSIS COMPTER CODE ,//,24X,62HADAPTED FROM THE BNWL	327500
169	.PROGRAM COBRA-IV-I WITH UPDATES THROUGH , 'FX 15',7H DATED ,	
170	.'062480',1H.)	

171	665 FORMAT(27HOCOBRA DIMENSION PARAMETERS /		327700
172	*5H MA =I5,5X'SUBCHANNELS WITH AREA VARIATIONS	GRP 5'/	327800
173	*5H MC =I5,5X'SUBCHANNELS	GRP 4'/	327900
174	*5H ME =I5,5X'(I=MX)	GRP 9'/	328000
175	*5H MG =I5,5X'SUBCHANNEL GAP CONNECTIONS	GRP 4'/	328100
176	*5H MI =I5,5X'CONNECTIONS TO A CHANNEL(THERMAL+FLOW)	GRP 0'/	328200
177	*5H MK =I5,5X'GRID SPACER TYPES	GRP 7'/	328300
178	*5H ML =I5,5X'AXIAL LOCATIONS FOR GAP AREA VARIATIONS	GRP 5'/	328400
179	*5H MO =I5,5X'WIDTH OF AAA ARRAY(TRIANGLE=5, HANGAR=7)	GRP 0'/	328600
180	*5H MP =I5,5X'CARDS IN COOLANT PROPERTY TABLE	GRP 1'/	328700
181	*5H MR =I5,5X'RODS	GRP 8'/	328800
182	*5H MS =I5,5X'GAPS WITH GAP SPACING VARIATIONS	GRP 6'/	328900
183	*5H MT =I5,5X'CORRELATIONS	GRP 2'/	329000
184	*5H MW =I5,5X'THERMAL CONNECTIONS	GRP 4'/	329100
185	*5H MX =I5,5X'AXIAL NODES PLUS ONE	GRP 9'/	329200
186	*5H MY =I5,5X'RADIAL ROD DIVISIONS	GRP 8'/	329300
187	*5H MZ =I5,5X'AXIAL LOCATIONS FOR GRID SPACERS	GRP 7'/	329400
188	*5H NU =I5,5X'SURFACES	GRP 3'/	329500
189	670 FORMAT (/1X,50H EXTERNAL CONVERGENCE CRITERIA NOT SATISFIED AFTER,		329600
190	*I4,11H ITERATIONS)		329700
191	680 FORMAT (10I5)		329800
192	690 FORMAT (/1X,24H * * * ERROR IN PROGRAM ,A6,17H CALCULATION FOR,19		329900
193	*H THIS CASE STOPPED.,3(4H * *)		330000
194	710 FORMAT (1X,47H * * * ABNORMAL EXIT. MAX TIME EXCEEDED. * * *)		330200
195	720 FORMAT (/1X,41H SPECIFIED NUMBER OF TIME STEPS COMPLETED)		330300
196	740 FORMAT (/1X TOTAL ELAPSED TIME IS'I4,1X8HSECONDS.)		330500
197	END		

@HDG

* C O N R O D *

@PRT,S COBRA*CFIL.CONROD
 FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:55

COBRA*CF TL(1).CONROD

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1  SUBROUTINE CONROD(A,T,RHS,Q,QPRIME,QRAD,TB,HT,THETA,DT,
2  1 MSP1,MS,NDIM,NR)
3  INCLUDE SPEC6,LIST
4  C  DIMENSION IPV T(29)
5  DIMENSION QRAD(1)
6  DIMENSION T(1),Q(1),QPRIME(1),TB(1),HT(1),THETA(1)
7  DIMENSION A(MSP1,1),RHS(1)
8  DIMENSION R(1),CP(1),XK(1),RHO(1)
9  EQUIVALENCE (R(1),RF(1)),(CP(1),CPF(1)),(XK(1),XKF(1)),
10 (RHO(1),RHOF(1))
11 DR(I)=0.5E0*(R(I)-R(I-1))
12 DST(I,J)=(R(I-1)+DR(I))*10.5E0*(THETA(J)+THETA(J+1))
13 DATA PI/3.141592653589793E0/
14 DO 10 J=1,NDIM
15 DO 10 I=1,MSP1
16 10 A(I,J)=0.E0
17 CRP1=R(1)*(1.E0/(R(1)/XK(1)+DR(2)/XK(2)+1.E0/HGAP(1)))
18 CS=RHO(1)*PI*(R(1)*R(1)*CP(1)/DT
19 CG=QPRIME(1)
20 C  WRITE(6,10210)CRP1,CS,CG
21 C10210 FORMAT(' CRP1/CS/CG',3G16.6)
22 DO 20 J=1,MS
23 CRP1T=THETA(J)*CRP1
24 C  A(1,1)=CRP1T+A(1,1)
25 A(MS+1,1)=CRP1T+A(MS+1,1)
26 C  10 A(1,J+1)=-CRP1T
27 20 A(MS-J+1,J+1)=-CRP1T
28 C  10 A(1,J+1)=-CRP1T
29 A(MS+1,1)=A(MS+1,1)+CS
30 C  A(1,1)=A(1,1)+CS
31 RHS(1)=CS*T(1)+CG
32 C  WRITE(6,10012)(A(1,J),J=1,8),RHS(1)
33 C10012 FORMAT(1H ,16F8.3)
34 NRM1=NR-1
35 DO 90 I=2,NRM1
36 II=(I-2)*MS+1
37 CRM1=R(I-1)*(1.E0/(DR(I-1)/XK(I-1)+DR(I)/XK(I)+1.E0/HGAP(I-1)))
38 CRP1=R(I)*(1.E0/(DR(I)/XK(I)+DR(I+1)/XK(I+1)+1.E0/HGAP(I)))
39 CS=RHO(I)*PI*(R(I)*R(I)-R(I-1)*R(I-1))*CP(I)/DT
40 CG=QPRIME(I)/(2.E0*PI)
41 DO 90 J=1,MS
42 CRP1T=THETA(J)*CRP1
43 IF(I.EQ.2)GOTO30
44 CRM1T=THETA(J)*CRM1
45 GOTO40
46 30 CRM1T=-A(MS-J+1,J+1)
47 C  6 CRM1T=-A(1,J+1)
48 40 CONTINUE
49 IF(J.EQ.1)GOTO50
50 CTM1=(R(I)-R(I-1))*XK(I)/DST(I,J-1)
51 C  JM1=J-1
52 GOTO60
53 50 CTM1=(R(I)-R(I-1))*XK(I)/
54 1 ((R(I-1)+DR(I))*0.5E0*(THETA(1)+THETA(MS)))
55 C  JM1=MS
56 60 IF(J.EQ.MS)GOTO70

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57      CTP1=(R(I)-R(I-1))*XK(I)/DST(I,J)
58      JP1=0
59      JM1=1
60      C      JP1=J+1
61      GOT080
62      70 CTP1=(R(I)-R(I-1))*XK(I)/
63      1 ((R(I-1)+OR(I))*0.5E0*(THETA(1)+THETA(MS)))
64      JP1=2-MS
65      JM1=0
66      C      JP1=1
67      80 CST=THETA(J)*CS
68      CGT=THETA(J)*CG
69      A(MS+1,II+J)=CRP1T+CRM1T+CTP1+CTM1+CST
70      C      A(II+J,II+J)=CRP1T+CRM1T+CTP1+CTM1+CST
71      A(MS+JP1,II+J+JM1)=-CTP1
72      C      A(II+J,II+JP1)=-CTP1
73      C      A(II+J,II+JM1)=-CTM1
74      A(1,II+J+MS)=-CRP1T
75      C      A(II+J,II+J+MS)=-CRP1T
76      C      A(II+J,MAX0(1,II+J-MS))=-CRM1T
77      RHS(II+J)=CST+T(II+J)+CGT
78      C      JJJ=MAX0(1,II+J-MS)
79      C      JJJJ=JJJ+14
80      C      WRITE(6,10012)(A(II+J,JJ),JJ=JJJ,JJJJ),RHS(II+J)
81      90 CONTINUE
82      II=(NR-2)*MS+1
83      CRM1=R(NR-1)*(1.E0/(DR(NR-1)/XK(NR-1)+
84      1 DR(NR)/XK(NR)+1.E0/HGAP(NR-1)))
85      CS=RHO(NR)*PI*(R(NR)*R(NR)-R(NR-1)*R(NR-1))/DT
86      CG=OPRIM(NR)/(2.E0*PI)
87      DO 140 J=1,MS
88      CRM1T=THETA(J)*CRM1
89      CPP1T=THETA(J)*R(NR)*(1.E0/(DR(NR)/XK(NR)+1.E0/HT(J)))
90      IF(J.EQ.MS)GOTO100
91      CTP1=(R(NR)-R(NR-1))*XK(NR)/DST(NR,J)
92      JP1=0
93      JM1=1
94      C      JP1=J+1
95      GOT0110
96      100 CTP1=(R(NR)-R(NR-1))*XK(NR)/((R(NR-1)+
97      1 DR(NR))*0.5E0*(THETA(1)+THETA(MS)))
98      JP1=2-MS
99      JM1=0
100     C      JP1=1
101     110 IF(J.EQ.1)GOTO120
102     CTM1=(R(NR)-R(NR-1))*XK(NR)/DST(NR,J-1)
103     C      JM1=J-1
104     GOT0130
105     120 CTM1=(R(NR)-R(NR-1))*XK(NR)/((R(NR-1)+
106     1 DR(NR))*0.5E0*(THETA(1)+THETA(MS)))
107     C      JM1=MS
108     130 CST=THETA(J)*CS
109     CGT=THETA(J)*CG
110     A(MS+1,II+J)=CRP1T+CRM1T+CTP1+CTM1+CST
111     C      A(II+J,II+J)=CRP1T+CRM1T+CTP1+CTM1+CST
112     A(MS+JP1,II+J+JM1)=-CTP1
113     C      A(II+J,II+JP1)=-CTP1

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114 C      A(II+J,II+JM1)=-CTM1
115 C      A(II+J,II+J-MS)=-CPM1T
116       RHS(II+J)=CST*T(II+J)+CGT*CRP1T*TB(J)
117 C FUDGE RADIANT HEAT TRANSFER AS IF HEAT SOURCE FOR INTERIM
118       RHS(II+J)=RHS(II+J)-QRAD(J)
119 C NEED TO CHECK ON SIGN CONVENTION FOR QRAD
120 C (SUBTRACT IF RADIANT HEAT LEAVES SURFACE)
121 C
122 C      JJJ=MAX0(1,II+J-MS)
123 C      JJJJ=JJJ+14-J
124 C      WRITE(6,10012)((A(II+J,J),J=JJJ,JJJJ),RHS(II+J))
125 140 CONTINUE
126 C      WRITE(6,10313)((A(I,J),I=1,MSP1),J=1,NDIM)
127 C10313 FORMAT(1H ,29(8F13.3,/))
128       NMAX=(NR-1)*MS+1
129       CALL SPBFA(A,MSP1,NMAX,MS,INFO)
130 C      CALL DECOMP(NDIM,NMAX,A,COND,IPVT,WORK)
131       IF(INFO.NE.0)WRITE(6,10010)INFO
132 C      IF(COND.GE.1.E0)WRITE(6,10013)COND
133 C10013 FORMAT(' CONDITION NUMBER ',G13.6)
134       CALL SPBSL(A,MSP1,NMAX,MS,RHS)
135 C      CALL SOLVE(NDIM,NMAX,A,RHS,IPVT)
136       DO 150 J=1,NMAX
137 150 T(J)=RHS(J)
138       DO 160 J=1,MS
139 C DETERMINE IF SURFACE OR LINEAR HEAT FLUX IS DESIRED
140       IS = (NR-2)*MS+1+J
141 160 Q(J)=(T(IS)-TB(J))/
142 C 40 Q(J)=(T((NR-2)*MS+1+J)-TB(J))*R(NR)*THETA(J)/
143 1 (0.5E0*(R(NR)-R(NR-1))/KK(NR)+1.E0/HT(J))
144       RETURN
145 10010 FORMAT(' INFO ',I5)
146       END

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GA-MAR81
GA-MAR81

@HOG * C U R V E *

@PRT,S COBRA*CFIL.CURVE
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:56

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COBRA*CFIL(1).CURVE
1      SUBROUTINE CURVE(FX,X,F,Y,N,J,ISAVE)
2      DIMENSION F(1),Y(1)
3      I3=6
4      C
5      C      FX - QUANTITY TO BE FOUND
6      C      X - INDEPENDENT VARIABLE
7      C      F - INPUT ARRAY FOR THE ORDINATE(MONOTONIC WITH Y)
8      C      Y - INPUT ARRAY FOR THE ABCISSA (MONOTONIC INCREASE)
9      C      N - NUMBER OF F(I) OR Y(I) VALUES
10     C      J - ERROR SIGNAL, J=10
11     C
12     IF (ISAVE.LT.1.OR.ISAVE.GT.2) GO TO 170
13     GO TO (100,150), ISAVE
14     100 DO 120 I=1,N
15         IF (X-Y(I)) 130,110,120
16     110 IF (I.EQ.N) GO TO 140
17     120 CONTINUE
18         GO TO 160
19     130 IF (I.EQ.1) GO TO 160
20     140 CONTINUE
21         IF (ABS(Y(I))-Y(I-1)).GT.1.0E-20) GO TO 145
22         WRITE(I3,190)
23         WRITE(I3,180) FX,X,(F(I),Y(I),I=1,N)
24         CALL ERROR
25     145 B = (X - Y(I-1))/(Y(I) - Y(I-1))
26     150 FX=F(I-1)+B*(F(I)-F(I-1))
27         RETURN
28     160 WRITE (I3,180) FX,X,(F(I),Y(I),I=1,N)
29     170 J=10
30         RETURN
31     C
32     C
33     180 FORMAT (49H TABULAR LOOKUP FAILED IN SUBROUTINE CURVE, FX = ,E12.6
34         +,6H X =,E12.6/(10E12.4))
35     190 FORMAT(//' DIVISION BY ZERO IN SUBROUTINE CURVE.')
36         END

```

```

10000
10100
10200
10300
10400
10500
10600
10700
10800
10900
11000
11100
11200
11300
11400
11500
11600
11700
11800
11900
12000
12100
12200
12400
12500
12600
12700
12800
12900
13000
13100
13200
13300
13400
13500

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@HDC      * D I F F E R *

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@PRT,S      COBRA*CFIL.DIFFER
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:56

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COBRA*CFIL(1).DIFFER

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1  SUBROUTINE DIFFER(IPART,J,JX)
2  INCLUDE SPEC1,LIST
3  INCLUDE SPEC2,LIST
4  INCLUDE SPEC3,LIST
5  INCLUDE SPEC5,LIST
6  INCLUDE SPEC10,LIST
7  INCLUDE SPEC19,LIST
8  INCLUDE SPEC51,LIST
9  INCLUDE SPEC52,LIST
10 INCLUDE SPEC53,LIST
11 INCLUDE SPEC56,LIST
12 INCLUDE SPEC57,LIST
13 INCLUDE SPEC71,LIST
14 INCLUDE SPEC72,LIST
15 INCLUDE SPEC73,LIST
16 INCLUDE SPEC76,LIST
17 INCLUDE SPEC77,LIST
18 LOGICAL GRID
19 REAL KPOUT
20 REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
21 S(K,I)=AMINO(1,IABS(I-JK(K)))-AMINO(1,IABS(I-IK(K)))
22
23 C      JMI=J-1+1/JX
24      JPRM=(J-1)*NWR
25      IF (IPART.LT.1.OR.IPART.GT.4) GO TO 480
26      GO TO (100,270,330,450), IPART
27
28 C      PART 1, CALCULATE DH/DX FOR STEADY STATE AT X AND T.
29 100 CONTINUE
30      DO 140 I=1,NCHANL
31      HH=H(I,J)
32      VIN=HH
33      CALL CURVE (VOUT,VIN,KPOUT,HGPT,NPROP,IERROR,1)
34      CON(I)=VOUT
35      CALL CURVE (VOUT,VIN,TPOUT,HGPT,NPROP,IERROR,2)
36      T(I)=VOUT
37      CALL CURVE (VOUT,VIN,CPPEUT,HGPT,NPROP,IERROR,2)
38      CP(I)=VOUT
39      TMH(I)=T(I)-H(I,J)/CP(I)
40 140 CONTINUE
41      IF (IERROR.GT.1) GO TO 480
42      IF (INWK.LE.0) GO TO 160
43      DO 150 K=1,NWK
44      II=IKW(K)
45      JJ=JKW(K)
46      UWALL(1,K)=1./(RWALL(1,K)+1./HFILM(II))
47      UWALL(2,K)=1./(RWALL(2,K)+1./HFILM(JJ))
48      UWCP(1,K)=UWALL(1,K)/CP(II)
49      UWCP(2,K)=UWALL(2,K)/CP(JJ)
50 150 CONTINUE
51 160 CONTINUE
52      IF (J5.EQ.0) GO TO 166
53      DO 165 K=1,NK
54      II=IK(K)
55      JJ=JK(K)
56 165 CONK(K)=(CON(II)+CON(JJ))*5*SAPI(K,J)/LENGTH(K)*GK

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361800
362000
362300
362500
362800
362900
363000
363100
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363300
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365100
365200
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366900
367000
367100
367200
367300
367400
367500
367600
367700
367800
367900
368000

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57      166 CONTINUE                                368200
58          DO 170 I=1,NCHANL                        368300
59          CON(I)=CON(I)/CP(I)                      368400
60      170 DHDX(I)=QPRIM(I)                        368500
61          IF(INK.EQ.0) GO TO 240                    369600
62          DO 230 K=1,NK                            369700
63          II=IK(K)                                369800
64          JJ=JK(K)                                369900
65          IW=IFIX(SIGN(1.,W(K,J)))                 370000
66          ISTAR(K)=IDIM(IW,D)*II+IDIM(0,IW)*JJ     370100
67          IF(J5.NE.0) WPP(K)=WP(K)-CONK(K)*(T(II)-T(JJ))/(H(JJ,J)-H(II,J) 370200
68              +1.E-6)
69      230 CONTINUE
70      240 CONTINUE                                370900
71          GO TO 470                                372000
72      C                                            372100
73      C      PART 2, CALCULATE CIJ(K) AND CROSSFLOW MOMENTUM FLUX TERM IF SPECI 372200
74      270 DO 280 K=1,NK                            372300
75          II=IK(K)                                372400
76          JJ=JK(K)                                372500
77          DUMY=GAP(K,J)
78          RSTAR=RHO(II,J)
79          IF(W(K,J).LT.0.) RSTAR=RHO(JJ,J)
80          WP(K)=GC*RSTAR*DUMY*DUMY
81      280 BETA(K,J)=0.                                372800
82      C                                            372900
83          IF (K12.EQ.0) GO TO 310                    373000
84          DO 300 KK=1,NK                            373100
85          III=IK(KK)                                373200
86          JJJ=JK(KK)                                373300
87          SAVE=0.                                    373400
88          IEND=LOCA(NAAAP1,KK)                      373500
89          DO 290 L=1,IEND                            373600
90          K=LOCA(L,KK)                              373700
91          WW=W(K,J)
92      290 SAVE=SAVE+COS(ANGLE(K)-ANGLE(KK))*WW*WW*(S(K,III)+S(K,JJJ))/WP(K) 373900
93      300 BETA(KK,J)=SAVE                            374000
94      C                                            374100
95      310 DO 320 K=1,NK                            374200
96      320 CIJ(K)=AMAX1(.001,ABS(W(K,J)))*KIJ*.5/WP(K) 374300
97          RETURN                                    374400
98      C                                            374500
99      C      PART 3, CALCULATE DP/DX WITHOUT W      374600
100     330 CONTINUE                                374700
101     350 IF (.NOT.GRID) GO TO 370                    374800
102         IF (NRAMP.LE.0) GO TO 480                    374900
103         DUMY=AMIN1(1.,FLOAT(ITERAT)/FLOAT(NRAMP)) 375000
104         IF(DT.LT.1.E6) DUMY=1.                    375100
105         DO 360 I=1,NCHANL                          375200
106         CDI = CD(I,NGTYPE)**CDC1(NGTYPE)*          375300
107             (CDC2(NGTYPE) + CDC3(NGTYPE)/RENO(I,J) **CDC4(NGTYPE)) 375400
108     360 DPK(I) = .5*CDI/(RHO(I,J)*DX)*DUMY          375500
109     370 DO 380 I=1,NCHANL                          375600
110         AIJI=1./A(I,J)                            375700
111         APPI=1./APPI(I,J)                          375800
112         FMI=F(I,JM1)                                375900
113         DPK(I)=(DPK(I)+.5*FSP(I)*V(I)/OHYD(I,J))*AIJI*AIJI 376000

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114	TERM1(I)=SIGN(OPK(I),F(I,J))	376100
115	TERM2(I)=V(I)*AIJI*APPI	
116	DPDX(I)=(-TERM1(I)-(TERM2(I)-VPA(I)*APPI)*DXI)*FM1*FM1/GC	376300
117	* -RHO(I,J)*ELEV*9.80	
118	380 FLOW(I)=F(I,J)+FM1	376500
119	IF(DT.GT.1.E6) GO TO 400	376600
120	DO 390 I=1,NCHANL	376700
121	RHODOT=(RHO(I,J)-RHODOT(I,J))/DT	376800
122	DPDX(I)=DPDX(I)+(FOLD(I,J)-F(I,JM1))/APP(I,J)/DTGC+RHODOT/GC*(DXID	376900
123	+T*FLOW(I)+V(I)/A(I,J)+DPK(I)*FLOW(I)*APP(I,J)*DX)	
124	390 CONTINUE	377100
125	400 CONTINUE	377200
126	IF (FTM.LE.0..OR.NK.EQ.0) GO TO 440	377300
127	C	377400
128	DO 410 I=1,NCHANL	377500
129	410 DPWP(I)=0.	377600
130	DO 420 K=1,NK	377700
131	II=IK(K)	377800
132	JJ=JK(K)	377900
133	DUMY=(UB(II,J)-UB(JJ,J))*WP(K)	378000
134	DPWP(II)=DPWP(II)+DUMY	378100
135	420 DPWP(JJ)=DPWP(JJ)-DUMY	378200
136	DO 430 I=1,NCHANL	
137	430 DPDX(I)=DPDX(I)-DPWP(I)/APP(I,J)/GC*FTM	378400
138	440 CONTINUE	378500
139	GO TO 470	378600
140	C	378700
141	C	378800
142	PART 4, CALCULATE DP/DX WITH W	378900
143	450 IF (J.EQ.1) RETURN	
144	DO 460 L=1,NK	
145	II=IK(L)	379100
146	JJ=JK(L)	379200
147	LPRM=L+JPRM	379300
148	DPDX(II)=DPDX(II)+WPRM(LPRM)*DTII(L)/GC	379400
149	DPDX(JJ)=DPDX(JJ)-WPRM(LPRM)*DTJJ(L)/GC	379500
150	460 CONTINUE	379600
151	470 RETURN	379700
152	480 IERROR=2	379800
153	RETURN	379900
	END	380000

ENDG

* D I V E R T *

APRT,S COBRA+CFIL.DIVERT
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:56

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COBRA*CFIL(1).DIVER T
1      SUBROUTINE DIVER T(J,JX)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC3,LIST
5      INCLUDE SPEC25,LIST
6      INCLUDE SPEC26,LIST
7      INCLUDE SPEC51,LIST
8      INCLUDE SPEC52,LIST
9      INCLUDE SPEC53,LIST
10     INCLUDE SPEC56,LIST
11     INCLUDE SPEC57,LIST
12     INCLUDE SPEC71,LIST
13     INCLUDE SPEC72,LIST
14     INCLUDE SPEC73,LIST
15     INCLUDE SPEC76,LIST
16     INCLUDE SPEC77,LIST
17     LOGICAL GRID
18     REAL KPOUT
19     REAL KF
20     REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
21     SIK(K,I)=1.-AMINO(1,IABS(I-IK(K)))
22     SJK(K,J)=1.-AMINO(1,IABS(J-JK(K)))
23     S(K,I)=SIK(K,I)-SJK(K,I)
24     DTU(I,IP,KP)=(DXIDT-USPRM(KP))/APPPRM(IP)+(TERM2(I)+TERM1(I)*DX)*F
25     +LOW(I)
26     SLDXGC=SLDX/GC
27     WERRYT=AMAX1(WERRY,AMIN1(.01,QOM*.01))
28     JM1=J-1
29     USWFAC=1.-FLOAT(1/ITERAT)
30     ADONOR=USDON*USWFAC
31     JPRM=JM1*NWR
32     JPRMM1=JPRM-NWR
33     M=NAAA*NK
34     DO 100 K=1,M
35     100 AAAPRM(K)=0
36     M=1
37     C
38     CALL DIFFER (2,J,JX)
39     C
40     DO 110 K=1,NK
41     II=IK(K)
42     JJ=JK(K)
43     IIPRM=JPRM+II
44     JJPRM=JPRM+JJ
45     KPRM=JPRM+K
46     KPRMM1=JPRMM1+K
47     WSAVE(K)=WPRM(KPRM)
48     C THE CROSSFLOW RESISTANCE IS TRANSFERRED IN B(K) FROM ST
49     AAAPRM(M)=CIJ(K)*SL
50     C
51     USWPRM(KPRMM1)=USPRM(KPRMM1)*WPRM(KPRMM1)
52     B(K)=((SPPRM(KPRM)-BETPRM(KPRM))*DXI-DPOX(II)+DPD
53     +X(JJ))*SLDX+WLODPM(KPRM)/DTGC+USWPRM(KPRMM1)
54     B(K)=B(K)+USWFAC*USWPRM(KPRM)
55     WKJ=SIGN(1.,WPRM(KPRM))
56     USPRM(KPRM)=UBPRM(IIPRM)*(1.5+ADONOR*(DIM(WKJ,0.)-.5))+UBPRM(JJPRM)

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384100

384200

384400

384500

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384900

385000

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57 **(.5*ADONOR*(DIM(O.,WKJ)-.5)) 385100
58 DTII(K)=DTU(II,IIPRM,KPRM) 385200
59 DTJJ(K)=DTU(JJ,JJPRM,KPRM) 385300
60 USPRM(KPRM)=USPRM(KPRM)/DXGC 385400
61 AAAPRM(M)=AAAPRM(M)+(1.+US*FAC)*USPRM(KPRM)+IDTGC 385500
62 M=M+NAAA 385600
63 110 CONTINUE 385700
64 C SET UP THE SIMULTANEOUS EQUATIONS 385800
65 M=0 385900
66 N=0 386000
67 DO 140 K=1,NK
68 AAAMAX=0. 386200
69 NLOOP=LOCAL(NAAAP1+N) 386300
70 II=IK(K) 386400
71 JJ=JK(K) 386500
72 DO 120 IL=1,NLOOP 386600
73 MPRM=M+IL 386700
74 MPRM1=N+IL 386800
75 L=LOCAL(MPRM1) 386900
76 DUMMY=(SIK(L,II)-SIK(L,JJ))*DTII(L)-(SJK(L,II)-SJK(L,JJ))*DTJJ(L) 387000
77 AAAPRM(MPRM)=DUMMY*SLDXGC+AAAPRM(MPRM)
78 AAAMAX=AMAX1(ABS(AAAPRM(MPRM)),AAAMAX) 387200
79 120 CONTINUE 387300
80 IF (AAAMAX.EQ.ABS(AAAPRM(M+1))) GO TO 130 387400
81 IERROR=3 387500
82 WRITE(I3,291) ((AAA(L,LL),L=1,NAAA),B(LL),LL=1,NK)
83 RETURN 387800
84 130 M=M+NAAA 387900
85 N=N+NAAAP1 388000
86 140 CONTINUE 388100
87 C 388200
88 C PRE-INITIALIZATION OF W 388300
89 IF(ITERAT.GT. 1 .OR. DT .LT. 1.E8) GO TO 160 388400
90 DO 150 K=1,NK 388500
91 150 W(K,J)=W(K,J)*FDIV(K)+W(K,JM1)*(1.-FDIV(K)) 388600
92 160 CONTINUE 388700
93 C 388800
94 C ORDER SOLUTION VIA FORCED OR NOT FORCED W. 388900
95 NF=0 389000
96 NBACK=NK+1 389100
97 M=0 389200
98 DO 180 K=1,NK 389300
99 KM1=K-1 389400
100 M=KM1+NAAA 389500
101 N=KM1+NAAAP1 389600
102 ANORM=ACCELY/AAAPRM(M+1) 389700
103 B(K)=B(K)*ANORM 389800
104 NLOOP=LOCAL(N+NAAAP1) 389900
105 DO 170 L=1,NLOOP 390000
106 MPRM=M+L 390100
107 170 AAAPRM(MPRM)=AAAPRM(MPRM)*ANORM 390200
108 IFADD=IFIX(1.-FDIV(K)) 390300
109 IBADD=IFIX(FDIV(K)) 390400
110 NF=NF+IFADD 390500
111 NBACK=NBACK-IBADD 390600
112 180 MARK(NF+IFADD+NBACK+IBADD,1)=K
113 C 390800

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114 C      PERFORM ITERATIVE SOLUTION (GAUSS-SEIDEL WITH OVER-RELAXATION)      390900
115      IF (INF.LE.0) GO TO 220
116      DO 210 I=1,ITRY      391000
117      ISAVE=I      391100
118 C      391200
119 C      SUCCESSIVE SUBSTITUTION SOLUTION SCHEME      391300
120      QUAN=0.      391400
121      DO 200 KW=1,NF      391500
122      K=MARK(KW,1)
123      C=B(K)      391700
124      KM1=K-1      391800
125      M=KM1*NAAA      391900
126      N=KM1*NAAAP1      392000
127      IEND=LOCAL(N+NAAAP1)      392100
128      DO 190 IL=1,IEND      392200
129      L=LOCAL(N+IL)      392300
130      C=C-AAAPRM(M+IL)*WPRM(L+JPRM)      392400
131 C      SOLVE FOR CROSSFLOWS IF NO FORCED DIVERSION      392500
132      KPRM=K+JPRM      392600
133      WPRM(KPRM)=WPRM(KPRM)+C      392700
134      ERROR=ABS(C)/(ABS(WPRM(KPRM))+1.E-6)
135      QUAN=AMAX1(QUAN,ERROR)      392900
136      200 CONTINUE      393000
137 C      CHECK INTERNAL CONVERGENCE      393100
138      QIM=AMAX1(QIM,QUAN)      393200
139      IF (ISAVE.LT.ITRYM) GO TO 210      393300
140      IF (QUAN.LT.WERRYT) GO TO 220      393400
141      210 CONTINUE      393500
142      220 CONTINUE      393600
143      ISAVT=ISAVT+ISAVE      393700
144      IF (JX.NE.NDXP1) GO TO 240      393800
145 C      INITIALIZE USW AT J=NDXP1      393900
146      DO 230 K=1,NK      394000
147      USW(K,J)=US(K,J)*W(K,J)      394100
148      240 CONTINUE      394200
149      IF (ICOUNT.EQ.0) GO TO 250      394300
150      IF (MOD(ITERAT,4).NE.1) GO TO 270      394400
151      WBAR(JX)=0.      394500
152      DO 260 K=1,NK      394600
153      WBAR(JX)=WBAR(JX)+ABS(W(K,J))      394700
154      WBAR(JX)=WBAR(JX)/FLOAT(NK)      394800
155      270 CONTINUE      394900
156      IERROR=0      395000
157      QUAN=0.      395100
158      DO 280 K=1,NF      395400
159      KPRM=JPRM+K
160      ABW=ABS(WPRM(KPRM))+1.E-6      395600
161      QDUM=(WBAR(JX)/ABW)**2*.001+ABW      395700
162      QUAN=AMAX1(ABS((WPRM(KPRM)-WSAVE(K))/QDUM),QUAN)      395800
163      280 CONTINUE      395900
164      IF (QUAN.GT.WERRX) IERROR=-1      396000
165 C      CHECK EXTERNAL CONVERGENCE      396100
166      IF (IERROR.NE.0) ISOUT=JX      396200
167      QOM=AMAX1(QOM,QUAN)      396300
168      RETURN      396400
169 C      396500
170 C

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171	291 FORMAT (48H1LOSS OF DIAGONAL DOMINANCE IN SUBROUTINE DIVERT/25X,24	396900
172	.HCOEFFICIENT MATRIX (AAA),30X,2DHFORCING FUNCTION (B)/15X,SF10.3,3	397000
173	.OX,F10.3))	397100
174	END	397200

@HDG

* D U C T *

@PRT,S COBRA*CFIL,DUCT
FURPUR 28R1 GA-B E35 574T11 05/26/81 17:36:57

COBRA*CFIL(1).DUCT

```

1  SUBROUTINE DUCT(HRIB,R1,R2,HPLUS,GPRIME,Q,TB,CP,VSK,TWTB,BIOT,
2      BIOTC,TD,I,AH)
3  INCLUDE SPEC23,LIST
4      C  HRIB,R1,R2, - M
5      C  Q - KW/M2
6      C  TB,TD, - DEG - C
7      C  CP - KJ/KG-K
8      C  VSK - KG/M-S
9      C
10     IF (LAMARK(1).EQ.1) GO TO 2
11     TWA=TWTB*(TB+273.)
12     TBA=TB+273.
13     TTW=TBA*(TWTB-1.)*(1.-BIOTC*BIOT)+TB
14     TD=TTW-Q*HRIB*(AH*ALOG((R2-R1)/HRIB)+GPRIME)
15     1  / (CP*HPLUS*VSK*TWTB**1.67)
16     GO TO 3
17     2  TD=TETA(1)*Q+TB
18     3  RETURN
19     END

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@HOG * E L A P I *

@PRT,S COBRA*CFIL.ELAPI
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* E L A P I *

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COBRA*CFIL(1).ELAPI

```
1      SUBROUTINE ELAPI
2      CALL TICKER(TJ)
3      RETURN
4      ENTRY ELAP(MTIME)
5      CALL TICKER(T1)
6      MTIME=(T1-T0)/60. + 1.
7      RETURN
8      END
```

GA-MAR81

GA-MAR81

@HOG

* E R R O R *

@PRT,S COBRA*CFIL.ERROR
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:57

* E R R O R *

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COBRA*CFIL(1).ERROR

1 SUBROUTINE ERROR
2 CALL MERR
3 RETURN
4 END

@HDG

* F O R C E *

@PRT,S

COBRA*CFIL.FORCE

FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:58

COBRA*CFIL(11).FORCE

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1  SUBROUTINE FORCE(J,JX,JMF)
2  INCLUDE SPEC1,LIST
3  INCLUDE SPEC3,LIST
4  INCLUDE SPEC51,LIST
5  INCLUDE SPEC52,LIST
6  INCLUDE SPEC71,LIST
7  INCLUDE SPEC72,LIST
8  LOGICAL GRID
9  REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
10 ICROSS(K)=IFIX(EINTEG*PITCH*ABS(ICROSS(K,L)))
11 IXC(K)=((IXJX-ICROSS(K))/IPITCH)*IPITCH+ICROSS(K)
12 GRID=.FALSE.
13 DO 130 K=1,NK
14 100 FDIV(K)=J.
15  NGTYPE=1
16  IF (J6.EQ.0) RETURN
17  JXM1=JX-1
18  IF (J.NE.1) GO TO 110
19  JXM1=1
20 110 CONTINUE
21  EINTEG = 1.0E9
22  IXJX=IFIX(EINTEG*X(JX))
23  IXJXM1=IFIX(EINTEG*X(JXM1))
24  IPITCH=IFIX(EINTEG*PITCH)
25  ZM=0
26  ZMM=DX
27  IF (K11.LE.0.OR.DT.GT.1.E6) GO TO 120
28  ZM=-.5*DX
29  ZMM=-ZM
30 120 IF (J6-2) 130,180,130
31  C FORCED DIVERSION CROSSFLOW FROM WIRE WRAPS
32 130 IF (PITCH.LE.0.) GO TO 220
33  DUMY=PI*(DIA+THICK)
34  WRAP=DUMY/PITCH
35  IF (NRAMP.LE.0) GO TO 220
36  DUMY=DUMY*DX*AMIN1(1.,FLOAT(ITERAT)/FLOAT(NRAMP))
37  C PL IS THE PITCH LENGTH CONTAINING X(J).
38  C FIND THE WRAP CROSSINGS IN DX.
39  IF (JX.EQ.1.OR.JX.EQ.NDXP1) GO TO 170
40  DO 160 K=1,NK
41  II=IK(K)
42  JJ=JK(K)
43  DO 160 L=1,2
44  IF (XCROSS(K,L).EQ.0.) GO TO 160
45  IF (IXC(K).LE.IXJXM1.OR.IXC(K).GT.IXJX) GO TO 160
46  FDIV(K)=1.
47  WDUMY=GAP(K,J)*DUR(K)*DUMY
48  IF (XCROSS(K,L)) 140,160,150
49 140 W(K,J)=-WDUMY*(F(JJ,J)/A(JJ,J))
50  GO TO 160
51 150 W(K,J)=WDUMY*(F(II,J)/A(II,J))
52 160 CONTINUE
53 170 CONTINUE
54  IF (J6.EQ.1) RETURN
55 180 IF (NGRID.LT.1) RETURN
56  C CHECK FOR GRID SPACERS IN NODE

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409900
410000
410300
410500
410600
410700
410800
410900
411100
411200
411400
411500
411600
411700
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411900
412000
412100
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412300
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413800
413900
414100
414200
414300
414400
414500
414600
414700
414800
414900

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57      DO 190 I=1,NGRID                      415000
58      ZG=X(JX)-(GRIDXL(I))*Z+1.E-12)        415100
59      IF (ZG.GE.2M.AND.ZG.LT.2MM) GO TO 200  415200
60      190 CONTINUE                          415300
61      RETURN                                415400
62      200 GRID=.TRUE.                       415500
63      NGTYPE=IGRID(I)                      415600
64      IF (NK.EQ.0) RETURN                   415700
65      DO 210 K=1,NK                         415800
66      IF (ABS(FXFLOW(K,NGTYPE)).LT.1.E-10) GO TO 210 415900
67      C ZERO FORCED FLOW FRACTION DOES NOT BLOCK THE NATURAL DIVERSION CRO 416000
68      II=IK(K)                             416100
69      JJ=JK(K)                             416200
70      FDIV(K)=1.                            416300
71      IF (NRAMP.LE.0) GO TO 220             416400
72      DUMY=AMIN1(1.,FLOAT(ITERAT)/FLOAT(NRAMP))*FXFLOW(K,NGTYPE)/DX 416500
73      IFG=II                                416600
74      IF (DUMY.LT.0.) IFG=JJ                416700
75      WDUMY=DUMY*F(IFG,J)                   416800
76      WIK,J)=WDUMY                          416900
77      210 CONTINUE                          417000
78      RETURN                                417100
79      220 IERROR=6                          417200
80      RETURN                                417300
81      END                                  417400

```

@MDG

* F U R E *

@PRT,S COBRA*CFIL.FURE
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:58

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* F U F E *

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COBRA*CFIL(1).FURE

1	FUNCTION FURE (RE)	19900
2	C *** REIBUNGSKOEFFIZIENT NACH PRANDTL-NIKURADSE ***	20000
3	FUN(F) = 4.0*ALOG10(RE*SQRT(F)) - 0.4 - 1.0/SQRT(F)	20100
4	J = 1	20200
5	FR = 0.1*RE**(-0.25)	20300
6	FRR = 0.07*RE**(-0.25)	20400
7	R = FUN(FR)	20500
8	RR = FUN(FRR)	20600
9	1 FR2 = FR - R*(FRR - FR)/(RR - R)	20700
10	J = J + 1	20800
11	IF(J.GT.30) GO TO 5	20900
12	R2 = FUN(FR2)	21000
13	IF(ABS(R2).LT.1.0E-4) GO TO 4	21100
14	IF((R-R2).GT.0.0) GO TO 2	21200
15	RR = R2	21300
16	FRR = FR2	21400
17	GO TO 1	21500
18	2 R = R2	21600
19	FR = FR2	21700
20	GO TO 1	21800
21	4 FURE = FR2	21900
22	RETURN	22000
23	5 WRITE(6,10) J	22100
24	10 FORMAT(/10X,25HREITERATION FAILED J = ,I2)	22200
25	RETURN	22300
26	END	22400

@HOG

* H E A T *

@PRT,S

COBRA*CFIL.HEAT

FURPUR 28R1 GA-8 E35 S74T11 05/26/81 17:36:58

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COBRA*CF TL(1),HEAT

```

1      SUBROUTINE HEAT(INSS,JB,MHT,JX3)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC6,LIST
4      INCLUDE SPEC12,LIST
5      INCLUDE SPEC19,LIST
6      INCLUDE SPEC22,LIST
7      REAL IDTGC,LENGTH,KIJ,LENSHO,LENROU
8      C      CALCULATE THE HEAT INPUT TO EACH SUBCHANNEL AT POSITION J.      433600
9      C
10     J=JB      434900
11     JX=JX3    435000
12     C      435100
13     C      THIS SUBROUTINE CONSISTS OF THREE PARTS AS INDICATED BY MHT 435200
14     C      PART 1 - INITIALIZES ALL TEMPERATURES, COMPUTES ROD POWER, 435300
15     C      ROD AND CLAD TEMPERATURES AND SURFACE HEAT FLOW.      435400
16     C      PART 2 - CALCULATES HEAT INPUT TO INDIVIDUAL SUBCHANNELS 435500
17     C      PART 3 - REMOVED
18     C      435800
19     RODPWR=AFLUX*POWER
20     IF (MHT.EQ.2) GO TO 170      436100
21     IF (ITERAT.GT.1) RETURN
22     C      437700
23     C      IMPLICIT SOLUTION REQUIRES ITERATION FOR ROD TEMPERATURES 437800
24     C      437900
25     DO 140 JF=1,NDXP1      438300
26     IF(JF.EQ.1)GO TO 140
27     DX = X(JF) - X(JF-1)      438400
28     DX2 = DX*DX      438600
29     JX=JF      438700
30     J=JF      438800
31     C      439200
32     C      CALCULATE AXIAL POWER FACTOR      439300
33     C      439400
34     C      THE FOLLOWING SET OF STATEMENTS PROVIDES AN
35     C      ACCURATE DETERMINATION OF AXIAL HEAT FLUX IN NODES WHERE STEP
36     C      CHANGES OCCUR.      439700
37     C      439800
38     CALL CURVE(QAX1,X(JX-1)/Z,AXIAL,Y,NAX,IERROR,1)      439900
39     CALL CURVE(QAX2,X(JX)/Z,AXIAL,Y,NAX,IERROR,1)      440000
40     TEST=(QAX2+1.E-5)/(QAX1+1.E-5)
41     IF(TEST.LT.3..AND.TEST.GT.0.33)GO TO 15
42     C      ENDPPOINTS HALVED ACCORDING TO TRAPEZOID RULE      440100
43     QAXSUM = (QAX1 + QAX2)*0.5      440200
44     DXF = DX/20.0      440500
45     XF = X(JX-1)      440600
46     DO 11 IDXF=1,19      440700
47     XF = XF + DXF      440800
48     CALL CURVE(QAX,XF/Z,AXIAL,Y,NAX,IERROR,1)      440900
49     11 QAXSUM = QAXSUM + QAX      441000
50     QAX = QAXSUM/20.0      441100
51     GO TO 18      441200
52     15 CONTINUE      441300
53     XDUMY=AMAX1(X(JX)-.5*DX)/Z,0.)      441400
54     CALL CURVE (QAX,XDUMY,AXIAL,Y,NAX,IERROR,1)      441500
55     18 CONTINUE      441600
56     C      441700

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57	RODQ=RODPWR*QAX	441800
58	DO 130 N=1,NROD	441900
59	C CALCULATE THE FORCED HEAT FLUX FROM EACH ROD	442000
60	FLUX(N,J)=RODQ*RADIAL(N)	442100
61	130 CONTINUE	444500
62	140 CONTINUE	444600
63	RETURN	445700
64	C	445800
65	C PART 2 - CALCULATE HEAT INPUT TO EACH CHANNEL	445900
66	170 DO 180 I=1,NCHANL	446000
67	180 QPRIM(I)=0.	
68	MT = 0	446200
69	DO 220 N=1,NROD	446300
70	FL=FLUX(N,J)	
71	DO 210 L=1,MSC	446700
72	I=LR(N,L)	446800
73	IF (I.LE.0) GO TO 220	446900
74	IF (IFL.NE.1) GO TO 210	447100
75	MT = MT+1	447200
76	FL = FLX(MT,JX)	
77	210 QPRIM(I)=QPRIM(I)+FL*PHI(N,L)*PI*D(N)	
78	220 CONTINUE	451300
79	RETURN	451400
80	END	456000

ENDG

* H E L I U M *

APRT,S COBPA*CFIL,HELIUM
 FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:36:59

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COBRA*CFIL(1).HELIUM

```

1      SUBROUTINE HELIUM(PRESS)
2      INCLUDE SPEC5,LIST
3      REAL KPOUT
4      C
5      C      THIS SUBROUTINE CALCULATES THE PROPERTIES OF HELIUM GAS AS A
6      C      FUNCTION OF PRESSURE AND TEMPERATURE. THE PROCEDURE AND
7      C      NOMENCLATURE ARE SIMILAR TO SUBROUTINE STEAM IN COBRA4.
8      C
9      C      ROUTINE WRITTEN ON 3/7/77.
10     C
11     C      PRESS = PRESSURE (PA)
12     C
13     HENT(TEMP,PRES) = 5557.0 + 5193.0*TEMP + PRES*(9.489433E-4 +
14     1 9.528079E-4/D1 + 2.73947E-3/D2 - TEMP*(3.259251E-5/D1**2 -
15     2 2.5776E-6/D2**2))
16     PS = PRESS
17     ISTAG = 3
18     IF(INPROP.LT.5) ISTAG = 1
19     MPM1 = NPROP - ISTAG
20     DT = DTMAX - TF
21     DELTT = DT/FLOAT(MPM1)
22     DO 20 I=1,NPROP
23     FACT = FLOAT(I - ISTAG)
24     IF(I.LE.ISTAG) FACT = FLOAT(I - 1)/FLOAT(ISTAG)
25     TS = TF + DELTT*FACT
26     TS = TS + 273.15
27     C
28     C      COMPUTE HELIUM ENTHALPY ( HENT ) KJ/KG
29     C
30     D1=1.0-3.42068E-2*TS
31     D2=1.0+9.40912E-4*TS
32     HENTH = HENT(TS,PS)/1000.
33     C
34     C      COMPUTE HELIUM CONDUCTIVITY ( HCON ) KW/M-K
35     C
36     HCON=2.774E-3*TS**0.701
37     HCON=HCON/1000.
38     C
39     C      COMPUTE HELIUM VISCOSITY ( HVIS ) PA-S
40     C
41     HVIS=3.953E-7*TS**0.687
42     C
43     C      COMPUTE HELIUM SPECIFIC VOLUME ( HVOL ) CU M/KG
44     C
45     HVOL=2077.22*TS/PS+9.489433E-4+9.528079E-4/D1+2.73947E-3/D2
46     C
47     C      COMPUTE HELIUM SPECIFIC HEAT (HCP) KJ/KG-K
48     C
49
50     TS1 = TS - 1.0
51     TS2 = TS + 1.0
52     DELTAT = 2.
53     D1 = 1.0 - 3.42068E-2*TS1
54     D2 = 1.0 + 9.40912E-4*TS1
55     HENT1 = HENT(TS1,PS)
56     D1 = 1.0 - 3.42068E-2*TS2

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456400
456500
456600
456700
456800
456900
457000
457200
457500
457600
457700
457900
458000
457790
458200
458300
458400
458500
458600
458700
458900
459100
459200
459300
459500
459700
459800
460000
460200
460300
460500
461300
461400
461500
461700
461800
461900
462000

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57	D2 = 1.0 * 9.40912E-4*TS2	462100
58	HENT2 = HENT(TS2,PS)	462200
59	DELENT = (HENT2 - HENT1)/1000.	
60	HCP = DELENT/DELTAT	462400
61	C	462500
62	HGPT(I) = HENTH	462600
63	TPOUT(I) = TS-273.15	
64	KPOUT(I) = HCON	
65	UPOUT(I) = HVIS	
66	VPOUT(I) = HVOL	463000
67	CPPOUT(I) = HCP	463100
68	20 CONTINUE	463200
69	CT = -.2	463300
70	RETURN	463400
71	END	463500

@HDG * I D D T *

@PRT,S COBRA*CFIL.IDDT
 FURPUR 28R1 GA-B E35 S7*111 D5/26/81 17:36:59

COBRA*CFIL(1).IDDT

```

1      SUBROUTINE IDDT(H,RE,R1,R2,TWTB,XLAM,ST,I,JN)
2      INCLUDE SPEC14,LIST
3      INCLUDE SPEC15,LIST
4      INCLUDE SPEC17,LIST
5      INCLUDE SPEC24,LIST
6      LOGICAL LF
7      LOGICAL LREFF,LREFST
8      C      XLAMST, STST - STARTING VALUES FOR FALSI POSITION
9      C      FSAVE, SSAVE - INITIAL GUESS FOR EACH NODE POSITION
10     XLAMST = 4.*FURE(RE)
11     FSAVE = 2.*XLAMST
12     STST = .003
13     SSAVE = .010
14     XLAM = XLAMST
15     ST = STST
16     LREFF=.TRUE.
17     LREFST=.TRUE.
18     IF(TWTB .LT. 1.) TWTB=1.
19     AL = R1/R2
20     AL2=AL*AL
21     AHS=CG(3)
22     AR=CR(2)
23     LF=.FALSE.
24     IHS=0
25     DO 1000 ITER=1,50
26     XA = 2.5
27     F = XLAM/4.
28     JJ=1
29     300 CALL BEF(AL,RE,F,XA,2.50)
30     CALL BETAF(BET,AL,02001)
31     BE2=BET*BET
32     CALL BEF4(FF1,FF2,RE1,RE2)
33     QF1=SQRT(2/FF1)
34     FR=FURE(RE2)
35     F12=FF1/FF2
36     F2S=FR*(1.005*F12+1.056)
37     WF2=SQRT(F2S/2.)
38     XAA=(5.5-1/WF2)/((3*BET)/(1+BET)/2- ALOG(RE2*WF2/(1+BET)/2))
39     IF (ABS(XA-XAA) .LT..100 ) GO TO 550
40     XA=XAA
41     JJ=JJ+1
42     IF(JJ .GT. 20) GO TO 555
43     GO TO 300
44     555 WRITE (6,556)
45     556 FORMAT (30X, 'AS ITERATION FAILED')
46     GO TO 1999
47     550 XA=XAA
48     RE1W=RE1*TWTB**(-1.67)
49     HPLUS=H /2./R1*RE1W/(BE2/AL2-1.)/QF1
50     AR=CR(2)
51     HDL=(BET*R2-R1)/H
52     IF(HPLUS.GT.CR(3))GO TO 101
53     AR=CR(6)-ALOG(HPLUS)*(CR(7)-CR(8)*ALOG(HPLUS))
54     GIHS=2.50*(1.50+0.50*BET/AL)/(1.+BET/AL)
55     RHPHS =QF1 *GIHS-2.50*ALOG(HDL)
56     101 G1=AR*(1.50+0.50*BET/AL)/(1.+BET/AL)

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57      RHP = QF1 * G1 - AR * ALOG(HDL)
58      IF (.NOT. LF) GO TO 1999
59      IF (ST) 1999, 1999, 560
60      560 GHP = SQRT((BE2 - AL2) / AL / (1. - AL)) / ST * SQRT(XLAM / 8.) - AHS
61      S      * ALOG((1 - AL) * R2 / H) + AHS * (0.5 + 1.5 * AL) / (1. + AL)
62      1999 CONTINUE
63      IF (LF) GO TO 710
64      RPRIME = CR(1)
65      IF (HPLUS.GT.CR(3)) GO TO 551
66      RPRIME = CR(4) - CR(5) * ALOG(HPLUS)
67      RHSM = 5.5 + 2.5 * ALOG(HPLJS * TWTB ** 1.67)
68      TEST = RPRIME * (AR - 2.50) * (ALOG(HDL) - .5 - 1. / (2. * HDL * H / R1))
69      ALOCK = TEST - RHSM
70      IF (IHS.EQ.1.AND.ALOCK.GT.-.15) GO TO 100
71      IHS = 0
72      C      IF TEST > RHSM FLOW IS HYDRAULICALLY SMOOTH
73      IF (ALOCK.LE.0) GO TO 561
74      100 IHS = 1
75      561 IF (.NOT. LREFF) GO TO 705
76      RDIF = RHP - RPRIME
77      RDIFHS = RHPHS - RHSM
78      LREFF = .FALSE.
79      XLAM = FSAVE
80      GO TO 1000
81      705 CONTINUE
82      IF (IHS.EQ.1) GO TO 102
83      IF (ABS(RHP - RPRIME) .LT. .05) GO TO 700
84      XLAM = (XLAMST * (RHP - RPRIME) - XLAM * RDIF)
85      / (RHP - RPRIME - RDIF)
86      GO TO 1000
87      102 IF (ABS(RHPHS - RHSM) .LT. .05) GO TO 700
88      XLAM = (XLAMST * (RHPHS - RHSM) - XLAM * RDIFHS) / (RHPHS - RHSM - RDIFHS)
89      GO TO 1000
90      700 CONTINUE
91      LF = .TRUE.
92      GO TO 1000
93      710 CONTINUE
94      GO = CG(1) * HPLUS ** CG(2)
95      IF (HPLUS.LT.CG(6)) GO = CG(7)
96      GPRIME = GO * PR ** CG(4) * TWTB ** CG(5)
97      IF (.NOT. LREFST) GO TO 712
98      GDIF = GHP - GPRIME
99      LREFST = .FALSE.
100      ST = SSAVE
101      GO TO 1000
102      712 CONTINUE
103      IF (ABS(GHP - GPRIME) .LT. .1) GO TO 2000
104      ST = (STST * (GHP - GPRIME) - ST * GDIF)
105      / (GHP - GPRIME - GDIF)
106      1000 CONTINUE
107      WRITE(6,1) RHP,RPRIME,XLAM,GHP,GPRIME,ST,I,JN,AR,TEST,RHSM,HPLUS
108      1 FORMAT(' SUBROUTINE IDDT NOT CONVERGED. RHP=',F9.4,2X,'RPRIME=',
109      .F9.4,2X,'XLAM=',F9.5,2X,'GHP=',F9.4,2X,'GPRIME=',F9.4,2X,'ST=',
110      .F9.6,/,32X,'CHANNEL',I4,3X,'NODE',I5,2X,'AR',F5.2,2X,'TEST',
111      4F6.2,2X,'RHSM',F7.4,2X,'HPLUS',F7.2)
112      RETURN
113      2001 CONTINUE

```

114700
115000

115500
115600

115700
115800
115900
116000

116300

116400
116500
116600
116700
116800

117200
117400

117700

118200

118400
118500

118700

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114	CALL ERROR	
115	2000 CONTINUE	119000
116	HPW(I,JN)=HPLUS	
117	RHPLS(I,JN)=RHP	
118	IF(IHS.EQ.0)GO TO 750	
119	RHPLS(I,JN)=RHPHS	
120	AR=2.50	
121	750 RETURN	119100
122	END	119200

@HDG * L I M I T S *

@PRT,S COBRA*CFIL.LIMITS
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:00

* L I M I T S *

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COBRA*CFIL(1),LIMITS
1      SUBROUTINE LIMITS (NUM,MIN,MAX,GROUP,CARD,ERROR)      26000
2      INTEGER GROUP,CARD      26100
3      LOGICAL ERROR
4      DATA KTR/0/      26200
5      IF ((NUM-MIN)*(NUM-MAX).LE.0) GO TO 110      26300
6      C      PRESET NUM.LE.MAX DIMENSION.      26400
7      MUN=NUM      26500
8      NUM=MAX0(NUM,MIN)      26600
9      ERROR=.TRUE.
10     KTR=KTR+1      26900
11     IF (KTR.LE.25) GO TO 100      26900
12     WRITE (6,120)      27000
13     STOP      27100
14     100 WRITE (6,130) GROUP,CARD,MUN,MIN,MAX      27200
15     110 RETURN      27300
16     C      27400
17     C      27500
18     120 FORMAT ('INPUT EDITING TERMINATED DUE TO EXCESSIVE NUMBER OF ERRO      27600
19     *RS.*')      27700
20     130 FORMAT ('ERROR IN CARD GROUP',I3,', CARD NUMBER',I4,', - ARGUMEN      27800
21     *T ',I4,' OUTSIDE RANGE ',I4,' TO ',I4/)      27900
22     END      28000

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@HDS * L O A D *

@PRT,S COBRA*CFIL,LOAD
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:00

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COBRA*CFITL(1).LOAD

1	SUBROUTINE LOAD (X,Y,Z,MIN,MAX,LIMIT,STEP,IMAGE,CARD,LU)	28300
2	REAL ARRAY(80),X(1),Y(1),Z(1)	28400
3	INTEGER LIST(80),STEP,CARD,COUNT,IMAGE(2)	28500
4	EQUIVALENCE (LIST(1),ARRAY(1))	
5	IF (MAX.LT,MIN) GO TO 120	28700
6	IF ((STEP-1)*(STEP-3).GT.0) GO TO 120	28800
7	MAXKRD=(MAX-1)*STEP/LIMIT+1	28900
8	MINKRD=(MIN-1)*STEP/LIMIT+1	29000
9	CARD=CARD+MAXKRD	29100
10	COUNT=0	29200
11	J=0	29300
12	100 J=J+1	29400
13	IF (J.GT,MAXKRD) GO TO 120	29500
14	READ (LU,IMAGE) (ARRAY(I),I=1,LIMIT)	29600
15	IF (J.GT,MINKRD) GO TO 100	29700
16	DO 110 I=1,LIMIT,STEP	29800
17	COUNT=COUNT+1	29900
18	IF (COUNT.GT,MIN) GO TO 100	30000
19	X(COUNT)=ARRAY(I)	30100
20	IF (STEP.EQ.1) GO TO 110	30200
21	Y(COUNT)=ARRAY(I+1)	30300
22	IF (STEP.EQ.2) GO TO 110	30400
23	Z(COUNT)=ARRAY(I+2)	30500
24	110 CONTINUE	30600
25	GO TO 100	30700
26	120 RETURN	30800
27	END	30900

@HDS * M I X *

@PRT,S COBRA*CFITL.MIX
FURPUR 28R1 GA-8 E35 S74T11 05/26/81 17:37:00

* M I X *

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COBRA*CFIL(1).MIX

1	SUBROUTINE MIX(J)	
2	INCLUDE SPEC1,LIST	
3	INCLUDE SPEC10,LIST	
4	REAL IDTGC,LENGTH,KIJ,LENSHO,LENROU	
5	DO 120 K=1,NK	
6	II=IK(K)	482900
7	JJ=JK(K)	483000
8	FRCTN = .5*(FSPI(II) + FSPI(JJ))	483100
9	WP(K)=0.	483200
10	DAVG=4.*(A(II,J)+A(JJ,J))/(PERIM(II)+PERIM(JJ))	483300
11	GAVG=(F(II,J)+F(JJ,J))/(A(II,J)+A(JJ,J))	483400
12	GAVG=ABS(GAVG)	483500
13	UAVG=0.5*(VISC(II)+VISC(JJ))	483900
14	IF (NSCBC.GE.1) RE=GAVG*DAVG/UAVG	484000
15	IF (NSCRC.EQ.0) WP(K)=GAP(K,J)*GAVG*ABETA	484100
16	IF (NSCBC.EQ.1) WP(K)=GAP(K,J)*GAVG*ABETA*RE**BBETA	484200
17	IF (NSCBC.EQ.2) WP(K)=DAVG*GAVG*ABETA*RE**BBETA	484300
18	IF (NSCBC.EQ.3.AND.LENGTH(K).LE.0.) GO TO 130	484400
19	IF (NSCBC.EQ.3) WP(K)=GAP(K,J)/LENGTH(K)*DAVG*GAVG*ABETA*RE**BBETA	484500
20	IF (NSCBC.EQ.4)	484600
21	WP(K)=ABETA*DAVG*GAVG*SQRT(FRCTN/8.)	484700
22	120 CONTINUE	485400
23	RETURN	485500
24	130 IERRGR=4	485600
25	RETURN	485700
26	END	485800

3H0G

* M O R C O N *

3PRT,S

COBRA*CFIL.MORCON

FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:00

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COBRA*CFIL(1).MORCON

```

1      SUBROUTINE MORCON (M,MS,THETA,HT,TB,QRAD)
2      DIMENSION THETA(1),HT(1),TB(1),QRAD(1)
3      DATA PI/3.141592653589793EO/
4      GO TO (10,20,40,60),M
5      10 WRITE(6,10010)
6      RETURN
7      C ASSUME 60 DEG SYMMETRY
8      20 MS=8
9      THETA(3)=(2.E0*PI-(THETA(1)+THETA(2)))/6.E0
10     DO 30 I=3,MS
11     THETA(I)=THETA(3)
12     IS = MOD(I,2)
13     HT(I)=HT(IS+1)
14     TB(I)=TB(IS+1)
15     QRAD(I)=QRAD(IS+1)
16     30 CONTINUE
17     RETURN
18     40 MS=6
19     DO 50 I=1,3
20     THETA(7-I)=THETA(I)
21     HT(7-I)=HT(I)
22     TB(7-I)=TB(I)
23     QRAD(7-I)=QRAD(I)
24     50 CONTINUE
25     RETURN
26     60 MS=8
27     DO 70 I=1,4
28     THETA(9-I)=THETA(I)
29     HT(9-I)=HT(I)
30     TB(9-I)=TB(I)
31     QRAD(9-I)=QRAD(I)
32     70 CONTINUE
33     RETURN
34     10010 FORMAT(' ERROR . ONE CHANNEL PER ROD ')
35     END

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GA-MAR81
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GA-MAR81
GA-MAR81

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END * P E T U K H *

@PRT,S COBRA*CFIL.PETUKH
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:01

* P E T U K H *

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COBRA*CFIL(1).PETUKH

1		SUBROUTINE PETUKH (RE,PR,DE,RZS,R2,R1,TW,TI,CT,STN)	
2	C	PETUKHOV-ROIZEN METHOD	121000
3	C	SMOOTH NUSSELT NUMBER	121100
4	C	ADDED TO COBRA 4 IN APRIL 1978 BY GA	121200
5	C		121300
6	C	UNITS FOR DE, D1, PH, R2 MUST BE CONSISTENT	121400
7	C	DE - HYDRAULIC DIAMETER	121500
8	C	D1 - ROD DIAMETER	121600
9	C	PH - ROD PITCH	121800
10	C	PR - PRANDTL	121900
11	C	RE - REYNOLDS	122000
12	C	RZS - RADIUS OF ZERO SHEAR	
13	C	R2 - TUBE RADIUS	122100
14	C	TI - INLET TEMPERATURE (C)	122200
15	C	TW - WALL TEMPERATURE (C)	122300
16	C		122400
17		PH = RZS/0.525	
18		D1 = R1*2.	122500
19	C		122800
20	C	INTERIOR CHANNELS (RZS>0)	122900
21		IF(RZS .GT. 0.) D2EQ = 1.05*PH	123000
22	C		123100
23	C	WALL PORTION OF WALL CHANNEL (RZS=0)	123200
24		IF(RZS.EQ.0.) D2EQ = 2.*R2	123300
25	C		123400
26		DEQA = D2EQ - D1	123500
27		REP = RE*DEQA/DE	123600
28		XLAM = 1./(1.82*ALOG10(REP) - 1.64)**2	
29		XKBAR = 1.07 + 900./REP - 0.63/(1.+10.*PR)	123800
30		P = 2./3.	123900
31		XNUO = XLAM/8.*REP*PR/(XKBAR + 12.7*SQRT(XLAM/8.)*(PR**P - 1.))	124000
32		OPR = 0.45/(2.4 + PR)	124100
33		HPR = 0.16/PR**0.15	
34		TWA = TW + 273.15	124300
35		TIA = TI + 273.15	124400
36		XNU1 = (1.-OPR)*(D2EQ/D1)**HPR*(TWA/TIA)**CT*XNUO	124500
37		XNU = XNU1*DE/DEQA	124600
38		STN = XNU/(RE*PR)	124700
39		RETURN	124800
40		END	124900

@HOG

* P R O P *

@PRT,S

COBRA*CFIL.PROP

FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:01

D-47

COBRA*CTFL(1).PROP

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1      SUBROUTINE PROP (IPART,J,JX,IBEGIN,IEND)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC3,LIST
5      INCLUDE SPEC5,LIST
6      INCLUDE SPEC6,LIST
7      INCLUDE SPEC13,LIST
8      INCLUDE SPEC17,LIST
9      INCLUDE SPEC22,LIST
10     INCLUDE SPEC23,LIST
11     INCLUDE SPEC55,LIST
12     LOGICAL GRID
13     REAL KPOUT
14     REAL KF
15     REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
16     IF (IPART.LT.1.OR.IPART.GT.2) GO TO 290
17     GO TO (100,140), IPART
18
19 C
20 100 CONTINUE
21     CALL HELIUM(PREF)
22     VF=VPOUT(1)
23     UF=UPOUT(1)
24     TF=TPOUT(1)
25     KF=KPOUT(1)
26     TWTB=0.
27     TW=0.
28     TIN=TF+5.
29     TIJ=0.
30     DO 1 I=1,NCHANL
31     1 HFILMS(I)=0.
32     RETURN
33 C
34 C PART 2, CALCULATE FLUID PROPERTIES AND PARAMETERS
35 140 CONTINUE
36     K=J-1
37     IF(J.EQ.1)K=1
38     PLOC=PREF+.5*(P(1,K)+P(1,J))
39     CALL HELIUM(PLOC)
40     IF(JX.GT.1)XJX1 = X(JX-1)
41     XJX=X(JX)
42     IF(JX.EQ.1) XJX1 = XJX
43 160 DO 250 I=IBEGIN,IEND
44     HFILM(I) = HFILMS(I)
45     YSI = 1.
46     VISC(I)=UF
47     T(I)=TF
48     CON(I)=KF
49     V(I)=VF
50     HH=H(I,J)
51     DO 181 L=1,NPROP
52     183 IF(L.EQ.NPROP) GO TO 185
53     181 CONTINUE
54     GO TO 190
55     182 IF(L.EQ.1) GO TO 190
56     185 DUMY=(HH-HGPT(L-1))/(HGPT(L)-HGPT(L-1))

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57      VISC(I)=UPOUT(I-1)+DUMY*(UPOUT(I)-UPOUT(I-1))
58      V(I)=VPOUT(I-1)+DUMY*(VPOUT(I)-VPOUT(I-1))
59      T(I)=TPOUT(I-1)+DUMY*(TPOUT(I)-TPOUT(I-1))
60      CON(I)=KPOUT(I-1)+DUMY*(KPOUT(I)-KPOUT(I-1))
61      CPI(I)=CPPOUT(I-1)+DUMY*(CPPOUT(I)-CPPOUT(I-1))
62      GO TO 200
63      190 WRITE (I3,330)
64      IERROR=10
65      RETURN
66      200 CONTINUE
67      RE=AMAX1(1.,ABS(F(I,J)))/A(I,J)*DHYD(I,J)/VISC(I)
68      RENO(I,J) = RE
69      PR=CPI(I)*VISC(I)/CON(I)
70      IF(INFH.GE.1) GO TO 66
71      HFILM(I)=(AH(1)*RE**AH(2)*PR**AH(3)+AH(4))*(CON(I)/DHYD(I,J))
72      L=NTYPE(I)
73      IF(L.GT.NFT)L=1
74      FSP(I) = AAL(I)*RE**BBL(I) + CC(L)
75      FLAM=0.
76      IF(FLAM.NE.0) FLAM = AAL(L)*RE**BBL(L)+CCL(L)
77      IF(FLAM.GT.FSP(I))GO TO 210
78      GO TO 250
79      66 CONTINUE
80      C
81      C CORRECT HEAT TRANSFER COEFFICIENT
82      IF(HFILM(I).EQ.0.) GO TO 69
83      IF(STNO(I,J).EQ.0.) GO TO 69
84      C XKC - THERMAL CONDUCTIVITY OF CLADDING, KW/M-C
85      XKC = 0.01420 + 1.087E-5*TW
86      C BIOT NUMBER CORRECTION
87      BIOT = HRIB*HFILM(I)/XKC
88      C APPLY BIOT CORRECTION ONLY TO ROUGH SECTION
89      IF(XJX.LE.LENSMO.OR.XJX.GE.LENROU) BIOT=0.
90      HFILM(I) = CON(I)/DHYD(I,J)*STNO(I,J)*RE*PR
91      HFILM(I) = HFILM(I)*(1.-BIOTC*BIOT)
92      C SPACER EFFECTS ON HEAT TRANSFER COEFFICIENT
93      IF(INGRID.LT.1) GO TO 34
94      DO 35 JG=1,NGRID
95      XBS = Z*GRIDXL(JG) - SH*0.5
96      IF(JG.LT.INGRID)XBS1=Z*GRIDXL(JG+1)-SH*0.5
97      C DXH - NUMBER OF HYDRAULIC DIAMETERS FROM BEGINNING OF SPACER
98      XDIF=X(JX)-XBS
99      SHHF=SH/2.
100     JXH = XDIF/DHYD(I,J)
101     IF(JG.LT.INGRID)DXH1=(X(JX)-XBS1)/DHYD(I,J)
102     IF(JG.EQ.INGRID)GO TO 36
103     IF(DXH.LT.-1.) GO TO 34
104     IF(DXH1.GT.-1.) GO TO 35
105     GO TO 36
106     35 CONTINUE
107     GO TO 34
108     36 CONTINUE
109     JGT = IGRID(JG)
110     AD=SHHF/DHYD(I,J)
111     C=ALOG10(RE)
112     IF(XJX.LT.LENSMO .OR. XJX.GT.LENROU) GO TO 38
113     C ROUGH BUNDLE

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114 IF(DXH.GT.AD)GO TO 32
 115 AKRE=.174*SQRT(RE)
 116 IF(RE.GT.2653.)AKRE=3.3+72700./RE**1.2
 117 GO TO 39 931000
 118 C SMOOTH BUNDLE 931100
 119 38 IF(RE.GT.3000.)AD=AD*2.
 120 IF(DXH.GT.AD)GO TO 33
 121 AKRE=.174*SQRT(RE)
 122 AKRE1=(6.38+4550./RE**.8)*CD(I,JGT)**.4
 123 IF(AKRE1.LT.AKRE)AKRE=AKRE1
 124 39 CONTINUE 931700
 125 ANUSM=AKRE*CD(I,JGT)**2
 126 YST=1.+ANUSM*(DXH*1.)/(AD*1.)
 127 GO TO 34
 128 32 AM=1.855E-3*RE
 129 IF(RE.GT.3000.)AM=1.+4.9E4/RE**1.2
 130 AK=4.42-1.05*C
 131 AKONE=-.344+0.35*C
 132 AKTWO=-.1298*C*C+1.2466*C-1.8478
 133 IF(RE.GT.3000.)AK=AMIN1(AKONE,AKTWO)
 134 IF(AK.LT..885)AK=.885
 135 GO TO 37
 136 33 AM=1.855E-3*RE
 137 IF(RE.GT.3000.)AM=30.34/RE**.253
 138 AK=4.42-1.05*C
 139 IF(RE.GT.3000.)AK=.426+.113*C
 140 IF(AK.LT..895)AK=.895
 141 37 AK=AK-2.25*CD(I,JGT)
 142 IF(AM.GT.4.)AM=4.
 143 AM=AM*CD(I,JGT)**2
 144 YST=AK/(DXH/RE/PR)**AM
 145 34 IF(YST.LT.1.)YST=1.
 146 HFILM(I) = HFILM(I)*YST 931800
 147 C CALCULATE TWTB FOR SUBCHANNEL I 932000
 148 CALL CURVE (TIJ,H(I,J),TPOUT,HGPT,NPROP,IERPOR,1) 932100
 149 NS = 0 932200
 150 TW = 0. 932300
 151 TWTB = 0. 932400
 152 DO 68 N=1,NROD 932500
 153 DFLUX = FLUX(N,J) 932600
 154 DO 67 L=1,MSC 932700
 155 II = LR(N,L) 932800
 156 IF(II.NE.I) GO TO 67 932900
 157 TW = TW + TIJ + DFLUX/HFILM(II) 933000
 158 NS = NS + 1 933100
 159 GO TO 68 933200
 160 67 CONTINUE 933300
 161 68 CONTINUE 933400
 162 IF(NS.EQ.0) GO TO 69 933500
 163 TW = TW/NS 933600
 164 TWA = TW + 273.
 165 TBA = TIJ + 273.
 166 TWTB = TWA/TBA 933900
 167 69 CONTINUE 934000
 168 IF(LAMNF.EQ.2)GO TO 242
 169 C 934100
 170 C FRICTION AND STANTON NUMBERS 934200

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171      L = NTYPE(I)
172      IF (L.GT.NFT) L=1
173      C ROUGHNESS STARTS AT X=0.
174      IF (LENSMO.EQ.0. .AND. XJX.LE.LENROU .AND. LENROU.GT.0.) GO TO 225
175      C NODE ALL SMOOTH
176      IF (XJX.LE.LENSMO .OR. XJX1.GE.LENROU) GO TO 212
177      C NODE SMOOTH AND ROUGH
178      IF (XJX.GT.LENSMO .AND. XJX1.LT.LENSMO) GO TO 215
179      C NODE ROUGH AND SMOOTH
180      IF (XJX.GT.LENROU .AND. XJX1.LT.LENROU) GO TO 222
181      C NODE ALL ROUGH
182      GO TO 225
183      C NODE ALL SMOOTH
184      212 CONTINUE
185      FSP(I) = AA(I)*RE**BB(I) + CC(I)
186      STN = HAA(I)*RE**HBB(I) + HCC(I)
187      IF (INFH.GT.2) CALL PETUKH (RE,PR,DHYD(I,J),RZS(L),RZ(I),
188      . RR(I),TIJ,TIN,CT,STN)
189      GO TO 241
190      C NODE SMOOTH AND ROUGH
191      215 CONTINUE
192      DXS = LENSMO - XJX1
193      DXR = XJX - LENSMO
194      FS = AA(I)*RE**BB(I) + CC(I)
195      FR = AAR(I)*RE**BBR(I) + CCR(I)
196      STN = HAAR(I)*RE**HBBR(I) + HCCR(I)
197      IF ((INFH-2)*(INFH-4).EQ.0) CALL PROPS (RE,L,FR,STN,I,J)
198      IF (TWB.GT.1.) FR = FR/TWB**29
199      FSP(I) = (DXS*FS + DXR*FR)/(DXS + DXR)
200      GO TO 241
201      C NODE ROUGH AND SMOOTH
202      222 CONTINUE
203      DXS = XJX - LENROU
204      DXR = LENROU - XJX1
205      FR = AAR(I)*RE**BBR(I) + CCR(I)
206      FS = AA(I)*RE**BB(I) + CC(I)
207      STN = HAA(I)*RE**HBB(I) + HCC(I)
208      IF (INFH.GT.2) CALL PETUKH (RE,PR,DHYD(I,J),RZS(L),RZ(I),
209      . RR(I),TIJ,TIN,CT,STN)
210      IF ((INFH-2)*(INFH-4).EQ.0) CALL PROPS (RE,L,FR,STN,I,J)
211      IF (TWB.GT.1.) FR = FR/TWB**29
212      FSP(I) = (DXS*FS + DXR*FR)/(DXS + DXR)
213      GO TO 241
214      C NODE ALL ROUGH
215      225 CONTINUE
216      FSP(I) = AAR(I)*RE**BBR(I) + CCR(I)
217      STN = HAAR(I)*RE**HBBR(I) + HCCR(I)
218      IF ((INFH-2)*(INFH-4).EQ.0) CALL PROPS (RE,L,FSP(I),STN,I,J)
219      IF (TWB.GT.1.) FSP(I) = FSP(I)/TWB**29
220      241 CONTINUE
221      IF (JX.EQ.1) HFILM(I) = CON(I)/DHYD(I,J)*STN*RE*PR
222      IF (LAMNF.GT.0) GO TO 242
223      244 STNO(I,J) = STN
224      LAMARK(I) = 0
225      C XKC - THERMAL CONDUCTIVITY OF CLADDING, KW/M-C
226      XKC = 0.01420 + 1.087E-5*TW
227      C BIOT NUMBER CORRECTION

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228      BIOT = HRIB*HFILM(I)/XKC
229      C      APPLY BIOT CORRECTION ONLY TO ROUGH SECTION
230      IFIXJX .LE. LENSNO .OR. XJX .GE. LENROU) BIOT=0.
231      HFILM(I) = CON(I)/DHYD(I,J)*STNO(I,J) *RE*PR
232      HFILM(I) = HFILM(I)*(1.-BIOTC*BIOT)*YST
233      GO TO 243
234      242 L=NTYPE(I)
235      IFIL.GT.NFT) L=1
236      FLAM=AAL(L)*RE**BBL(L)+CCL(L)
237      IFILAMNF.EQ.2) GO TO 210
238      IF(FLAM.LT.FSP(I)) GO TO 244
239      210 LAMARK(I)=1
240      FSP(I)=FLAM
241      C      INCLUDE TWTB IN CORRELATION FOR LAMINAR CASE
242      IF(TWTB.GT.0.) FSP(I) = FSP(I)+TWTB
243      C      FIND LAMINAR FLOW NUSSELT NO.
244      RO=R2(L)
245      IFIRO.LT.0.001) RO=RZS(L)
246      RAS=RR(L)/RO
247      IFIL.EQ.1.OR.L.GT.3) GO TO 245
248      C      WALL OR CORNER CHANNELS
249      ANU=4.07+1.237/RAS**0.8027
250      GO TO 246
251      245 CONTINUE
252      C      CENTRAL OR SUPPORT CHANNELS
253      ANU=RAS/(1.+RAS)*(14.121+4.126*ALOG(0.9523/RAS-1.))
254      ANU=ANU*DHYD(I,J)/2./RO/(1.-RAS)
255      246 CONTINUE
256      X1=XJX-XH
257      IF(X1.LE.0) GO TO 247
258      C      ENTRY LENGTH CORRECTION TO NUSSELT NO.
259      DEI=2.*(RO-RR(L))
260      GRI=X1/(DEI*RE*PR)
261      IF(GRI.GT.0.025) GO TO 248
262      B=-0.1933+0.1217/GRI**0.1483
263      GO TO 249
264      248 B=-1.338E-3+2.772E-5/GRI**1.763
265      IF(B.LT.0.) B=0.
266      249 ANU=ANU*(RAS/6.2E-4)**B
267      C      CORRECT FOR NON-ANNULAR WALL AND CORNER CHANNELS
268      247 IFIL.EQ.2.OR.L.EQ.3) ANU=ANU*0.967
269      ANJ=ANU*YST
270      STNO(I,J)=ANU/RE/PR
271      HFILM(I)=ANU*CON(I)/DHYD(I,J)
272      TETA(I)=0.
273      IFIL.EQ.1.OR.L.GT.3) GO TO 243
274      C      WALL OR CORNER CHANNELS ONLY. COMPUTE EFFECTIVE SHROUD NUSSELT NO.
275      IF(RAS.GT.0.1) GO TO 5
276      TETA2I=-0.1033*RAS**0.9489
277      GO TO 6
278      5 TETA2I=0.0142-0.07849*RAS**0.4828
279      6 CONTINUE
280      IFIX1.LE.0) GO TO 10
281      IF(GRI.GT.0.01) GO TO 7
282      YTE2=31.105*GRI
283      GO TO 9
284      7 IF(GRI.GE.0.025) GO TO 8

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* P R O P *

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285      YTE2=15.5994*GRI**0.8501
286      GO TO 9
287      8 YTE2=1./10.9829*1.26E-4/GRI**2.242)
288      IF(YTE2.GT.1.)YTE2=1.
289      GO TO 9
290      10 YTE2=1.
291      9 TETA(I)=TETA2I*YTE2*DEI/CON(I)
292      243 HFILMS(I) = HFILM(I)
293      250 CONTINUE
294      RETURN
295      290 IERROR=11
296      RETURN
297      C
298      C
299      330 FORMAT (5X,'OUT OF RANGE FOR PROPERTY TABLE,')
300      ENC

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@HOG

* F R O P S *

@PRT,S COBRA*CFIL,PROPS
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* P R O P S *

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COBRA+CFTL(1).PROPS

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1  SUBROUTINE PROPS(IRE,L,FRIC,STN,I,J)
2  INCLUDE SPEC13,LIST
3  IF(IRZS(L).LE.0)GO TO 20
4  CALL BASIC(IRZS(L),RR(L),HRIB,RE,TWTB,FRIC,STN,I,J)
5  RETURN
6  20 CONTINUE
7  CALL IDDT(HRIB,RE,RR(L),R2(L),TWTB,FRIC,STN,I,J)
8  RETURN
9  END
```

@HMG

* R A D I A T *

@PRT,S

COBRA+CFTL.RADIAT

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COBRA*CFIL(1),RADIAT

1		SUBROUTINE RADIAT(JX)	
2		INCLUDE SPEC12,LIST	
3		INCLUDE SPEC21,LIST	
4		DATA I/O/,J/O/,K/O/,IS/O/	
5		DATA S/OEO/	CYS
6	C	EFFECTS OF RADIATION INCLUDED IN FLUX	CYS
7	C		492700
8	C	HFA(I,K) - HCTTEL FACTORS ARRAY	492800
9	C	IJ(I,K) - SURFACE CONNECTIONS	492900
10	C	NSF - NUMBER OF SURFACES	493000
11	C	QR(I,JX) - RADIATION HEAT FLUX FOR SURFACE I	493100
12	C	TSF(I) - TEMPERATURE OF SURFACE I, KELVINS	493200
13	C		
14	C		493800
15	C	FLUX DUE TO RADIATION, KW/M2	495600
16		S = 0.	
17		IS = 1	495800
18		DO 204 K=1,IJM	495900
19		I = IIS(K)	496000
20		J = JJS(K)	496100
21		IF(I.EQ.IS) GO TO 203	496200
22		QR(IS,JX) = S	496300
23		S = 0.	496400
24		IS = I	496500
25	203	CONTINUE	496600
26		S = HFA(K) *5.6688E-11*(TSF(I)**4 - (TSF(J)**4) * S	496700
27	204	CONTINUE	
28		QR(IS,JX) = S	496900
29	C		497000
30		RETURN	497100
31	C		498200
32	C	READ INPUT VALUES	498300
33		ENTRY RADRED (LU)	498400
34		READ (LU,5) NSF,IJM	498500
35		READ(LU,5) (IIS(K),K=1,IJM)	498600
36		READ(LU,5) (JJS(K),K=1,IJM)	498700
37		READ(LU,6) (HFA(K),K=1,IJM)	498800
38		RETURN	498900
39	C		499000
40	5	FORMAT(16I5)	499100
41	6	FORMAT(8E10.5)	499200
42		END	499300
			499400

@HDG

* R E S L T 2 *

@PRT,S

COBRA*CFIL,RESLT2

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COBRA*CFIL(1).RESLT2

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1      SUBROUTINE RESLT2(IPART,*,*)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC5,LIST
4      INCLUDE SPEC6,LIST
5      INCLUDE SPEC7,LIST
6      INCLUDE SPEC8,LIST
7      INCLUDE SPEC12,LIST
8      INCLUDE SPEC13,LIST
9      INCLUDE SPEC14,LIST
10     INCLUDE SPEC15,LIST
11     INCLUDE SPEC22,LIST
12     INCLUDE SPEC24,LIST
13     DIMENSION NOCHAN(12)
14     LOGICAL PRINT
15     REAL KPOUT
16     REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
17     INTEGER PRINTC,PRINTG,PRINTR
18     C      THIS SUBROUTINE PRINTS SUBCHANNEL AND FUEL ROD TEMPERATURES
19     C
20     C      IPART = 1, PRINT SUBCHANNEL RESULTS
21     C      2, RETURN
22     C      3, PRINT FUEL ROD AND DUCT RESULTS
23     C
24     GO TO (100,200,300), IPART
25     C
26     C      PRINT SUBCHANNEL RESULTS
27     100 CONTINUE
28     PREF0=PREF/1000.
29     DO 180 JJ=1,NPCHAN
30     I=PRINTC(JJ)
31     WRITE (I3,750) KASE,TEXT,DATE,TIMNOW
32     WRITE (I3,790) ETIME,PREF0,I
33     WRITE (I3,801)
34     DO 170 JX=1,NDXP1,NSKIPX
35     J=JX
36     OUTPUT(1)=X(JX)*1000.
37     OUTPUT(2) = P(I,J)/1000.
38     VIN=H(I,J)
39     CALL CURVE (OUTPUT(3),VIN,TPOUT,HGPT,NPROP,IERROR,1)
40     IF (IERROR.GT.1) GO TO 730
41     OUTPUT(4)=RHO(I,J)
42     CALL CURVE (VIS,OUTPUT(3),UPOUT,TPOUT,NPROP,IERROR,1)
43     OUTPUT(6) = F(I,J)*DHYD(I,J)/(A(I,J)*VIS)
44     OUTPUT(5)=F(I,J)
45     OUTPUT(7) = A(I,J)*1.E6
46     CALL PROP (2,J,JX,I,I)
47     OUTPUT(8) = FSP(I)
48     OUTPUT(9) = STNO(I,J)
49     IF (AFLUX.LT.1.E-6.OR.OUTPUT(9).GE.1.E-6) GO TO 130
50     CALL CURVE (CONDOC,OUTPUT(3),KPOUT,TPOUT,NPROP,IERROR,1)
51     CALL CURVE (CSUBP,OUTPUT(3),CPPOUT,TPOUT,NPROP,IERROR,1)
52     PR = VIS*CSUBP/CONDOC
53     OUTPUT(9) = (AH(1)*OUTPUT(6)**AH(2)*PR**AH(3) + AH(4))/
54     1 (OUTPUT(6)*PR)
55     130 CONTINUE
56     OUTPUT(10) = HFILM(I)

```

517500

517800

517900

521500

521600

521800

521900

522000

522300

522400

522500

523200

523800

523900

524100

524200

524400

525000

525300


```

57      OUTPUT(11)=HPW(I,J)
58      OUTPUT(12)=RHPLS(I,J)
59      IF(HPW(I,J).EQ.0.) AR = 0.
60      OUTPUT(13)=AR
61      WRITE(I3,811) (OUTPUT(II),II=1,13)
62      170 CONTINUE
63      180 CONTINUE
64      RETURN 2
65      C
66      200 CONTINUE
67      RETURN 2
68      C
69      C      PRINT FUEL ROD RESULTS
70      300 CONTINUE
71      DO 480 NN=1,NPROD
72      N = PRINTN(NN)
73      WRITE (I3,820) KASE,TEXT,DATE,TIMNOW,ETIME,N
74      DO 470 JX=1,NDXP1,NSKIPX
75      CALL CLDTMP(JX,N)
76      470 CONTINUE
77      480 CONTINUE
78      C
79      C      PRINT DUCT TEMPERATURES
80      C      FIND AXIAL POSITIONS FOR ROUGH SECTION
81      IF((INFH-2)*(INFH-4).NE.0) RETURN 2
82      DO 27910 JX=1,NDXP1
83      IF(X(JX) .LT. LENSROU) JXRB=JX
84      IF(X(JX) .LT. LENROU) JXRE=JX
85      27910 CONTINUE
86      JXRB = JXRB + 1
87      MAXCHN = 0
88      DO 27960 IC=1,NCHANL
89      NTYP = NTYPE(IC)
90      IF(NTYP.GT.NFT) NTYP=1
91      IF(R2(NTYP) .EQ. 0.) GO TO 27951
92      MAXCHN = MAXCHN + 1
93      NOCHAN(MAXCHN) = IC
94      IF(MAXCHN .GT. 11) GO TO 27920
95      GO TO 27951
96      27920 CONTINUE
97      PRINT 951,KASE,TEXT,DATE,TIMNOW,ETIME,(NOCHAN(II),II=1,MAXCHN)
98      IF(MAXCHN.LT.12) PRINT 953
99      DO 27950 JX=JXRB,JXRE
100      J = JX
101      XDUMY = X(JX)*1000.
102      DO 27940 II=1,MAXCHN
103      I = NOCHAN(II)
104      NTYP = NTYPE(I)
105      IF(NTYP.GT.NFT) NTYP=1
106      CALL PROP (2,J,JX,I,I)
107      C      DUCT HAS ONLY ONE ROD CONNECTED TO IT
108      M=0
109      DO 27931 NN=1,NROD
110      N = NN
111      DO 27930 L=1,MSC
112      IS = LR(NN,L)
113      IF(IS.GT.0) M=M+1

```

```

525600
525700
GA-MAR81
525900
526100
GA-MAR81
531100
531200
531300
531400
531500
533600
533700
533800
534000
534100
534200
GA-MAR81
534300
534600
534700
534800
534900
535000
535100
535200
535300
535400
535500
535600
536300
536400
537400
537500
537600
537700
537800
537900
538000
538100
538200
538300
538400

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114 IF(I.EQ. 15) GO TO 27932 538500
115 27930 CONTINUE 538600
116 27931 CONTINUE 538700
117 CALL ERROR
118 27932 CONTINUE 538900
119 DFLUX = FLUX(N,J)
120 IF(IFL.GT.0) DFLUX = FLX(M,JX)
121 CALL CURVE(ITIJ,HII,J),TPOUT,HGPT,NPROP,IERROR,1) 539200
122 CALL CURVE(CPP,HII,J),CPPOUT,HGPT,NPROP,IERROR,1) 539300
123 CALL CURVE(VSK,HII,J),UPOUT,HGPT,NPROP,IERROR,1) 539400
124 CALL DUCT (HRIB,RR(NTYP),R2(NTYP),HPLUS ,GPRIME,OFLUX,TIJ,CPP,VSK,
125 TWTB,BIOT,BIOTE,TD,I,AHS)
126 OUTPUT(II) =TD
127 27940 CONTINUE 539900
128 PRINT 952, XDUMY,(OUTPUT(III),III=1,MAXCHN) 540000
129 27950 CONTINUE 540100
130 MAXCHN = 0 540200
131 27951 CONTINUE 540300
132 IF(IC.LT.NCHANL) GO TO 27960 540400
133 IF(MAXCHN.EQ.0) GO TO 27960 540500
134 GO TO 27920 540600
135 27960 CONTINUE 540700
136 RETURN 2 GA-MAR81
137 C 540900
138 C ERROR EXIT 541000
139 730 CONTINUE 541100
140 RETURN 3 GA-MAR81
141 750 FORMAT (17H1CHANNEL RESULTS ,/5H CASE,I5,5X17A4,9H DATE ,2A6,7HGA-MAR81
142 + TIME ,2A6/) GA-MAR81
143 790 FORMAT (8H TIME = ,F8.5,9H SECONDS ,13H PRESSURE =,F7.1,5H KPA , 541500
144 +25H DATA FOR CHAVNEL ,I3,/) 541600
145 801 FORMAT(' DISTANCE',3X,'DELTA-P',3X,'TEMPERATURE',3X,'DENSITY',5X,
146 1 'FLOW',5X,'REYNOLDS',4X,'AREA',3X,'FRICTION',3X,'STANTON',3X,
147 2 'FILM H',3X,' H+',3X,'R(H+)',3X,'AR',
148 2 /,3X,'(MM)',6X,'(MPA)',6X,'(DEG-C)',5X,
149 3 '(KG/M3)',4X,'(KG/S)',5X,'NUMBER',4X,'(MM2)',4X,'FACTOR',4X,
150 4 'NUMBER',4X,'KW/M2-C')
151 811 FORMAT(2X,F6.1,3X,F8.3,5X,F6.1,7X,F5.3,4X,F8.6,4X,F7.0,1X,F7.2,
152 1 3X,F7.5,3X,F8.5,3X,F6.3,3X,F5.1,3X,F5.2,2X,F5.1)
153 820 FORMAT (5H1CASE,I5,5X17A4,9H DATE ,2A6,7H TIME ,2A6//8H TIME =GA-MAR81
154 + ,F8.5,9H SECONDS ,28H TEMPERATURE DATA FOR ROD,I3,3X,10HIFUEL 542500
155 +TYPE,3H - , 'CYLINDER',1H))
156 951 FORMAT('1DUCT TEMPERATURE RESULTS IDEG-C)',/, ' CASE',I5,5X,16A4,A2 542700
157 .,3X,'DATE ',2A, ' TIME ',2A6,/, ' TIME = ',F8.5, ' SECONDS',/, 542800
158 . ' DISTANCE',12I ' CHANNEL ',/,3X,'(MM)',2X,12(3X,'( ',I3,') ',2X),/
159 .)
160 952 FORMAT(F7.1,12F10.1) 543000
161 953 FORMAT(1X)
162 END

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@HOG * R E S U L T *

@PRT,S COBRA*CFIL.RESULT
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:03

COBRA*CF TL(1),RESULT

```

1      SUBROUTINE RESULT(NT)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC5,LIST
5      INCLUDE SPEC6,LIST
6      INCLUDE SPEC7,LIST
7      INCLUDE SPEC8,LIST
8      INCLUDE SPEC22,LIST
9      INCLUDE SPEC52,LIST
10     INCLUDE SPEC72,LIST
11     LOGICAL PRINT
12     REAL KPOUT
13     REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
14     INTEGER PRINTC,PRINTG,PRINTR
15     C      THIS SUBROUTINE PERFORMS OUTPUT FUNCTION (PRINTING)
16     C      FOR EACH TIME STEP.
17     DATA KT/D/
18     C
19     IF (NT.EQ.1.OR.NT.EQ.NDTP1) KT=NSKIPT-1
20     KT=KT+1
21     IF (KT.LT.NSKIPT.AND.ETIME.LT.TTIME) GO TO 520
22     KT=0
23     C
24     C      PRINT RESULTS
25     IF (ETIME.GT.0.) GO TO 160
26     C
27     C      COMPUTE MASS AND ENERGY BALANCE
28     FLOIN=0.
29     FLOOUT=0.
30     ENGIN=0.
31     ENGOUT=0.
32     NDXP1=NDX+1
33     DO 100 I=1,NCHANL
34     IF (INTYPE(I).GT.NFT) GO TO 100
35     FLOIN=FLOIN+F(I,1)
36     FLOOUT=FLOOUT+F(I,NDXP1)
37     ENGIN=ENGIN+F(I,1)*H(I,1)
38     ENGOUT=ENGOUT+F(I,NDXP1)*H(I,NDXP1)
39     100 CONTINUE
40     FLOERR=FLOOUT-FLOIN
41     ENGADD = 0.0
42     DO 104 J=2,NDXP1
43     DX = X(J) - X(J-1)
44     DO 104 N=1,NRSD
45     DO 104 L=1,MSL
46     I = LRIN,L)
47     IF (I.EQ.0) GO TO 104
48     ENGADD = ENGADD + PHI(N,L)*FLUX(N,J)*PI*DX
49     *DX
50     104 CONTINUE
51     ENGERR=ENGOUT-ENGIN-ENGADD
52     ENGPCT=0.
53     IF (ABS(ENGADD).GT.1.E-3) ENGPCT = 100.0*ENGERR/ENGADD
54     WRITE (I3,920) KASE,TEXT,DATE,TIMNOW,FLOIN,ENGIN,FLOOUT,ENGADD,
55     FLOERR,ENGOUT,ENGERR,ENGPCT
56     C

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543600

546900

547400

547500

547600

547700

547800

548100

548200

548400

548500

548600

548700

548800

548900

549000

549200

549300

549400

549500

549600

549700

550400

550500

550600

550700

550800

550900

551000

551100

551200

551300

551600

552300

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57 C PREPARE CHANNEL EXIT SUMMARY 552400
58 J=NDXP1 552500
59 DO 110 I=1,NCHANL 552600
60 VIN=H(I,J) 552800
61 CALL CURVE (OUTPUT(1),VIN,TPOUT,HGPT,NPROP,IERROR,1)
62 OUTPUT(2)=F(I,J)/AN(I)/1000.
63 WRITE (13,930) I,H(I,J),OUTPUT(1),RHO(I,J),F(I,J),OUTPUT(2)
64 110 CONTINUE 554200
65 NDXP1 = NDX + 1 554300
66 IF (IERROR.GT.1) GO TO 730 554400
67 C 554500
68 C COMPUTE BUNDLE AVERAGED RESULTS 554600
69 WRITE (13,750) KASE,TEXT,DATE,TIMNOW
70 WRITE (13,940)
71 WRITE (13,801)
72 NDXP1=NDX+1 554800
73 DO 150 JX=1,NDXP1 554900
74 J=JX 555400
75 SAVE1=0. 555600
76 SAVE2=0. 555700
77 SAVE3=0. 557000
78 SAVE4=0. 557100
79 SAVE5=0. 557200
80 SAVE6=0. 557300
81 DO 140 I=1,NCHANL 557400
82 IF (INTYPE(I)).GT.NFT)GO TO 140 557500
83 SAVE1=SAVE1+P(I,J)*A(I,J) 557600
84 SAVE2=SAVE2+H(I,J)*F(I,J) 557700
85 SAVE3=SAVE3+F(I,J) 557800
86 SAVE5=SAVE5+A(I,J) 557900
87 SAVE6=SAVE6 + PW(I) 558000
88 SAVE4=SAVE4+RHO(I,J)*A(I,J) 558200
89 140 CONTINUE
90 OUTPUT(1)=X(JX)*1000.
91 OUTPUT(2)=SAVE1/SAVE5/1000. 558400
92 OUTPUT(3)=SAVE2/SAVE3 558500
93 CALL CURVE (OUTPUT(4),OUTPUT(3),TPOUT,HGPT,NPROP,IERROR,1)
94 IF (IERROR.GT.1) GO TO 730 559100
95 OUTPUT(5)=SAVE4/SAVE5 559300
96 OUTPUT(6)=SAVE3
97 CALL CURVE (VIS,OUTPUT(4),UPOUT,TPOUT,NPROP,IERROR,1) 560100
98 OUTPUT(7) = 4.*OUTPUT(6)/(SAVE6*VIS)
99 OUTPUT(8)=SAVE3/SAVE4
100 OUTPUT(9)=SAVE5*1.E6
101 WRITE(13,811) (OUTPUT(I),I=1,9)
102 150 CONTINUE 560600
103 IF (IERROR.GT.1) GO TO 730 561200
104 C 561300
105 C PRINT CHANNEL AND ROD RESULTS AS DEFINED BY OUTPUT OPTIONS 561400
106 160 CONTINUE 561500
107 C 562700
108 C PRINT SUBCHANNEL RESULTS
109 CALL RESLT2 (1,0181,0730)
110 181 CONTINUE 566200
111 IF (NOUT.EQ.0 .OR. NOUT.EQ.10) GO TO 510 566300
112 IF (NOUT.EQ.2 .OR. NOUT.EQ.12) GO TO 340 566400
113 IF (NIN.EQ.0) GO TO 330 566500

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114 C
115 C PRINT CROSSFLOWS 566600
116 DO 210 M=1,NPGAP,10 566800
117 MM=M+9 566900
118 IF (NPGAP.LE.MM) MM=NPGAP 567000
119 I=0 567100
120 DO 190 MKK=M,MM 567200
121 I=I+1 567300
122 IMAX=I 567400
123 K=PRINTG(MKK) 567500
124 IMP(I)=IM(K) 567600
125 190 JMP(I)=JK(K) 567700
126 WRITE (I3,770) KASE,TEXT,DATE,TIMNOW,ETIME,(IMP(I),JMP(I),
127 +I=1,IMAX)
128 DO 210 J=1,NDXP1,NSKIPX 568000
129 J=JX 568100
130 IF (JX.EQ.1) GO TO 210 568200
131 XDM=X(JX-1)*1000.
132 XDUMY=X(JX)*1000.
133 DO 200 I=M,MM 568500
134 II=PRINTG(I) 568600
135 III=I-M+1 568700
136 200 OUTPUT(III)=W(II,J) 568800
137 NDUM=MM-M+1 568900
138 WRITE (I3,760) XDM,XDUMY,(OUTPUT(II),I=1,NDUM) 569000
139 210 CONTINUE 569100
140 330 IF (NOUT.EQ.1 .OR. NOUT.EQ.11) GO TO 510 582100
141 340 IF (NPROC.LT.1) GO TO 510
142 C 582300
143 C PRINT ROD RESULTS 582400
144 CALL RESLT2 (I3,6510,6730)
145 510 WRITE (I3,780) ITERAT 593100
146 520 RETURN
147 730 IERROR=1 603500
148 RETURN 603600
149 C 603700
150 C 603800
151 750 FORMAT (17H1CHANNEL RESULTS ,/5H CASE,I5,5X,17A4,9H DATE ,2A6,7HGA-MAR81
152 + TIME ,2A6/) GA-MAR81
153 760 FORMAT(1X,F6.1,2H -,F6.1,10F11.5)
154 770 FORMAT (68H1DIVERSION CROSSFLOW BETWEEN ADJACENT CHANNELS, W(I,J), 604400
155 + (KG/SEC-M). ,//5H CASE,I5,5X,17A4,9H DATE ,2A6,7H TIME ,2A6//GA-MAR81
156 +7H TIME =,F9.5,8H SECONDS//,
157 3 1X,15H AXIAL ZONE ,10(1X,'W(',I3,',',I3,')')
158 780 FORMAT (//14H ITERATIONS = ,I4) 604800
159 801 FORMAT(' DISTANCE',3X,'DELTA-P',3X,'ENTHALPY',3X,'TEMPERATURE',
160 1 3X,'DENSITY',5X,'FLOW',5X,'REYNOLDS',3X,'VELOCITY',5X,'AREA',/,
161 2 3X,'(M)',6X,'(K>A)',4X,'(KJ/KG)',6X,'(DEG-C)',5X,'(KG/M3)',4X,
162 3 '(KG/S)',5X,'NUMBER',6X,'(M/S)',5X,'(ISO-MM)',/)
163 811 FORMAT(2X,F6.1,3X,F8.3,3X,F7.2,7X,F5.1,7X,F5.3,5X,F6.4,5X,F6.0,
164 1 6X,F6.3,6X,F5.1)
165 920 FORMAT(1H1,' CHANNEL EXIT SUMMARY RESULTS',/, ' CASE',I5,5X,17A4,
166 1 2X,'DATE',2X,2A6,1X,'TIME',2X,2A6,/, ' MASS BALANCE - -',33X, GA-MAR81
167 2 'ENERGY BALANCE - -',/,5X,'MASS FLOW IN',6X,F12.5,' KG/SEC',13X,
168 3 'FLOW ENERGY IN',6X,F12.5,' KW',/,5X,'MASS FLOW OUT',5X,F12.5,
169 4 ' KG/SEC',13X,'ENERGY ADDED',8X,F12.5,' KW',/,5X,
170 5 'MASS FLOW ERROR',3X,E12.5,' KG/SEC',13X,'FLOW ENERGY OUT',5X,

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171      6 F12.5,' KW',/,56X,'ENERGY ERROR',6X,E12.5,' KW',3X,
172      7 'OR',F8.3,' PCT.',
173      8//,' CHANNEL',1X,'ENTHALPY',3X,'TEMPERATURE',3X,'DENSITY',5X,
174      9 'FLOW',5X,'MASS FLUX',/,2X,'(NO.)',2X,'(KJ/KG)',6X,'(DEG-C)',5X,
175     10 '(KG/M3)',4X,'(KG/S)',4X,'(G/S-MM2)',/)
176     930 FORMAT(I5,4X,F7.2,7X,F5.1,7X,F5.3,4X,F7.5,5X,F6.4)
177     940 FORMAT (1X,24H BUNDLE AVERAGED RESULTS/)
178     END

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611000
612500

@HDG * R O D C O N *

@PRT,S COBRA*CFIL.RODCON
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:04

COBRA*CFIL(1).RODCON

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1  SUBROUTINE RODCON(NROD,JX,TBLK,HTC,DFX,DT)
2  INCLUDE SPEC6,LIST
3  INCLUDE SPEC12,LIST
4  INCLUDE SPEC21,LIST
5  INCLUDE SPEC16,LIST
6  DIMENSION QRAD(24)
7  DIMENSION TBLK(1),HTC(1)
8  C DIMENSIONS OF T,Q,RHS ARE NDIM=(NR-1)*MS+1
9  C DIMENSIONS OF HT,TB,THETA ARE MS=BANDWIDTH=MAX NUMBER OF CHANNELS
10 C LEADING DIMENSION OF A MATRIX=MS+1
11   DIMENSION T(97),Q(97),HT(24),TB(24),THETA(24),QPRIME(5)
12   DIMENSION A(25,97),RHS(97)
13  C
14  C   LR(N,K) - THE NUMBER OF THE KTH SUBCHANNEL CONNECTED TO ROD N.
15  C   PHI(N,K) - THE FRACTION OF THE KTH SUBCHANNEL CONNECTED TO ROD N.
16  C   TBLK(II,J) - BULK TEMPERATURE OF SUBCHANNEL I AT AXIAL LOCATION J
17  C   DFLX(N,J) - HEAT FLUX FOR ROD N AT AXIAL LOCATION J
18  C   HS(N,I,J) - HEAT TRANSFER COEFFICIENT FOR ROD N, SUBCHANNEL CONNEX
19  C   AXIAL LOCATION J
20  C
21  C MUST USE CONSISTANT UNITSJJJJJ
22   DATA TWOPI/6.283185307EJ/
23  C DEFINE NR AND ITHETA NOW. INPUT THEM LATER
24   NR=3
25   ITHETA=1
26  C
27  C
28   MT=0
29   DO 280 N=1,NROD
30   DFLX=DFX*RADIAL(N)
31   M=0
32   DO 10 II=1,MS
33   I=LR(N,II)
34   IF(I.EQ.0)GOTO20
35   M=M+1
36   THETA(II)=TWOPI*PHI(N,II)
37   TB(II)=TBLK(II)
38   HT(II)=HTC(II)
39  C MUST FUDGE RADIANT HEAT FLUX AS LINEAR HEAT SINK(SOURCE) IN CLAD
40   QRAD(II)=QR(II+MT,JX)*RF(NR)*THETA(II)
41  C
42   10 CONTINUE
43   20 CONTINUE
44   DO 30 I=1,NCONR
45   IF(N.EQ.ICONR(II))GOTO50
46   30 CONTINUE
47  C DO NOT CONSIDER CONDUCTION ON THIS ROD
48   DO 40 J=1,M
49   FLX(MT+J,JX)=DFLX
50   TSF(MT+J)=TB(J)+273.
51   40 CONTINUE
52   MT=MT+M
53   GOTO280
54   50 CONTINUE
55  C CONROD NEEDS LINEAR HEAT FLUX FOR EACH INTERNAL RADIAL RING
56   DO 60 I=1,NR

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57      60 QPRIME(I)=DFLX*TWOPI*RF(NR)*QPFRAC(I)
58      MS=M
59      IF(M.LT.5) CALL MORCON (M,MS,THETA,HT,TB,QRAD)
60      MSO=MS
61      GO TO (70,80,100),ITHETA
62      70 CONTINUE
63      MSP1=MS+1
64      GO TO 120
65      80 CONTINUE
66      MS=2*MSO
67      MSP1=MS+1
68      MSM1=MS-1
69      DO 90 I=1,MSM1,2
70      MSP1MI = MSP1 - I
71      MSOMI2 = MSO - I/2
72      MSMI = MS - I
73      THETA(MSP1MI)=THETA(MSOMI2)/2.0
74      THETA(MSMI)=THETA(MSOMI2)/2.0
75      HT(MSP1MI)=HT(MSOMI2)
76      HT(MSMI)=HT(MSOMI2)
77      TB(MSP1MI)=TB(MSOMI2)
78      TB(MSMI)=TB(MSOMI2)
79      QRAD(MSP1MI)=QRAD(MSOMI2)
80      QRAD(MSMI)=QRAD(MSOMI2)
81      90 CONTINUE
82      GO TO 120
83      100 CONTINUE
84      MS=3*MSO
85      MSP1=MS+1
86      MSM1=MS-1
87      MSM2=MS-2
88      DO 110 I=1,MSM2,3
89      MSP1MI = MSP1 - I
90      MSOI3 = MSO - I/3
91      MSMI = MS - I
92      MSM1MI = MSM1 - I
93      THETA(MSP1MI)=THETA(MSOI3)/3.0
94      THETA(MSMI)=THETA(MSOI3)/3.0
95      THETA(MSM1MI)=THETA(MSOI3)/3.0
96      HT(MSP1MI)=HT(MSOI3)
97      HT(MSMI)=HT(MSOI3)
98      HT(MSM1MI)=HT(MSOI3)
99      TB(MSP1MI)=TB(MSOI3)
100     TB(MSMI)=TB(MSOI3)
101     TB(MSM1MI)=TB(MSOI3)
102     QRAD(MSP1MI)=QRAD(MSOI3)
103     QRAD(MSMI)=QRAD(MSOI3)
104     QRAD(MSM1MI)=QRAD(MSOI3)
105     110 CONTINUE
106     120 CONTINUE
107     C
108     NDIM=(NR-1)*MS+1
109     DO 130 I=1,NDIM
110     T(I)=0.E0
111     C
112     C
113     CALL CONRODIA,T,RMS,Q,QPRIME,QRAD,TB,HT,THETA,DT,MSP1,MS,NDIM,NR)

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GA-MAR81
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* R O D C O N *

DATE 052681

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114 C      ISTRT=NDIM-MS+1
115 C      WRITE(6,10010)T(1),T(1),I=ISTRT,NDIM)
116 C10010 FORMAT(1H ,F10.3,7(3F10.3,/))
117 C      WRITE(6,10010)T(1),T(1),I=2,NDIM)
118 C10010 FORMAT(1H , 'TEMPS',/,F10.2,/,5(7F9.1,/))
119 GO TO (180,140,160),ITHETA
120 140 CONTINUE
121 DO 150 I=1,MSM1,2
122 IS = I/2+1
123 150 Q(IS)=(Q(I)+Q(I+1))/2.E0
124 GO TO 180
125 160 CONTINUE
126 DO 170 I=1,MSM2,3
127 IS = I/3+1
128 Q(IS)=(Q(I)+Q(I+1)+Q(I+2))/3.E0
129 170 CONTINUE
130 180 CONTINUE
131 190 CONTINUE
132 200 CONTINUE
133 QS=0.
134 PHIT=0.
135 DO 125 J=1,M
136 QS=QS+(Q(J)+QRAD(J)/4RF(NR)*THETA(J))*PHI(N,J)
137 125 PHIT=PHIT+PHI(N,J)
138 IF(DFLX.EQ.0)GO TO 127
139 QS=QS/(PHIT*DFLX)
140 DO 126 J=1,M
141 Q(J)=Q(J)/QS
142 GO TO 129
143 127 CONTINUE
144 QS=QS/PHIT
145 DO 128 J=1,M
146 Q(J)=Q(J)-QS
147 129 CONTINUE
148 DO 270 J=1,M
149 FLX(MT+J,JX)=Q(J)
150 TSF(MT+J)=TB(J)+Q(J)/HT(J)+273.
151 270 CONTINUE
152 MT=MT+M
153 280 CONTINUE
154 C
155 IF(MT.GT.NSF)CALL ERROR
156 RETURN
157 END

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GA-MAR81

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@HDG

* S A X P Y *

@PRT,S

COBPA*CFIL.SAXPY

FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:04

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COBRA*CFITL(1),SAXPY
1      SUBROUTINE SAXPY(N,SA,SX,INCX,SY,INCY)
2
3      C
4      C      CONSTANT TIMES A VECTOR PLUS A VECTOR.
5      C      USES UNROLLED LOOP FOR INCREMENTS EQUAL TO ONE.
6      C      JACK DONGARRA, LINPACK, 3/11/78.
7
8      REAL SX(1),SY(1),SA
9      INTEGER I,INCX,INCY,IX,IY,M,MP1,N
10
11     IF(N.LE.0)RETURN
12     IF (SA .EQ. 0.0) RETURN
13     IF(INCX.EQ.1.AND.INCY.EQ.1)GO TO 20
14
15     C      CODE FOR UNEQUAL INCREMENTS OR EQUAL INCREMENTS
16     C      NOT EQUAL TO 1
17
18     IX = 1
19     IY = 1
20     IF(INCX.LT.0)IX = (-N+1)*INCX + 1
21     IF(INCY.LT.0)IY = (-N+1)*INCY + 1
22     DO 10 I = 1,N
23         SY(IY) = SY(IY) + SA*SX(IX)
24         IX = IX + INCX
25         IY = IY + INCY
26     10 CONTINUE
27     RETURN
28
29     C      CODE FOR BOTH INCREMENTS EQUAL TO 1
30
31     C      CLEAN-UP LOOP
32
33     20 M = MOD(N,4)
34     IF( M .EQ. 0 ) GO TO 40
35     DO 30 I = 1,M
36         SY(I) = SY(I) + SA*SX(I)
37     30 CONTINUE
38     IF( N .LT. 4 ) RETURN
39     40 MP1 = M + 1
40     DO 50 I = MP1,N,4
41         SY(I) = SY(I) + SA*SX(I)
42         SY(I + 1) = SY(I + 1) + SA*SX(I + 1)
43         SY(I + 2) = SY(I + 2) + SA*SX(I + 2)
44         SY(I + 3) = SY(I + 3) + SA*SX(I + 3)
45     50 CONTINUE
46     RETURN
47     END

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@HOG * S C H E M E *

@PRT,S COBRA*CFITL.SCHEM
FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:04

COBRA*CFIL(1).SCHEME

```

1      SUBROUTINE SCHEME(NTRIES,JUMP,MAXT)
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC3,LIST
5      INCLUDE SPEC4,LIST
6      INCLUDE SPEC10,LIST
7      INCLUDE SPEC12,LIST
8      INCLUDE SPEC19,LIST
9      INCLUDE SPEC25,LIST
10     INCLUDE SPEC51,LIST
11     INCLUDE SPEC52,LIST
12     INCLUDE SPEC53,LIST
13     INCLUDE SPEC56,LIST
14     INCLUDE SPEC71,LIST
15     INCLUDE SPEC72,LIST
16     INCLUDE SPEC73,LIST
17     INCLUDE SPEC76,LIST
18     LOGICAL GRID
19     REAL IDTGC,LENGTH,KIJ,LENSHO,LENROU
20
21     C      THIS SUBROUTINE SETS UP AND PERFORMS THE SOLUTION OF THE IMPLICIT
22     C      FINITE DIFFERENCE SCHEME.
23     C
24     NDXP1=NDX+1
25     C SET FLOW ACCELERATION
26     ACCF=ACCELF
27     IF (DT.LT.1.E+6) ACCF=1.
28     C
29     NTRYS=NTRIES
30     DO 490 NN=1,NTRYS
31     CALL ELAP(MTIME)
32     IF(INN.EQ.1)WRITE(I3,570)MTIME
33     IF(MTIME.GT.MAXT)NTRIES=NN-1
34     IF(MTIME.GT.MAXT)RETURN
35     ITERAT=NN
36     CALL HEAT (0,1,1,1)
37     JUMP=2
38     IF (IERROR.LT.0) JUMP=1
39     QOF=0.
40     IFOUT=0
41     QIM=0.
42     QOM=0.
43     QOH=0.
44     ISAVT=0
45     ISOUT=0
46     TFLO=0.
47     IF(ITERAT.EQ.2) IFL=MAXD(ICON,IFAD)
48     C
49     C      BEGIN STEPPING THROUGH CHANNEL
50     DO 449 JX=1,NDXP1
51     IF(JX.GT.1)DX = X(JX) - X(JX-1)
52     IF(JX.EQ.1) DX = X(2)-X(1)
53     DXGC = DX*GC
54     SLDX = SL*DX
55     DXI = 1./DX
56     DX2 = DX*DX

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622000
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622200
622300

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57      DXIDT = DX/DT                      622400
58      TFLOJ=0.                          622600
59      J=JX                              622700
60      JM1=J-1                            623000
61      JF=J-1/ITERAT                     623200
62      IF (DT.LT.1.E+9) JF=J             623300
63      IF (NN.EQ.1.OR.ITERAT.LE.NARAMP) CALL AREA (J,JX)
64      IF (IERROR.GT.1) GO TO 430          623500
65      IF (J.GT.1) GO TO 110              623600
66      C SET CONDITIONS AT START OF CHANNEL 623700
67      DO 100 I=1,NCHANL                  623800
68      TFLO=TFLO+F(I,1)
69      100 QPRIM(I)=0.                    624000
70      GRID=.FALSE.                      624100
71      IF (IERROR.GT.1) GO TO 430          624200
72      CALL PROP (2,J,JX,1,NCHANL)        624300
73      IF (IERROR.GT.1) GO TO 430          624400
74      DO 1 I=1,NCHANL
75      RHO(I,1)=1./V(I)
76      UB(I,1)=F(I,1)*V(I)/A(I,1)
77      1 CONTINUE
78      IF (IERROR.GT.1) GO TO 430          624600
79      CALL FORCE (J,JX,J)                 624700
80      GO TO 440                          624900
81      C CALCULATE PARAMETERS TO BE SAVED FROM PREVIOUS SPACE
82      110 DO 120 I=1,NCHANL              625000
83      F(I,J)=F(I,JF)                     625100
84      RHO(I,J)=RHO(I,JF)                 625200
85      H(I,J)=H(I,JF)                     625300
86      UB(I,J)=UB(I,JF)                   625400
87      VPA(I)=V(I)/A(I,JM1)               625500
88      DPK(I)=0.
89      IF (NN.GT.1.OR.DT.LT.1.E+6) GO TO 120 625700
90      TFLOJ=TFLOJ+F(I,J)                 625800
91      120 CONTINUE                       626000
92      CALL HEAT (0,J,2,JX)                626100
93      IF (INSCBC.EQ.4) CALL PROP (2,J,JX,1,NCHANL) 626200
94      IF (INK.GT.0) CALL MIX(J)           626300
95      IF (IERROR.GT.1) GO TO 430          626400
96      CALL DIFFER (1,J,JX)                626500
97      IF (IERROR.GT.1) GO TO 430          626600
98      C                                   626700
99      C SIMULTANEOUS SOLUTION FOR ENTHALPY 626800
100     ACCELH=1.5                          626900
101     DO 130 I=1,NCHANL                   627000
102     IF (NN.EQ.1.AND.DT.GE.1.E+6) F(I,J)=F(I,J)*TFLO/TFLOJ 627100
103     130 FLOW(I)=0.                       627200
104     IF (INK.LE.0) GO TO 150              627300
105     DO 140 K=1,NK                        627400
106     II=IK(K)                             627500
107     JJ=JK(K)                             627600
108     FLOW(II)=FLOW(II)+W(K,J)             627700
109     140 FLOW(JJ)=FLOW(JJ)-W(K,J)         627800
110     150 CONTINUE                         627900
111     HERROR=1.E-6                         628000
112     DO 160 I=1,NCHANL                   628100
113     M=1+(I-1)*NAAH                      628200
                                           628300

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114      AR=(RH0OLD(I,J))*APP(I,J)/DT
115      FJUMY=F(I,JM1)*DXI
116      DUMY=DHDX(I)
117      AAH(M)=AR+FJUMY-FLOW(I)
118      160 DHDX(I)=DUMY+AR*HOLD(I,J)+FJUMY*H(I,JM1)
119      IF (NK.EQ.0.AND.NWK.EQ.0) GO TO 320
120      DO 200 I=1,NCHANL
121      M=(I-1)*NAAH
122      N=(I-1)*NAAHP1
123      IEND=ILOC(N+NAAH)
124      MP1=M+1
125      IF (IEND.LE.0) GO TO 180
126      DO 170 L=1,IEND
127      K=ILOC(N+L)
128      ABW=ABS(W(K,J))
129      DUMY=AMINO(1,IABS(I-ISTAR(K)))
130      AAH(MP1)=AAH(MP1)+(1.-DUMY)*ABW+WPP(K)
131      170 AAH(MP1+L)=-DUMY*ABW-WPP(K)
132      180 IF (NWK.EQ.0) GO TO 200
133      IENDS=ILOC(N+NAAHP1)
134      IF (IENDS.LE.0) GO TO 200
135      NPP=N+IEND
136      MPP=MP1+IEND
137      DO 190 L=1,IENDS
138      MPPL=MPP+L
139      K=ILOC(NPP+L)
140      INDEX=1-MIND(1,IABS(I-IKW(K)))+2*(1-MIND(1,IABS(I-JKW(K))))
141      AAH(MP1)=AAH(MP1)+UNCP(INDEX,K)*WIDTH(K)
142      AAH(MPPL)=-UWALL(INDEX,K)*WIDTH(K)
143      190 DHDX(I)=DHDX(I)-TMH(I)*UWALL(INDEX,K)*WIDTH(K)
144      200 CONTINUE
145      DO 210 I=1,NCHANL
146      M=NAAH*(I-1)
147      DUMY=ACCELH/AAH(M+1)
148      DHDX(I)=DHDX(I)*DUMY
149      DO 210 L=1,NAAH
150      MPL=M+L
151      AAH(MPL)=AAH(MPL)*DUMY
152      210 CONTINUE
153      IF (NWK.EQ.0) GO TO 230
154      IAAK=NCHANL*NAAH
155      DO 220 K=1,NWK
156      M=IAAK+(K-1)*3
157      II=IKW(K)
158      JJ=JKW(K)
159      DUMY=(RHOLCP(K)/DT+UWALL(1,K)+UWALL(2,K))/ACCELH
160      AAH(M+1)=-UNCP(1,K)/DUMY
161      AAH(M+2)=-UNCP(2,K)/DUMY
162      AAH(M+3)=(TMH(II)*UWALL(1,K)+TMH(JJ)*UWALL(2,K)+RHOLCP(K)/DT*TWOLD
163      +(K,J))/DUMY
164      220 CONTINUE
165      230 CONTINUE
166      C      ITERATIVE SOLUTION
167      DO 310 IHH=1,ITRY
168      EFR=0.
169      DO 280 I=1,NCHANL
170      IM1=I-1

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171      M=NAAH*IM1+1                      634200
172      N=NAAHP1*IM1                      634300
173      C=DHDX(I)-ACCELH*H(I,J)           634400
174      IEND=ILOC(N+NAAH)                  634500
175      IF (IEND.LE.0) GO TO 250           634600
176      DO 240 L=1,IEND                    634700
177      K=ILOC(N+L)                        634800
178      KI=IK(K)+JK(K)-I                   634900
179      240 C=C-AAH(M+L)*H(KI,J)           635000
180      250 CONTINUE                       635100
181      IENDS=ILOC(N+NAAHP1)               635200
182      IF (IENDS.LE.0) GO TO 270          635300
183      MPP=M+IEND                         635400
184      NPP=N+IEND                         635500
185      DO 260 L=1,IENDS                   635600
186      MPPL=MPP+L                         635700
187      K=ILOC(NPP+L)                     635800
188      260 C=C-AAH(MPPL)*TWALL(K,J)       635900
189      270 CONTINUE                       636000
190      ERR=AMAX1(ERR,ABS(C/H(I,J)))        636100
191      280 H(I,J)=H(I,J)+C                636200
192      IF (NWK.LE.0) GO TO 300            636300
193      DO 290 K=1,NWK                     636400
194      M=IAAK+(K-1)*3                     636500
195      II=IKW(K)                          636600
196      JJ=JKW(K)                          636700
197      C=AAH(M+3)-ACCELH*TWALL(K,J)-AAH(M+1)*H(II,J)-AAH(M+2)*H(JJ,J) 636800
198      TWALL(K,J)=TWALL(K,J)+C            636900
199      290 CONTINUE                       637000
200      300 CONTINUE                       637100
201      QOH=AMAX1(QOH,ERR)                  637200
202      IF (ERR.LT.HERROR) GO TO 340       637300
203      310 CONTINUE                       637400
204      GO TO 340                          637500
205      320 DO 330 I=1,NCHANL              637600
206      M=1+(I-1)*NAAH                    637700
207      330 H(I,J)=DHDX(II)/AAH(M)         637800
208      340 CONTINUE                       637900
209      C                                  638000
210      CALL PROP (2,J,JX,1,NCHANL)        638100
211      IF (IERROR.GT.1) GO TO 430         638200
212      DO 2 I=1,NCHANL
213      RHO(I,J)=1./V(II)
214      UB(I,J)=F(I,J)*V(II)/A(I,J)
215      2 CONTINUE
216      IF (IERROR.GT.1) GO TO 430          638400
217      CALL FORCE (J,JX,JM1)               638600
218      IF (IERROR.GT.1) GO TO 430          638700
219      IF (FTH*J5.NE.0) CALL MIX(J)        638800
220      CALL DIFFER (3,J,JX)               638900
221      IF (IERROR.GT.1) GO TO 430          639000
222      C CALCULATE THE DIVERSION CROSSFLOW AT X. 639100
223      IF (INK.GT.0) CALL DIVERT (J,JX)    639200
224      IF (IERROR.GT.1) GO TO 430          639500
225      C CALCULATE THE FLOW AT X AND CHECK FOR CONVERGENCE. 639600
226      DO 350 I=1,NCHANL                  639700
227      350 DFDX(I)=0.                     639800

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```

228      IF (NK.LE.0) GO TO 370
229      DO 360 K=1,NK
230      II=IK(K)
231      JJ=JK(K)
232      DFDX(II)=DFDX(II)+W(K,J)
233      360 DFDX(JJ)=DFDX(JJ)-W(K,J)
234      370 QUAN=0.
235      DO 380 I=1,NCHANL
236      FSAVE=F(I,J)
237      DUMY=APP(I,J)*(RHO(I,J)-RHOOLD(I,J))/DT
238      C    USERS MAY WISH TO TRY OTHER COMBINATIONS OF CONSTANTS.
239      F(I,J)=(F(I,JM1)-DX*(DFDX(II)+DUMY))*ACCF+(1.-ACCF)*FSAVE
240      FINDER=ABS((F(I,J)-FSAVE)/(F(I,J)+1.E-4))
241      QUAN=AMAX1(QUAN,FINDER)
242      380 CONTINUE
243      IF (QUAN.GT.FERROR.OR.IERROR.LT.0) JUMP=1
244      IF (NK.GT.0) CALL DIFFER (4,J,JX)
245      IF (IERROR.GT.1) GO TO 430
246      IF (NK.EQ.0) GO TO 400
247      DO 390 K=1,NK
248      II=IK(K)
249      JJ=JK(K)
250      SP(K,JM1)=DAMPNG*(SP(K,J)-(DPDX(II)-DPDX(JJ))*DX)+(1.-DAMPNG)*SP(K
251      +,JM1)
252      390 CONTINUE
253      400 CONTINUE
254      QOF=AMAX1(QOF,QUAN)
255      IF (QUAN.GT.FERROR) IFOUT=JX
256      DO 410 I=1,NCHANL
257      P(I,J)=P(I,JM1)+DX*DPDX(II)
258      410 CONTINUE
259      C    PRINT OUT CROSSFLOW FORCE POINTS IF USED.
260      IF (J6.NE.1.AND.J6.NE.3.OR.ITERAT.GT.1) GO TO 440
261      IF (JX.EQ.2) WRITE (I3,530)
262      NCOUNT=0
263      DO 420 K=1,NK
264      IFDUM=IFIX(FDIV(K))
265      IFDIV(NCOUNT+1)=K*IFDUM
266      420 NCOUNT=NCOUNT+IFDUM
267      IF (NCOUNT.GT.0) WRITE (I3,540) JX,(IFDIV(L),L=1,NCOUNT)
268      GO TO 440
269      430 WRITE (I3,500) JX,X(JX)
270      WRITE (I3,510)
271      WRITE (I3,520) (I,H(I,J),F(I,J),P(I,J),H(I,JM1),F(I,JM1),P(I,JM1),
272      +I=1,NCHANL)
273      IF (IERROR.GT.1) CALL ERROR
274      440 CONTINUE
275      C
276      C    RADIAL CONDUCTION FOR RODS
277      IF (ICON.EQ.0) GO TO 445
278      C
279      CALL CURVE(QX1,X(JX-1)/Z,AXIAL,Y,NAX,IERROR,1)
280      CALL CURVE(QX2,X(JX)/Z,AXIAL,Y,NAX,IERROR,1)
281      TEST=(QX2+1.E-5)/(QX1+1.E-5)
282      IF (TEST.LT.3..AND.TEST.GT.0.33) GO TO 15
283      C    ENDPOINTS HALVED ACCORDING TO TRAPEZOID RULE
284      QXSUM = (QX1 + QX2)*0.5

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285      DXF = DX/20.0
286      XF = X(JX-1)
287      DO 11 IDXF=1,19
288      XF = XF + DXF
289      CALL CURVE (QX,XF/Z,AXIAL,Y,NAX,IERROR,1)
290      11 QXSUM = QXSUM + QX
291      QX = QXSUM/20.0
292      GO TO 18
293      15 CONTINUE
294      XDUMY=AMAX1((X(JX)-.5*QX)/Z,0.)
295      CALL CURVE (QX,XDUMY,AXIAL,Y,NAX,IERROR,1)
296      18 CONTINUE
297      C                                     441700
298      DFX = AFLUX*QX
299      CALL RODCON (NROD,JX,T,HFILM,DFX,DT)
300      445 CONTINUE                                     645200
301      C                                     645300
302      C                                     645400
303      RADIATION INCLUDED IN HEAT FLUX
304      IF (IRAD.EQ.0) GO TO 449
305      CALL RADIAT(JX)
306      449 CONTINUE                                     645600
307      IF (INN.EQ.1) WRITE (I3,550)
308      CALL ELAP(MTIME)
309      WRITE(I3,560) ITERAT,ISAVT,ISOUT,IFOUT,QIM,QDM,QOF,QOH,MTIME
310      IF (JUMP.EQ.2.AND.DT.LT.1.E6) CALL HEAT(0,1,1,-3)
311      IF (JUMP.EQ.1.AND.ITERAT.NE.NTRIES) GO TO 490
312      IF (JUMP.NE.1) RETURN
313      490 CONTINUE                                     646700
314      RETURN
315      C                                     646900
316      C                                     648900
317      C                                     649000
318      C                                     649100
319      C                                     649200
320      C                                     649300
321      500 FORMAT (44H1ERROR DETECTED AT SUBROUTINE SCHEME AT NODE,I3,6H X
322      +,F10.5,5H MTR /34H CALCULATION FOR THIS CASE STOPPED)
323      510 FCORMAT (76H I H(I,J) F(I,J) P(I,J) H(I,J-1)
324      + F(I,J-1) P(I,J-1))
325      520 FORMAT (I5,6E12.6)
326      530 FORMAT (20H1FORCE POINT SUMMARY/9HD JX *,10X,17HGAPS FORCED AT
327      +JX)
328      540 FORMAT (2X,I4,3H *,3X,25I4/(12X,25I4))
329      550 FORMAT (29H1DATA FROM ITERATIVE SOLUTION//63H ITERATION TOTAL INT
330      +ERNAL LAST NODE OUT MAXIMUM ERROR /6+ NO.,3X,51HITERATIO
331      +NS OF CONVERGENCE INTERNAL EXTERNAL,EX,4HFLOW,4X,8HENTHALP
332      +Y,7X4HTIME/32X,1HW,7X,1HF/)
333      560 FORMAT(3X,I3,9X,I5,10X,I3,5X,I3,2X,4(1X,F10.4),1X,I7)
334      570 FORMAT(1H1, ' ELAPSED TIME UPON ENTERING SUBROUTINE SCHEME IS',
335      1 17,9H SECONDS. )
336      END
337      650700
338      650900

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@HOG

* S D O T *

@PRT,S

COBRA*CFIL.SDOT

FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:05


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COBRA*CFIL(1),SDOT
1      REAL FUNCTION SDOT(IN,SX,INCX,SY,INCY)
2      C
3      C   FORMS THE DOT PRODUCT OF TWO VECTORS.
4      C   USES UNROLLED LOOPS FOR INCREMENTS EQUAL TO ONE.
5      C   JACK DONGARRA, LINPACK, 3/11/78.
6      C
7      REAL SX(1),SY(1),STEMP
8      INTEGER I,INCX,INCY,IX,IY,M,MP1,N
9      C
10     STEMP = 0.0E0
11     SDOT = 0.0E0
12     IF(N.LE.0)RETURN
13     IF(INCX.EQ.1.AND.INCY.EQ.1)GO TO 20
14     C
15     C   CODE FOR UNEQUAL INCREMENTS OR EQUAL INCREMENTS
16     C   NOT EQUAL TO 1
17     C
18     IX = 1
19     IY = 1
20     IF(INCX.LT.0)IX = (-N+1)*INCX + 1
21     IF(INCY.LT.0)IY = (-N+1)*INCY + 1
22     DO 10 I = 1,N
23         STEMP = STEMP + SX(IX)*SY(IY)
24         IX = IX + INCX
25         IY = IY + INCY
26     10 CONTINUE
27     SDOT = STEMP
28     RETURN
29     C
30     C   CODE FOR BOTH INCREMENTS EQUAL TO 1
31     C
32     C   CLEAN-UP LOOP
33     C
34     C
35     20 M = MOD(IN,5)
36     IF(M.EQ.0)GO TO 40
37     DO 30 I = 1,M
38         STEMP = STEMP + SX(I)*SY(I)
39     30 CONTINUE
40     IF(N.LT.5)GO TO 60
41     40 MP1 = M + 1
42     DO 50 I = MP1,N,5
43         STEMP = STEMP + SX(I)*SY(I) + SX(I+1)*SY(I+1) +
44         * SX(I+2)*SY(I+2) + SX(I+3)*SY(I+3) + SX(I+4)*SY(I+4)
45     50 CONTINUE
46     60 SDOT = STEMP
47     RETURN
48     END

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@HDG * S E T U P *

@PRT,S COBRA*CFIL.SETUP
 FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:05

D-74

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1 SUBROUTINE SETUP
2 INCLUDE SPEC1,LIST
3 INCLUDE SPEC2,LIST
4 INCLUDE SPEC3,LIST
5 INCLUDE SPEC4,LIST
6 INCLUDE SPEC5,LIST
7 INCLUDE SPEC6,LIST
8 INCLUDE SPEC7,LIST
9 INCLUDE SPEC8,LIST
10 INCLUDE SPEC9,LIST
11 INCLUDE SPEC10,LIST
12 INCLUDE SPEC11,LIST
13 INCLUDE SPEC12,LIST
14 INCLUDE SPEC13,LIST
15 INCLUDE SPEC15,LIST
16 INCLUDE SPEC16,LIST
17 INCLUDE SPEC20,LIST
18 INCLUDE SPEC51,LIST
19 INCLUDE SPEC52,LIST
20 INCLUDE SPEC53,LIST
21 INCLUDE SPEC71,LIST
22 INCLUDE SPEC72,LIST
23 INCLUDE SPEC73,LIST
24 INTEGER PRINTC,PRINTG,PRINTR
25 EQUIVALENCE (ZDUM(1),IZDUM(1))
26 LOGICAL PRINT
27 LOGICAL GRID
28 LOGICAL LREADX
29 LOGICAL ERROR
30 REAL KPOUT
31 REAL IDTGC,LENGTH,KIJ,LENSHO,LENROU
32 REAL ZDUM(15)
33 INTEGER CARD,IZDUM(15)
34 REAL*8 FORMAT(2,4)/'(I2E5.0)',',','(I10I5)',',',
35 1 '(I6IE5.0,',',I5)' ',',(24I3)',',',
36 C THIS SUBROUTINE READS INPUT DATA FOR EACH CASE 654400
37 C ALSO INITIALIZES AND SETS UP VARIABLES TO RUN PROBLEM. 654500
38 C CHECK PROGRAMMING IF USING MSC GREATER THAN 7 658400
39 EPROR=.FALSE. 65E800
40 C READ CASE CONTROL CARD
41 100 READ (I2,1700) KASE,TEXT
42 IF(KASE.LT.1)RETURN
43 IERROR=0 661300
44 DO 150 I=1,I3
45 PRINT(I)=.FALSE. 662100
46 150 CONTINUE 662300
47 CALL DATGT2 (DATE) GA-MAR81
48 CALL GTIME (TIMNOW) GA-MAR81
49 WRITE (I3,1710) KASE,TEXT,DATE,TIMNOW 662700
50 WRITE(I3,2530)
51 C 663600
52 C READ GROUP CONTROL CAPD 663700
53 180 READ (I2,1690) NGROUP,N1,N2,N3,N4,N5,N6,N7,N8,N9,N10 664200
54 IF (NGROUP.EQ.0) GO TO 1090 664300
55 NGROUP=IABS(NGROUP) 664500
56 IF(NGROUP.LE.13) GO TO 190 664600

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57      EPROR=.TRUE.
58      WRITE (I3,2640) NGROUP
59      GO TO 1090
60      190 CARD=1
61      PRINT(NGROUP)=.TRUE.
62      WRITE (I3,1690) NGROUP,N1,N2,N3,N4,N5,N6,N7,N8,N9,N10
63      C      3GROUP 1,2,3,4,5,6,7,8,9,10,11,12,13
64      GO TO (200,240,250,260,470,510,550,630,740,800,820,1080,1085),
65      NGROUP
66      C**** CARD GROUP 1 *****
67      200 CALL LIMITS (N1,1,MP,NGROUP,CARD,ERROR)
68      NPROP=MIND(N1,MP)
69      DTMAX=750.
70      IF (N3.EQ.1) READ (I2,1730) DTMAX
71      GO TO 180
72      C**** CARD GROUP 2 *****
73      240 CONTINUE
74      LAMNF=N5
75      NFH = N7
76      NFT=N8
77      IF (NFH.GT.0) GO TO 241
78      READ(I2,2041)(AA(I),BB(I),CC(I),I=1,NFT)
79      241 AH(1)=0.023
80      AH(2)=0.8
81      AH(3)=0.4
82      AH(4)=0.0
83      IF (LAMNF.GT.0) READ(I2,2041)(AAL(I),BBL(I),CCL(I),I=1,NFT)
84      IF (N6.GT.0) CALL LOAD (AH,ZDUM,ZDUM,4,4,12,1,FORMAT(1,1),CARD,I2)
85      IF (NFH.EQ.0) GO TO 244
86      GO TO (242,243,242,243) , NFH
87      242 CONTINUE
88      READ(I2,2041) (AA(I),BB(I),CC(I),I=1,NFT)
89      READ(I2,2041) (AAR(I),BBR(I),CCR(I),I=1,NFT)
90      IF (NFH.EQ.1)
91      .READ(I2,2041) (HAA(I),HBB(I),HCC(I),I=1,NFT)
92      READ(I2,2041) (HAAR(I),HBBR(I),HCCR(I),I=1,NFT)
93      GO TO 244
94      243 CONTINUE
95      READ(I2,2041) (AA(I),BB(I),CC(I),I=1,NFT)
96      IF (NFH.EQ.4) GO TO 244
97      READ(I2,2041) (HAA(I),HBB(I),HCC(I),I=1,NFT)
98      244 CONTINUE
99      GO TO 180
100     C**** CARD GROUP 3 *****
101     250 CALL LIMITS (N1,1,MP,NGROUP,CARD,ERROR)
102     NAX=MIND(N1,MP)
103     CALL LOAD (Y,AXIAL,ZDUM,NAX,N1,12,2,FORMAT(1,1),CARD,I2)
104     IRAD=N2
105     IF (IRAD.EQ.0) GO TO 252
106     CALL LIMITS (IRAD,0,1,NGROUP,CARD,ERROR)
107     CALL RADRED (N3)
108     CALL LIMITS (NSF,1,NU,NGROUP,CARD,ERROR)
109     252 CONTINUE
110     GO TO 180
111     C**** CARD GROUP 4 *****
112     260 CALL LIMITS (N2,1,MC,NGROUP,CARD,ERROR)
113     NCHANL=MIND(N2,MC)

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674000
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674200

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114      CALL LIMITS (N1,1,N2,NGROUP,CARD,ERROR)
115      NWK=MAX0(N4,0)
116      NWKK=NWK
117      IF (NWK.EQ.0) GO TO 270
118      CALL LIMITS (NWKK,1,MW,NGROUP,CARD,ERROR)
119      NWK=MIND(NWKK,MW)
120      270 NS=MAX0(N3,0)
121      NSS=NS
122      IF (NS.EQ.0) GO TO 280
123      CALL LIMITS (NSS,1,MG,NGROUP,CARD,ERROR)
124      NS=MIND(NSS,MG)
125      280 LU=I2
126      IF (NS.GT.0) LU=NS
127      J=0
128      NK=0
129      290 J=J+1
130      IF (J.GT.N1) GO TO 320
131      READ (LU,1750) N,I,(IZDUM(K),K=1,15)
132      N=MAX0(N,1)
133      CARD=CARD+1
134      IF (J.GT.NCHANL) GO TO 290
135      CALL LIMITS (I,1,NCHANL,NGROUP,CARD,ERROR)
136      I=MIND(I,NCHANL)
137      NTYPE(I)=N
138      AC(I)=ZDUM(1)*1.E-6
139      PW(I)=ZDUM(2)*1.E-3
140      DO 310 L=1,4
141      L1=3*L+1
142      L2=IABS(IZDUM(L1))
143      CALL LIMITS (L2,0,NCHANL,NGROUP,CARD,ERROR)
144      L2=MIND(L2,NCHANL)
145      IF (L2*(L2-1).LE.0) GO TO 300
146      NK=NK+1
147      CALL LIMITS (NK,1,MG,NGROUP,CARD,ERROR)
148      300 CONTINUE
149      LC(I,L)=ISIGN(L2,IZDUM(L1))
150      GAPS(I,L)=ZDUM(L1+1)*1.E-3
151      DIST(I,L)=ZDUM(L1+2)*1.E-3
152      310 CONTINUE
153      GO TO 290
154      320 ATOTAL=C.
155      NK=0
156      DO 350 I=1,NCHANL
157      DO 330 L=1,4
158      IF (LC(I,L).EQ.0) GO TO 330
159      J=IABS(LC(I,L))
160      IF (J.LE.I) GO TO 330
161      NK=MIND(NK+1,MG)
162      JK(NK)=J
163      IK(NK)=I
164      GAPN(NK)=GAPS(I,L)
165      GAP(NK,1)=GAPN(NK)
166      LENGTH(NK)=DIST(I,L)
167      330 CONTINUE
168      IF (PW(I).GT.0..AND.AC(I).GT.0.) GO TO 340
169      ERROR=.TRUE.
170      WRITE (I3,2650) NGROUP

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680000
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680500
680600

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171      GO TO 350
172      340 AN(I)=AC(I)
173      A(I,1)=AN(I)
174      DC(I)=4.0*AC(I)/PW(I)
175      DHYDN(I)=DC(I)
176      DHYD(I,1)=DHYDN(I)
177      350 ATOTAL=ATOTAL+AN(I)
178      IF (NK.EQ.0) GO TO 410
179      DO 380 K=1,NK
180      II=IK(K)
181      JJ=JK(K)
182      LOCA(I,K)=K
183      LOCA(NAAAP1,K)=1
184      DO 380 L=1,NK
185      IF (K.EQ.L) GO TO 380
186      I=IK(L)
187      J=JK(L)
188      IF (II.EQ.I.OR.II.EQ.J) GO TO 360
189      IF (JJ.EQ.I.OR.JJ.EQ.J) GO TO 360
190      GO TO 380
191      360 NAD=LOCA(NAAAP1,K)+1
192      IF (NAD.LT.NAAAP1) GO TO 370
193      ERROR=.TRUE.
194      WRITE (I3,2740) K
195      GO TO 1680
196      370 LOCA(NAD,K)=L
197      LOCA(NAAAP1,K)=NAD
198      380 CONTINUE
199      L=NAAHP1*NCHANL
200      DO 390 I=1,L
201      390 ILOC(I)=0
202      IF (NK.EQ.0) GO TO 410
203      DO 400 K=1,NK
204      II=(IK(K)-1)*NAAHP1
205      JJ=(JK(K)-1)*NAAHP1
206      I=II+NAAH
207      J=JJ+NAAH
208      NADI=ILOC(I)+1
209      NADJ=ILOC(J)+1
210      IF (NADI.LE.MI.AND.NADJ.LE.MI) GO TO 395
211      ERROR=.TRUE.
212      WRITE (I3,2750) NADI,NADJ,MI
213      GO TO 1680
214      395 CONTINUE
215      ILOC(II+NADI)=K
216      ILOC(JJ+NADJ)=K
217      ILOC(I)=NADI
218      400 ILOC(J)=NADJ
219      410 IF (NWK.EQ.0) GO TO 430
220      DO 420 K=1,NWKK
221      READ (I2,1800) KW,(ZDUM(I),I=1,6)
222      CARD=CARD+1
223      IF (K.GT.NWK) GO TO 420
224      CALL LIMITS (KW,1,NWK,NGROUP,CARD,ERROR)
225      KW=MIND(KW,NWK)
226      RHOLCP(KW)=ZDUM(1)
227      WIDTH(KW)=ZDUM(2)

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685000

685100

685200

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685900

686000

686100

686200

686300

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228      IKW(KW)=IZDUM(3)                      686500
229      RWALL(1,KW)=ZDUM(4)                  686600
230      JKW(KW)=IZDUM(5)                    686700
231      RWALL(2,KW)=ZDUM(6)                  686800
232      II=(IKW(KW)-1)*NAAHP1                686900
233      JJ=(JKW(KW)-1)*NAAHP1                687000
234      ILI=II+NAAHP1                        687100
235      ILJ=JJ+NAAHP1                        687200
236      NADI=ILOC(ILI)+1                     687300
237      NADJ=ILOC(ILJ)+1                     687400
238      IF (NADI.LE.MI.AND.NADJ.LE.MI) GO TO 415 687500
239      ERROR=.TRUE.                          687600
240      WRITE(I3,2750) NADI,NADJ,MI           687700
241      GO TO 1680                             687800
242      415 CONTINUE                          687900
243      ILOC(ILI)=NADI                        688000
244      ILOC(ILJ)=NADJ                        688100
245      ILI=ILI-1                             688200
246      ILJ=ILJ-1                             688300
247      NIS=ILOC(ILI)                         688400
248      NJS=ILOC(ILJ)                         688500
249      ILOC(II+NIS+NADI)=KW                  688600
250      ILOC(JJ+NJS+NADJ)=KW                  688700
251      420 CONTINUE                          688800
252      430 K12=0                             688900
253      IF (NS.EQ.0) GO TO 460                 689000
254      K12=1                                 689100
255      LU=I2                                 689200
256      IF (N6.GT.0) LU=N6                    689300
257      MAXKRD=(NSS-1)*2/10+1                 689400
258      MINKRD=(NS-1)*2/10+1                 689500
259      J=0                                   689600
260      440 J=J+1                             689700
261      IF (J.GT.MAXKRD) GO TO 460             689800
262      READ (LU,2120) (IZDUM(I),ZDUM(I+1),I=1,10,21 689900
263      CARD=CARD+1                           690000
264      IF (J.GT.MINKRD) GO TO 440             690100
265      DO 450 I=1,10,2                       690200
266      IF (IZDUM(I).LE.0) GO TO 440          690300
267      K=IZDUM(I)                            690400
268      CALL LIMITS (K,1,NS,NGROUP,CARD,ERROR) 690500
269      K=MIND(K,NS)                          690600
270      ANGLE(K)=ZDUM(I+1)*PI/180.            690700
271      450 CONTINUE                          690800
272      GO TO 440                             690900
273      460 CONTINUE                          691000
274      GO TO 180                             691100
275      C**** CARD GROUP 5 *****            691200
276      470 IF ((INCHANL-1)*(INCHANL-MC).LE.0) GO TO 480 691300
277      ERROR=.TRUE.                          691400
278      WRITE (I3,2660) NGROUP                 691500
279      GO TO 1680                             691600
280      480 NARAMP=MAX0(IN3,1)                 691700
281      NARS=NARAMP                           691800
282      CALL LIMITS (N2,0,ML,NGROUP,CARD,ERROR) 691900
283      MAXL=MIND(N2,ML)                       692000
284      CALL LIMITS (N1,0,MA,NGROUP,CARD,ERROR) 692100

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285      NAFACI=MIND(IN1,MA)
286      IF(N2.LE.0) GO TO 180
287      CALL LOAD (AXL,ZDUM,ZDUM,NAXL,N2,12,1,FORMAT(1,1),CARD,I2)
288      DO 490 J=1,NAFACI
289      READ (I2,1690) I
290      CARD=CARD+1
291      CALL LIMITS (I,1,NCHANL,NGROUP,CARD,ERROR)
292      I=MIND(I,NCHANL)
293      IDAREA(I)=J
294      NCH(I)=I
295      CALL LOAD (AFACI(I,J),ZDUM,ZDUM,NAXL,NAXL,12,1,FORMAT(1,1),CARD,I2
296      *)
297      490 CONTINUE
298      IF (N1.EQ.NAFACI) GO TO 180
299      N2=N1-NAFACI
300      DO 500 J=1,N2
301      READ (I2,1760) I,(ZDUM(I),L=1,12)
302      500 CONTINUE
303      GO TO 180
304      C**** CARD GROUP 6 *****
305      510 IF ((NK-1)*(NK-MG).LE.0) GO TO 520
306      ERROR=.TRUE.
307      WRITE (I3,2670) NGROUP
308      GO TO 1680
309      520 CALL LIMITS (N2,0,ML,NGROUP,CARD,ERROR)
310      NGXL=MIND(N2,ML)
311      CALL LIMITS (N1,0,MS,NGROUP,CARD,ERROR)
312      NGAPS=MIND(N1,MS)
313      IF(N2.LE.0) GO TO 180
314      CALL LOAD (GAPXL,ZDUM,ZDUM,NGXL,N2,12,1,FORMAT(1,1),CARD,I2)
315      DO 530 LL=1,NGAPS
316      READ (I2,1690) K
317      CARD=CARD+1
318      CALL LIMITS (K,1,NK,NGROUP,CARD,ERROR)
319      K=MIND(K,MG)
320      IDGAP(K)=LL
321      NGAP(LL)=K
322      L=LL
323      CALL LOAD (GFACT(I,L),ZDUM,ZDUM,NGXL,NGXL,12,1,FORMAT(1,1),CARD,I2
324      *)
325      530 CONTINUE
326      IF (N1.EQ.NGAPS) GO TO 180
327      N2=N1-NGAPS
328      DO 540 J=1,N2
329      READ (I2,1690) K
330      READ (I2,1730) (ZDUM(I),I=1,12)
331      540 CONTINUE
332      GO TO 180
333      C**** CARD GROUP 7 *****
334      550 J6=N1
335      IF(N7.LE.0) N7=NCHANL
336      IF(N7.GT.NCHANL) N7=NCHANL
337      NRAMP=MAX0(N5,1)
338      NARAMP=MAXJ(1,NARAMP)
339      GRID=.FALSE.
340      IF ((J6-1)*(J6-3).GT.0) GO TO 180
341      IF ((NCHANL-1)*(NCHANL-MC).LE.0) GO TO 560

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342      ERROR=.TRUE.
343      WRITE (I3,2660) NGROUP
344      GO TO 1680
345      560 CALL LIMITS (N3,0,MZ,NGROUP,CARD,ERROR)
346      NGRID=MIND(N3,MZ)
347      IF (J6.EQ.2) GO TO 590
348      CALL LIMITS (N2,1,MG,NGROUP,CARD,ERROR)
349      READ (I2,2050) PITCH,DIA,THICK
350      CARD=CARD+1
351      PITCH=PITCH*1.E-3
352      DIA=DIA*1.E-3
353      THICK=THICK*1.E-3
354      LU=I2
355      IF (N6.GT.0) LU=N6
356      DO 570 M=1,N2
357      READ (LU,2240) K,(ZDUM(I),I=1,3)
358      CARD=CARD+1
359      CALL LIMITS (K,1,MG,NGROUP,CARD,ERROR)
360      K=MIND(K,MG)
361      DUR(K)=ZDUM(1)
362      XCROSS(K,1)=ZDUM(2)
363      XCROSS(K,2)=ZDUM(3)
364      570 CONTINUE
365      CALL LOAD (NWRAP,I2DUM,I2DUM,N7,N7,10,1,FORMAT(1,2),CARD,
366      +LU)
367      DO 580 I=1,NCHANL
368      580 NWRAPS(I)=NWRAP(I)
369      IF (J6.EQ.3) GO TO 590
370      GO TO 180
371      590 N4=IABS(N4)
372      CALL LIMITS (N4,1,MK,NGROUP,CARD,ERROR)
373      NGRIDT=MIND(N4,MK)
374      MIN=NGRID
375      CALL LOAD (GRIDXL,IGRID,ZDUM,MIN,N3,12,2,FORMAT(1,3),CARD,I2)
376      DO 595 I=1,NGRIDT
377      READ(I2,2041) CDC1(I),CDC2(I),CDC3(I),CDC4(I)
378      595 CONTINUE
379      READ(I2,2050) SH,RSC,SSC
380      SH=SH*1.E-3
381      DO 620 I=1,N4
382      DO 610 II=1,NCHANL
383      READ (I2,2260) J,ZDUM(1),K,ZDUM(2)
384      CARD=CARD+1
385      IF (I.GT.NGRIDT) GO TO 620
386      CALL LIMITS (J,1,NCHANL,NGROUP,CARD,ERROR)
387      J=MIND(J,NCHANL)
388      CD(J,I)=ZDUM(1)
389      IF (K.LE.0) GO TO 610
390      CALL LIMITS (K,1,NK,NGROUP,CARD,ERROR)
391      K=MIND(K,NK)
392      FXFLOW(K,I)=ZDUM(2)
393      610 CONTINUE
394      620 CONTINUE
395      GO TO 180
396      C**** CARD GROUP 8 *****
397      630 CALL LIMITS (N2,1,MR,NGROUP,CARD,ERROR)
398      NROD=MIND(N2,MR)

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704300
704400

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399      NC=MAX0(N3,0)
400      IF(N6.EQ.4) ICON=1
401      LU=12
402      IF (N9.GT.0) LU=N9
403      CALL LIMITS (N1,1,N2,NGROUP,CARD,ERROR)
404      MSC = MAX0(N10,6)
405      DO 660 J=1,N1
406      READ (LU,1799) I,(ZDUM(L1),L1=1,14)
407      CARD=CARD+1
408      CALL LIMITS (I,1,NROD,NGROUP,CARD,ERROR)
409      I=MIN0(I,NROD)
410      DR(I)=ZDUM(1)*1.E-3
411      RADIAL(I)=ZDUM(2)
412      DO 650 L=1,6
413      LR(I,L)=IZDUM(2*L+1)
414      PHI(I,L)=ZDUM(2*L+2)
415 650 CONTINUE
416      IF(MSC .LE. 6) GO TO 652
417      READ(LU,1801) LR(I,7),PHI(I,7)
418 652 CONTINUE
419      D(I)=DR(I)
420 660 CONTINUE
421      TREF=0.
422      IF (NC.GT.0) GO TO 661
423      RF(1)=0.
424      GO TO 180
425 661 READ (I2,1770) (RF(J), J=1,5)
426      READ (I2,1770) (XKF(J), J=1,5)
427      READ (I2,1770) (HGAP1J), J=1,4)
428      READ (I2,1770) (CPF(J), J=1,5)
429      READ (I2,1770) (QPFAC1J),J=1,5)
430      READ (I2,1770) (RHOF1J), J=1,5)
431      IF(ICON.NE.1) GO TO 180
432      NSF = NU
433      READ(I2,1690) NCONR
434      CARD = CARD + 1
435      IF(NCONR.EQ.0) GO TO 683
436      CALL LIMITS(NCONR,1,NROD,NGROUP,CARD,ERROR)
437      READ(I2,1690) (ICONR(I),I=1,NCONR)
438      DO 682 I=1,NCONR
439      CALL LIMITS(ICONR(I),1,NROD,NGROUP,CARD,ERROR)
440 682 CONTINUE
441      GO TO 180
442 683 CONTINUE
443      DO 684 I=1,NROD
444      ICONR(I) = I
445 684 CONTINUE
446      NCONR = NROD
447      GO TO 180
448 C**** CARD GROUP 9 *****
449 740 NSKIPX=MAX0(N1,1)
450      NSKIPT=MAX0(N2,1)
451      READ(I2,1790) Z,TTIME,WEFRX,WERRY,FERROR,KIJ,SL,FTM,THETA,USDON,D
452      AMPNG,ACCELY,ACCELF
453      CARD=CARD+1
454      IZ=CARD
455      READ(I2,1691) NDX,NDT,NTFIES,ITRY,ITRYM,LENSMO,LENROU

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704500
705900
706100
706200
706300
706400
706600
706800
707000
707100
707300
707400
707500
707600
707700
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708500
709000
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711400
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711600
711700
711800
711900
712000
712100
712200
712300
712400
712500
712600
712700
712800
715400
715500
716600
716700
718000
718100
718200

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456	LENSMO=LENSMO/1000.	
457	LENROU=LENROU/1000.	
458	CARD=CARD+1	718300
459	CALL LIMITS (NDX,1,MX-1,NGROUP,CARD,ERROR)	718400
460	NDXP1=NDX+1	718500
461	IF (SL.LT.1.0E-5) SL=0.5	718600
462	ELEV=COS(THETA*PI/180.)	718700
463	IF (NTRIES.LT.1) NTRIES=20	718800
464	IF (FERROR.LE.1.E-5) FERROR=0.01	718900
465	IF (ITRY.LT.1) ITRY=MAX0(2*NK,20)	719000
466	IF (ITRYM.LT.1) ITRYM=5	719100
467	IF (KIJ.LE.1.E-5) KIJ=0.5	719200
468	IF (WERRY.LE.1.E-5) WERRY=0.001	719300
469	IF (DAMPNG.LE.1.E-5) DAMPNG=0.8	719400
470	IF (ACCELF.LE.1.E-5) ACCELF=1.0	719500
471	IF (ACCELY.LE.1.E-5) ACCELY=1.6	719600
472	IF (WERRX.LE.1.E-5) WERRX=0.1	720000
473	LREADX=.FALSE.	720100
474	IF (N7.EQ.1) LREADX=.TRUE.	720200
475	IF (.NOT. LREADX) GO TO 775	720300
476	READ 2041, (X(I),J=1,NDX)	720400
477	X(NDXP1)=Z	
478	DO 774 J=1,NDXP1	720700
479	X(J) = X(J)/1000.	
480	774 CONTINUE	720900
481	DX = (X(2)-X(1))	721000
482	775 CONTINUE	721100
483	ZZ=Z	
484	Z=Z/1000.	
485	C FIND RELATIVE AXIAL LOCATION WHERE HEATING STARTS	721200
486	DO 776 I=1,NAX	721300
487	IF (AXIAL(I).GT.0.05) GO TO 777	
488	776 CONTINUE	721500
489	XH = Y(NAX)	721600
490	GO TO 779	721700
491	777 CONTINUE	721800
492	IF (I.GT.1) GO TO 778	721900
493	XH = Y(I)	722000
494	GO TO 779	722100
495	778 CONTINUE	722200
496	XH = Y(I-1)	722300
497	779 CONTINUE	722400
498	XH = XH*Z	722500
499	IF (LREADX) GO TO 795	724100
500	DX = Z/FLOAT(NDX)	724200
501	DO 794 J=1,NDXP1	724300
502	X(J) = DX*(J-1)	724400
503	794 CONTINUE	724500
504	795 CONTINUE	724600
505	DT=1.E10	724700
506	IF (NDT.GT.0.AND.TTIME.LE.0.) NDT=0	724800
507	IF (NDT.GT.0) DT=TTIME/FLOAT(NDT)	724900
508	SAVEDT=DT	725000
509	IF (.NOT. LREADX) DX = DX	
510	IF (Z.GT.0.) GO TO 180	725300
511	WRITE (I3,2690) NGROUP,I2	725400
512	ERROR=.TRUE.	725500

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513      GO TO 180                                     725600
514 C**** CARD GROUP 10 *****                          725700
515 800 CALL LIMITS (N1,0,4,NGROUP,CARD,ERROR)          725800
516      NSCBC = MINO(N1,4)                             725900
517      JS=N3                                           726100
518      READ (I2,1730) ABETA,BBETA                     726200
519      CARD=CARD+1                                     726300
520      IF (JS.EQ.0) GK=0.
521      IF (JS.EQ.1) READ (I2,1730) GK
522      GO TO 180                                     726700
523 C**** CARD GROUP 11 *****                          726800
524 820 IF ((NCHANL-1)*(NCHANL-MC1.LE.0) GO TO 830      726900
525      EPROR=.TRUE.                                    727000
526      WRITE (I3,2660) NGROUP                          727100
527      GO TO 1680                                       727200
528 830 IF ((NPROP-1)*(NPROP-MP).LE.0) GO TO 840        727300
529      ERROR=.TRUE.                                    727400
530      WRITE (I3,2700) NGROUP                          727500
531      GO TO 1680                                       727600
532 840 IH=IABS(N1)                                       727700
533      IG=IABS(N2)                                       727800
534      NP=MINO(MAXO(N3,1),MP)                          727900
535      IF (NP.EQ.1) GO TO 860
536      CALL LIMITS (N3,1,MP,NGROUP,CARD,ERROR)          729100
537      NP=MINO(N3,MP)                                   729200
538 860 NH=MINO(MAXO(N4,1),MP)                          729300
539      IF (NH.EQ.1) GO TO 870                          729400
540      CALL LIMITS (N4,1,MP,NGROUP,CARD,ERROR)          729500
541      NH=MINO(N4,MP)                                   729600
542 870 NG=MINO(MAXO(N5,1),MP)                          729700
543      IF (NG.EQ.1) GO TO 880                          729800
544      CALL LIMITS (N5,1,MP,NGROUP,CARD,ERROR)          729900
545      NG=MINO(N5,MP)                                   730000
546 880 NQ=MINO(MAXO(N6,1),MP)                          730100
547      IF (NQ.EQ.1) GO TO 890                          730200
548      CALL LIMITS (N6,1,MP,NGROUP,CARD,ERROR)          730300
549      NQ=MINO(N6,MP)                                   730400
550 890 K10=N7                                           730500
551      NHX=MINO(MAXO(N8,1),MP)                          730600
552      IF (NHX.EQ.1) GO TO 900                          730700
553      CALL LIMITS (N8,1,MP,NGROUP,CARD,ERROR)          730800
554      NHX=MINO(N8,MP)                                   730900
555 900 READ (I2,1770) PEXIT,HIN,GIN,AFLUX              731000
556      PEXIT=PEXIT*1000.
557      GIN=GIN*1000.
558      CARD=CARD+1                                     731200
559      HIN=ABS(HIN)                                     731900
560      PREF=PEXIT                                       732000
561      TF = 250.
562      IF (IH.EQ.1 .OR. IH.EQ.3) TF=HIN-1.             732200
563      CALL PROP (1,1,1,1,NCHANL)                      732300
564      IF (IERPOR.LT.1) GO TO 910                      732400
565      EPROR=.TRUE.                                    732500
566      WRITE (I3,2710)                                  732600
567      IERROR=0                                         732700
568 910 CONTINUE                                         732800
569      IF (IH.GE.2) GO TO 960

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570      IF (IH.EQ.1) GO TO 930                                733300
571      CALL CURVE (TIN,HIN,TPOUT,HGPT,NPROP,IERROR,1)
572      GO TO 940                                              733700
573      930 TIN=HIN                                           733800
574      CALL CURVE (HIN,TIN,HGPT,TPOUT,NPROP,IERROR,1)
575      940 DO 950 I=1,NCHANL                                734100
576      950 HINLET(I)=HIN                                     734200
577      GO TO 990                                              734300
578      960 CALL LOAD(HINLET,ZDUM,ZDUM,NCHANL,NCHANL,12,1,FOR
579      *MAT(1,1),CARD,I2)
580      IF (IH.LT.3) GO TO 990                                734600
581      DO 980 I=1,NCHANL                                     734700
582      VIN=HINLET(I)
583      CALL CURVE (VOUT,VIN,HGPT,TPOUT,NPROP,IERROR,1)
584      HINLET(I)=VOUT
585      980 CONTINUE
586      990 DO 1010 I=1,NCHANL
587      VIN=HINLET(I)
588      CALL CURVE (VOUT,VIN,TPOUT,HGPT,NPROP,IERROR,1)
589      TINLET(I)=VOUT
590      IF (I.EQ.1) TIN=TINLET(I)
591      1010 TIN=AMIN1(TINLET(I),TIN)
592      IF (IERROR.LT.1) GO TO 1020                            736800
593      ERROR=.TRUE.                                           736900
594      WRITE (I3,2720)                                         737000
595      IERROR=0                                                737100
596      1020 CONTINUE
597      CALL SPLIT (IG,GIN)
598      DO 1050 I=1,NCHANL
599      1050 FINLET(I)=F(I,1)
600      IF (IG.LT.2) GO TO 1070
601      CALL LOAD(FINLET,ZDUM,ZDUM,NCHANL,NCHANL,12,1,FORMAT(1,1),
602      *CARD,I2)
603      DO 1060 I=1,NCHANL
604      1060 FINLET(I)=GIN*ATOTAL*FINLET(I)
605      1070 IF (NP.GT.1) CALL LOAD (YP,FP,ZDUM,NP,N3,12,2,FORMAT(1,1),CARD,I2) 739200
606      IF (NH.GT.1) CALL LOAD (YH,FH,ZDUM,NH,N4,12,2,FORMAT(1,1),CARD,I2) 739300
607      IF (NG.GT.1) CALL LOAD (YG,FG,ZDUM,NG,N5,12,2,FORMAT(1,1),CARD,I2) 739400
608      IF (NQ.GT.1) CALL LOAD (YQ,FQ,ZDUM,NQ,N6,12,2,FORMAT(1,1),CARD,I2) 739500
609      IF (NHX.GT.1) CALL LOAD (YHX,FHX,ZDUM,NHX,NP,12,2,FORMAT(1,1),CARD 739600
610      *,I2)
611      GO TO 180
612      C**** CARD GROUP 12 *****
613      1080 NOUT=N1
614      NPCHAN=MAX0(N2,0)
615      IF (NPCHAN.NE.0) CALL LIMITS (N2,1,MC,NGROUP,CARD,ERROR)
616      NPCHAN=MIND(NPCHAN,N2,MC)
617      NPROD=MAX0(N3,0)
618      IF (NPROD.NE.0) CALL LIMITS (N3,1,MR,NGROUP,CARD,ERROR)
619      NPROD=MIND(NPROD,N3,MR)
620      NPGAP=MAX0(N5,0)
621      IF (NPGAP.NE.0) CALL LIMITS (N5,1,MG,NGROUP,CARD,ERROR)
622      NPGAP=MIND(NPGAP,N5,MG)
623      IF (NPCHAN.GT.0) CALL LOAD (PRINTC,ZDUM,ZDUM,NPCHAN,N2,24,1,FORMA 741800
624      *T(1,4),CARD,I2)
625      IF (NPROD.GT.0) CALL LOAD (PRINTR,ZDUM,ZDUM,NPROD,N3,24,1,FORMAT 741900
626      *1,4),CARD,I2)
627      742100

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627      IF (NPGAP.GT.0) CALL LOAD (PRINTG,ZDUM,ZDUM,NPGAP,N5,24,1,FORMAT(
628      +1,4),CARD,I2)
629      GO TO 180
630 C**** CARD GROUP 13 *****
631 1085 CONTINUE
632      READ (I2,1770) (R2(I),I=1,NFT)
633      READ (I2,1770) (RZS(I),I=1,NFT)
634      READ (I2,1770) (RR(I),I=1,NFT)
635      READ (I2,1770) HRIB
636      READ(I2,2041) B10TC
637      READ (I2,2050) (CR(I),I=1,8)
638      READ (I2,2050) (CG(I),I=1,8)
639      GO TO 180
640 1090 IF (.NOT.ERROR) GO TO 1100
641      WRITE (I3,2730)
642 1100 CONTINUE
643 C**** COMPUTE MISCELLANEOUS FROM INPUT *****
644      SLGC=SL*GC
645      IF ((J6-1)*(J6-3).NE.0) GO TO 1110
646      NARAMP=MAX0(NARAMP,NRAMP)
647 1110 CONTINUE
648      IF(INGRIDT.EQ.0) CDC(11) = 1.
649 C
650      IF (NPCHAN.GT.0) GO TO 1130
651      NPCHAN=NCHANL
652      DO 1120 I=1,NCHANL
653 1120 PRINTC(I)=I
654 1130 IF (NPROD.GT.0) GO TO 1170
655      NPROD=NR00
656      DO 1140 N=1,NR00
657 1140 PRINTR(N)=N
658 1170 IF (NPGAP.GT.0) GO TO 1230
659      NPGAP=NK
660      IF (NK.EQ.0) GO TO 1230
661      DO 1180 K=1,NK
662 1180 PRINTG(K)=K
663 1230 CONTINUE
664      CALL SETUP2
665      IF (IERPOR.GT.0) GO TO 100
666 1680 IF (ERROR) STOP
667      RETURN
668 C
669 C
670 1690 FORMAT (11I5)
671 1691 FORMAT(5I5,2E5.0)
672 1700 FORMAT (I5,17A4)
673 1710 FORMAT (15HINPUT FOR CASEI6,5X,16A4,A2,9H DATE 2A6,7H TIME 2A6-MAR81
674      +6)
675 1730 FORMAT (12F5.3)
676 1750 FORMAT (I1,I4,3E5.2,4(I5,2E5.2))
677 1760 FORMAT (I5/(12F5.3))
678 1770 FORMAT (6F10.0)
679 1780 FORMAT (12E5.0)
680 1790 FORMAT (16E5.0)
681 1799 FORMAT (I5,2E5.2,6(I5,E5.2))
682 1800 FORMAT (I5,2E5.2,6(I5,E5.2))
683 1801 FORMAT(15X,I5,E5.2)

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742200
742300
743000
743100
743200
743300
743400
743500
743700
744000
GA-MAR81
744200
744300
744400
744600
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746400
746600
746700
747700
747800
750000
GA-MAR81
750200
750300
750400
750500
750600
751200
751300
751400
751500
751600
751700
751900

684	2041 FORMAT(6E10.5)	752100
685	2050 FORMAT (8E10.5)	752200
686	2120 FORMAT (5(I5,F5.0))	752300
687	2240 FORMAT (I5,10E5.2)	752700
688	2260 FORMAT (I5,E5.2,I5,E5.2)	752900
689	2380 FORMAT (9E5.2)	753000
690	2530 FORMAT (25HOSUMMARY OF INPUT OPTIONS/56H GROUP N1 N2 N3 N4	753100
691	+ N5 N6 N7 N8 N9 N10)	753200
692	2640 FORMAT ('!ILLEGAL GROUP IDENTIFICATION. IMPOSSIBLE TO CONTINUE EDI	
693	+TING. CASE WILL BE ABORTED. NGROUP= ',I5)	753500
694	2650 FORMAT ('!DERROR CONDITION EXISTS IN EITHER PW(I) OR AC(I) WITHIN C	753600
695	+ARD GROUP ',I5)	753700
696	2660 FORMAT ('!D***NCHANL HAS NOT BEEN DEFINED FOR GROUP ',I5,'. EDITING	753800
697	+ WILL BE TERMINATED.')	753900
698	2670 FORMAT ('!D***NK HAS NOT BEEN DEFINED FOR GROUP ',I5,'. EDITING WIL	754000
699	+L BE TERMINATED.')	754100
700	2690 FORMAT ('!DILLEGAL INPUT FOR (Z) IN CARD GROUP ',I5,' CARD NUMBER '	754400
701	+',I5)	754500
702	2700 FORMAT ('!DCAUTION---NPROP HAS NOT BEEN DEFINED FOR GROUP ',I5,' ED	754600
703	+ITING WILL BE TERMINATED.')	754700
704	2710 FORMAT ('!DCAUTION---ERROR DETECTED IN SUBROUTINE PROP.'/' EDITING	754800
705	+WILL CONTINUE, EXECUTION WILL BE ABORTED.')	754900
706	2720 FORMAT ('!DCAUTION---ERROR DETECTED IN SUBROUTINE CURVE.'/' EDITING	755000
707	+ WILL CONTINUE, EXECUTION WILL BE ABORTED.')	755100
708	2730 FORMAT ('!DCAUTION---ERROR(S) HAVE BEEN DETECTED WITHIN THE INPUT S	755200
709	+TREAM.'/' EDITING HAS BEEN COMPLETED AND THE INPUT WILL BE PRINTED	755300
710	+ . HOWEVER, THE EXECUTION WILL BE ABORTED.')	755400
711	2740 FORMAT ('!DGEOMETRY ILL-DEFINED. FOR M= ',I5,' NO IN DIMENSION SPEC	755500
712	+IFICATION IS TOO SMALL.')	755600
713	2750 FORMAT('!DPREMATURE TERMINATION FROM CARD GROUP 4.'/'	755700
714	+1X,'EITHER FLOW OR THERMAL CONNECTIONS (NADI=',I5,', NADJ=',I5,	755800
715	+') HAVE EXCEEDED THE SPECS FOR MI=',I5)	755900
716	END	756300

@HOG

* S E T U P 2 *

@PRT,S COBRA*CFIL.SETUP2
 FURPUR 28R1 GA-B E35 S74T11 05/26/81 17:37:07

COBRA*CFIL(1).SETUP2

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1      SUBROUTINE SETUP2
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC3,LIST
5      INCLUDE SPEC4,LIST
6      INCLUDE SPEC5,LIST
7      INCLUDE SPEC6,LIST
8      INCLUDE SPEC7,LIST
9      INCLUDE SPEC10,LIST
10     INCLUDE SPEC11,LIST
11     INCLUDE SPEC12,LIST
12     INCLUDE SPEC13,LIST
13     INCLUDE SPEC15,LIST
14     INCLUDE SPEC16,LIST
15     INCLUDE SPEC20,LIST
16     INCLUDE SPEC51,LIST
17     INCLUDE SPEC52,LIST
18     INCLUDE SPEC53,LIST
19     INCLUDE SPEC71,LIST
20     INCLUDE SPEC72,LIST
21     INCLUDE SPEC73,LIST
22     LOGICAL PRINT
23     LOGICAL GRID
24     REAL KPOUT
25     REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
26     PRINTS INPUT DATA FOR EACH CASE.
27     C      CARD GROUP 1
28     IF (.NOT.PRINT(1)) GO TO 1260
29     PREFO=PREF/1000.
30     WRITE(I3,2620) PREFO
31     WRITE(I3,2622)
32     DO 1240 NN=1,NPROP
33     OUTPUT(1)=TPOUT(NN)
34     OUTPUT(2)=HGPT(NN)
35     OUTPUT(3)=CPPOUT(NN)
36     OUTPUT(4)=VPOUT(NN)
37     OUTPUT(5)=UPOUT(NN)
38     OUTPUT(6)=KPOUT(NN)
39     OUTPUT(7)=UPOUT(NN)*CPPOUT(NN)/KPOUT(NN)
40     WRITE (I3,2630) (OUTPUT(I),I=1,7)
41     1240 CONTINUE
42     C      CARD GROUP 2
43     1260 IF (.NOT.PRINT(2)) GO TO 1290
44     IF(INFH.EQ.0) WRITE (I3,1920)
45     DO 1280 J=1,NFT
46     IF (INFH.EQ.0) WRITE (I3,1930) J,AA(J),BB(J),CC(J)
47     IF (LAMNF.GT.0) WRITE (I3,1940) J,AAL(J),BBL(J),CCL(J)
48     1280 CONTINUE
49     IF(INFH.EQ.0)WRITE (I3,1950) (AH(I),I=1,4)
50     IF(LAMNF.GT.0) WRITE (I3,1941)
51     IF(INFH.EQ.0)GO TO 1284
52     1282 CONTINUE
53     WRITE(I3,1919)
54     DO 1283 J=1,NFT
55     IF((INFH-1)*(INFH-3) .EQ.0)
56     .WRITE(I3,1929) J,AA(J),BB(J),CC(J),J,AA(J),BB(J),CCR(J)

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761000

761300

761400

761500

761700

762700

763200

763300

763500

763600

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57      IF (NFH-2)*(NFH-4) .EQ. 0) WRITE(I3,1929) J,AA(J),BB(J),CC(J),J      763700
58      IF (NFH-2)*(NFH-4) .EQ. 0) WRITE(I3,1928)                               763800
59      1283 CONTINUE                                                            763900
60      WRITE (I3,1951)                                                         764000
61      DO 1281 J=1,NFT
62      IF (NFH.EQ.1)
63      .WRITE(I3,1952)J,HAA(J),HBB(J),HCC(J),J,HAAR(J),HBBR(J),HCCR(J)      764200
64      IF (NFH.EQ.2) WRITE (I3,1952) J,HAA(J),HBB(J),HCC(J),J               764300
65      IF (NFH.EQ.2) WRITE (I3,1949)                                           764400
66      IF (NFH.EQ.3) WRITE (I3,1948) J,J,HAAR(J),HBBR(J),HCCR(J)             764500
67      IF (NFH.EQ.4) WRITE (I3,1947)NFT,NFT
68      IF (NFH.EQ.4) GO TO 1284                                                764800
69      1281 CONTINUE                                                            764900
70      1284 CONTINUE                                                            765000
71      C CARD GROUP 3
72      1290 IF (.NOT.PRINT(3)) GO TO 1300                                     766100
73      XHO=XH*1000.
74      WRITE (I3,1740) XHO,(Y(I),AXIAL(I),I=1,NAX)
75      IF (IRAD.EQ.1) WRITE (I3,1742)                                           766300
76      C CARD GROUP 4
77      1300 IF (.NOT.PRINT(4)) GO TO 1320                                     766400
78      WRITE(I3,1810)
79      DO 1301 I=1,NCHANL
80      ACOUT=AC(I)*1.E6
81      PWOUT=PW(I)*1000.
82      DCOUT=DC(I)*1000.
83      DO 1302 J=1,4
84      GAPS(I,J)=GAPS(I,J)*1000.
85      1302 DIST(I,J)=DIST(I,J)*1000.
86      WRITE (I3,1811) I,NTYPE(I),ACOUT,PWOUT,DCOUT,(LC(I,L),GAPS(I,L),
87      +DIST(I,L),L=1,4)
88      DO 1303 J=1,4
89      GAPS(I,J)=GAPS(I,J)/1000.
90      1303 DIST(I,J)=DIST(I,J)/1000.
91      1301 CONTINUE
92      IF (NWK.LE.0)GO TO 1305
93      WRITE(I3,1830)
94      DO 1304 K=1,NWK
95      WRITE (I3,1831) K,RHOLCP(K),WIDTH(K),IKW(K),RWALL(1,K),
96      +JKW(K),RWALL(2,K)
97      WIDTH(K)=WIDTH(K)/1000.
98      1304 CONTINUE
99      1305 IF (K12.LE.0) GO TO 1320
100     DO 1310 K=1,NK
101     1310 WP(K)=ANGLE(K)*180./PI
102     WRITE (I3,1850) (K,WP(K),K=1,NK)
103     1320 IF (NAXL.LT.1) GO TO 1350
104     C CARD GROUP 5
105     IF (.NOT.PRINT(5)) GO TO 1350
106     N=1
107     NN=10
108     1325 CONTINUE
109     IF (NN.GT.NAFACT) NN=NAFACT
110     WRITE (I3,1880) (NCH(J),J=N,NN)
111     DO 1330 I=1,NAXL
112     1330 WRITE (I3,2020) AXL(I),(AFACT(I,J),J=N,NN)
113     N=N+10

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114      NN=NN+10
115      IF (N.GT.NAFACT) GO TO 1350
116      GO TO 1325
117 1350 IF (NGXL.LT.1) GO TO 1390
118 C      CARD GROUP 6
119      IF (.NOT.PRINT(6)) GO TO 1390
120      N=1
121      NN=10
122      DO 1380 LL=1,6
123      IF (NN.GT.NGAPS) NN=NGAPS
124      DO 1360 M=N,NN
125      K=NGAP(M)
126      IM(M)=IK(K)
127 1360 JM(M)=JK(K)
128      WRITE (I3,1890) ((IM(M),JM(M)),M=N,NN)
129      DO 1370 L=1,NGXL
130 1370 WRITE (I3,2020) GAPXL(L),(GFACT(L,M),M=N,NN)
131      N=N+10
132      NN=NN+10
133      IF (N.GE.NGAPS) GO TO 1390
134 1380 CONTINUE
135 C      CARD GROUP 7
136 1390 IF (.NOT.PRINT(7)) GO TO 1450
137      IF (J6.EQ.0) GO TO 1450
138      IF (J6-2) 1400,1410,1400
139 1400 PITCH0=PITCH*1000.
140      DIA0=DIA*1000.
141      THICK0=THICK*1000.
142      WRITE (I3,2270) PITCH0,THICK0,DIA0
143      WRITE (I3,2280) (K,IK(K),JK(K),DUR(K),(XCROSS(K,L),L=1,2)
144      ,K=1,NK)
145      WRITE (I3,2320) (NWRAPS(I),I=1,NCHANL)
146      IF (J6.NE.3) GO TO 1450
147 1410 WRITE (I3,2290) (IGRID(I),I=1,NGRID)
148      WRITE (I3,2300) (GRIDXL(I),I=1,NGRID)
149      WRITE (I3,2302)
150      DO 1405 I=1,NGRIDT
151      WRITE (I3,2301) I,CDC1(I),CDC2(I),CDC3(I),CDC4(I)
152 1405 CONTINUE
153      SHO=SH*1000.
154      WRITE (I3,2303) SHO,RSC,SSC
155      DO 1420 L=1,NGRIDT
156 1420 WRITE (I3,2310) L,(I,CD(I,L),I=1,NCHANL)
157      IF (NK.EQ.0) GO TO 1450
158      DO 1440 I=1,NGRIDT
159      II=0
160      DO 1430 K=1,NK
161      IF (ABS(FXFLOW(K,I)).GT.0) II=1
162 1430 CONTINUE
163      IF (II.EQ.0) GO TO 1440
164      WRITE (I3,2330) I,(KK,IM(KK),JK(KK),FXFLOW(KK,I),KK=1,NK)
165 1440 CONTINUE
166 C      CARD GROUP 8
167 1450 IF (.NOT.PRINT(8)) GO TO 1510
168      WRITE (I3,1840)
169      DO 1451 I=1,NROD
170      DROUT=DR(I)*1000.

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171 WRITE (I3,1841) I,DROUT,RADIAL(I),(PHI(I,L),LR(I,L),L=1,MSC)
172 1451 CONTINUE
173 IF (RF(I).LT.1.E-6) GO TO 1510
174 WRITE (I3,2340) (PF(I), I=1,5)
175 WRITE (I3,2350) (KKF(I), I=1,5)
176 WRITE (I3,2355) (HGAP(I), I=1,4)
177 WRITE (I3,2360) (CPF(I), I=1,5)
178 WRITE (I3,2365) (QPFAC(I),I=1,5)
179 WRITE (I3,2370) (RHOF(I), I=1,5)
180 IF (ICON.EQ.1) WRITE (I3,1741) (ICONR(I),I=1,NCONR)
181 C CARD GROUP 9
182 1510 IF (.NOT.PRINT(9)) GO TO 1530
183 WRITE (I3,2550)
184 WRITE (I3,1860) KI,J,ZZ,SL,NDX,FTM
185 IF (DXX.GT.0.) WRITE (I3,1861) DXX
186 ALNSMO=LENSMO*1000.
187 ALNROU=LENROU*1000.
188 WRITE (I3,1862) ALNSMO,ALNROU,THETA,TTIME,NDT,DT
189 WRITE (I3,1870) NTRIES,ITRYM,ITRY,USDON,WERPX,ACCELY,WERRY,DAMPNG,
190 *FERROR,ACCELF
191 IF (DXX.GT.0.) GO TO 1522
192 DO 1523 J=1,NDXP1
193 X(J) = X(J)*1000.
194 1523 CONTINUE
195 PRINT 1921, (X(J),J=1,NDXP1)
196 DO 1521 J=1,NDXP1
197 X(J) = X(J)/1000.
198 1521 CONTINUE
199 1522 CONTINUE
200 C CARD GROUP 10
201 1530 IF (.NOT.PRINT(10)) GO TO 1570
202 WRITE (I3,1990)
203 IF (NSCBC.LT.1) WRITE (I3,1960) ABETA
204 IF (NSCBC.EQ.1) WRITE (I3,1970) ABETA,BBETA
205 IF (NSCBC.EQ.2) WRITE (I3,1980) ABETA,BBETA
206 IF (NSCBC.EQ.3) WRITE (I3,2030) ABETA,BBETA
207 IF (NSCBC.EQ.4) WRITE (I3,2031) ABETA
208 IF (J5.EQ.1) WRITE (I3,2230) GK
209 C CARD GROUP 11
210 1570 IF (.NOT.PRINT(11)) GO TO 1595
211 PEXITP=PEXIT/1000.
212 GINP=GIN/1000.
213 WRITE (I3,1900) PEXITP,HIN,GINP,TIN,AFLUX
214 IF (HOUT.GT.0.) WRITE (I3,1910) HOUT
215 IF (IH.EQ.0) WRITE (I3,2460)
216 IF (IH.EQ.1) WRITE (I3,2470)
217 IF (IH.EQ.2) WRITE (I3,2480) (I,HINLET(I),I=1,NCHANL)
218 IF (IH.EQ.3) WRITE (I3,2490) (I,TINLET(I),I=1,NCHANL)
219 IF (IG.EQ.0) WRITE (I3,2500)
220 IF (IG.EQ.1) WRITE (I3,2510) (I,FINLET(I),I=1,NCHANL)
221 IF (IG.EQ.2) WRITE (I3,2520) (I,FINLET(I),I=1,NCHANL)
222 IF (NP.GT.1) WRITE (I3,2390) (YP(I),FP(I),I=1,NP)
223 IF (NH.GT.1) WRITE (I3,2400) (YH(I),FH(I),I=1,NH)
224 IF (K11.EQ.0.OR.K11.GT.2) GO TO 1580
225 IF (NG.LE.1) GO TO 1590
226 IF (K10.EQ.1) WRITE (I3,2440) (YG(I),FG(I),I=1,NG)
227 IF (K10.EQ.0) WRITE (I3,2450) (YG(I),FG(I),I=1,NG)

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228      GO TO 1590
229      1580 IF (NG.GT.1) WRITE (I3,2410) (YG(I),FG(I),I=1,NG)
230      1590 IF (NO.GT.1) WRITE (I3,2420) (YQ(I),FQ(I),I=1,NO)
231      IF (NHX.GT.1) WRITE (I3,2430) (YHX(I),FHX(I),I=1,NHX)
232      C      CARD GROUP 13
233      1595 IF (.NOT.PRINT(I3)) GO TO 1600
234      PRINT 1954, (I,I=1,NFT)
235      PRINT 1961, (R2(I),I=1,NFT)
236      PRINT 1962, (RZS(I),I=1,NFT)
237      PRINT 1969, (RR(I),I=1,NFT)
238      PRINT 1963, HRIB
239      PRINT 1953, BIOTC
240      WRITE(I3,1965)CR(1),CR(2),(CR(I),I=4,8)
241      WRITE(I3,1968)CG(1),CG(2),(CG(I),I=4,7)
242      DO 1599 I=1,NFT
243      R2(I)=R2(I)/1000.
244      RZS(I)=RZS(I)/1000.
245      1599 RR(I)=RR(I)/1000.
246      HPB=HRIB/1000.
247      1600 CONTINUE
248      RETURN
249      C
250      C
251      1740 FORMAT (23H0HEAT FLUX DISTRIBUTION/23H X/L RELATIVE FLUX
252      .10X,'BEGINNING OF HEATING =',F6.2,' MM',/(F7.4,F12.4))
253      1741 FORMAT('0CIRCUMFERENTIAL CONDUCTION CONSIDERED FOR ROD NUMBERS',/,
254      .(26I5))
255      1742 FORMAT('0RADIATION INCLUDED IN HEAT FLUX CALCULATIONS')
256      1810 FORMAT (22H0SUBCHANNEL INPUT DATA/103H CHANNEL TYPE AREA WET
257      +TED HYDRAULIC (ADJACENT CHANNEL NO., SPACING, CENTROID D
258      21STANCE) /,3X,'NO.',10X,'(SQ-MM)',2X,'PERIM.',8X,'DIAMETER',
259      + /26X,'(MM)',11X,'(MM)')
260      1811 FORMAT(I5,I7,2F9.2,F16.3,5X,4(1H(I3,1H,F5.3,1H,F5.3,1H)))
261      1830 FORMAT (36H0SUBCHANNEL THERMAL CONNECTION DATA /4X,46HCONNECTION
262      +WALL AVERAGE WIDTH OF CHANNEL,38H CONDUCTIVE CHANNEL CON
263      +DUCTIVE /4X,84H NO. HEAT CAPACITY CONNECTION NO.
264      +RESISTANCE NO. RESISTANCE /18X,73H(KJ/42-K) (MM)
265      + (M2-K/KW) (M2-K/KW) //)
266      1831 FORMAT(I10,2(6X,F8.2),4X,2(I5,6X,F9.4,3X))
267      1840 FORMAT (15H0ROD INPUT DATA/96H ROD DIA RADIAL POWER
268      +FRACTION OF POWER TO ADJACENT CHANNELS (ADJ. CHANNEL NO.) /30H
269      + NO. (MM) FACTOR )
270      1841 FORMAT(I5,5X,F7.3,F10.4,2X,7(F8.4,1H(I3,1H)))
271      1850 FORMAT (32H0GAP ORIENTATION (GAP NO. ANGLE)/(8X,8(1H(I3,1H,F5.0,2
272      +H )))
273      1860 FORMAT (23H0CALCULATION PARAMETERS/30H LATERAL RESISTANCE FACTOR
274      + ,F9.4,31X,27HCHANNEL LENGTH ,F9.2,7H MM ,/30H (
275      +S/L) PARAMETER ,F9.4,31X,27HNUMBER OF AXIAL NODES
276      +,I9,/30H TURBULENT MOMENTUM FACTOR ,F9.4)
277      1861 FORMAT(1H+,69X,27HAXIAL NODE LENGTH ,F9.4,7H MM )
278      1862 FORMAT(70X,27HROUGHENING BEGINS
279      .,F9.1,7H MM ,/70X,27HROUGHENING ENDS
280      + ,F9.1,7H MM ,/30H CHANNEL ORIENTATION ,F9.
281      +4,8H DEGREES,23X,27HTOTAL TRANSIENT TIME ,F9.4,8H SECONDS,/
282      + 70X,27HNUMBER OF TIME STEPS
283      + ,I9,/70X,27HNOMINAL TIME STEP ,E9.4,8H SECONDS)
284      1870 FORMAT (27H0DATA FOR IMPLICIT SOLUTION/30H EXTERNAL ITERATION LI

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285      +MIT ,I9,31X,27HMINIMUM INTERNAL ITERATIONS,I9,/30H INTERNAL IT 788800
286      +ERATION LIMIT ,I9,31X,27HFRACTION DONOR CELL USTAR ,F9.4,/30H 788900
287      + CONVERGENCE FACTORS ,40X,21HACCELERATION FACTORS ,/30H 789000
288      + EXTERNAL (DW/W) ,F9.4,31X,27H CROSSFLOW SOLUTION 789100
289      +,F9.4,/30H INTERNAL (DW/W) ,F9.4,31X,27H LATERAL 789200
290      +DELTA-P ,F9.4,/30H FLOW (DF/F) ,F9.4,31X,27 789300
291      +H FLOW ,F9.4)
292      1880 FORMAT (50H0 X/L AREA VARIATION FACTORS FOR SUBCHANNEL (I)/8X,1
293      +O(2X,'(I,I3,'I',1X)) 789800
294      1890 FORMAT (69H0 X/L GAP SPACING VARIATION FACTORS FOR ADJACENT SUB 789900
295      +CHANNELS (I,J)/8X,10(1X,'(I,I2,'',I2,''))
296      1900 FORMAT(' OPERATING CONDITIONS',/3X,'SYSTEM PRESSURE =',F8.2,
297      1 ' KPA',/3X,'INLET ENTHALPY =',F8.1,' KJ/KG',/3X,
298      2 'INLET MASS FLUX =',F8.5,' G/S-MM2',/3X,'INLET TEMPERATURE =
299      3',F8.1,' DEGREES C',/3X,'MAX. HEAT FLUX =',F8.2,' KW/M2')
300      1910 FORMAT (25H EXIT ENTHALPY = ,F8.1,74 KJ/KG)
301      1919 FORMAT (/29H FRICTION FACTOR CORRELATION ,/22X,14HSMOOTH SECTION,
302      .57X,13HROUGH SECTION) 790700
303      1920 FORMAT (/29H FRICTION FACTOR CORRELATION ) 790800
304      1921 FORMAT('OAXIAL NODE LOCATIONS (MM)',/,(10F13.1)) 790900
305      1928 FORMAT(1H+,94X,35H R-FUNCTION CORRELATION ) 791000
306      1929 FORMAT(14H CHANNEL TYPE,I3,8H FRICT=,E10.5,6H*RE**I,E10.4,4H) + 791100
307      .,E10.5,4X,12HCHANNEL TYPE,I3,8H FRICT=,E10.5,6H*RE**I,E10.4,4H) + 791200
308      .,E10.5) 791300
309      1930 FORMAT (16H CHANNEL TYPE,I3,11H FRICT = ,F6.3,6H*RE**I,F6.3,4 791400
310      +H) + F6.4) 791500
311      1940 FORMAT(/4X,'CHANNEL TYPE',I3,5X,'LAMINAR FRICTION CORRELATION',4X, 791600
312      1 F7.3,'*RE**I',F6.3,') + ',F6.3)
313      1941 FORMAT(1H0,'LAMINAR FLOW HEAT TRANSFER CORRELATION',/4X,
314      . 'CENTRAL CHANNELS : NU = ALPHA / (1+ALPHA) * (14.12 + 4.13 ALOG
315      .(10.95 / ALPHA-1))',/4X,
316      . 'WALL/CORNER CHANNELS: NU = 4.07 + 1.24 / ALPHA**0.803')
317      1947 FORMAT(' CHANNEL TYPE 1-',I1,' STN = PETUKHOV-ROIZEN METHOD',
318      120X,'CHANNEL TYPE 1-',I1,' STN = G-FUNCTION CORRELATION')
319      1948 FORMAT(14H CHANNEL TYPE,I3,30H STN = PETUKHOV-ROIZEN METHOD,22X, 792200
320      .12HCHANNEL TYPE,I3,8H STN = ,E10.5,6H*RE**I,E10.5,4H) + ,E10.5) 792300
321      1949 FORMAT(1H+,94X,35H G-FUNCTION CORRELATION ) 792400
322      1950 FORMAT (/42H DITTUS-BOELTER HEAT TRANSFER CCRRELATION /6X,9H HFILM 792500
323      + = ,4HK/DI,F5.3,6H*RE**I,F5.3,7H)*PR**I,F5.3,4H) + ,F5.3,1H)/) 792600
324      1951 FORMAT(/,27H STANTON NUMBER CORRELATION,/22X,14HSMOOTH SECTION, 792700
325      .57X,13HROUGH SECTION) 792800
326      1952 FORMAT(14H CHANNEL TYPE,I3,8H STN = ,E10.5,6H*RE**I,E10.4,4H) +
327      .,E10.5,4X,12HCHANNEL TYPE,I3,8H STN = ,E10.5,6H*RE**I,E10.4,4H) +
328      .,E10.5) 793100
329      1953 FORMAT('OBLOT COEFFICIENT',G13.3)
330      1954 FORMAT('O',36X,'SUBCHANNEL TYPES',/24X,9I12)
331      1960 FORMAT(28H WP =,F7.4,9H*GAP*GAVG) 793300
332      1961 FORMAT('GTUBE RADIUS (MM)',9X,9F12.3)
333      1962 FORMAT('ORADIUS OF ZERO SHEAR (MM)',9F12.3)
334      1963 FORMAT('OROUGHNESS RIB HEIGHT=',F13.3,' MM')
335      1965 FORMAT(/5X,'FULLY ROUGH FLOW (H+ > ',F4.0,'):',2X,'R(H+)=',F5.2,
336      1 19X,'SLOPE A= ',F4.2//5X,'TRANSITION REGION:',12X,'R(H+)=',F5.2,
337      2 ' - ',F6.4,' LN(H+)',9X,'A= ',F5.3,' - ',F6.4,' LN(H+) + ',
338      3 F6.4,' LN(H+))**2',/5X,'HYDRAULICALLY SMOOTH:',9X,'R(H+)= 5.5 +
339      42.5 LN(HB+)',12X,'A= 2.50',//)
340      1968 FORMAT(5X,'G(HW+)=',F6.2,' *(HW+)**',F6.2,' *PR**',F4.2,' *(TW/TB
341      1)**',F6.2,75X,'FOR H+<',F5.1,' G(HW+)=',F5.2)

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342 1969 FORMAT('OROD RADIUS (MM)',10X,9F12.3)
343 1970 FORMAT(28H                                WP =,F7.4,6H*RE**1,F6.4,10H)*GAP 794000
344      .GAVG) 794100
345 1980 FORMAT(28H                                WP =,F7.4,6H*RE**1,F6.4,11H)*DAV 794200
346      .G*GAVG) 794300
347 1990 FORMAT (20HOMIXING CORRELATIONS: 794400
348 2020 FORMAT (F7.4,10F8.4) 794800
349 2030 FORMAT(28H                                WP =,F7.4,6H*RE**1,F6.4,22H)*GAP 794900
350      ./LENGTH*DAVG*GAVG) 795000
351 2031 FORMAT(28H                                WP =,F7.4,20H*DAVG*GAVG*SQRT(1/F 795100
352      .)) 795200
353 2230 FORMAT (42H      CONDUCTION MIXING, GEOMETRY FACTOR = F6.4) 797400
354 2270 FORMAT (1/62H WIRE WRAP SPACER DATA FOR FORCED DIVERSION CROSSFLOW 797500
355      +MIXING //20H      WRAP PITCH      =F6.1,7H      MM //20H      WRAP THICKN 797600
356      +ESS =F6.2,7H      MM //20H      PIN DIAMETER      =F6.2,7H      MM //1) 797700
357 2280 FORMAT (23H      WRAP CROSSING DATA /60H      GAP      SUBCHANNEL      MI 797800
358      +XING      RELATIVE LOCATION /60H      NO.      PAIR NO.      PARAM 797900
359      +ETER      OF WRAP CROSSINGS //19,3X,'(,13,',',13,')',F11.4,2F10
360      +.4)) 798100
361 2290 FORMAT (1/12H SPACER DATA/20H      SPACER TYPE NO. ,12I7) 798200
362 2300 FORMAT (21H      LOCATION (X/L) ,12F7.3) 798300
363 2301 FORMAT(' SPACER TYPE',13,' COEF = CD**',E10.5,'*(,E10.5,' + ', 798400
364      .E10.5,'/RE**',E10.5,')') 798500
365 2302 FORMAT('SPACER LOSS COEFFICIENT',/) 798600
366 2303 FORMAT('SPACER WIDTH = ',F7.2,' MM',/, 798800
367      . ' HEAT TRANSFER COEFFICIENT ENHANCEMENT DUE TO SPACERS',/,5X,
368      . ' ROUGH BUNDLE - YST = 1 + ',F7.3,' * CD**2 * F(X)',20X,
369      3' SMOOTH BUNDLE - YST = 1 + ',F7.3,' * CD**2 * F(X)')
370 2310 FORMAT (15H      SPACER TYPE,12,/,60H      CHANNEL      CHANNEL 799000
371      . CHANNEL      CHANNEL      ,/,65H      NO. SOLIDITY NO. SOLI 799100
372      DITY NO. SOLIDITY NO. SOLIDITY,/(3X,4(I6,F9.4))) 799200
373 2320 FORMAT (46H      INITIAL WRAP INVENTORY FOR EACH SUBCHANNEL/(10I5)) 799300
374 2330 FORMAT (43H      FLOW DIVERSION FACTORS FOR SPACER TYPE 12/5X46HGAP 799400
375      + CHANNEL FRACTION      GAP CHANNEL FRACTION/5X46HNO. PAIR DIVER 799500
376      +TED NO. PAIR DIVERED/(2(5X,13,1X,'(,12,',',12,')',F9.4)))
377 2340 FORMAT(1H,'FUEL DATA:',/, ' ZONAL RADII ',5F10.3)
378 2350 FORMAT(1H, ' CONDUCTIVITY ',5F10.3)
379 2355 FORMAT(1H, ' GAP CONDUCTANCE',6X,4F10.3)
380 2360 FORMAT(1H, ' SPECIFIC HEAT ',5F10.3)
381 2365 FORMAT(1H, ' POWER FRACTION ',5F10.3)
382 2370 FORMAT(1H, ' DENSITY ',5F10.3)
383 2390 FORMAT (33H      FORCING FUNCTION FOR PRESSURE /23H      TIME      PRE 800800
384      +SSURE/23H      (SEC)      FACTOR /(F10.4,F13.4)) 800900
385 2400 FORMAT (38H      FORCING FUNCTION FOR INLET ENTHALPY/28H      TIME      I 801000
386      +NLET ENTHALPY /23H      (SEC)      FACTOR /(F10.4,F13.4)) 801100
387 2410 FORMAT (38H      FORCING FUNCTION FOR INLET FLOW /28H      TIME      I 801200
388      +NLET FLOW /23H      (SEC)      FACTOR /(F10.4,F13.4)) 801300
389 2420 FORMAT (38H      FORCING FUNCTION FOR HEAT FLUX /38H      TIME 801400
390      +HEAT FLUX /23H      (SEC)      FACTOR /(F10.4,F13.4) 801500
391      +) 801600
392 2430 FORMAT (38H      FORCING FUNCTION FOR EXIT ENTHALPY /38H      TIME 801700
393      + ENTHALPY /24H      (SEC)      FACTOR /(F10.4,F13.1 801800
394      +) 801900
395 2440 FORMAT (45H      FORCING FUNCTION FOR PRESSURE DIFFERENCE /22H 802000
396      + TIME      DELTA-P/21H      (SEC)      FACTOR/(F10.4,F13.4)) 802100
397 2450 FORMAT (45H      FORCING FUNCTION FOR PRESSURE DIFFERENCE /22H 802200
398      + TIME      DELTA-P/20H      (SEC)      (PSI)/(F10.4,F13.4)) 802300

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399 2460 FORMAT (30H0 UNIFORM INLET ENTHALPY ) 802400
400 2470 FORMAT (35H0 UNIFORM INLET TEMPERATURE ) 802500
401 2480 FORMAT (65H0 INDIVIDUAL SUBCHANNEL ENTHALPY SPECIFIED (CHANNEL 802600
402 +ENTHALPY)/(3X,8(1X,'(',13,2H -,F6.1,'))))) 802700
403 2490 FORMAT (71H0 INDIVIDUAL SUBCHANNEL TEMPERATURE SPECIFIED (CHAN 802800
404 +NEL-TEMPERATURE)/(3X,8(1X,'(',13,2H -,F6.1,'))))) 802900
405 2500 FORMAT (35H0 UNIFORM INLET MASS VELOCITY ) 803000
406 2510 FORMAT (59H0 FLOWS SPLIT FOR EQUAL PRESSURE GRADIENT (CHANNEL-F 803100
407 +LOW)/(3X,6(1X,'(',13,2H -,1PE10.3,'))))) 803200
408 2520 FORMAT (57H0 INDIVIDUAL SUBCHANNEL FLOWS SPECIFIED (CHANNEL-FLO 803500
409 +W)/(3X,6(1X,'(',13,2H -,1PE10.3,'))))) 803600
410 2550 FORMAT (45H0IMPLICIT SOLUTION WITH INLET FLCWS SPECIFIED) 803700
411 2620 FORMAT('HELIUM PROPERTIES AT',F8.2,4H KPA)
412 2622 FORMAT(10X,1HT,8X,1HH, 805400
413 1 10X2HCP,12X1HV,12X4HVISC,13X1HK,10X2HPR/ 8X5HDEG C,3X7H KJ/KG,
414 2 4X9H KJ/KG-K,5X9HCU M/KG ,5X9H KG/M-S ,6X7H KW/M-K )
415 2630 FORMAT (6X,F7.1,3X,F7.1,5X,F6.3,7X,F7.4,5X,F10.7,6X,F9.6,6X,F5.3)
416 END

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@HOG * S P B F A *

@PRT,S COBRA*CFIL.SPBFA
 FURPUR 28R1 GA-B E35 574T11 05/26/81 17:37:09

COBRA*CFIL(1).SPBFA

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1      SUBROUTINE SPBFA(ABD,LCA,N,M,INFO)
2      INTEGER LDA,N,M,INFO
3      REAL ABD(LDA,1)
4      C
5      C      SPBFA FACTORS A REAL SYMMETRIC POSITIVE DEFINITE MATRIX
6      C      STORED IN BAND FORM.
7      C
8      C      SPBFA IS USUALLY CALLED BY SPBCO, BUT IT CAN BE CALLED
9      C      DIRECTLY WITH A SAVING IN TIME IF RCOND IS NOT NEEDED.
10     C
11     C      ON ENTRY
12     C
13     C      ABD      REAL(LDA, N)
14     C               THE MATRIX TO BE FACTORED.  THE COLUMNS OF THE UPPER
15     C               TRIANGLE ARE STORED IN THE COLUMNS OF ABD AND THE
16     C               DIAGONALS OF THE UPPER TRIANGLE ARE STORED IN THE
17     C               ROWS OF ABD.  SEE THE COMMENTS BELOW FOR DETAILS.
18     C
19     C      LDA      INTEGER
20     C               THE LEADING DIMENSION OF THE ARRAY ABD.
21     C               LDA MUST BE .GE. M + 1.
22     C
23     C      N        INTEGER
24     C               THE ORDER OF THE MATRIX A.
25     C
26     C      M        INTEGER
27     C               THE NUMBER OF DIAGONALS ABOVE THE MAIN DIAGONAL.
28     C               0 .LE. M .LT. N.
29     C
30     C      ON RETURN
31     C
32     C      ABD      AN UPPER TRIANGULAR MATRIX R, STORED IN BAND
33     C               FORM, SO THAT  $A = TRANS(R)*R$ .
34     C
35     C      INFO      INTEGER
36     C               = 0 FOR NORMAL RETURN.
37     C               = K IF THE LEADING MINOR OF ORDER K IS NOT
38     C               POSITIVE DEFINITE.
39     C
40     C      BAND STORAGE
41     C
42     C      IF A IS A SYMMETRIC POSITIVE DEFINITE BAND MATRIX,
43     C      THE FOLLOWING PROGRAM SEGMENT WILL SET UP THE INPUT.
44     C
45     C      M = (BAND WIDTH ABOVE DIAGONAL)
46     C      DO 20 J = 1, N
47     C          I1 = MAX(1, J-M)
48     C          DO 10 I = I1, J
49     C              K = I-J+M+1
50     C              ABD(K,J) = A(I,J)
51     C          10 CONTINUE
52     C      20 CONTINUE
53     C
54     C      LINPACK. THIS VERSION DATED 08/14/78.
55     C      CLEVE MOLER, UNIVERSITY OF NEW MEXICO, ARGONNE NATIONAL LAB.
56     C

```

```

57 C SUBROUTINES AND FUNCTIONS
58 C
59 C BLAS SDOT
60 C FORTRAN MAX0,SQRT
61 C
62 C INTERNAL VARIABLES
63 C
64 REAL SDOT,T
65 REAL S
66 INTEGER IK,J,JK,K,MU
67 C BEGIN BLOCK WITH ...EXITS TO 40
68 C
69 C
70 DO 30 J = 1, N
71 INFO = J
72 S = 0.0E0
73 IK = M + 1
74 JK = MAX0(J-M,1)
75 MU = MAX0(M+2-J,1)
76 IF (M.LT. MU) GO TO 20
77 DO 10 K = MU, M
78 T = ABD(K,J) - SDOT(K-MU,ABD(IK,JK),1,ABD(MU,J),1)
79 T = T/ABD(M+1,JK)
80 ABD(K,J) = T
81 S = S + T*T
82 IK = IK - 1
83 JK = JK + 1
84 10 CONTINUE
85 20 CONTINUE
86 S = ABD(M+1,J) - S
87 C .....EXIT
88 IF (S.LE. 0.0E0) 30 TO 40
89 ABD(M+1,J) = SQRT(S)
90 30 CONTINUE
91 INFO = 0
92 40 CONTINUE
93 RETURN
94 END

```

@HMG

* S P B S L *

@PRT,S COBRA*CFIL.SPBSL
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COBRA*CTFL(1),SPBSL

```

1  SUBROUTINE SPBSL(ABD,LDA,N,M,B)
2  INTEGER LDA,N,M
3  REAL ABD(LDA,1),B(1)
4  C
5  C  SPBSL SOLVES THE REAL SYMMETRIC POSITIVE DEFINITE BAND
6  C  SYSTEM  $A \cdot X = B$ 
7  C  USING THE FACTORS COMPUTED BY SPBCO OR SPBFA.
8  C
9  C  ON ENTRY
10 C
11 C      ABD      REAL(LDA, N)
12 C              THE OUTPUT FROM SPBCO OR SPBFA.
13 C
14 C      LDA      INTEGER
15 C              THE LEADING DIMENSION OF THE ARRAY ABD.
16 C
17 C      N        INTEGER
18 C              THE ORDER OF THE MATRIX A.
19 C
20 C      M        INTEGER
21 C              THE NUMBER OF DIAGONALS ABOVE THE MAIN DIAGONAL.
22 C
23 C      B        REAL(N)
24 C              THE RIGHT HAND SIDE VECTOR.
25 C
26 C  ON RETURN
27 C
28 C      B        THE SOLUTION VECTOR X.
29 C
30 C  ERROR CONDITION
31 C
32 C      A DIVISION BY ZERO WILL OCCUR IF THE INPUT FACTOR CONTAINS
33 C      A ZERO ON THE DIAGONAL.  TECHNICALLY THIS INDICATES
34 C      SINGULARITY BUT IT IS USUALLY CAUSED BY IMPROPER SUBROUTINE
35 C      ARGUMENTS.  IT WILL NOT OCCUR IF THE SUBROUTINES ARE CALLED
36 C      CORRECTLY AND INFO .EQ. 0.
37 C
38 C  TO COMPUTE  $INVERSE(A) \cdot C$  WHERE C IS A MATRIX
39 C  WITH P COLUMNS
40 C      CALL SPBCO(ABD,LDA,N,RCOND,Z,INFO)
41 C      IF (RCOND IS TOO SMALL .OR. INFO .NE. 0) GO TO ...
42 C      DO 10 J = 1, P
43 C          CALL SPBSL(ABD,LDA,N,C(1,J))
44 C      10 CONTINUE
45 C
46 C  LINPACK.  THIS VERSION DATED 08/14/78.
47 C  CLEVE MOLER, UNIVERSITY OF NEW MEXICO, ARGONNE NATIONAL LAB.
48 C
49 C  SUBROUTINES AND FUNCTIONS
50 C
51 C  BLAS SAXPY,SDOT
52 C  FORTRAN MIND
53 C
54 C  INTERNAL VARIABLES
55 C
56 C  REAL SDOT,T

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```

57      INTEGER K,KB,LA,LB,LM
58      C
59      C      SOLVE TRANS(R)*Y = B
60      C
61      DO 10 K = 1, N
62          LM = MIN0(K-1,M)
63          LA = M + 1 - LM
64          LB = K - LM
65          T = SDOT(LM,ABD(LA,K),1,B(LB),1)
66          B(K) = (B(K) - T)/ABD(M+1,K)
67      10 CONTINUE
68      C
69      C      SOLVE R*X = Y
70      C
71      DO 20 KB = 1, N
72          K = N + 1 - KB
73          LM = MIN0(K-1,M)
74          LA = M + 1 - LM
75          LB = K - LM
76          B(K) = B(K)/ABD(M+1,K)
77          T = -B(K)
78          CALL SAXPY(LM,T,ABD(LA,K),1,B(LB),1)
79      20 CONTINUE
80      RETURN
81      END

```

@HDG: * S P L I T *

@PRT,S COBRA*CFIL.SPLIT
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COBRA*CFIL(1).SPLIT

```

1  SUBROUTINE SPLIT (IG,GIN)
2  INCLUDE SPEC1,LIST
3  INCLUDE SPEC2,LIST
4  INCLUDE SPEC4,LIST
5  INCLUDE SPEC10,LIST
6  INCLUDE SPEC20,LIST
7  INCLUDE SPEC51,LIST
8  INCLUDE SPEC56,LIST
9  INCLUDE SPEC71,LIST
10 INCLUDE SPEC76,LIST
11 REAL IDTGC,LENGTH,KIJ,LENSMO,LENROU
12 C   CORRECT FLOW ESTIMATE BY ITERATION. THIS PROCEDURE ASSUMES THERE I 806200
13 C   DENSITY CHANGE WITH LENGTH AND THAT NO DIVERSION CROSSFLOW IS OCCU 806300
14 C   CONVERGENCE TOLERANCE IS E. 806400
15 E=0.005 807200
16 SAVEDT=DT 807500
17 FLO=0. 807600
18 DO 100 I=1,NCHANL 807700
19 PERIM(I)=PW(I)
20 AP(I,1)=A(I,1)
21 100 H(I,1)=HINLET(I) 808000
22 ITERAT=NARAMP
23 CALL AREA (1,1) 808100
24 ITERAT=1
25 DO 110 I=1,NCHANL 808200
26 F(I,1)=GIN*A(I,1)
27 110 FLO=FLO+F(I,1) 808400
28 IF (IG.NE.1) RETURN 808500
29 DT=1.E+10 808600
30 DO 160 K=1,200 808700
31 CALL PROP (2,1,1,1,NCHANL) 808800
32 IF (IERROR.GT.1) GO TO 170 808900
33 DO 120 I=1,NCHANL 809100
34 RHO(I,1)=1./V(I)
35 UB(I,1)=F(I,1)*V(I)/A(I,1)
36 STUW(I,2)=0. 809200
37 120 VPA(I)=V(I)/A(I,1)
38 IF (IERROR.GT.1) GO TO 170 809400
39 IF (INK.GT.0.AND.FTH.GT.0.) CALL MIX(1) 809500
40 IF (IERROR.GT.1) GO TO 170 809600
41 CALL DIFFER (3,1,1) 809700
42 IF (IERROR.GT.1) GO TO 170 809800
43 DPAVG=0. 809900
44 DO 130 I=1,NCHANL 810000
45 130 DPAVG=DPAVG+OPDX(I)*AN(I) 810100
46 DPAVG=DPAVG/ATOTAL 810200
47 J=2 810300
48 FTOT=0. 810400
49 DO 140 I=1,NCHANL 810500
50 DELTAF=(DPAVG-OPDX(I))/2./OPDX(I)*F(I,1) 810600
51 IF (FTH.GT.0.) DELTAF=DELTAF*0.5 810700
52 FSAVE=F(I,1) 810800
53 F(I,1)=F(I,1)+DELTAF 810900
54 IF (F(I,1).LT.0.) GO TO 170 811000
55 IF (ABS(F(I,1)-FSAVE)/FSAVE.GT.E) J=1 811100
56 FTOT=FTOT+F(I,1) 811200

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57	140	CONTINUE	811300
58		DO 150 I=1,NCHANL	811400
59		F(I,1)=F(I,1)*FLO/FTOT	811500
60	150	FINLET(I)=F(I,1)	811600
61		IF (J.GT.1) GO 0 180	811700
62	160	CONTINUE	811800
63	170	WRITE (I3,190) (I,F(I,J),DPDX(I),I=1,NCHANL)	811900
64		IERROR=8	812000
65	180	DT=SAVEDT	812100
66		RETURN	812200
67	C		812300
68	C		812400
69	190	FORMAT (40H FLOW SPLIT TO GIVE EQUAL DP/DX FAILED /I15,2E14.6)	813000
70		END	812600

@HDG

* Z E R O I T *

@PRT,S

COBRA*CFIL.ZEROIT

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COBRA*CFIL(1).ZEROIT

```
1      SUBROUTINE ZEROIT
2      INCLUDE SPEC1,LIST
3      INCLUDE SPEC2,LIST
4      INCLUDE SPEC3,LIST
5      INCLUDE SPEC4,LIST
6      INCLUDE SPEC5,LIST
7      INCLUDE SPEC6,LIST
8      INCLUDE SPEC7,LIST
9      INCLUDE SPEC8,LIST
10     INCLUDE SPEC9,LIST
11     INCLUDE SPEC10,LIST
12     INCLUDE SPEC11,LIST
13     INCLUDE SPEC12,LIST
14     INCLUDE SPEC13,LIST
15     INCLUDE SPEC14,LIST
16     INCLUDE SPEC15,LIST
17     INCLUDE SPEC16,LIST
18     INCLUDE SPEC17,LIST
19     INCLUDE SPEC19,LIST
20     INCLUDE SPEC20,LIST
21     INCLUDE SPEC21,LIST
22     INCLUDE SPEC22,LIST
23     INCLUDE SPEC23,LIST
24     INCLUDE SPEC24,LIST
25     INCLUDE SPEC25,LIST
26     INCLUDE SPEC26,LIST
27     C##      CLEAR ALL COMMON AREAS FROM ALL SPEC-SETS.
28     CALL ZERSET(IK(1),END1)
29     CALL ZERSET(ANGLE(1),END2)
30     CALL ZERSET(INCHANL,END3)
31     CALL ZERSET(SAVE,L(1),END4)
32     CALL ZERSET(AN(1),END5)
33     CALL ZERSET(GRIDXL(1),END6)
34     CALL ZERSET(AFACT(1,1),END7)
35     CALL ZERSET(AA(1),END8)
36     CALL ZERSET(RF(1),END9)
37     CALL ZERSET(OUTPUT(1),END10)
38     CALL ZERSET(PRINTC(1),END11)
39     CALL ZERSET(GAPN(1),END12)
40     CALL ZERSET(ABETA,END13)
41     CALL ZERSET(GAPS(1,1),END14)
42     CALL ZERSET(NSF,END15)
43     CALL ZERSET(R2(1),END16)
44     CALL ZERSET(LREFF,END17)
45     CALL ZERSET(CR(1),END18)
46     CALL ZERSET(ICONR(1),END19)
47     CALL ZERSET(PR,END20)
48     CALL ZERSET(OPRIM(1),END21)
49     CALL ZERSET(AC(1),END22)
50     CALL ZERSET(QR(1,1),END23)
51     CALL ZERSET(LAMARK(1),END24)
52     CALL ZERSET(HPW(1,1),END25)
53     CALL ZERSET(ISAVT,END26)
54     CALL ZERSET(ICOUNT,END27)
55     CALL ZERSET(FLUX(1,1),END28)
56     RETURN
```

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57

END

@HOG

* Z E R S E T *

@PRT,S

COBRA*CFIL.ZERSET

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COBRA*CFIL(1).ZERSET

```
1      SUBROUTINE ZERSET(A,/E/)
2      DIMENSION A(1)
3      LENG  = (LOCIE) - LOCIA(1))/4 + 1
4      C##    THIS IS THE ZEROIT.BVM CODING
5      C##    USED WITH THE SET MEMBER OF CLIFF'S LIBRARY-A.SCFLF231
6      C##    CALL SETZER(LENG,A)
7      C
8      DO 100 I=1,LENG
9      100    A(I) = 0.0
10     RETURN
11     END
```

@FIN

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