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AIREK-PUL
A VERSION OF THE KINETIC CODE AIREK-MOD FOR PERIODICALLY PULSED FAST REACTORS

by

A. INZAGHI and R. MISENTA

1965

Joint Nuclear Research Center
Ispra Establishment - Italy

Scientific Data Processing Center - CETIS
Reactor Physics Department

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space points and few neutron groups and for one group with an external neutron source.

The kinetic equations solved by the code AIREK-PUL are described and the listings of the three versions of the code are given in the report.

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Abstract

For kinetic calculations of a periodically pulsed fast reactor the code AIREK-MOD has been supplemented. The new code AIREK-PUL integrates the kinetic equations for a periodically pulsed reactor for two space points and few neutron groups and for one group with an external neutron source.

The kinetic equations solved by the code AIREK-PUL are described and the listings of the three versions of the code are given in the report.

Manuscript received on August 30, 1965.

Table of content

I. Introduction

II. Integration of the kinetic equations with a periodically varying reactivity and search for a stationary solution

A. Kinetic equations to be solved

B. AIREK-Transformations for the kinetic equations of the core region

C. Integration of the kinetic equations for the core region

1) General

2) Integration over several periods

3) Integration over a single pulse and use of the stationarity condition

D. Integration of the kinetic equations in the scatterer region

III. Integration of the kinetic equation with periodical variations of the reactivity and an external source

1) General

2) Division in integration intervals

IV. The code AIREK-PUL and its versions

A. General description of the versions

B. Preparation of the input data

1) General input data

2) Particular data for the versions

3) Output data

References

Appendix : Listing of AIREK-PUL with typical cases

"Two group " (for several periods)

"Few group - Two point "

"Source"

I. Introduction

The code AIREK-PUL is a version of the code AIREK-MOD [1] which has been prepared for kinetic calculations for fast reactors periodically pulsed by reactivity variations.

A design study has been made for a periodically pulsed fast reactor with a highly enriched core surrounded by a steel reflector with water scatters in the reflector [2]. For the kinetic studies of this reactor it was necessary to develop a few-neutron-group kinetic theory [3, 4] and subsequently to extend the few-energy-group model to a two-space-point-model [5]. In addition to these kinetic calculations a study has been made on the performance characteristics of a fast reactor by periodic and coincident variations of the reactivity and an external source [6]. For this kind of calculations the code AIREK-MOD has been supplemented.

The new code is called AIREK-PUL and has been used in three versions:

AIREK-PUL "Two group" (for several periods)
"Few group - Two point "
"Source"

The version AIREK-PUL "Two group" solves the kinetic equation for two neutron groups which have been described in a previous report [4] and for the delayed emitters in single or double precision. The program with the single precision integrates the kinetic equation over one reactivity pulse and varies the maximum of the multiplication factor until the obtained pulse fulfils the stationarity condition. For a fast reactor periodically pulsed by reactivity variations exists such a condition for the stationarily pulsed operation, i.e. an operation with time independent pulse amplitudes [7, 8, 9]. After stationary pulses have been obtained the program evaluates the main characteristics of the pulses, the amplitude and the half width.

The program in double precision integrates the kinetic equations for the two neutron groups and the groups of delayed emitters over several periods. In this case the stationarity is reached if the shapes of the pulses are periodical. This is seen directly by comparing the amplitude of consequent pulses.

The version AIREK-PUL "Few group - Two point " calculates and plots the shape of the neutron flux for one of the space points, the core region, in two neutron groups and for the second point, the scatter region, in three groups. For all two point calculations the stationary solution has been first searched with the version "Two group". The flux shapes in the core and scatter region have been calculated and plotted with the version "Few group - Two point " for the stationary maximum value of the multiplication factor.

The version AIREK-PUL "Source" integrates the kinetic equation over one reactivity pulse and for a neutron source which has a certain value during a small time interval of the reactivity pulse. The maximum of the multiplication factor is kept constant for these calculations but the time interval during which the source is on is varied until the stationarity condition is fulfilled. The main characteristics, amplitude and halfwidth, are evaluated from the calculated pulse shapes.

II. Integration of the kinetic equations with a periodically varying reactivity and search for a stationary solution

A. Kinetic equations to be solved

The equations which had to be solved during the course of the kinetic studies for a periodically pulsed reactor are

$$(1a)\quad \frac{dn_{1c}}{dt} = \frac{k_1(t)(1-\beta)-1}{l_{1c}}\, n_{1c}(t) + \frac{k_2(1-\beta)}{l_{2c}}\, n_{2c}(t) + \Sigma\lambda_i c_i(t) + S_o$$

$$(1b)\quad \frac{dn_{2c}(t)}{dt} = \frac{\bar{p}_{12c}}{l_{1c}}\, n_{1c}(t) - \frac{1}{l_{2c}}\, n_{2c}(t)$$

$$(1c)\quad \frac{dc_i(t)}{dt} = \beta\, f_i\, \frac{1}{l_{1c}}\, n_{1c}(t) - \lambda_i\; c_i(t)$$

$$(2a)\quad \frac{dn_{1s}(t)}{dt} = \frac{n_{1s}(t)}{n_{1c}(t)}\, \frac{dn_{1c}(t)}{dt}$$

$$(2b)\quad \frac{dn_{2s}(t)}{dt} = \bar{p}_{12s}\, \frac{n_{1s}(t)}{l_{1s}} - \frac{n_{2s}(t)}{l_{2s}}$$

$$(2c)\quad \frac{dn_{3s}(t)}{dt} = \bar{p}_{13s}\, \frac{n_{1s}(t)}{l_{1s}} + \bar{p}_{23s}\, \frac{n_{2s}(t)}{l_{2s}} - \frac{n_{3s}(t)}{l_{3s}}$$

where

- the subscripts 1, 2 and 3 indicate the first, second and third neutron group;
- the subscripts c and s indicate the core region and the scatterer region;

and

n_{jr} the neutron density in the group j and region r

l_{jr} the mean lifetime of the neutrons in the group j and region r

k_j the multiplication factor in the group j

c_i the density of the delayed emitters in the group i

β the total fraction of the delayed neutron groups

f_i the fraction of β for the group i of the delayed emitters

λ_i the decay constant for the group i of the delayed emitters

The derivations of the eq. (1) and (2) are given in two previous reports [4, 5].

The multiplication factor k_1 is a periodic function in time

$$k_1(t-T) = k_1(t)$$

and a parabolic shape during one period has been used

$$k_1(s) = k_{1m} - \alpha v^2 (s - s_o)^2 \qquad 0 \leq s \leq 2s_o \tag{3a}$$

$$k_1(s) = k_{10} \qquad 2s_o < s < T \tag{3b}$$

$$s_o = \sqrt{\frac{k_{1m} - k_{10}}{\alpha v^2}} \tag{3c}$$

where

k_{1m}, k_{10} the maximum and the minimum of the multiplication factor in the first group

α, v a constant and the velocity in the parabolic reactivity variations

B. <u>AIREK-Transformations of the kinetic equations for the core region</u>

For the numerical integration of the kinetic equations for the core region equations (1) are modified by introducing the reactivity

(4a) $$\rho_1(t) = k_1(t) - 1$$

and the relative quantitatives

(4b) $$N_{1c}(t) = \frac{n_{1c}(t)}{\bar{n}_{1c}} \; ; \; N_{2c}(t) = \frac{n_{2c}(t)}{\bar{n}_{1c}}$$

(4c) $$\xi_i(t) = \frac{c_i(t)}{\bar{n}_{1c}}$$

where $\bar{n}_{1c}$ is the neutron density in the first group of the core averaged over one period

(4d) $$\bar{n}_{1c} = \frac{1}{T}\int_0^T n_{1c}(t)dt$$

Furthermore the equation for the neutron density of the second group in the core N_{2c}, is rewritten in the same form as the equation for the delayed neutron emitters by introducing the definitions

(5a) $$\xi_{2c}(t) = N_{2c}(t)$$

(5b) $$f_{2c} = \frac{\bar{p}_{12c}}{\beta}$$

(5c) $$\lambda_{2c} = \frac{1}{l_{2c}}$$

With the definitions (5) equations (1) are rewritten

(6a) $$\frac{dN_{1c}(t)}{dt} = \frac{\rho_1(t)-\beta}{l_{1c}} N_{1c}(t) + k_2 \lambda_{2c} \xi_{2c}(t) + \sum_1^6 \lambda_i\xi_i(t) + S_o$$

(6b) $$\frac{dN_{2c}(t)}{dt} = \beta f_{2c} \frac{1}{l_{1c}} N_{1c}(t) - \lambda_{2c} N_{2c}(t)$$

(6c) $$\frac{d\xi_i}{dt} = \beta f_i \frac{1}{l_{1c}} N_{1c}(t) - \lambda_i \xi_i(t)$$

where the value β in the term with the multiplication factor k_2 has been neglected.

The equations (6) are transformed further in the usual form of the code AIREK by introducing the reactivity in dollars.

(7a) $$r_1(t) = \frac{\rho_1(t)}{\beta}$$

and transforming the quantities $\xi_j(t)$ and S_o.

(7b) $$W_j(t) = \frac{l_{1c}\ \lambda_j}{\beta f_j}\ \xi_j(t) \qquad j = 2c,\ 1,2,...6$$

(7c) $$S^* = \frac{1}{\beta}\ S_o$$

With these definitions equation (5) are obtained in the form

(8a) $$\frac{dN_{1c}(t)}{dt} = \frac{\beta}{l_{1c}} \left\{ \left[r_1(t)-1 \right] N_{1c}(t)+k_2 f_{2c} W_{2c}(t) + \sum_{i=1}^{6} f_i W_i(t)+S^* \right\}$$

(8b) $$\frac{dW_j(t)}{dt} = \lambda_j\ N_{1c}(t)-\lambda_j W_j(t) \qquad j = 2c,\ 1,2,...6$$

The kinetic equations in the form (7) are numerically integrated with the input function (3) in the form

(8c) $$\rho_1(t) = \rho_{1m} - \alpha v^2 (s-s_o)^2$$

(8d) $$\rho_1(t) = \rho_{10}$$

From the pulses which are obtained for the relative neutron densities $N_{1c}(t)$ and $N_{2c}(t)$ the main characteristics: pulse maximum N_{1m} and N_{2m} the half width of the pulses ϑ_{1c} and ϑ_{2c} are printed. For this purpose the value $W_{2c}(t)$ is retransformed to give $N_{2c}(t)$ by means of the definition (7b).

C. Integration of the kinetic equations for the core region

1. General

For the numerical solution of the kinetic equations in the form (8) the code AIREK II has been written by A. Schwartz [10]. This code uses a modified Runge-Kutta method developped by E.R. Cohen [11]. Among other modifications C. Mongini-Tamagnini introduced in the code AIREK II a periodically varying reactivity and called the modified code AIREK-MOD [1]. The code AIREK-MOD has been used as starting point for the calculations for periodically pulsed reactors. These calculations lead to the writing of a new code, called AIREK-PUL.

In the code AIREK II and AIREK-MOD the integration interval can be given as input data or an adjustment by the code can be chosen. In the first case the integration interval is kept constant during the calculation. In the second case the slope of the flux is calculated and the integration interval is chosen by the code accordingly. In a periodically pulsed fast reactor e.g. Ref. [2] the multiplication factor is constant and smaller than 1 for the largest part of the period but is raised above the prompt critical value during the remaining fraction of the period. In a typical case the period is 10^{-2} sec and the time interval during which the multiplication factor is above the prompt critical value is about 10^{-4} sec. Due to the above prompt critical value of the multiplication factor the flux can increase in this short time interval by a factor of 500 to 1000, depending on the kinetic parameters. Due to this steep slope of the flux the self-adjusting of the integration interval is not efficient. In the time interval where the multiplication factor is constant and below 1 the flux changes very slowly.

Because of these difficulties the code AIREK-MOD has been modified to integrate with two appropriately chosen integration intervals: the first during the reactivity pulse, the second during the remaining time interval and exchanging them automatically at the end of the pulses.

2. Integration over several periods

For the integration of the kinetic equations (8) over several periods the introduction of two different integration intervals was not sufficient because of the small intervals and the large number needed for the integration. Generally the number of integration steps during the pulses was chosen to be 1000 and in the remaining interval to be 100. This choice give for typical cases an integration interval of about 4×10^{-7} sec. during the pulse and for the remaining part of the period an interval of 10^{-4} sec. By operating the program in single precision the error caused by the conversion of the input data accumulates and assumes already after very few pulses magnitudes of the integration interval used during the pulse. Consequently the point in which a change of the integration intervals occurs, shifted, and it was not possible to obtain a stationary solution.

Because of these difficulties the program had to be operated completely in double precision for the integration over several periods. In this way the system (8) has been solved satisfactorily over 10 periods and it is possible to integrate even over a larger number.

3. Integration over a single pulse and use of the stationarity condition

Over a single pulse the kinetic equations for the neutron density in the two group are either integrated with or without the kinetic equations for the density of the delayed emitters.

In the first case the kinetic equations are integrated in the form (8) by setting the source term S* equal to zero. In the second case the time behaviour of the delayed neutron emitters during the pulse is neglected and only the two equations for the neutron density are integrated.

(9a) $$\frac{dN_{1c}(t)}{dt} = \frac{\beta}{l_{1c}} \left\{ \left[r_1(t)-1 \right] N_{1c}(t)+k_2 f_{2c} W_{2c}(t)+\sum_{i=1}^{6} f_i \bar{W}_{io}(t) \right\}$$

(9b) $$\frac{dW_{2c}(t)}{dt} = \lambda_{2c} \left[N_{1c}(t)-W_{2c}(t) \right]$$

where $\bar{W}_{io}$ is constant during the pulse and corresponds to the mean value of the density of delayed neutron emitters in the steady state. This density is obtained from eq. (1c) by introducing the average density of delayed neutron emitters

$$\bar{c}_i(t) = \frac{1}{T} \int_{t-T}^{t} c_i(s)\, ds$$

and setting the time derivative equal to zero

$$\Sigma\, \lambda_i\, \bar{c}_{io} = \beta \frac{1}{l_{c1}} \bar{n}_1$$

By performing the transformations (4c) and (7b) the value of $\Sigma\, f_i\, \bar{W}_{io}$ is obtained.

The pulse integral Mβ or I which is defined by the integration of the relative neutron density in the first group over the duration of the reactivity wave, depends if all other parameters are determined on the maximum value of the multiplication factor

(10a) $$I(k_{1m}) = \int_{o}^{2t_o} N_1(k_{1m}, t)dt$$

For a stationarily pulsed operation this integral must have a certain value I_o which is given by the stationarity condition [7, 8, 9]. The value of the multiplication factor k_{1mO} which fulfils the condition

(10b) $$I(k_{1mO}) = I_o$$

gives pulses with time independent amplitudes.

The code has been provided for varying the maximum of the multiplication factor k_1 until the function

(10c) $$F_\Delta = I(k_{1m}) - I_o$$

is zero.

D. Integration of the kinetic equation in the scatterer region

The version "Two points" is written to solve the kinetic equations in the two regions in order to obtain the pulse shapes in the scatterer region for three energy groups. Eq. (1) are integrated in the form (8). For the integration of eq.(2) the solution which is obtained by variation of the constant is used

(11a) $$N_{1s}(t) = \frac{N_{1sO}}{N1cO} N_{1c}(t)$$

(11b) $$N_{2s}(t) = b_{12s}\, e^{-t/l_{2s}} \int_{o}^{t} N_{1s}(t)\; e^{t'/l_{1s}}\, dt' + N_{2sO}\; e^{-t/l_{2s}}$$

(11c) $$N_{3s}(t) = e^{-t/l_{3s}} \int_{o}^{t} e^{t'/l_{3s}} \left[b_{13s} N_{1s}(t') + b_{23s} N_{2s}(t') \right] dt' + N_{3sO}\; e^{-t/l_{3s}}$$

where $$N_{js} = \frac{n_{js}(t)}{n_1}$$

and (11d) $$b_{kjs} = \frac{\bar{p}_{kjs}}{l_{ks}}$$

The numerical calculations of the integrals (11) has been added to the program "Two group". In order to obtain the pulse shapes in the scatterer region for the stationary state the equations (8) and (11) are solved for the value k_{1m0} which has been obtained for the stationary state by means of the version "Two group".

III. Integration of the kinetic equation with periodical variation of the reactivity and an external source

1. General

The kinetic equation to be solved is

$$(12) \qquad \frac{dn(t)}{dt} = \frac{k(t)(1-\beta)-1}{l} n(t) + \Sigma \lambda_i c_i(t) + S(t)$$

with a periodic variation of the multiplication factor k(t) and the neutron source density S(t) due to an external source.

$$k(t-T) = k(t) \qquad S(t-T) = S(t)$$

During one period T the multiplication factor has the shape given by relations (3). The neutron source density S(t) is a rectangular function which is zero except in a time interval Δt_A. In this time interval the source function has the constant value S_o.

The position of the time interval Δt_A with reference to the maximum of the reactivity can be chosen in two ways:

- the time interval Δt_A is symmetric to the maximum value of the reactivity
- the end of the time interval coincidences with a value k of the multiplication factor, which can be chosen freely.

In order to study the characteristics of a fast reactor pulsed by coincident periodical variations of the reactivity and an external source the kinetic equation is integrated over one pulse and the stationarity condition is used, as in the case of a reactor periodical pulsed by reactivity variation only.

The maximum multiplication factor k_m is kept constant. In order to achieve stationarity the time interval during which the source is on is varied until the pulse integral has the stationary value.

With the relative neutron density and the mean density of the delayed emitters in the stationary state eq. (12) is rewritten

$$\text{(13a)} \qquad \frac{dN(t)}{dt} = \frac{k(t)(1-\beta)-1}{l} N(t) + \frac{\beta}{l}\left[1 + R(t)\right]$$

with

$$\text{(13b)} \qquad R(t) = \frac{S(t)}{\Sigma \lambda_i c_{io}}$$

and $\qquad \Sigma \lambda_i \bar{c}_{io} = \frac{\beta}{l} \bar{n}$

The ratios R(t) is the source density ratio and has the same form as the source density S(t).

Further details on the kinetic equation for a reactor periodically pulsed by coincident variations of the reactivity and an external source are given in another report [6].

Eq. (13a) is integrated numerically with the corresponding functions for the multiplication factor and the source density ratio. The source at time Δt_A is varied until the pulse integral

$$I(\Delta t_A) = \int_o^{2t_o} N(\Delta t_A, t)dt$$

has the value

$$I(\Delta t_{Ao}) = I_o$$

which is given by the stationarity condition.

2. Division in integration intervals

Due to the steepnes of the resulting neutron pulses different width of the integration intervals have been used. The width of the integration intervals are compiled in Table 1 together with the corresponding time intervals and values of the source strength. The time t_1 is given by the relation

$$t_1 = t_o + \sqrt{\frac{k_m - k}{\alpha v^2}} \tag{14}$$

Table 1 The width of the integration intervals and values of the source used in the numerical integration procedures.

A) Accelerator-on-time symmetric to maximum of the reactivity

time interval	value of the source	width of the integration interval
$0 < t \leq t_o - \frac{\Delta t_A}{2}$	σ	$h_1 = \frac{1}{500}\left(t_o - \frac{\Delta t_A}{2}\right)$
$t_o - \frac{\Delta t_A}{2} < t \leq t_o + \frac{\Delta t_A}{2}$	S_o	$h_2 = \frac{h_1}{100}$
$t_o + \frac{\Delta t_A}{2} < t \leq 2t_o$	σ	$h_3 = h_1$

B) End of the accelerator-on-time coincident with a value k of the multiplication factor

time interval	value of the source	width of the integration interval
$\sigma < t < t_o - \Delta t_A$	σ	$h_1 = \frac{1}{700}(t_1 - \Delta t_A)$
$t_1 - \Delta t_A < t < t_1$	S_o	$h_2 = \frac{\Delta t_A}{100}$
$t_1 < t < t = t_1 + 40\ h_2$	σ	$h_3 = \frac{h_1}{5}$
$t_1 + 40\ h_2 < t < 2t_o$	σ	$h_4 = h_1$

IV. The code AIREK-PUL and its versions

A. General description of the versions

The code AIREK-PUL has three versions

"Two group" (for several pulses)
"Few group - Two point"
"Source"

The version "Two group" integrates the kinetic equations for the neutron groups and for the delayed emitters, Eq. (8) in double precision over one or more periods.

The version "Few group - Two point" integrates the two group kinetic equations for one region with or without the equations for the delayed emitters Eq. (8) over one reactivity pulse and varies the maximum value of the multiplication factor until the obtained pulse fulfils the stationarity condition. With the stationary solution for the one region as input the kinetic equations for the scatterer region Eq. (11) are solved.

The version "Source" solves the one-group kinetic equation with an external neutron source in the form of Eq. (13) and varies the on-time of the external source until a stationary value is achieved.

B. Preparation of the input data

1. General input data

For all three versions "General data" are necessary. Up to 500 memory positions are reserved for input of "General data", which are labelled Data (1), Data (2),..., Data (500). Since entire groups of successive data may be zero, the input is such that it is possible to read only sets of significant data. Each set of successive significant data (Data k_1), Data (K_i+1),...., Data (k_2) must be preceded by the integers k_1 and k_2 defining the number of the decimal Data to be read. It is to be noticed that the k_2 , the last integer which appears in the input sheets, must be preceded by the minus sign. A zero data contained in a set to be read may be left blank. Many cases can be run sequentially.

Description of the General Input Data

Data (1) = Total number of the differential equations to be solved.

Data (2) = Total number of the delayed neutron groups.

Data (4) = (Used only for "Version Source").

Data (5) =
- +1.0 The subroutine RANAL will be used. The expression for the reactivity in the RANAL is relative to dollars unities.
- -1.0 The subroutine RANAL will be used. The expression for the reactivity in the RANAL is relative to pure numbers.

Data (6) = k_2

Data (7) = 0

Data (8) = Integration step during pulse (half period).

Data (13) = Total fraction of delayed neutrons.

Data (14) = Neutron lifetime.

Data (15) = Constant source term.

Data (18) = +1

Data (19) ... Data (68) = This space of memory is reserved for the initial conditions: N(0), W_i(0), T_m(0) are to be introduced in order. (If inhour is used the W_i(0) will be calculated by the code itself).

Data (69) ... Data (93) = Insert in order the f_i the fraction of each delayed neutron group.

Data (94) ... Data (142)= Insert in order the P_n coefficients.

Data (143) = Number of "half-periods"

Data (144) ... Data (192) = Insert in order the U_n coefficients.

Data (193) = $\leqslant$ 0 start with the pulse / > 0 start with $\rho(t) = \rho(0)$

Data (194) ... Data (242) = Insert in order the Y_n coefficients.

Data (243) = Integration step during the second "half period"

Data (244) = r(0) or $\rho(0)$ depending on the sign of Data (5).
(Data (244) is used in RANAL)

Data (245) = Interval of integration for a "half period". It is correspondent to Data (243).

Data (246) ... Data (261) = Are the coefficients A_1, A_2, ... Ω, Ω^*, y in the following expression for the analitycal function.

$$\text{Data }(244) + A_1 + A_2 t + A_3 t^2 + A_4 t^3 + $$
$$+ A_5 \sin \Omega t + A_6 \sin 2\Omega t + A_7 \sin 3\Omega t$$
$$+ A_8 \cos \Omega^* t + A_9 \cos 2\Omega^* t + A_{10} \cos 3\Omega^* t +$$
$$+ A_{11} e^{yt} + A_{12} e^{2yt} + A_{13} e^{3yt}$$

Data (262) = Interval of integration for pulse. It is correspondent to Data (8).

Data (263) ... Data (310) = In these data must be given the coefficients appearing in the following expression for the feedback terms in reactivity: $a_1 T_1 + a_2 T_2 + \ldots$
This expression is used both in RANAL and in the RTABL.

Data (498) = 0. Normal integration method. / $\neq$ 0. A longer but better integration method is used.

Data (500) = N = indicator for printing. It is necessary for printing the output every N steps.

2. Particular input data for the versions

a) Input for "Two group" (more periods)

No particular data for this version

b) Input for "Few group - Two point"

K_{m0}	initial multiplication factor	
D	increment (is done always + D)	
IO	stationarity condition	
EP	precision	
HHH	indicator for calculation of "Two-point"	
ETA10	initial condition for neutron density	are not read if HHH = 0
ETA20	" " " " "	
ETA30	" " " " "	
B1 B2	fractions defined by equation (11d)	
EL2	lifetime in the second group of the scatterer region	
EL3	lifetime in the third group of the scatterer region	
AA BB A1 A2 A3	factors for the conversion of the relative neutron densities N_{1c}, N_{2c} N_{1s}, N_{2s}, N_{3s} into fluxes.	
PRINT	indicator. If zero ; no tabulation Fluxes	

c) Input for "Source"

DATA (4)	k_m
ΔTA_o	initial value
Δ	increment (is done always + Δ)
IO	stationarity condition

EP	precision	
R_o	constant source	
ALQ	αv^2	
KA	....	(If KA $= 0$ symmetric calculation; $\neq 0$ unsymmetric calculation)

3. Output data [(*), (**)]

a) Version "Two-group" (more periods)

1) Input data
2) For every N time steps are printed:
   Reactivity
   Average inverse period
   Neutron flux
   Delayed neutron groups
   Feedback variables
3) For each pulse are printed:
   Maximum reactivity
   Maximum flux
   Interval of time corresponding to the half-maximum flux.

b) Version "Few group - Two point"

1) Input data
2) Iterations
3) KM (I) good

(*) In addition to the described output data it is possible to plot the solutions as function of time by use of the "Calcomp" [12] Curves plotted with the program are given in Ref. [4] and [5]. The program for plotting has not been included in the listing but it can be obtained on request.

(**) Running time for typical cases (IBM 7090)
a) "Two group" (ten periods). About 50 minutes.
b) "Few group and two point". About 5 minutes.
c) "Source". About 2 minutes.

4) Data for "Two point" calculation
5) Characteristics core and scatterer in the order maximum neutron density and time.
   NMAX/NO , FMAX , TETA are also printed.
6) Data for Fi(j)

c) Version "Source"

1) Input data
2) Iterations
3) ΔTA (I) good.
4) Characteristics for "SYMMETRIC" or "UNSYMMETRIC"

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```
C                                   AIREK-PUL TWO GROUP  (VERSION FOR SEVERAL PULSES)

*      LABEL
CMAIN
D      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
      X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50),IERR(1)
D      DIMENSION HH(100),AM(100),MM(100),BM(100)
D      DIMENSION SFW(1)
D      DIMENSION XX(1100),YY(1100),ZZ(1100)
       COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
      X,ALPHN,JC,J7,JN,INZ,J6,DELTA
       COMMON RS,KRK
       WRITE OUTPUT TAPE 6,4
     4 FORMAT (1H1/////24H INPUT DATA     I,DATA(I)///)
     1 READ INPUT TAPE 5,2,K1,K2,(DATA(I),I=K1,K2)
       WRITE OUTPUT TAPE 6,3,(I,DATA(I),I=K1,K2)
     3 FORMAT (5(I6,E14.6))
     2 FORMAT(2I12/(6E12.8))
       IF(K2) 10,10,1
    10 J1=DATA(1)+0.002
       J2=DATA(2)+1.002
       J3=ABSF(DATA(3))
       J4=ABSF(DATA(4))
D      AXA=DATA(8)*0.5
D      RS=0.
       KK=DATA(500)+0.0002
       KM=KK
       N=DATA(143)+0.0002
       NN=N-1
       IF(DATA(193))800,800,900
   800 DO 700 I=1,NN,2
D      AM(I)=DATA(262)
D  700 HH(I)=DATA(8)
       DO 701 I=2,N,2
D      AM(I)=DATA(245)
D  701 HH(I)=DATA(243)
D      X(1)=HH(1)
       KRK=0
       GO TO 901
   900 DO 600 I=1,NN,2
D      AM(I)=DATA(245)
D  600 HH(I)=DATA(243)
       DO 601 I=2,N,2
D      AM(I)=DATA(262)
D  601 HH(I)=DATA(8)
D      X(1)=HH(1)
       KRK=1
   901 CONTINUE
       JK=1
       JJJ=1
D      ACC=AM(JJJ)
    14 IF(DATA(7))15,20,15
    15 CALL INHOUR
    20 DO 25 I=1,J1
D      ANS(I)=DATA(I+18)
D   25 TVB(I)=ANS(I)
       INZ=0
       J7=0
       JN=0
D      TIME(1)=0.0
D      TIME(2)=0.0
       IF(ABSF(DATA(5))-1.0)30,30,35
```

```
   30 CALL RANAL
      GO TO 40
   35 CALL RTABL
D  40 REAC(1)=REAC(2)
D     SFW=0.0
      JJ3=J2-1
      DO 45 I=2,JJ3
D  45 SFW=SFW+DATA(I+67)*ANS(I)
D     SFW=SFW+DATA(J2+67)*ANS(J2)*DATA(6)
D     OMEGA(1)=DATA(13)/DATA(14)*((REAC(1)-1.0)+(SFW+DATA(15))/ANS(1))
      WRITE OUTPUT TAPE 6,50,(DATA(I+92),DATA(I+142),DATA(I+192),I=2,J1)
   50 FORMAT(1H0,44H   INPUT COEFFICIENTS FOR FEEDBACK EQUATIONS/(3E16.8
     X))
      WRITE OUTPUT TAPE 6,60,(DATA(I),I=13,15),SFW
   60 FORMAT(1H0,61H BETA EFFECTIVE NEUTRON LIFETIME   SOURCE TERM     S
     XUM  FI*WI/(4E16.8))
      WRITE OUTPUT TAPE 6,703
  703 FORMAT (1H1)
      WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(1),ANS(1)
   65 FORMAT(1H0,62H  TIME IN SEC.      REACTIVITY   AVG.INVERSE PER.  NE
     XUTRON FLUX/(4E16.8))
      WRITE OUTPUT TAPE 6,70,(ANS(I),I=2,J1)
   70 FORMAT(1H0,59H  DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(
     X1 TO K)/(6E16.8))
   74 CALL INTER
D     WKW=ANS(8)*DATA(13)*DATA(75)/(DATA(100)*DATA(14))
      IF(JN) 1,22,1
   22 IF(DATA(499)) 23,251,23
   23 CALL CUSPR
      GO TO 27
  251 CONTINUE
   27 GO TO 254
  254 IF((TIME(1)+AXA)-ACC)302,301,301
D 301 X(1)=HH(JJJ+1)
      JJJ=JJJ+1
D     ACC=AM(JJJ)+ACC
      JK=1
      KM=KK
      IF(DATA(193))401,401,402
  401 CONTINUE
      CALL REMAX(XX,YY,ZZ,IP)
D     DATA(193)=1.
D     RS=RS+1.
      GO TO 400
D 402 DATA(193)=0.
  400 CONTINUE
      WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(2),ANS(1)
      WRITE OUTPUT TAPE 6,70,(ANS(I),I=2,J1)
      KTT=JJJ-1
      WRITE OUTPUT TAPE 6,1111,KTT
 1111 FORMAT (1H0,50X,6HINDIC=I6////)
      GO TO 300
  302 CONTINUE
      IF(DATA(193))333,111,333
D 111 XX(JK)=TIME(1)
D     YY(JK)=ANS(1)
D     ZZ(JK)=REAC(1)
  333 CONTINUE
      IF(JK-KM)991,990,991
  990 WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(2),ANS(1)
      WRITE OUTPUT TAPE 6,70,(ANS(I),I=2,J1)
      KM=KM+KK
  991 JK=JK+1
      IP=JK
  300 CONTINUE
```

```
      IF(JJJ-N)74,74,1
      END

*     LABEL
CRNFBT
      SUBROUTINE RNFBT
D     DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
     1CAPR(200),ALPHN(50),CAPC(150)
D     DIMENSION SFW(1)
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     1,ALPHN,JC,J7,JN
D     SFW=0.0
      JJ3=J2-1
      DO 1150 I=2,JJ3
D1150 SFW=SFW+DATA(I+67)*TVB(I)
D     SFW=SFW+DATA(J2+67)*TVB(J2)*DATA(6)
D     CAPR(JR)=((REAC(2)-REAC(1))*TVB(1)+SFW+DATA(15))*DATA(13)/DATA(14)
      IF(DATA(18))3,3,2
    2 DO 4 I=2,J1
      JR=JR+4
D   4 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+142)*DATA(19)
      GO TO 6
    3 J1=J1-6
      DO 1153 I=2,J1
      JR=JR+4
D1153 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+142)*DATA(19)
D     SLB1=0.0
      DO 8476 I=1,5
      J1AI=J1+I+1
D8476 SLB1=SLB1+DATA(I+318)*TVB(J1AI)
D     DATA(492)=SLB1
D     SLB2=DATA(324)*TVB(J1+1)
      DO 8477 I=1,4
      J1BI=J1+I+2
D8477 SLB2=SLB2+DATA(I+324)*TVB(J1BI)
D     DATA(493)=SLB2
D     SLB3=0.0
      DO 8478 I=1,2
      J1CI=J1+I
D8478 SLB3=SLB3+DATA(I+328)*TVB(J1CI)
      DO 8479 I=1,3
      J1DI=J1+I+3
D8479 SLB3=SLB3+DATA(I+320)*TVB(J1DI)
D     DATA(494)=SLB3
D     SLB4=0.0
      DO 8480 I=1,3
      J1EI=J1+I
D8480 SLB4=SLB4+DATA(I+333)*TVB(J1EI)
      DO 8481 I=1,2
      J1FI=J1+I+4
D8481 SLB4=SLB4+DATA(I+336)*TVB(J1FI)
D     DATA(495)=SLB4
D     SLB5=0.0
      DO 8482 I=1,4
      J1GI=J1+I
D8482 SLB5=SLB5+DATA(I+338)*TVB(J1GI)
D     SLB5=SLB5+DATA(I+343)*TVB(J1+6)
D     DATA(496)=SLB5
D     SLB6=0.0
      DO 8483 I=1,5
      J1HI=J1+I
D8483 SLB6=SLB6+DATA(I+343)*TVB(J1HI)
D     DATA(497)=SLB6
      J1T=J1+1
```

```
      J1=J1+6
      DO 8484 I=J1T,J1
      JR=JR+4
      LLL=I+13-J1+484
D8484 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+ 142)*DATA(19)+DATA(LLL)
    6 RETURN
      END

*     LABEL
CINTER
      SUBROUTINE INTER
D     DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50)
D     DIMENSION SFW(1)
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN,INZ,J6,DELTA
   75 JR=1
      IF(ABSF(DATA(5))-1.0)80,80,85
   80 CALL RANAL
      GO TO 90
   85 CALL RTABL
   90 CALL RNFBT
D     X(2)=X(1)/2.0
D     ALPHN(1)=(REAC(1)-1.0)*X(2)*DATA(13)/DATA(14)
      DO 95 I=2,J1
D  95 ALPHN(I)=X(2)*DATA(I+192)
      CALL CNFBT
      IF(JN) 96,97,96
   96 CALL DIREC
      IF(JN) 256,75,256
   97 JR=1
      JT=0
      JC=1
      DO 105 I=1,J1
D     DELTA(I)=((ALPHN(I)*ANS(I))+(CAPR(JR)*X(2)))*CAPC(JC)
      JR=JR+4
      JC=JC+3
      IF(DELTA(I)-(2.0**(-14))*ANS(I)) 105,100,100
  100 JT=0
D 105 TVB(I)=ANS(I)+DELTA(I)
      JR=2
D     TIME(2)=TIME(1)+X(2)
      IF(ABSF(DATA(5))-1.)110,110,115
  110 CALL RANAL
      GO TO 120
  115 CALL RTABL
  120 CALL RNFBT
      JR=1
      JC=1
      DO 125 I=1,J1
D     DELTA(I)=DELTA(I)+(X(2)*CAPC(JC+1)*(CAPR(JR+1)-CAPR(JR)))
      JR=JR+4
      JC=JC+3
D 125 TVB(I)=ANS(I)+DELTA(I)
      JR=3
      IF(ABSF(DATA(5))-1.)130,130,135
  130 CALL RANAL
      GO TO 140
  135 CALL RTABL
  140 CALL RNFBT
      DO 150 I=1,J1
D 150 ALPHN(I)=X(1)*ALPHN(I)/X(2)
      CALL CNFBT
      IF(JN) 151,152,151
```

```
  151 CALL DIREC
      IF (JN) 256,75,256
  152 JR=1
      JC=1
      DO 160 I=1,J1
D     DELTA(I)=2.0*X(1)*CAPC(JC+1)*(CAPR(JR+2)-CAPR(JR))+CAPC(JC)*(X(1)*
     XCAPR(JR)+ALPHN(I)*ANS(I))
D     TVB(I)=DELTA(I)+ANS(I)
      JC=JC+3
  160 JR=JR+4
D     TIME(2)=TIME(1)+X(1)
      IF (DATA(498)) 161,164,161
  161 JR=4
      IF(ABSF(DATA(5))-1.)162,162,163
  162 CALL RANAL
      GO TO 166
  163 CALL RTABL
  166 CALL RNFBT
      JR=1
      JC=1
      DO 168 I=1,J1
D     DELTA(I)=DELTA(I)+X(1)*(CAPR(JR+3)-2.0*CAPR(JR+2)+CAPR(JR))*(2.0*C
     XAPC(JC+2)-CAPC(JC+1))
      JR=JR+4
      JC=JC+3
D 168 TVB(I)=DELTA(I)+ANS(I)
  164 CONTINUE
      IF(ABSF(DATA(5))-1.)165,165,170
  165 CALL RANAL
      GO TO 175
  170 CALL RTABL
  175 CALL RNFBT
D     OMEGA(3)=DATA(13)/DATA(14)*((REAC(2)-1.0)+(SFW+DATA(15))/TVB(1))
      IF(TVB(1)/ANS(1)) 180,180,190
 180  JN=1
      CALL DIREC
      GO TO 256
D 190 OMEGA(2)= (LOG F(TVB(1)/ANS(1)))/X(1)
      IF(JT) 191,250,191
  191 IF(DATA(6)) 200,200,195
  195 IF(J6) 200,200,250
D 200 Q=X(1)*ABSF(OMEGA(3)-2.0*OMEGA(2)+OMEGA(1))*CAPC(2)/(CAPC(1)+1.0)
      IF(DATA(16)) 205,230,205
  205 IF(DATA(16)-OMEGA(3)) 230,210,210
  210 IF(ABSF(DATA(15)/TVB(1)+REAC(2))-DATA(17)) 230,230,215
  215 IF(INZ) 225,220,225
  220 INZ=1
D     X(2)=DATA(9)
      GO TO 245
  225 IF(ABSF(OMEGA(3))-DATA(16)) 250,230,230
  230 IF(Q-DATA(11)) 235,250,245
  235 IF(Q-DATA(12)) 240,250,250
D 240 X(1)=2.0*X(1)
      GO TO 250
  245 CALL DIREC
      IF (JN) 256,75,256
D 250 TIME(1)=TIME(2)
D     OMEGA(1)=OMEGA(3)
D     REAC(1)=REAC(2)
      DO 255 I=1,J1
D 255 ANS(I)=TVB(I)
  256 RETURN
      END
```

```
*       LABEL
CRFMAX
        SUBROUTINE RFMAX(XX,YY,ZZ,IP)
D       DIMENSION XX(1100),YY(1100),ZZ(1100)
        DO 30 I =2,IP
        IF (ZZ(I))30,60,60
     60 IF(ZZ(I)-ZZ(I-1))31,30,30
D    31 A=ZZ(I-1)
D       T=XX(I-1)
        WRITE OUTPUT TAPE 6,32,A,T
     32 FORMAT (1H0,10X,10HMAX REAC =E16.8,5X,6HTIME =E16.8)
        GO TO 33
     30 CONTINUE
     33 CONTINUE
        DO 1 I =200,IP
        IF(YY(I)-YY(I-1))2,1,1
D     2 A=YY(I-1)
D       T=XX(I-1)
        WRITE OUTPUT TAPE 6,4,A,T
      4 FORMAT (1H0,10X,10HMAX FLUX =E16.8,5X,6HTIME =E16.8)
        GO TO 6
      1 CONTINUE
      6 CONTINUE
D       S=A*0.5
        DO 3 I =1,IP
        IF(YY(I)-S)3,5,5
D     5 A=YY(I)
D       T=XX(I)
D       TT=T
        J=I
        GO TO 8
      3 CONTINUE
      8 CONTINUE
        DO 9 K =J,IP
        IF(YY(K)-S)10,9,9
D    10 A=YY(K-1)
D       T=XX(K-1)
        GO TO 11
      9 CONTINUE
     11 CONTINUE
D       DT=T-TT
D       Q=(XX(2)-XX(1))*0.5
D       RQ=0.
        DO 40 K =2,IP
D    40 RQ=RQ+(YY(K)+YY(K-1))*Q
        WRITE OUTPUT TAPE 6,20,DT,RQ
     20 FORMAT(1H0,10X,4HDT =E16.8,5X,7HI IMP =E16.8)
        RETURN
        END

*       LABEL
CCNFBT
        SUBROUTINE CNFBT
D       DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
       XCAPR(200),ALPHN(50),CAPC(150)
D       DIMENSION SFW(1)
        COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
       X,ALPHN,JC,J7,JN
        JC=1
        DO 1170 I=1,J1
        IF(ABSF(ALPHN(I))-1.0) 1155,1165,1160
D1155   CD=10.0
D       CN=1.0
        DO 1157 L=1,7
```

```
D      CN=CN/CD*ALPHN(I)+1.0
D1157  CD=CD-1.0
D      CAPC(JC+2)=CN/3.0
D      CAPC(JC+1)=(CAPC(JC+2)*ALPHN(I)+1.0)/2.0
D      CAPC(JC)=CAPC(JC+1)*ALPHN(I)+1.0
       GO TO 1170
 1160  IF(ABSF(ALPHN(I))-88.0) 1165,1165,1161
 1161  IF(ALPHN(I)) 1162,1162,1180
D1162  CAPC(JC)=-1.0/ALPHN(I)
       GO TO 1166
D1165  CAPC(JC)=(EXPF(ALPHN(I))-1.0)/ALPHN(I)
D1166  CAPC(JC+1)=(CAPC(JC)-1.0)/ALPHN(I)
D      CAPC(JC+2)=(2.0*CAPC(JC+1)-1.0)/ALPHN(I)
 1170  JC=JC+3
 1171  RETURN
 1180  JN=-1
       GO TO 1171
       END

*      LABEL
CDIREC
       SUBROUTINE DIREC
D      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
      X,CAPR(200),ALPHN(50),CAPC(150)
D      DIMENSION SFW(1)
       COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
      X,ALPHN,JC,J7,JN
       IF(JN) 1184,1184,2025
 1184  IF(X(2)-DATA(9)) 1185,1190,1190
 1185  IF(X(1)-DATA(9)) 2000,2000,1190
D1190  X(1)=X(2)
D1191  TIME(2)=TIME(1)
D      REAC(2)=REAC(1)
       DO 1195 I=1,J1
D1195  TVB(I)=ANS(I)
       JN=0
       GO TO 2035
 2000  IF(JN) 2005,2015,2025
 2005  WRITE OUTPUT TAPE 6,2010,X(1),(ALPHN(I),I=1,J1)
 2010  FORMAT(1H0,81H  INTERVAL AND F(ALPHA)AT TIME OF FAILURE DUE TO EXC
      XEEDING EXPONENTIAL SUBROUTINE/(6E16.8))
       GO TO 2035
 2015  WRITE OUTPUT TAPE 6,2020,X(1)
 2020  FORMAT(1H0,66H  FAILURE DUE TO ATTEMPTING TO REDUCE INTERVAL BELOW
      X MINIMUM VALUE/(1E16.8))
       JN=1
       GO TO 2035
 2025  WRITE OUTPUT TAPE 6,2030,TVB(1),ANS(1)
 2030  FORMAT(1H0,50H  FAILURE DUE TO RATIO OF N(1)/N(0) IN LOG ROUTINE/(
      X2E16.8))
 2035  RETURN
       END

*      LABEL
CINHOUR
       SUBROUTINE INHOUR
D      DIMENSION DATA(500),REAC(2)
       COMMON  DATA.REAC,J1,J2,J3,J4
D      TEMP1=0.0
       DO 1000 I=2,J2
D      TEMP2  =DATA(7)-DATA(I+192)
D      DATA(I+18)=-DATA(I+192)*DATA(19)/TEMP2
D1000  TEMP1  =TEMP1  +DATA(I+67)/TEMP2
```

EURATOM - CETIS

GENERAL DATA INPUT

K_1	K_2					
DATA(K_1)	DATA(K_1+1)	DATA(K_1+2)	- - - -	- - - -		
	- - -	- - -	- - -	DATA(K_2)		

SET-1

⋮

K_1	K_2					
DATA(K_1)	DATA(K_1+1)		- - -	- - -	DATA(K_1+5)	
			DATA(K_2)			

SET-N

PARTICULAR DATA INPUT FOR =FEW GROUPS - TWO POINTS=

Km_0	D	io	EP	
HHH				
ETA10	ETA20	ETA30		
B1	B2	EL2	EL3	
AA	BB	A1	A2	A3
PRINT				

PARTICULAR DATA INPUT FOR -SOURCE-

ATA_0	D	io	EP	R_0	ALQ
KA					

NB: NO PARTICULAR DATA INPUT FOR =TWO GROUPS (SEVERAL PERIODS)=

EURATOM - CETIS

INPUT TYPICAL CASE FOR - TWO GROUPS (MORE PERIODS) -

	1–9	10–13	14–21	22–25	26–32	33–37	38–49	50–61	62–69	70–80
1		1		26						
2	8.		7.		0.		0.	-1.	1.	
3	0.		.43886	-06	0.		0.	0.	0.	
4	.0164		-2	-07	0.		0.	0.	1.	
5	.205		1.		1.		1.	1.	1.	
6	1.		1.							
7		69		75						
8	.01483		.08311		.07335		.15884	.04994	.01012	
9	.60975									
10		94		100						
11	.0127		.0317		.115		311	1.4	3.87	
12	.1	+07								
13		143		143						
14	20.									
15		193		193						
16	0.									
17		194		200						
18	-.0127		-.0317		-.115		-.311	-1.4	-3.87	
19	-.1	+07								
20		243		248						
21	.956114	-04	-.0256		.956114	-02	0.	302.889	-.69017	+06
22		262		262						
23	.43886	-03								
24		497		-500						
25	0.		1.		0.		2000.			

```
D       REAC(1)=(TEMP1   +(DATA(14)/DATA(13)))*DATA(7)
        IF(DATA(5)) 1005,1005,1010
D1005   REAC(1)=REAC(1)*DATA(13)
 1010   IF(DATA(5)-1.0)   1015,1015,1020
D1015   DATA(244)=REAC(1)
D1020   DATA(349)=REAC(1)
        RETURN
        END

*       LABEL
CCUSPR
        SUBROUTINE CUSPR
D       DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
       XCAPR(200),ALPHN(50),CAPC(150),DELTA(50)
D       DIMENSION SFW(1)
        COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
       X,ALPHN,JC,J7,JN,INZ,J6,DELTA
        WRITE OUTPUT TAPE 6,3000,ANS(1)
 3000   FORMAT(1H0,10HDUMMY ANSW/(1E12.8))
        RETURN
        END

*       LABEL
CRANAL
        SUBROUTINE RANAL
D       DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
       X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50),IERR(1)
D       DIMENSION SFW(1)
        COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
       X,ALPHN,JC,J7,JN,INZ,J6,DELTA
        COMMON RS,KRK
        IF(KRK)5,5,6
      5 CONTINUE
        IF(DATA(193))3,3,4
D     4 REAC(2)=DATA(244)+DATA(246)
        GO TO 9
      3 CONTINUE
D       TACT=TIME(2)-(DATA(245)+DATA(262))*RS
D       REAC(2)=DATA(244)+DATA(246)+DATA(247)*TACT    +DATA(248)*(TACT    **
       12)+DATA(249)*(TACT    **3)+DATA(250)*SINF(DATA(259)*TACT    )+DATA(2
       251)*SINF(DATA(259)*TACT    *2.)+DATA(252)*SINF(DATA(259)*TACT    *3.
       3)+DATA(253)*COSF(DATA(260)*TACT    )+DATA(254)*COSF(DATA(260)*TACT
       4   *2.)+DATA(255)*COSF(DATA(260)*TACT    *3.)+DATA(256)*EXPF(DATA(26
       51)*TACT    )+DATA(257)*EXPF(DATA(261)*TACT    *2.)+DATA(258)*EXPF(DA
       6TA(261)*TACT    *3.)
        GO TO 9
      6 CONTINUE
        IF(DATA(193))7,7,8
D     8 REAC(2)=DATA(244)+DATA(246)
        GO TO 9
      7 CONTINUE
D       TACT=TIME(2)-(DATA(245)+(DATA(245)+DATA(262))*RS)
D       REAC(2)=DATA(244)+DATA(246)+DATA(247)*TACT    +DATA(248)*(TACT    **
       12)+DATA(249)*(TACT    **3)+DATA(250)*SINF(DATA(259)*TACT    )+DATA(2
       251)*SINF(DATA(259)*TACT    *2.)+DATA(252)*SINF(DATA(259)*TACT    *3.
       3)+DATA(253)*COSF(DATA(260)*TACT    )+DATA(254)*COSF(DATA(260)*TACT
       4   *2.)+DATA(255)*COSF(DATA(260)*TACT    *3.)+DATA(256)*EXPF(DATA(26
       51)*TACT    )+DATA(257)*EXPF(DATA(261)*TACT    *2.)+DATA(258)*EXPF(DA
       6TA(261)*TACT    *3.)
D     9 SUM=0.0
        JJJ=J1-J2
        DO 1 K=1,JJJ
        MI=K+J2
```

```
D     1 SUM=SUM+DATA(K+262)*TVB(MI)
D       REAC(2)=REAC(2)+SUM
        IF(DATA(5))1065,1070,1070
D1065 REAC(2)=REAC(2)/DATA(13)
 1070 RETURN
        END


*       LABEL
CRTABL
        SUBROUTINE RTABL
D       DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2)
        COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X
        K=0
        DO 1130 I=2,70
        IF(TIME(2)-DATA(I+419))1100,1130,1130
 1100 K=I-1
D       REAC(2)=((TIME(2)-DATA(K+419))/(DATA(K+420)-DATA(K+419)))*(DATA(K+
       1349)-DATA(K+348))+DATA(K+348)
        JJJ=J1-J2
D       SUM=0.0
        DO 5 K=1,JJJ
        MI=K+J2
D     5 SUM=SUM+DATA(K+262)*TVB(MI)
D       REAC(2)=REAC(2)+SUM
        IF(DATA(5)) 1120,1120,1140
D1120 REAC(2)=REAC(2)/DATA(13)
        GO TO 1140
 1130 CONTINUE
 1140 RETURN
        END
```

```
 TIME IN SEC.       REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX
0.29999999E-01 -0.15609755E 01 -0.34822198E-00  0.20002069E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000095E 01  0.10000236E 01  0.10000847E 01  0.10002211E 01  0.10008050E 01  0.10010940E 01
0.20002178E-00
                                                  INDIC=      6


         MAX REAC =  0.46533728E-00      TIME =  0.30219429E-01
         MAX FLUX =  0.13554062E 03      TIME =  0.30261999E-01
         DT =  0.53979779E-04      I IMP =  0.83360077E-02
 TIME IN SEC.       REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX
0.30438859E-01 -0.15609503E 01 -0.96099047E 04  0.20254361E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001098E 01  0.10002740E 01  0.10009928E 01  0.10026771E 01  0.10118578E 01  0.10316329E 01
0.20451820E-00
                                                  INDIC=      7


 TIME IN SEC.       REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX
0.39999999E-01 -0.15609755E 01 -0.34827885E-00  0.20003664E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000127E 01  0.10000316E 01  0.10001130E 01  0.10002950E 01  0.10010680E 01  0.10014372E 01
0.20003773E-00
                                                  INDIC=      8


         MAX REAC =  0.46533728E-00      TIME =  0.40219429E-01
         MAX FLUX =  0.13555142E 03      TIME =  0.40261999E-01
         DT =  0.53979779E-04      I IMP =  0.83366722E-02
 TIME IN SEC.       REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX
0.40438859E-01 -0.15609489E 01 -0.96099083E 04  0.20255989E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001130E 01  0.10002819E 01  0.10010212E 01  0.10027511E 01  0.10121217E 01  0.10319781E 01
0.20453464E-00
                                                  INDIC=      9


 TIME IN SEC.       REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX
0.49999999E-01 -0.15609755E 01 -0.34833451E-00  0.20005248E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000159E 01  0.10000395E 01  0.10001414E 01  0.10003687E 01  0.10013285E 01  0.10017703E 01
0.20005357E-00
                                                  INDIC=     10
```

```
          MAX REAC =  0.46533728E-00      TIME =  0.50219429E-01
          MAX FLUX =  0.13556214E 03      TIME =  0.50261998E-01
          DT =  0.53979779E-04      I IMP =  0.83373320E-02

 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.50438859E-01 -0.15609476E 01 -0.96099120E 04  0.20257606E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001162E 01  0.10002899E 01  0.10010497E 01  0.10028251E 01  0.10123830E 01  0.10323133E 01
0.20455097E-00
                                                      INDIC=     11

 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.59999999E-01 -0.15609755E 01 -0.34838898E-00  0.20006821E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000191E 01  0.10000475E 01  0.10001699E 01  0.10004426E 01  0.10015866E 01  0.10020939E 01
0.20006929E-00
                                                      INDIC=     12

          MAX REAC =  0.46533728E-00      TIME =  0.60219429E-01
          MAX FLUX =  0.13557280E 03      TIME =  0.60261998E-01
          DT =  0.53979779E-04      I IMP =  0.83379873E-02

 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.60438859E-01 -0.15609463E 01 -0.96099156E 04  0.20259213E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001194E 01  0.10002979E 01  0.10010783E 01  0.10028990E 01  0.10126417E 01  0.10326388E 01
0.20456719E-00
                                                      INDIC=     13

 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.69999998E-01 -0.15609755E 01 -0.34844231E-00  0.20008382E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000223E 01  0.10000555E 01  0.10001983E 01  0.10005164E 01  0.10018422E 01  0.10024082E 01
0.20008491E-00
                                                      INDIC=     14

          MAX REAC =  0.46533728E-00      TIME =  0.70219429E-01
          MAX FLUX =  0.13558338E 03      TIME =  0.70261998E-01
          DT =  0.53979779E-04      I IMP =  0.83386382E-02

 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.70438859E-01 -0.15609449E 01 -0.96099193E 04  0.20260808E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001227E 01  0.10003059E 01  0.10011069E 01  0.10029731E 01  0.10128981E 01  0.10329551E 01
0.20458330E-00
                                                      INDIC=     15
```

```
INPUT DATA    I,DATA(I)

    1  0.800000E 01      2  0.700000E 01      3  0.                  4  0.                  5 -0.100000E 01
    6  0.100000E 01      7 -0.                 8  0.438860E-06       9 -0.                 10 -0.
   11 -0.                12 -0.                13  0.164000E-01      14  0.200000E-07      15 -0.
   16 -0.                17 -0.                18  0.100000E 01      19  0.205000E-00      20  0.100000E 01
   21  0.100000E 01     22  0.100000E 01      23  0.100000E 01      24  0.100000E 01      25  0.100000E 01
   26  0.100000E 01
   69  0.148300E-01     70  0.831100E-01      71  0.733500E-01      72  0.158840E-00      73  0.499400E-01
   74  0.101200E-01     75  0.609750E 00
   94  0.127000E-01     95  0.317000E-01      96  0.115000E-00      97  0.311000E-00      98  0.140000E 01
   99  0.387000E 01    100  0.100000E 07
  142 -0.               143  0.200000E 02
  192 -0.               193 -0.
  194 -0.127000E-01    195 -0.317000E-01     196 -0.115000E-00     197 -0.311000E-00     198 -0.140000E 01
  199 -0.387000E 01    200 -0.100000E 07
  242 -0.               243  0.956114E-04
  244 -0.256000E-01    245  0.956114E-02     246 -0.               247  0.302889E 03     248 -0.690170E 06
  261 -0.               262  0.438860E-03
  497 -0.               498  0.100000E 01     499 -0.               500  0.200000E 04

   INPUT COEFFICIENTS FOR FEEDBACK EQUATIONS
 0.12700000E-01  0.               -0.12700000E-01
 0.31699999E-01  0.               -0.31699999E-01
 0.11499999E-00  0.               -0.11499999E-00
 0.31100000E-00  0.               -0.31100000E-00
 0.13999999E 01  0.               -0.13999999E 01
 0.38699999E 01  0.               -0.38699999E 01
 0.09999999E 07  0.               -0.09999999E 07

 BETA EFFECTIVE  NEUTRON LIFETIME   SOURCE TERM      SUM  FI*WI
 0.16400000E-01  0.20000000E-07 -0.                0.99993999E 00
```

```
 TIME IN SEC.       REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.              -0.15609755E 01  0.18997600E 07  0.20500000E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.09999999E 01  0.09999999E 01  0.09999999E 01  0.09999999E 01  0.09999999E 01  0.09999999E 01
0.09999999E 01

         MAX REAC =  0.46533728E-00      TIME =  0.21942999E-03

         MAX FLUX =  0.13550775E 03      TIME =  0.26199941E-03

         DT =  0.53979779E-04      I IMP =  0.83342158E-02

 TIME IN SEC.       REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.43885999E-03 -0.15609543E 01 -0.96098938E 04  0.20249406E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001002E 01  0.10002502E 01  0.10009079E 01  0.10024553E 01  0.10110509E 01  0.10305340E 01
0.20446817E-00

                                                  INDIC=      1


 TIME IN SEC.       REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.99999999E-02 -0.15609755E 01 -0.34810443E-00  0.19998846E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000031E 01  0.10000078E 01  0.10000281E 01  0.10000737E 01  0.10002711E 01  0.10003763E 01
0.19998955E-00

                                                  INDIC=      2


         MAX REAC =  0.46533728E-00      TIME =  0.10219429E-01

         MAX FLUX =  0.13551878E 03      TIME =  0.10261999E-01

         DT =  0.53979779E-04      I IMP =  0.83346645E-02

 TIME IN SEC.       REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.10438859E-01 -0.15609530E 01 -0.96098974E 04  0.20251069E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001034E 01  0.10002581E 01  0.10009362E 01  0.10025292E 01  0.10113224E 01  0.10309113E 01
0.20448496E-00

                                                  INDIC=      3


 TIME IN SEC.       REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.20000000E-01 -0.15609755E 01 -0.34816385E-00  0.20000464E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000063E 01  0.10000157E 01  0.10000563E 01  0.10001475E 01  0.10005394E 01  0.10007405E 01
0.20000573E-00

                                                  INDIC=      4


         MAX REAC =  0.46533728E-00      TIME =  0.20219430E-01

         MAX FLUX =  0.13552974E 03      TIME =  0.20261998E-01

         DT =  0.53979779E-04      I IMP =  0.83353385E-02

 TIME IN SEC.       REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.20438860E-01 -0.15609516E 01 -0.96099010E 04  0.20252721E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001066E 01  0.10002660E 01  0.10009644E 01  0.10026031E 01  0.10115914E 01  0.10312775E 01
0.20450164E-00

                                                  INDIC=      5
```

```
 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.79999999E-01 -0.15609755E 01 -0.34849452E-00  0.20009934E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000255E 01  0.10000636E 01  0.10002270E 01  0.10005902E 01  0.10020953E 01  0.10027135E 01
0.20010043E-00
                                                 INDIC=     16


          MAX REAC =  0.46533728E-00     TIME =  0.80219429E-01
          MAX FLUX =  0.13559389E 03     TIME =  0.80261998E-01
          DT =  0.53979779E-04      I IMP =  0.83392847E-02

 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.80438858E-01 -0.15609436E 01 -0.96099228E 04  0.20262393E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001259E 01  0.10003140E 01  0.10011355E 01  0.10030472E 01  0.10131519E 01  0.10332625E 01
0.20459931E-00
                                                 INDIC=     17


 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.89999998E-01 -0.15609755E 01 -0.34854566E-00  0.20011475E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000288E 01  0.10000716E 01  0.10002556E 01  0.10006642E 01  0.10023460E 01  0.10030103E 01
0.20011584E-00
                                                 INDIC=     18


          MAX REAC =  0.46533728E-00     TIME =  0.90219428E-01
          MAX FLUX =  0.13560433E 03     TIME =  0.90261997E-01
          DT =  0.53979779E-04      I IMP =  0.83399270E-02

 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.90438858E-01 -0.15609422E 01 -0.96099265E 04  0.20263967E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10001291E 01  0.10003221E 01  0.10011642E 01  0.10031212E 01  0.10134034E 01  0.10335612E 01
0.20461521E-00
                                                 INDIC=     19


 TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.  NEUTRON FLUX
0.99999999E-01 -0.15609755E 01 -0.34859575E-00  0.20013007E-00

 DELAYED NEUTRON GROUPS(1 TO N),FEEDBACK VARIABLES(1 TO K)
0.10000321E 01  0.10000797E 01  0.10002843E 01  0.10007381E 01  0.10025942E 01  0.10032987E 01
0.20013116E-00
                                                 INDIC=     20
```

C   AIREK-PUL --FEW GROUP AND TWO POINT --

```
*       LABEL
CMAIN
        DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
        DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
        DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
       1 00),ETA3(1500)
        DIMENSION DATA(500)
        COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
        COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
        COMMON DATA
        WRITE OUTPUT TAPE 6,44
   44   FORMAT (1H1/////24H INPUT DATA     I,DATA(I)///)
    1   READ INPUT TAPE 5,2,K1,K2,(DATA(I),I=K1,K2)
    2   FORMAT (2I12/(6E12.8))
        WRITE OUTPUT TAPE 6,33,(I,DATA(I),I=K1,K2)
   33   FORMAT (5(I6,E14.6))
        IF(K2)10,10,1
   10   READ INPUT TAPE 5,6,X,D,AR,EP
    6   FORMAT (4E12.8)
        READ INPUT TAPE 5,111,HHH
  111   FORMAT (E12.8)
        J1=DATA(1)+0.002
        WRITE OUTPUT TAPE 6,50,(DATA(I+92),DATA(I+142),DATA(I+192),I=2,J1)
   50   FORMAT(1H0,44H    INPUT COEFFICIENTS FOR FEEDBACK EQUATIONS/(3E16.8
       X))
        KQ=0
        WRITE OUTPUT TAPE 6,2000,X,D,AR,EP
 2000   FORMAT (///1H0,5X,4HKM =E16.8,5X,3HD =E16.8,5X,4HI0 =E16.8,5X,4HEP
       1 =E16.8///)
        ALQ=DATA(248)*(-1.)
        WRITE OUTPUT TAPE 6,703
  703   FORMAT (1H1)
        F1=0.
        ASSIGN 20 TO KK
   11   CONTINUE
        T0=SQRTF((X-(1.0+DATA(244)))/ALQ)
        DATA(8)=T0*0.002
        DATA(262)=2.*T0
        DATA(247)=2.*ALQ*T0
        KQ=KQ+1
        CALL AIREK(ARR,IP,IIP)
        ITS=IIP
        GO TO KK,(20,21)
   20   F2=AR-ARR
        X2=X
        IF(F1*F2)18,9,9
    9   CONTINUE
        IF(KQ-1)90,90,92
   92   CONTINUE
        IF(ABSF(F2)-ABSF(F1))90,90,91
   91   D=-D
   90   CONTINUE
        X1=X
        X=X+D
        F1=F2
        GO TO 11
   18   ASSIGN 21 TO KK
   13   X=-F1*(X2-X1)/(F2-F1)+X1
        GO TO 11
   21   FUN=AR-ARR
```

```
      IF(FUN*F1)14,14,15
   14 IF(ABSF(FUN)-EP)12,12,45
   45 F2=FUN
      X2=X
      GO TO 13
   15 IF(ABSF(FUN)-EP)12,12,53
   53 F1=FUN
      X1=X
      GO TO 13
   12 CONTINUE
      WRITE OUTPUT TAPE 6,703
      WRITE OUTPUT TAPE 6,700,X,FUN
  700 FORMAT (1H0,10X,4HKM =E16.8,5X,5HEPF =E16.8///)
      WRITE OUTPUT TAPE 6,17,X1,X2,F1,F2
   17 FORMAT (1H0,10X,5HKM1 =E16.8,5X,5HKM2 =E16.8,5X,5HEP1 =E16.8,5X,5H
     1EP2 =E16.8////)
      IF(HHH)2002,3003,2002
 2002 CALL TWOS(ITS)
 3003 CONTINUE
      UU1(1)=0.
      UU1(2)=DATA(19)
      UU1(3)=DATA(26)*DATA(13)*DATA(75)/(DATA(100)*DATA(14))
      CALL OUTPUT (ITS)
      WRITE OUTPUT TAPE 6,44
      GO TO 1
      END

*     LABEL
COUT
      SUBROUTINE OUTPUT (ITS)
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ  (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION FIM(6)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ  ,YY,WW,ETA1,ETA2,ETA3
      READ INPUT TAPE 5,8,AA,BB,A1,A2,A3
    8 FORMAT (6E12.8)
      READ INPUT TAPE 5,11,PRINT
   11 FORMAT (E12.8)
      PP1(1)=UU2(2)/UU1(2)
      PP1(2)=UU5(3)/UU1(3)
      PP1(3)=UU3(4)/UU1(4)
      PP1(4)=UU4(5)/UU1(5)
      PP1(5)=UU6(6)/UU1(6)
      FIM(1)=AA*UU2(2)
      FIM(2)=BB*UU5(3)
      FIM(3)=A1*UU3(4)
      FIM(4)=A2*UU4(5)
      FIM(5)=A3*UU6(6)
      WRITE OUTPUT TAPE 6,7
    7 FORMAT (1H1)
      WRITE OUTPUT TAPE 6,1
    1 FORMAT (1H0,40X,35HCHARACTERISTICS CORE AND SCATTERERS//)
      WRITE OUTPUT TAPE 6,10
   10 FORMAT (1H0,17X,4HTIME,13X,3H1-C,13X,3H2-C,17X,3H1-S,13X,3H2-S,13X
     1,3H3-S)
    2 FORMAT (///1H0,10X,E16.8,2E16.6,E20.6,2E16.6)
      WRITE OUTPUT TAPE 6,2,(UU1(I),I=1,6)
      WRITE OUTPUT TAPE 6,2,(UU2(I),I=1,6)
      WRITE OUTPUT TAPE 6,2,(UU3(I),I=1,6)
      WRITE OUTPUT TAPE 6,2,(UU4(I),I=1,6)
      WRITE OUTPUT TAPE 6,2,(UU5(I),I=1,6)
```

```
      WRITE OUTPUT TAPE 6,2,(UU6(I),I=1,6)
      WRITE OUTPUT TAPE 6,3,(PP1(I),I=1,5)
    3 FORMAT (/////1H0,20X,6HNM/NO  ,2E16.6,E20.6,2E16.6///)
      WRITE OUTPUT TAPE 6,4,(FIM(I),I=1,5)
    4 FORMAT (1H0,20X,6HFMAX  ,2E16.6,E20.6,2E16.6///)
      WRITE OUTPUT TAPE 6,5,(PP3(I),I=1,5)
    5 FORMAT (1H0,20X,6HTETA  ,2E16.6,E20.6,2E16.6)
      WRITE OUTPUT TAPE 6,6,PP4(1),PP4(2),PP4(3)
    6 FORMAT (////1H0,15X,6HTIME =E16.8,5X,11HREAC(MAX) =E16.8,5X,13HI I
     1MP(GOOD) =E16.8)
      WRITE OUTPUT TAPE 6,9,AA,BB,A1,A2,A3
    9 FORMAT (1H1,55X,14HDATA FOR FI(J)////5X,4HAA =E16.6,3X,4HBB =E16.6
     1,3X,4HA1 =E16.6,3X,4HA2 =E16.6,3X,4HA3 =E16.6)
      IF(PRINT)12,13,12
   12 CONTINUE
      DO 3335 I=1,ITS
      YY(I)=YY(I)*AA
      WW(I)=WW(I)*BB
      ETA1(I)=ETA1(I)*A1
      ETA2(I)=ETA2(I)*A2
      ETA3(I)=ETA3(I)*A3
 3335 CONTINUE
      WRITE OUTPUT TAPE 6,7
      WRITE OUTPUT TAPE 6,15
   15 FORMAT (1H0,12X,4HTIME,24X,2HF1,14X,2HF2,13X,3HF1S,12X,3HF2S,13X,3
     1HF3S//)
      K1=1
      K2=30
   17 CONTINUE
      DO 16 I=K1,K2
      WRITE OUTPUT TAPE 6,14,XX(I),YY(I),WW(I),ETA1(I),ETA2(I),ETA3(I)
      IF(I-(ITS-1))16,13,13
   16 CONTINUE
      WRITE OUTPUT TAPE 6,7
      K1=K2+1
      K2=K2+31
      GO TO 17
   14 FORMAT (1H0,5X,E16.8,10X,5E16.6)
   13 CONTINUE
      RETURN
      END

*     LABEL
CRRRMA
      SUBROUTINE RRRMA(ITS)
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      DO 1 I=200,ITS
      IF(ETA1(I)-ETA1(I-1))2,1,1
    2 A=ETA1(I-1)
      T=XX(I-1)
      GO TO 6
    1 CONTINUE
    6 CONTINUE
      UU3(1)=T
      UU3(4)=A
      S=A*0.5
      DO 3 I=1,ITS
      IF(ETA1(I)-S)3,5,5
```

```
    5 A=ETA1(I)
      T=XX(I)
      TT=T
      J=I
      GO TO 8
    3 CONTINUE
    8 CONTINUE
      DO 9 K=J,ITS
      IF(ETA1(K)-S)10,9,9
   10 A=ETA1(K-1)
      T=XX(K-1)
      GO TO 11
    9 CONTINUE
   11 CONTINUE
      DT=T-TT
      PP3(3)=DT
      DO 100 I=200,ITS
      IF(ETA2(I)-ETA2(I-1))200,100,100
  200 A=ETA2(I-1)
      T=XX(I-1)
      GO TO 600
  100 CONTINUE
  600 CONTINUE
      UU4(1)=T
      UU4(5)=A
      S=A*0.5
      DO 300 I=1,ITS
      IF(ETA2(I)-S)300,500,500
  500 A=ETA2(I)
      T=XX(I)
      TT=T
      J=I
      GO TO 800
  300 CONTINUE
  800 CONTINUE
      DO 900 K=J,ITS
      IF(ETA2(K)-S)1000,900,900
 1000 A=ETA2(K-1)
      T=XX(K-1)
      GO TO 1111
  900 CONTINUE
 1111 CONTINUE
      DT=T-TT
      PP3(4)=DT
      DO 15 I=200,ITS
      IF(ETA3(I)-ETA3(I-1))25,15,15
   25 A=ETA3(I-1)
      T=XX(I-1)
      GO TO 65
   15 CONTINUE
   65 CONTINUE
      UU6(1)=T
      UU6(6)=A
      S=A*0.5
      DO 35 I=1,ITS
      IF(ETA3(I)-S)35,55,55
   55 A=ETA3(I)
      T=XX(I)
      TT=T
      J=I
      GO TO 85
   35 CONTINUE
   85 CONTINUE
      DO 95 K=J,ITS
      IF(ETA3(K)-S)105,95,95
```

```
  105 A=ETA3(K-1)
      T=XX(K-1)
      GO TO 115
   95 CONTINUE
  115 CONTINUE
      DT=T-TT
      PP3(5)=DT
      RETURN
      END

*     LABEL
CREMAX
      SUBROUTINE REMAX(RQ,IP)
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      DO 30 I=2,IP
      IF  (ZZ(I))30,60,60
   60 IF(ZZ(I)-ZZ(I-1))31,30,30
   31 A=ZZ(I-1)
      T=XX(I-1)
      GO TO 33
   30 CONTINUE
   33 CONTINUE
      PP4(1)=T
      PP4(2)=A
      DO 83 I=200,IP
      IF(WW(I)-WW(I-1))34,83,83
   34 A=WW(I-1)
      T=XX(I-1)
      GO TO 63
   83 CONTINUE
   63 CONTINUE
      UU5(1)=T
      UU5(3)=A
      S=A*0.5
      DO 333 I=1,IP
      IF(WW(I)-S)333,553,553
  553 A=WW(I)
      T=XX(I)
      TT=T
      J=I
      GO TO 88
  333 CONTINUE
   88 CONTINUE
      DO 99 K=J,IP
      IF(WW(K)-S)103,99,99
  103 A=WW(K-1)
      T=XX(K-1)
      GO TO 113
   99 CONTINUE
  113 CONTINUE
      DT=T-TT
      PP3(2)=DT
      DO 1 I=200,IP
      IF(YY(I)-YY(I-1))2,1,1
    2 A=YY(I-1)
      T=XX(I-1)
      GO TO 6
    1 CONTINUE
    6 CONTINUE
```

```
      UU2(1)=T
      UU2(2)=A
      S=A*0.5
      DO 3 I=1,IP
      IF(YY(I)-S)3,5,5
    5 A=YY(I)
      T=XX(I)
      TT=T
      J=I
      GO TO 8
    3 CONTINUE
    8 CONTINUE
      DO 9 K=J,IP
      IF(YY(K)-S)10,9,9
   10 A=YY(K-1)
      T=XX(K-1)
      GO TO 11
    9 CONTINUE
   11 CONTINUE
      DT=T-TT
      PP3(1)=DT
      Q=(XX(2)-XX(1))*0.5
      RQ=0.
      DO 40 K =2,IP
   40 RQ=RQ+(YY(K)+YY(K-1))*Q
      PP4(3)=RQ
      RETURN
      END

*     LABEL
CTWOS
      SUBROUTINE TWOS(ITS)
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION DATA(500)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA
      READ INPUT TAPE 5,1000,ETA10,ETA20,ETA30
      READ INPUT TAPE 5,1000,B1,B2,EL2,EL3
 1000 FORMAT (6F12.8)
      ETA1(1)=ETA10
      ETA2(1)=ETA20
      ETA3(1)=ETA30
      UU1(4)=ETA10
      UU1(5)=ETA20
      UU1(6)=ETA30
      CCC=EXPF(-DATA(8)/EL2)
      SS2=ETA20
      DO 3333 I=2,ITS
      ETA1(I)=YY(I)*ETA10/DATA(19)
      EEE=(ETA1(I)+ETA1(I-1)*CCC)*0.5*DATA(8)*B1
      SS2=SS2*CCC+EEE
      ETA2(I)=SS2
 3333 CONTINUE
      CCC=EXPF(-DATA(8)/EL3)
      SS3=ETA30
      DO 7777 I=2,ITS
      EEE=(ETA2(I)+ETA2(I-1)*CCC)*0.5*DATA(8)*B2
      SS3=SS3*CCC+EEE
      ETA3(I)=SS3
 7777 CONTINUE
```

```
      CALL RRRMA(ITS)
      WRITE OUTPUT TAPE 6,2000
 2000 FORMAT (///1H0,55X,13HDATA FOR TWOS//)
      WRITE OUTPUT TAPE 6,1001,B1,B2,EL2,FL3
 1001 FORMAT (1H0,10X,4HB1 =E14.6,5X,4HB2 =E14.6,5X,5HEL2 =E14.6,5X,5HEL
     13 =E14.6//)
      RETURN
      END

*     LABEL
CAIREK
      SUBROUTINE AIREK(ARR,IP,IIP)
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ  (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50),IERR(1)
      DIMENSION HH(100),AM(100),MM(100),BM(100)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ  ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN,INZ,J6,DELTA
      COMMON RS,KRK
      J1=DATA(1)+0.002
      J2=DATA(2)+1.002
      J3=ABSF(DATA(3))
      J4=ABSF(DATA(4))
      RS=0.
      KK=DATA(500)+0.0002
      KM=KK
      N=DATA(143)+0.0002
      NN=N-1
      IF(DATA(193))800,800,900
  800 DO 700 I=1,NN,2
      AM(I)=DATA(262)
  700 HH(I)=DATA(8)
      DO 701 I=2,N,2
      AM(I)=DATA(245)
  701 HH(I)=DATA(243)
      X(1)=HH(1)
      KRK=0
      GO TO 901
  900 DO 600 I=1,NN,2
      AM(I)=DATA(245)
  600 HH(I)=DATA(243)
      DO 601 I=2,N,2
      AM(I)=DATA(262)
  601 HH(I)=DATA(8)
      X(1)=HH(1)
      KRK=1
  901 CONTINUE
      JK=1
      JJJ=1
      ACC=AM(JJJ)
   14 IF(DATA(7))15,20,15
   15 CALL INHOUR
   20 DO 25 I=1,J1
      ANS(I)=DATA(I+18)
   25 TVB(I)=ANS(I)
      INZ=0
      J7=0
      JN=0
      TIME(1)=0.0
```

```
      JR=2
      TIME(2)=TIME(1)+X(2)
      IF(ABSF(DATA(5))-1.)110,110,115
 110  CALL RANAL
      GO TO 120
 115  CALL RTABL
 120  CALL RNFBT
      JR=1
      JC=1
      DO 125 I=1,J1
      DELTA(I)=DELTA(I)+(X(2)*CAPC(JC+1)*(CAPR(JR+1)-CAPR(JR)))
      JR=JR+4
      JC=JC+3
 125  TVB(I)=ANS(I)+DELTA(I)
      JR=3
      IF(ABSF(DATA(5))-1.)130,130,135
 130  CALL RANAL
      GO TO 140
 135  CALL RTABL
 140  CALL RNFBT
      DO 150 I=1,J1
 150  ALPHN(I)=X(1)*ALPHN(I)/X(2)
      CALL CNFBT
      IF(JN) 151,152,151
 151  CALL DIREC
      IF (JN) 256,75,256
 152  JR=1
      JC=1
      DO 160 I=1,J1
      DELTA(I)=2.0*X(1)*CAPC(JC+1)*(CAPR(JR+2)-CAPR(JR))+CAPC(JC)*(X(1)*
     XCAPR(JR)+ALPHN(I)*ANS(I))
      TVB(I)=DELTA(I)+ANS(I)
      JC=JC+3
 160  JR=JR+4
      TIME(2)=TIME(1)+X(1)
      IF (DATA(498)) 161,164,161
 161  JR=4
      IF(ABSF(DATA(5))-1.)162,162,163
 162  CALL RANAL
      GO TO 166
 163  CALL RTABL
 166  CALL RNFBT
      JR=1
      JC=1
      DO 168 I=1,J1
      DELTA(I)=DELTA(I)+X(1)*(CAPR(JR+3)-2.0*CAPR(JR+2)+CAPR(JR))*(2.0*C
     XAPC(JC+2)-CAPC(JC+1))
      JR=JR+4
      JC=JC+3
 168  TVB(I)=DELTA(I)+ANS(I)
 164  CONTINUE
      IF(ABSF(DATA(5))-1.)165,165,170
 165  CALL RANAL
      GO TO 175
 170  CALL RTABL
 175  CALL RNFBT
      OMEGA(3)=DATA(13)/DATA(14)*((REAC(2)-1.0)+(SFW+DATA(15))/TVB(1))
      IF(TVB(1)/ANS(1)) 180,180,190
 180  JN=1
      CALL DIREC
      GO TO 256
 190  OMEGA(2)= (LOG F(TVB(1)/ANS(1)))/X(1)
      IF(JT) 191,250,191
 191  IF(DATA(6)) 200,200,195
 195  IF(J6) 200,200,250
```

```
  200 Q=X(1)*ABSF(OMEGA(3)-2.0*OMEGA(2)+OMEGA(1))*CAPC(2)/(CAPC(1)+1.0)
      IF(DATA(16)) 205,230,205
  205 IF(DATA(16)-OMEGA(3)) 230,210,210
  210 IF(ABSF(DATA(15)/TVB(1)+REAC(2))-DATA(17)) 230,230,215
  215 IF(INZ) 225,220,225
  220 INZ=1
      X(2)=DATA(9)
      GO TO 245
  225 IF(ABSF(OMEGA(3))-DATA(16)) 250,230,230
  230 IF(Q-DATA(11)) 235,250,245
  235 IF(Q-DATA(12)) 240,250,250
  240 X(1)=2.0*X(1)
      GO TO 250
  245 CALL DIREC
      IF (JN) 256,75,256
  250 TIME(1)=TIME(2)
      OMEGA(1)=OMEGA(3)
      REAC(1)=REAC(2)
      DO 255 I=1,J1
  255 ANS(I)=TVB(I)
  256 RETURN
      END

*     LABEL
CCNFBT
      SUBROUTINE CNFBT
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
     XCAPR(200),ALPHN(50),CAPC(150)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN
      JC=1
      DO 1170 I=1,J1
      IF(ABSF(ALPHN(I))-1.0) 1155,1165,1160
 1155 CD=10.0
      CN=1.0
      DO 1157 L=1,7
      CN=CN/CD*ALPHN(I)+1.0
 1157 CD=CD-1.0
      CAPC(JC+2)=CN/3.0
      CAPC(JC+1)=(CAPC(JC+2)*ALPHN(I)+1.0)/2.0
      CAPC(JC)=CAPC(JC+1)*ALPHN(I)+1.0
      GO TO 1170
 1160 IF(ABSF(ALPHN(I))-88.0) 1165,1165,1161
 1161 IF(ALPHN(I)) 1162,1162,1180
 1162 CAPC(JC)=-1.0/ALPHN(I)
      GO TC 1166
 1165 CAPC(JC)=(EXPF(ALPHN(I))-1.0)/ALPHN(I)
 1166 CAPC(JC+1)=(CAPC(JC)-1.0)/ALPHN(I)
      CAPC(JC+2)=(2.0*CAPC(JC+1)-1.0)/ALPHN(I)
 1170 JC=JC+3
 1171 RETURN
 1180 JN=-1
      GO TC 1171
      END

*     LABEL
CDIREC
```

```
      SUBROUTINE DIREC
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ  (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ  ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN
      IF(JN) 1184,1184,2025
 1184 IF(X(2)-DATA(9)) 1185,1190,1190
 1185 IF(X(1)-DATA(9)) 2000,2000,1190
 1190 X(1)=X(2)
 1191 TIME(2)=TIME(1)
      REAC(2)=REAC(1)
      DO 1195 I=1,J1
 1195 TVB(I)=ANS(I)
      JN=0
      GO TO 2035
 2000 IF(JN) 2005,2015,2025
 2005 WRITE OUTPUT TAPE 6,2010,X(1),(ALPHN(I),I=1,J1)
 2010 FORMAT(1H0,81H  INTERVAL AND F(ALPHA)AT TIME OF FAILURE DUE TO EXC
     XEEDING EXPONENTIAL SUBROUTINE/(6E16.8))
      GO TO 2035
 2015 WRITE OUTPUT TAPE 6,2020,X(1)
 2020 FORMAT(1H0,66H  FAILURE DUE TO ATTEMPTING TO REDUCE INTERVAL BELOW
     X MINIMUM VALUE/(1E16.8))
      JN=1
      GO TO 2035
 2025 WRITE OUTPUT TAPE 6,2030,TVB(1),ANS(1)
 2030 FORMAT(1H0,50H  FAILURE DUE TO RATIO OF N(1)/N(0) IN LOG ROUTINE/(
     X2E16.8))
 2035 RETURN
      END

*     LABEL
CINHOUR
      SUBROUTINE INHOUR
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ  (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION DATA(500),REAC(2)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ  ,YY,WW,ETA1,ETA2,ETA3
      COMMON  DATA,REAC,J1,J2,J3,J4
      TEMP1=0.0
      DO 1000 I=2,J2
      TEMP2  =DATA(7)-DATA(I+192)
      DATA(I+18)=-DATA(I+192)*DATA(19)/TEMP2
 1000 TEMP1  =TEMP1  +DATA(I+67)/TEMP2
      REAC(1)=(TEMP1  +(DATA(14)/DATA(13)))*DATA(7)
      IF(DATA(5)) 1005,1005,1010
 1005 REAC(1)=REAC(1)*DATA(13)
 1010 IF(DATA(5)-1.0)  1015,1015,1020
 1015 DATA(244)=REAC(1)
 1020 DATA(349)=REAC(1)
      RETURN
      END

*     LABEL
```

```
CCUSPR
      SUBROUTINE CUSPR
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
     XCAPR(200),ALPHN(50),CAPC(150),DELTA(50)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN,INZ,J6,DELTA
      WRITE OUTPUT TAPE 6,3000,ANS(1)
 3000 FORMAT(1H0,10HDUMMY ANSW/(1E12.8))
      RETURN
      END
```

```
      TIME(2)=0.0
      IF(ABSF(DATA(5))-1.0)30,30,35
   30 CALL RANAL
      GO TO 40
   35 CALL RTABL
   40 REAC(1)=REAC(2)
      SFW=0.0
      JJ3=J2-1
      DO 45 I=2,JJ3
   45 SFW=SFW+DATA(I+67)*ANS(I)
      SFW=SFW+DATA(J2+67)*ANS(J2)*DATA(6)
      OMEGA(1)=DATA(13)/DATA(14)*((REAC(1)-1.0)+(SFW+DATA(15))/ANS(1))
      WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(1),ANS(1),ANS(8)
   65 FORMAT(1H0,82H  TIME IN SEC.      REACTIVITY    AVG.INVERSE PER.   NE
     1UTRON FLUX(1)   NEUTRON FLUX(2)/(5E16.8))
   74 CALL INTER
      WKW=ANS(8)*DATA(13)*DATA(75)/(DATA(100)*DATA(14))
      IF(JN) 1,22,1
   22 IF(DATA(499)) 23,251,23
   23 CALL CUSPR
  251 IF((TIME(1)+DATA(8))-ACC)302,301,301
  301 X(1)=HH(JJJ+1)
      JJJ=JJJ+1
      ACC=AM(JJJ)+ACC
      JK=1
      KM=KK
      IF(DATA(193))401,401,402
  401 CONTINUE
      CALL RFMAX(ARR,IP)
      IIP=IP
      DATA(193)=1.
      RS=RS+1.
      GO TO 400
  402 DATA(193)=0.
  400 CONTINUE
      WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(1),ANS(1),WKW
      WRITE OUTPUT TAPE 6,1111,ARR
 1111 FORMAT (1H0,15X,7HI IMP =E16.8,10X,13HEND ITERATION///)
      GO TO 300
  302 CONTINUE
      IF(DATA(193))333,111,333
  111 XX(JK)=TIME(1)
      YY(JK)=ANS(1)
      ZZ(JK)=REAC(1)
      WW(JK)=WKW
  333 CONTINUE
      IF(JK-KM)991,990,991
  990 CONTINUE
      WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(1),ANS(1),WKW
      KM=KM+KK
  991 JK=JK+1
      IP=JK
  300 CONTINUE
      IF(JJJ-N)74,74,1
    1 CONTINUE
      DATA(193)=0.
      RETURN
      END


*     LABEL
CRNFBT
      SUBROUTINE RNFBT
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
```

```
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ  (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
     1CAPR(200),ALPHN(50),CAPC(150)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ  ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     1,ALPHN,JC,J7,JN
      JJ3=J2-1
      SFW=0.0
      DO 1150  I=2,JJ3
 1150 SFW=SFW+DATA(I+67)*TVB(I)
      SFW=SFW+DATA(J2+67)*TVB(J2)*DATA(6)
      CAPR(JR)=((REAC(2)-REAC(1))*TVB(1)+SFW+DATA(15))*DATA(13)/DATA(14)
      IF(DATA(18))3,3,2
    2 DO 4  I=2,J1
      JR=JR+4
    4 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+142)*DATA(19)
      GO TO 6
    3 J1=J1-6
      DO 1153  I=2,J1
      JR=JR+4
 1153 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+142)*DATA(19)
      SLB1=0.0
      DO 8476  I=1,5
      J1AI=J1+I+1
 8476 SLB1=SLB1+DATA(I+318)*TVB(J1AI)
      DATA(492)=SLB1
      SLB2=DATA(324)*TVB(J1+1)
      DO 8477  I=1,4
      J1BI=J1+I+2
 8477 SLB2=SLB2+DATA(I+324)*TVB(J1BI)
      DATA(493)=SLB2
      SLB3=0.0
      DO 8478  I=1,2
      J1CI=J1+I
 8478 SLB3=SLB3+DATA(I+328)*TVB(J1CI)
      DO 8479  I=1,3
      J1DI=J1+I+3
 8479 SLB3=SLB3+DATA(I+320)*TVB(J1DI)
      DATA(494)=SLB3
      SLB4=0.0
      DO 8480  I=1,3
      J1EI=J1+I
 8480 SLB4=SLB4+DATA(I+333)*TVB(J1EI)
      DO 8481  I=1,2
      J1FI=J1+I+4
 8481 SLB4=SLB4+DATA(I+336)*TVB(J1FI)
      DATA(495)=SLB4
      SLB5=0.0
      DO 8482  I=1,4
      J1GI=J1+I
 8482 SLB5=SLB5+DATA(I+338)*TVB(J1GI)
      SLB5=SLB5+DATA( I+343)*TVB(J1+6)
      DATA(496)=SLB5
      SLB6=0.0
      DO 8483  I=1,5
      J1HI=J1+I
 8483 SLB6=SLB6+DATA(I+343)*TVB(J1HI)
      DATA(497)=SLB6
      J1T=J1+1
      J1=J1+6
      DO 8484  I=J1T,J1
      JR=JR+4
```

```
      LLL=I+13-J1+484
 8484 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+ 142)*DATA(19)+DATA(LLL)
    6 RETURN
      END

*     LABEL
CRTABL
      SUBROUTINE RTABL
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X
      K=0
      DO 1130 I=2,70
      IF(TIME(2)-DATA(I+419))1100,1130,1130
 1100 K=I-1
      REAC(2)=((TIME(2)-DATA(K+419))/(DATA(K+420)-DATA(K+419)))*(DATA(K+
     1349)-DATA(K+348))+DATA(K+348)
      SUM=0.0
      JJJ=J1-J2
      DO 5 K=1,JJJ
      MI=K+J2
    5 SUM=SUM+DATA(K+262)*TVB(MI)
      REAC(2)=REAC(2)+SUM
      IF(DATA(5)) 1120,1120,1140
 1120 REAC(2)=REAC(2)/DATA(13)
      GO TO 1140
 1130 CONTINUE
 1140 RETURN
      END

*     LABEL
CRANAL
      SUBROUTINE RANAL
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50),IERR(1)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN,INZ,J6,DELTA
      COMMON RS,KRK
      IF(KRK)5,5,6
    5 CONTINUE
      IF(DATA(193))3,3,4
    4 REAC(2)=DATA(244)+DATA(246)
      GO TO 9
    3 CONTINUE
      TACT=TIME(2)-(DATA(245)+DATA(262))*RS
      REAC(2)=DATA(244)+DATA(246)+DATA(247)*TACT    +DATA(248)*(TACT    **
     12)+DATA(249)*(TACT    **3)+DATA(250)*SINF(DATA(259)*TACT    )+DATA(2
     251)*SINF(DATA(259)*TACT    *2.)+DATA(252)*SINF(DATA(259)*TACT    *3.
     3)+DATA(253)*COSF(DATA(260)*TACT    )+DATA(254)*COSF(DATA(260)*TACT
     4    *2.)+DATA(255)*COSF(DATA(260)*TACT    *3.)+DATA(256)*EXPF(DATA(26
     51)*TACT    )+DATA(257)*EXPF(DATA(261)*TACT    *2.)+DATA(258)*EXPF(DA
     6TA(261)*TACT    *3.)
```

```
      GO TO 9
    6 CONTINUE
      IF(DATA(193))7,7,8
    8 REAC(2)=DATA(244)+DATA(246)
      GO TO 9
    7 CONTINUE
      TACT=TIME(2)-(DATA(245)+(DATA(245)+DATA(262))*RS)
      REAC(2)=DATA(244)+DATA(246)+DATA(247)*TACT    +DATA(248)*(TACT    **
     12)+DATA(249)*(TACT    **3)+DATA(250)*SINF(DATA(259)*TACT    )+DATA(2
     251)*SINF(DATA(259)*TACT    *2.)+DATA(252)*SINF(DATA(259)*TACT    *3.
     3)+DATA(253)*COSF(DATA(260)*TACT    )+DATA(254)*COSF(DATA(260)*TACT
     4   *2.)+DATA(255)*COSF(DATA(260)*TACT    *3.)+DATA(256)*EXPF(DATA(26
     51)*TACT    )+DATA(257)*EXPF(DATA(261)*TACT    *2.)+DATA(258)*EXPF(DA
     6TA(261)*TACT    *3.)
    9 SUM=0.0
       JJJJ=J2
      JJJ=J1-JJJJ
      DO 1 K=1,JJJ
      MI=K+JJJJ
    1 SUM=SUM+DATA(K+262)*TVB(MI)
      REAC(2)=REAC(2)+SUM
      IF(DATA(5))1065,1070,1070
 1065 REAC(2)=REAC(2)/DATA(13)
 1070 RETURN
      END


*     LABEL
CINTER
      SUBROUTINE INTER
      DIMENSION UU1(6),UU2(6),UU3(6),UU4(6),UU5(6),UU6(6)
      DIMENSION PP1(5),PP2(5),PP3(5),PP4(3)
      DIMENSION XX(1500),ZZ   (1500),YY(1500),WW(1500),ETA1(1500),ETA2(15
     100),ETA3(1500)
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50)
      COMMON UU1,UU2,UU3,UU4,UU5,UU6,PP1,PP2,PP3,PP4
      COMMON XX,ZZ   ,YY,WW,ETA1,ETA2,ETA3
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN,INZ,J6,DELTA
   75 JR=1
      IF(ABSF(DATA(5))-1.0)80,80,85
   80 CALL RANAL
      GO TO 90
   85 CALL RTABL
   90 CALL RNFBT
      X(2)=X(1)/2.0
      ALPHN(1)=(REAC(1)-1.0)*X(2)*DATA(13)/DATA(14)
      DO 95 I=2,J1
   95 ALPHN(I)=X(2)*DATA(I+192)
      CALL CNFBT
      IF(JN) 96,97,96
   96 CALL DIREC
      IF(JN) 256,75,256
   97 JR=1
      JT=0
      JC=1
      DO 105 I=1,J1
      DELTA(I)=((ALPHN(I)*ANS(I))+(CAPR(JR)*X(2)))*CAPC(JC)
      JR=JR+4
      JC=JC+3
      IF(DELTA(I)-(2.0**(-14))*ANS(I)) 105,100,100
  100 JT=0
  105 TVB(I)=ANS(I)+DELTA(I)
```

EURATOM - CETIS

INPUT TYPICAL CASE FOR = FEW GROUPS - TWO POINTS =

	1–12	13–24	25–36	37–48	49–60	61–72	73–80
1			GENERAL DATA				
2	1	6					
3	8.	7.	0.	0.	-1.	18.4	
4	13	26					
5	.0064	.106 -07	0.	0.	0.	1.	
6	.206	1.	1.	1.	1.	1.	
7	1.	-206					
8	69	75					
9	.0379	.213	.188	.407	.128	.0261	
10	.009375						
11	94	100					
12	.0127	.0317	.115	.311	1.4	3.87	
13	.614 +05						
14	143	143					
15	1.						
16	193	193					
17	0.						
18	194	200					
19	-.0127	-.0317	-.115	-.311	-1.4	-3.87	
20	-.614 +05						
21	244	248					
22	-0.0275	0.	0.	0.	-.533232 +06		
23	497	-500					
24	0.	1.	0.	2000.			
25							

EURATOM-CETIS

FEW-GROUPS TWO POINTS "CONTINUE"

PARTICULAR DATA

1										
2										
3	1.00613		.0002		.00794		.00001			
4	1.									
5	.01596		.18043		6.757					
6	1.503	+07	8.115	+05	7.523	-07	4.614	-05		
7	1.		1.		1.136		.01254		.6516	-03
8	0.									

```
INPUT DATA     I,DATA(I)

   1  0.800000E 01      2  0.700000E 01      3 -0.                  4 -0.                  5 -0.100000E 01
   6  0.184000E 02
  13  0.640000E-02     14  0.106000E-07     15 -0.                 16 -0.                 17 -0.
  18  0.100000E 01     19  0.206000E-00     20  0.100000E 01      21  0.100000E 01      22  0.100000E 01
  23  0.100000E 01     24  0.100000E 01     25  0.100000E 01      26  0.206000E-00
  69  0.379000E-01     70  0.213000E-00     71  0.188000E-00      72  0.497000E-00      73  0.128000E-00
  74  0.261000E-01     75  0.937500E-02
  94  0.127000E-01     95  0.317000E-01     96  0.115000E-00      97  0.311000E-00      98  0.140000E 01
  99  0.387000E 01    100  0.614000E 05
 143  0.100000E 01
 193  0.
 194 -0.127000E-01    195 -0.317000E-01    196 -0.115000E-00     197 -0.311000E-00     198 -0.140000E 01
 199 -0.387000E 01    200 -0.614000E 05
 244 -0.275000E-01    245  0.              246  0.               247  0.               248 -0.533232E 06
 497  0.              498  0.100000E 01    499  0.               500  0.200000E 04

  INPUT COEFFICIENTS FOR FEEDBACK EQUATIONS
0.12700000E-01  0.                -0.12700000E-01
0.31699999E-01  0.                -0.31699999E-01
0.11499999E-00  0.                -0.11499999E-00
0.31100000E-00  0.                -0.31100000E-00
0.13999999E 01  0.                -0.13999999E 01
0.38699999E 01  0.                -0.38699999E 01
0.61399999E 05  0.                -0.61399999E 05


   KM =  0.10061300E 01      D =  0.20000000E-03      IO =  0.79399999E-02      EP =  0.09999999E-04
```

```
 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.                -0.42968749E 01 -0.16302259E 06  0.20599999E-00  0.20599999E-00

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.50226686E-03 -0.42968365E 01 -0.83300751E 04  0.19763230E-00  0.21818352E-01

               I IMP =  0.80327801E-02          END ITERATION

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.                -0.42968749E 01 -0.16302259E 06  0.20599999E-00  0.20599999E-00

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.50375827E-03 -0.42968444E 01 -0.84195405E 04  0.19859076E-00  0.22514342E-01

               I IMP =  0.16607063E-01          END ITERATION

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.                -0.42968749E 01 -0.16302259E 06  0.20599999E-00  0.20599999E-00

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.50226685E-03 -0.42968409E 01 -0.83300392E 04  0.19763207E-00  0.21818300E-01

               I IMP =  0.80323775E-02          END ITERATION

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.                -0.42968749E 01 -0.16302259E 06  0.20599999E-00  0.20599999E-00

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.50077138E-03 -0.42968537E 01 -0.82810239E 04  0.19724502E-00  0.21551400E-01

               I IMP =  0.45245042E-02          END ITERATION

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.                -0.42968749E 01 -0.16302259E 06  0.20599999E-00  0.20599999E-00

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.50222680E-03 -0.42968132E 01 -0.83283838E 04  0.19761816E-00  0.21807704E-01

               I IMP =  0.78969526E-02          END ITERATION

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.                -0.42968749E 01 -0.16302259E 06  0.20599999E-00  0.20599999E-00

 TIME IN SEC.        REACTIVITY    AVG.INVERSE PER.   NEUTRON FLUX(1)  NEUTRON FLUX(2)
0.50223868E-03 -0.42967893E 01 -0.83290675E 04  0.19762383E-00  0.21811323E-01

               I IMP =  0.79395016E-02          END ITERATION


          KM =  0.10061263E 01     EPF =  0.49825758E-06

          KM1 =  0.10061299E 01     KM2 =  0.10061247E 01     EP1 = -0.92377653E-04     EP2 =  0.43047243E-04


                                                  DATA FOR TWOS

          B1 =  0.150300E 08     B2 =  0.811500E 06     EL2 =  0.752300E-06     EL3 =  0.461400E-04
```

CHARACTERISTICS CORE AND SCATTERERS

TIME	1-C	2-C	1-S	2-S	3-S
0.	0.206000E-00	0.206000E-00	0.159600E-01	0.180430E-00	0.675700E 01
0.28577431E-03	0.121667E 03	0.	0.	0.	0.
0.28577431E-03	0.	0.	0.980707E 01	0.	0.
0.28627655E-03	0.	0.	0.	0.115095E 03	0.
0.29782801E-03	0.	0.967021E 01	0.	0.	0.
0.30837500E-03	0.	0.	0.	0.	0.264330E 04
NM/NO	0.590617E 03	0.469427E 02	0.614478E 03	0.637893E 03	0.391194E 03
FMAX	0.121667E 03	0.967021E 01	0.111408E 02	0.144329E 01	0.172237E 01
TETA	0.547439E-04	0.637842E-04	0.547439E-04	0.547439E-04	0.878916E-04

TIME = 0.25111992E-03 REAC(MAX) = 0.95724630E 00 I IMP(GOOD) = 0.79395016E-02

DATA FOR FI(J)

AA = 0.100000E 01 BB = 0.100000E 01 A1 = 0.113600E 01 A2 = 0.125400E-01 A3 = 0.651600E-03

```
*       LABEL
CMAIN
        DIMENSION DATA(500)
        DIMENSION GG(10)
        COMMON DATA
        WRITE OUTPUT TAPE 6,44
   44   FORMAT (1H1////24H INPUT DATA     I,DATA(I)///)
    1   READ INPUT TAPE 5,2,K1,K2,(DATA(I),I=K1,K2)
    2   FORMAT (2I12/(6E12.8))
        WRITE OUTPUT TAPE 6,33,(I,DATA(I),I=K1,K2)
   33   FORMAT (5(I6,E14.6))
        IF(K2)10,10,1
   10   READ INPUT TAPE 5,6,X,D,AR,EP,RO,ALQ,AK
    6   FORMAT (6E12.8/E12.8)
        CCC=(1.0+DATA(244))
 1002   FORMAT(/////)
        WRITE OUTPUT TAPE 6,1002
        WRITE OUTPUT TAPE 6,1000,X,D,ALQ,RO,AR,EP
 1000   FORMAT (1H0,6HDTAJ =E12.4,3X,3HD =E12.4,3X,5HALQ =E12.4,3X,4HRO =E
       112.4,3X,4HIO =E12.4,3X,4HEP =E12.4//)
        WRITE OUTPUT TAPE 6,1001,DATA(4),AK,CCC
 1001   FORMAT (1H0,4HKM =E16.8,3X,4HKA =E16.8,3X.4HKO =E16.8/)
        J1=DATA(1)+0.002
        WRITE OUTPUT TAPE 6,703
  703   FORMAT (1H1)
        KQ=0
        F1=0.
        ASSIGN 20 TO KK
        T0=SQRTF((DATA(4)-CCC)/ALQ)
        DATA(262)=2.*T0
        DATA(247)=2.*ALQ*T0
        IF(AK)71,70,71
   71   T1=T0+SQRTF((DATA(4)-AK)/ALQ)
        GO TO 11
   70   T1=T0
   11   CONTINUE
        IF(AK)73,72,73
   73   DATA(8)=(T1-X)/700.
        GO TO 74
   72   DATA(8)=(T1-X*0.5)/500.
   74   CONTINUE
        KQ=KQ+1
        CALL AIREK(ARR,X,T1,RO,AK,GG)
        GO TO KK,(20,21)
   20   F2=AR-ARR
        X2=X
        IF(F1*F2)18,9,9
    9   CONTINUE
        IF(KQ-1)90,90,92
   92   CONTINUE
        IF(ABSF(F2)-ABSF(F1))90,90,91
   91   D=-D
   90   CONTINUE
        X1=X
        X=X+D
        F1=F2
        GO TO 11
   18   ASSIGN 21 TO KK
   13   X=-F1*(X2-X1)/(F2-F1)+X1
        GO TO 11
   21   FUN=AR-ARR
```

```
      IF(FUN*F1)14,14,15
   14 IF(ABSF(FUN)-EP)12,12,45
   45 F2=FUN
      X2=X
      GO TO 13
   15 IF(ABSF(FUN)-EP)12,12,53
   53 F1=FUN
      X1=X
      GO TO 13
   12 CONTINUE
      WRITE OUTPUT TAPE 6,703
      WRITE OUTPUT TAPE 6,700,X,FUN
  700 FORMAT (1H0,10X,5HDTA =E16.8,5X,5HEPF =E16.8///)
      WRITE OUTPUT TAPE 6,17,X1,X2,F1,F2
   17 FORMAT (1H0,10X,6HDTA1 =E16.8,5X,6HDTA2 =E16.8,5X,5HEP1 =E16.8,5X,
     15HEP2 =E16.8/)
  802 FORMAT (///1H0,45X,32HCHARACTERISTICS FOR  -SYMMETRIC-///)
  804 FORMAT (///1H0,42X,36HCHARACTERISTICS FOR  -NOT SYMMETRIC-///)
      IF(AK)801,800,801
  800 CONTINUE
      WRITE OUTPUT TAPE 6,1002
      WRITE OUTPUT TAPE 6,802
      GO TO 803
  801 CONTINUE
      WRITE OUTPUT TAPE 6,1002
      WRITE OUTPUT TAPE 6,804
  803 CONTINUE
      WRITE OUTPUT TAPE 6,805,GG(1),GG(2),GG(3)
  805 FORMAT (1H0,10X,10HMAX REAC =E16.8,5X,6HTIME =E16.8,20X,13HI IMP(G
     1OOD) =E16.8///)
      WRITE OUTPUT TAPE 6,806,GG(4),GG(5)
  806 FORMAT (1H0,10X,10HMAX FLUX =E16.8,5X,6HTIME =E16.8//)
      WRITE OUTPUT TAPE 6,807,GG(6),GG(7),GG(8),T1
  807 FORMAT (1H0,10X,4HDT =E16.8,5X,5HDTL =E16.8,5X,5HDTR =E16.8,10X,4H
     1T1 =E16.8/)
      WRITE OUTPUT TAPE 6,44
      GO TO 1
      END

*     LABEL
CAIREK
      SUBROUTINE AIREK(ARR,DTA,T1,RO,AK,GG)
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50)
      DIMENSION HH(100),AM(100),MM(100),BM(100)
      DIMENSION ZZ(2500),XX(2500),YY(2500)
      DIMENSION GG(10)
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN,INZ,J6,DELTA
      COMMON RS,KRK
      IF(AK)91,90,91
   91 AAL=T1-DTA
      ASSIGN 2000 TO KU
      GO TO 92
   90 ASSIGN 5000 TO JU
      AAL=T1-DTA*0.5
   92 CONTINUE
      J1=DATA(1)+0.002
      J2=DATA(2)+1.002
      J3=ABSF(DATA(3))
      J4=ABSF(DATA(4))
      RS=0.
      KK=DATA(500)+0.0002
      KM=KK
```

```
      N=DATA(143)+0.0002
      NN=N-1
      IF(DATA(193))800,800,900
  800 DO 700 I=1,NN,2
      AM(I)=DATA(262)
  700 HH(I)=DATA(8)
      DO 701 I=2,N,2
      AM(I)=DATA(245)
  701 HH(I)=DATA(243)
      X(1)=HH(1)
      KRK=0
      GO TO 901
  900 DO 600 I=1,NN,2
      AM(I)=DATA(245)
  600 HH(I)=DATA(243)
      DO 601 I=2,N,2
      AM(I)=DATA(262)
  601 HH(I)=DATA(8)
      X(1)=HH(1)
      KRK=1
  901 CONTINUE
      JK=1
      JJJ=1
      ACC=AM(JJJ)
   14 IF(DATA(7))15,20,15
   15 CALL INHOUR
   20 DO 25 I=1,J1
      ANS(I)=DATA(I+18)
   25 TVB(I)=ANS(I)
      INZ=0
      J7=0
      JN=0
      TIME(1)=0.0
      TIME(2)=0.0
      IF(ABSF(DATA(5))-1.0)30,30,35
   30 CALL RANAL
      GO TO 40
   35 CALL RTABL
   40 REAC(1)=REAC(2)
      SFW=1.0
      JJ3=J2-1
      DO 45 I=2,JJ3
   45 SFW=SFW+DATA(I+67)*ANS(I)
      SFW=SFW+DATA(J2+67)*ANS(J2)*DATA(6)
      OMEGA(1)=DATA(13)/DATA(14)*((REAC(1)-1.0)+(SFW+DATA(15))/ANS(1))
      WRITE OUTPUT TAPE 6,60,(DATA(I),I=13,15),SFW
   60 FORMAT(1H0,61H BETA EFFECTIVE NEUTRON LIFETIME   SOURCE TERM      S
     XUM  FI*WI/(4E16.8))
      WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(1),ANS(1)
   65 FORMAT(1H0,62H  TIME IN SEC.      REACTIVITY   AVG.INVERSE PER.  NE
     XUTRON FLUX/(4E16.8))
   74 CALL INTER
      IF(JN) 1,22,1
   22 IF(DATA(499)) 23,251,23
   23 CALL CUSPR
  251 IF((TIME(1)+DATA(8))-ACC)302,301,301
  301 X(1)=HH(JJJ+1)
      JJJ=JJJ+1
      ACC=AM(JJJ)+ACC
      JK=1
      KM=KK
      IF(DATA(193))401,401,402
  401 CONTINUE
      CALL RFMAX(XX,YY,ZZ,IP,ARR,AAL,GG)
      DATA(193)=1.
```

```
CCNFBT
      SUBROUTINE CNFBT
      DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
     XCAPR(200),ALPHN(50),CAPC(150)
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN
      JC=1
      DO 1170 I=1,J1
      IF(ABSF(ALPHN(I))-1.0) 1155,1165,1160
 1155 CD=10.0
      CN=1.0
      DO 1157 L=1,7
      CN=CN/CD*ALPHN(I)+1.0
 1157 CD=CD-1.0
      CAPC(JC+2)=CN/3.0
      CAPC(JC+1)=(CAPC(JC+2)*ALPHN(I)+1.0)/2.0
      CAPC(JC)=CAPC(JC+1)*ALPHN(I)+1.0
      GO TO 1170
 1160 IF(ABSF(ALPHN(I))-88.0) 1165,1165,1161
 1161 IF(ALPHN(I)) 1162,1162,1180
 1162 CAPC(JC)=-1.0/ALPHN(I)
      GO TO 1166
 1165 CAPC(JC)=(EXPF(ALPHN(I))-1.0)/ALPHN(I)
 1166 CAPC(JC+1)=(CAPC(JC)-1.0)/ALPHN(I)
      CAPC(JC+2)=(2.0*CAPC(JC+1)-1.0)/ALPHN(I)
 1170 JC=JC+3
 1171 RETURN
 1180 JN=-1
      GO TO 1171
      END

*     LABEL
CDIREC
      SUBROUTINE DIREC
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150)
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN
      IF(JN) 1184,1184,2025
 1184 IF(X(2)-DATA(9)) 1185,1190,1190
 1185 IF(X(1)-DATA(9)) 2000,2000,1190
 1190 X(1)=X(2)
 1191 TIME(2)=TIME(1)
      REAC(2)=REAC(1)
      DO 1195 I=1,J1
 1195 TVB(I)=ANS(I)
      JN=0
      GO TO 2035
 2000 IF(JN) 2005,2015,2025
 2005 WRITE OUTPUT TAPE 6,2010,X(1),(ALPHN(I),I=1,J1)
 2010 FORMAT(1H0,81H  INTERVAL AND F(ALPHA)AT TIME OF FAILURE DUE TO EXC
     XEEDING EXPONENTIAL SUBROUTINE/(6E16.8))
      GO TO 2035
 2015 WRITE OUTPUT TAPE 6,2020,X(1)
 2020 FORMAT(1H0,66H  FAILURE DUE TO ATTEMPTING TO REDUCE INTERVAL BELOW
     X MINIMUM VALUE/(1E16.8))
      JN=1
      GO TO 2035
 2025 WRITE OUTPUT TAPE 6,2030,TVB(1),ANS(1)
 2030 FORMAT(1H0.50H  FAILURE DUE TO RATIO OF N(1)/N(0) IN LOG ROUTINE/(
     X2E16.8))
 2035 RETURN
      END
```

```
*       LABEL
CINHOUR
        SUBROUTINE INHOUR
        DIMENSION DATA(500),REAC(2)
        COMMON  DATA,REAC,J1,J2,J3,J4
        TEMP1=0.0
        DO 1000 I=2,J2
        TEMP2  =DATA(7)-DATA(I+192)
        DATA(I+18)=-DATA(I+192)*DATA(19)/TEMP2
 1000   TEMP1  =TEMP1  +DATA(I+67)/TEMP2
        REAC(1)=(TEMP1  +(DATA(14)/DATA(13)))*DATA(7)
        IF(DATA(5)) 1005,1005,1010
 1005   REAC(1)=REAC(1)*DATA(13)
 1010   IF(DATA(5)-1.0)  1015,1015,1020
 1015   DATA(244)=REAC(1)
 1020   DATA(349)=REAC(1)
        RETURN
        END

*       LABEL
CCUSPR
        SUBROUTINE CUSPR
        DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
       XCAPR(200),ALPHN(50),CAPC(150),DELTA(50)
        COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAP
       X,ALPHN,JC,J7,JN,INZ,J6,DELTA
        WRITE OUTPUT TAPE 6,3000,ANS(1)
 3000   FORMAT(1H0,10HDUMMY ANSW/(1E12.8))
        RETURN
        END
```

```
      MI=K+JJJJ
    1 SUM=SUM+DATA(K+262)*TVB(MI)
      REAC(2)=REAC(2)+SUM
      IF(DATA(5))1065,1070,1070
 1065 REAC(2)=REAC(2)/DATA(13)
 1070 RETURN
      END

*     LABEL
CINTER
      SUBROUTINE INTER
      DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
     X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50)
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     X,ALPHN,JC,J7,JN,INZ,J6,DELTA
   75 JR=1
      IF(ABSF(DATA(5))-1.0)80,80,85
   80 CALL RANAL
      GO TO 90
   85 CALL RTABL
   90 CALL RNFBT
      X(2)=X(1)/2.0
      ALPHN(1)=(REAC(1)-1.0)*X(2)*DATA(13)/DATA(14)
      DO 95 I=2,J1
   95 ALPHN(I)=X(2)*DATA(I+192)
      CALL CNFBT
      IF(JN) 96,97,96
   96 CALL DIREC
      IF(JN) 256,75,256
   97 JR=1
      JT=0
      JC=1
      DO 105 I=1,J1
      DELTA(I)=((ALPHN(I)*ANS(I))+(CAPR(JR)*X(2)))*CAPC(JC)
      JR=JR+4
      JC=JC+3
      IF(DELTA(I)-(2.0**(-14))*ANS(I)) 105,100,100
  100 JT=0
  105 TVB(I)=ANS(I)+DELTA(I)
      JR=2
      TIME(2)=TIME(1)+X(2)
      IF(ABSF(DATA(5))-1.)110,110,115
  110 CALL RANAL
      GO TO 120
  115 CALL RTABL
  120 CALL RNFBT
      JR=1
      JC=1
      DO 125 I=1,J1
      DELTA(I)=DELTA(I)+(X(2)*CAPC(JC+1)*(CAPR(JR+1)-CAPR(JR)))
      JR=JR+4
      JC=JC+3
  125 TVB(I)=ANS(I)+DELTA(I)
      JR=3
      IF(ABSF(DATA(5))-1.)130,130,135
  130 CALL RANAL
      GO TO 140
  135 CALL RTABL
  140 CALL RNFBT
      DO 150 I=1,J1
  150 ALPHN(I)=X(1)*ALPHN(I)/X(2)
      CALL CNFBT
      IF(JN) 151,152,151
  151 CALL DIREC
```

```
      IF (JN) 256,75,256
  152 JR=1
      JC=1
      DO 160 I=1,J1
      DELTA(I)=2.0*X(1)*CAPC(JC+1)*(CAPR(JR+2)-CAPR(JR))+CAPC(JC)*(X(1)*
     XCAPR(JR)+ALPHN(I)*ANS(I))
      TVB(I)=DELTA(I)+ANS(I)
      JC=JC+3
  160 JR=JR+4
      TIME(2)=TIME(1)+X(1)
      IF (DATA(498)) 161,164,161
  161 JR=4
      IF(ABSF(DATA(5))-1.)162,162,163
  162 CALL RANAL
      GO TO 166
  163 CALL RTABL
  166 CALL RNFBT
      JR=1
      JC=1
      DO 168 I=1,J1
      DELTA(I)=DELTA(I)+X(1)*(CAPR(JR+3)-2.0*CAPR(JR+2)+CAPR(JR))*(2.0*C
     XAPC(JC+2)-CAPC(JC+1))
      JR=JR+4
      JC=JC+3
  168 TVB(I)=DELTA(I)+ANS(I)
  164 CONTINUE
      IF(ABSF(DATA(5))-1.)165,165,170
  165 CALL RANAL
      GO TO 175
  170 CALL RTABL
  175 CALL RNFBT
      OMEGA(3)=DATA(13)/DATA(14)*((REAC(2)-1.0)+(SFW+DATA(15))/TVB(1))
      IF(TVB(1)/ANS(1)) 180,180,190
 180  JN=1
      CALL DIREC
      GO TO 256
  190 OMEGA(2)= (LOG F(TVB(1)/ANS(1)))/X(1)
      IF(JT) 191,250,191
  191 IF(DATA(6)) 200,200,195
  195 IF(J6) 200,200,250
  200 Q=X(1)*ABSF(OMEGA(3)-2.0*OMEGA(2)+OMEGA(1))*CAPC(2)/(CAPC(1)+1.0)
      IF(DATA(16)) 205,230,205
  205 IF(DATA(16)-OMEGA(3)) 230,210,210
  210 IF(ABSF(DATA(15)/TVB(1)+REAC(2))-DATA(17)) 230,230,215
  215 IF(INZ) 225,220,225
  220 INZ=1
      X(2)=DATA(9)
      GO TO 245
  225 IF(ABSF(OMEGA(3))-DATA(16)) 250,230,230
  230 IF(Q-DATA(11)) 235,250,245
  235 IF(Q-DATA(12)) 240,250,250
  240 X(1)=2.0*X(1)
      GO TO 250
  245 CALL DIREC
      IF (JN) 256,75,256
  250 TIME(1)=TIME(2)
      OMEGA(1)=OMEGA(3)
      REAC(1)=REAC(2)
      DO 255 I=1,J1
  255 ANS(I)=TVB(I)
  256 RETURN
      END

*     LABEL
```

```
      DIMENSION SFW(1)
      COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
     1,ALPHN,JC,J7,JN
      JJ3=J2-1
      SFW=1.0
      DO 1150 I=2,JJ3
 1150 SFW=SFW+DATA(I+67)*TVB(I)
      SFW=SFW+DATA(J2+67)*TVB(J2)*DATA(6)
      CAPR(JR)=((REAC(2)-REAC(1))*TVB(1)+SFW+DATA(15))*DATA(13)/DATA(14)
      IF(DATA(18))3,3,2
    2 DO 4 I=2,J1
      JR=JR+4
    4 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+142)*DATA(19)
      GO TO 6
    3 J1=J1-6
      DO 1153 I=2,J1
      JR=JR+4
 1153 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+142)*DATA(19)
      SLB1=0.0
      DO 8476 I=1,5
      J1AI=J1+I+1
 8476 SLB1=SLB1+DATA(I+318)*TVB(J1AI)
      DATA(492)=SLB1
      SLB2=DATA(324)*TVB(J1+1)
      DO 8477 I=1,4
      J1BI=J1+I+2
 8477 SLB2=SLB2+DATA(I+324)*TVB(J1BI)
      DATA(493)=SLB2
      SLB3=0.0
      DO 8478 I=1,2
      J1CI=J1+I
 8478 SLB3=SLB3+DATA(I+328)*TVB(J1CI)
      DO 8479 I=1,3
      J1DI=J1+I+3
 8479 SLB3=SLB3+DATA(I+320)*TVB(J1DI)
      DATA(494)=SLB3
      SLB4=0.0
      DO 8480 I=1,3
      J1EI=J1+I
 8480 SLB4=SLB4+DATA(I+333)*TVB(J1EI)
      DO 8481 I=1,2
      J1FI=J1+I+4
 8481 SLB4=SLB4+DATA(I+336)*TVB(J1FI)
      DATA(495)=SLB4
      SLB5=0.0
      DO 8482 I=1,4
      J1GI=J1+I
 8482 SLB5=SLB5+DATA(I+338)*TVB(J1GI)
      SLB5=SLB5+DATA(I+343)*TVB(J1+6)
      DATA(496)=SLB5
      SLB6=0.0
      DO 8483 I=1,5
      J1HI=J1+I
 8483 SLB6=SLB6+DATA(I+343)*TVB(J1HI)
      DATA(497)=SLB6
      J1T=J1+1
      J1=J1+6
      DO 8484 I=J1T,J1
      JR=JR+4
      LLL=I+13-J1+484
 8484 CAPR(JR)=DATA(I+92)*TVB(1)+DATA(I+ 142)*DATA(19)+DATA(LLL)
    6 RETURN
      END
```

```
*       LABEL
CRTABL
        SUBROUTINE RTABL
        DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2)
        COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X
        K=0
        DO 1130 I=2,70
        IF(TIME(2)-DATA(I+419))1100,1130,1130
 1100   K=I-1
        REAC(2)=((TIME(2)-DATA(K+419))/(DATA(K+420)-DATA(K+419)))*(DATA(K+
       1349)-DATA(K+348))+DATA(K+348)
        SUM=0.0
        JJJ=J1-J2
        DO 5 K=1,JJJ
        MI=K+J2
    5   SUM=SUM+DATA(K+262)*TVB(MI)
        REAC(2)=REAC(2)+SUM
        IF(DATA(5)) 1120,1120,1140
 1120   REAC(2)=REAC(2)/DATA(13)
        GO TO 1140
 1130   CONTINUE
 1140   RETURN
        END

*       LABEL
CRANAL
        SUBROUTINE RANAL
        DIMENSION  DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3)
       X,CAPR(200),ALPHN(50),CAPC(150),DELTA(50),IERR(1)
        COMMON DATA,REAC,J1,J2,J3,J4,ANS,TVB,TIME,X,OMEGA,SFW,CAPR,JR,CAPC
       X,ALPHN,JC,J7,JN,INZ,J6,DELTA
        COMMON RS,KRK
        IF(KRK)5,5,6
    5   CONTINUE
        IF(DATA(193))3,3,4
    4   REAC(2)=DATA(244)+DATA(246)
        GO TO 9
    3   CONTINUE
        TACT=TIME(2)-(DATA(245)+DATA(262))*RS
        REAC(2)=DATA(244)+DATA(246)+DATA(247)*TACT    +DATA(248)*(TACT    **
       12)+DATA(249)*(TACT    **3)+DATA(250)*SINF(DATA(259)*TACT    )+DATA(2
       251)*SINF(DATA(259)*TACT    *2.)+DATA(252)*SINF(DATA(259)*TACT    *3.
       3)+DATA(253)*COSF(DATA(260)*TACT    )+DATA(254)*COSF(DATA(260)*TACT
       4   *2.)+DATA(255)*COSF(DATA(260)*TACT    *3.)+DATA(256)*EXPF(DATA(26
       51)*TACT    )+DATA(257)*EXPF(DATA(261)*TACT    *2.)+DATA(258)*EXPF(DA
       6TA(261)*TACT    *3.)
        GO TO 9
    6   CONTINUE
        IF(DATA(193))7,7,8
    8   REAC(2)=DATA(244)+DATA(246)
        GO TO 9
    7   CONTINUE
        TACT=TIME(2)-(DATA(245)+(DATA(245)+DATA(262))*RS)
        REAC(2)=DATA(244)+DATA(246)+DATA(247)*TACT    +DATA(248)*(TACT    **
       12)+DATA(249)*(TACT    **3)+DATA(250)*SINF(DATA(259)*TACT    )+DATA(2
       251)*SINF(DATA(259)*TACT    *2.)+DATA(252)*SINF(DATA(259)*TACT    *3.
       3)+DATA(253)*COSF(DATA(260)*TACT    )+DATA(254)*COSF(DATA(260)*TACT
       4   *2.)+DATA(255)*COSF(DATA(260)*TACT    *3.)+DATA(256)*EXPF(DATA(26
       51)*TACT    )+DATA(257)*EXPF(DATA(261)*TACT    *2.)+DATA(258)*EXPF(DA
       6TA(261)*TACT    *3.)
    9   SUM=0.0
         JJJJ=J2
        JJJ=J1-JJJJ
        DO 1 K=1,JJJ
```

```
      RS=RS+1.
      GO TO 400
  402 DATA(193)=0.
  400 CONTINUE
      WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(2),ANS(1)
      WRITE OUTPUT TAPE 6,1111,ARR
 1111 FORMAT (1H0,10X,7HI IMP =E16.8,10X,13HEND ITERATION///)
      GO TO 300
  302 CONTINUE
      IF(AK)4001,4000,4001
 4000 CONTINUE
      GO TO JU,(5000,5001,1000)
 5000 IF((TIME(1)+DATA(8)*0.5)-AAL)1000,3001,3001
 3001 DATA(15)=R0
      DATA(8)=DTA/100.
      X(1)=DATA(8)
      AAR=(T1+DTA*0.5)
      ASSIGN 5001 TO JU
 5001 IF((TIME(1)+DATA(8)*0.5)-AAR)1000,3002,3002
 3002 DATA(8)=(T1-DTA*0.5)/500.
      X(1)=DATA(8)
      DATA(15)=0.
      ASSIGN 1000 TO JU
      GO TO 1000
 4001 CONTINUE
      GO TO KU,(2000,2001,2002,1000)
 2000 CONTINUE
      IF((TIME(1)+DATA(8)*0.5)-AAL)1000,1001,1001
 1001 DATA(15)=R0
      RRR=DATA(8)
      DATA(8)=DTA/100.
      X(1)=DATA(8)
      ASSIGN 2001 TO KU
      AAR=T1
 2001 CONTINUE
      IF((TIME(1)+DATA(8)*0.5)-AAR)1000,1002,1002
 1002 DATA(8)=RRR*0.2
      X(1)=DATA(8)
      DATA(15)=0.
      ASSIGN2002 TO KU
      BBR=T1+RRR*40.
 2002 CONTINUE
      IF((TIME(1)+DATA(8)*0.5)-BBR)1000,1003,1003
 1003 DATA(8)=(T1-DTA)/700.
      X(1)=DATA(8)
      ASSIGN 1000 TO KU
 1000 CONTINUE
      IF(DATA(193))333,111,333
  111 XX(JK)=TIME(1)
      YY(JK)=ANS(1)
      ZZ(JK)=REAC(1)
  333 CONTINUE
      IF(JK-KM)991,990,991
  990 WRITE OUTPUT TAPE 6,65,TIME(1),REAC(1),OMEGA(2),ANS(1)
      KM=KM+KK
  991 JK=JK+1
      IP=JK
  300 CONTINUE
      IF(JJJ-N)74,74,1
    1 CONTINUE
      DATA(193)=0.
      RETURN
      END
```

```
*       LABEL
CRFMAX
        SUBROUTINE RFMAX(XX,YY,ZZ,IP,RQ,PP,GG)
        DIMENSION ZZ(2500),XX(2500),YY(2500)
        DIMENSION GG(10)
        DO 30 I=2,IP
        IF (ZZ(I))30,60,60
   60   IF(ZZ(I)-ZZ(I-1))31,30,30
   31   A=ZZ(I-1)
        T=XX(I-1)
        GG(1)=A
        GG(2)=T
        GO TO 33
   30   CONTINUE
   33   CONTINUE
        DO 90 I=1,IP
        IF(XX(I)-PP)90,90,91
   90   CONTINUE
   91   KKK=I+3
        DO 1 I=KKK,IP
        IF(YY(I)-YY(I-1))2,1,1
    2   A=YY(I-1)
        T=XX(I-1)
        TM=T
        GG(4)=A
        GG(5)=T
        GO TO 6
    1   CONTINUE
    6   CONTINUE
        S=A*0.5
        DO 3 I=KKK,IP
        IF(YY(I)-S)3,5,5
    5   A=YY(I)
        T=XX(I)
        TT=T
        DTL=TM-TT
        J=I
        GO TO 8
    3   CONTINUE
    8   CONTINUE
        DO 9 K=J,IP
        IF(YY(K)-S)10,9,9
   10   A=YY(K-1)
        T=XX(K-1)
        GO TO 11
    9   CONTINUE
   11   CONTINUE
        DT=T-TT
        DTR=T-TM
        RQ=0.
        DO 40 K =2,IP
   40   RQ=RQ+(YY(K)+YY(K-1))*(XX(K)-XX(K-1))*0.5
        GG(3)=RQ
        GG(6)=DT
        GG(7)=DTL
        GG(8)=DTR
        RETURN
        END

*       LABEL
CRNFBT
        SUBROUTINE RNFBT
        DIMENSION DATA(500),REAC(2),ANS(50),TVB(50),TIME(2),X(2),OMEGA(3),
       1CAPR(200),ALPHN(50),CAPC(150)
```

EURATOM - CETIS

INPUT TYPICAL CASE FOR "SOURCE"

GENERAL DATA

	1–12	13–24	25–36	37–48	49–60	61–72
3	1	6				
4	1.	0.	0.	.9968	-1.	0.
5	13	19				
6	.0064	.2 -07	0.	0.	0.	1.
7	.165					
8	143	143				
9	1.					
10	244	248				
11	-0.0352	0.	0.	0.	-.533232 +06	
12	497	-500				
13	0.	1.	0.	2600.		

PARTICULAR DATA

	1–12	13–24	25–36	37–48	49–60	61–72
17	.1246 -04	.2 -07	.00846	.00008	1000.	.533232 +06
18	0.					

```
  1  0.100000E 01     2  0.               3  0.                4  0.996800E 00     5 -0.100000E 01
  6  0.
 13  0.640000E-02    14  0.200000E-07    15  0.               16  0.               17  0.
 18  0.100000E 01    19  0.165000E-00
143  0.100000E 01
244 -0.352000E-01   245  0.             246  0.              247  0.              248 -0.533232E 06
497  0.             498  0.100000E 01   499  0.              500  0.260000E 04
```

```
DTAO =  0.1246E-04   D =  0.2000E-07   ALQ =  0.5332E 06   RO =  0.1000E 04   IO =  0.8460E-02   EP =  0.8000E-04

KM =  0.99680000E 00   KA =  0.              KO =  0.96480000E 00
```

```
BETA EFFECTIVE NEUTRON LIFETIME   SOURCE TERM     SUM  FI*WI
0.63999999E-02  0.20000000E-07  0.              0.09999999E 01

 TIME IN SEC.     REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.             -0.55000000E 01 -0.14060605E 06  0.16500000E-00

 TIME IN SEC.     REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.48994207E-03 -0.54999018E 01 -0.63093631E 04  0.15431632E-00

        I IMP =  0.84555694E-02         END ITERATION

BETA EFFECTIVE NEUTRON LIFETIME   SOURCE TERM     SUM  FI*WI
0.63999999E-02  0.20000000E-07  0.              0.09999999E 01

 TIME IN SEC.     REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.             -0.55000000E 01 -0.14060605E 06  0.16500000E-00

 TIME IN SEC.     REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.48994298E-03 -0.54999391E 01 -0.63093678E 04  0.15431544E-00

        I IMP =  0.84688751E-02         END ITERATION

BETA EFFECTIVE NEUTRON LIFETIME   SOURCE TERM     SUM  FI*WI
0.63999999E-02  0.20000000E-07  0.              0.09999999E 01

 TIME IN SEC.     REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.             -0.55000000E 01 -0.14060605E 06  0.16500000E-00

 TIME IN SEC.     REACTIVITY   AVG.INVERSE PER.  NEUTRON FLUX
0.48994408E-03 -0.54999839E 01 -0.63093537E 04  0.15431437E-00

        I IMP =  0.84601099E-02         END ITERATION
```

DTA = 0.12466659E-04 EPF = -0.11001248E-06

DTA1 = 0.12459999E-04 DTA2 = 0.12480000E-04 EP1 = 0.44304179E-05 EP2 = -0.88751549E-05

CHARACTERISTICS FOR -SYMMETRIC-

MAX REAC = 0. TIME = 0. I IMP(GOOD) = 0.84601099E-02

MAX FLUX = 0.66486940E 03 TIME = 0.25120536E-03

DT = 0.12403063E-04 DTL = 0.10970630E-04 DTR = 0.14324323E-05 T1 = 0.24497224E-03

ADDENDUM TO : EUR 2552e

NOTE:

The pages containing listings and samples of the programs were unfortunately mixed altogether in the version you have received. So as to have them in the right order, do the following:

1) Number the pages starting from the beginning of the listing of AIREK-PUL TWO GROUP (VERSION FOR SEVERAL PULSES) (The numbers will be 1,2,3,4,.........16)

2) Number the pages starting from the beginning of the listing of AIREK-PUL FEW GROUP AND TWO POINT (The numbers will be 1,2,3,...........20)

3) Number the pages starting from the beginning of the listing of AIREK-PUL SOURCE (The numbers will be 1,2,3,.......... 14)

4) Now read the contents following the numeration (respectively for the 3 programs mentioned above):

- 1,2,3,4,5,6,7,1o,11,8,9,14,15, 12,13,16
- 1,2,3,4,5,6,7,12,13,14,15,8,9,1o,11,16,17,18,19,20
- 1,2,3,1o,11,8,9,6,7,4,5,12,13,14

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Alfred Nobel

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