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FITPULS

**A Code for Obtaining Analytic Fits to Aggregate
Fission-Product Decay-Energy Spectra**

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FITPULS
A CODE FOR OBTAINING ANALYTIC FITS TO AGGREGATE
FISSION-PRODUCT DECAY-ENERGY SPECTRA

by

R. J. LaBauve, D. C. George, and T. R. England

ABSTRACT

This report describes the operation and input to the FITPULS code, recently updated to utilize interactive graphics. The code is designed to retrieve data from a library containing aggregate fine-group spectra (150 energy groups) from fission products, collapse the data to few groups (up to 25), and fit the resulting spectra along the cooling time axis with a linear combination of exponential functions. Also given in this report are useful results for aggregate gamma and beta spectra from the decay of fission products released from ^{235}U irradiated with a pulse (10^{-4} s irradiation time) of thermal neutrons. These fits are given in 22 energy groups that are the first 22 groups of the LASL 25-group decay-energy group structure, and the data are expressed both as MeV per fission second and particles per fission second; these pulse functions are readily folded into finite fission histories.

I. INTRODUCTION

Aggregate fission-product beta and gamma spectra in 150 energy groups (the PEFPYD library)¹ have been generated from ENDF/B-IV using the CINDER-10 summation code and other Los Alamos Scientific Laboratory (LASL) processing codes as described in Ref. 1. The FITPULS code is designed to collapse the 150 energy-group fission-product spectra to few groups (up to 25) and fit the resulting spectra along the cooling time axis with a linear combination of exponential functions. An earlier version of FITPULS is described in Ref. 1, including 11-group fits, but recently the code has been updated to improve resulting fits by using

interactive graphics. It is the purpose of this report to describe the operation of and input to this version of FITPULS and to provide specific 22-group spectrum fits for the ^{235}U thermal fission products. Familiarity with Ref. 1 may be of help to the reader, particularly in definition of units and utility of the fitted data. The energy boundaries of the 11 groups used in Ref. 1 correspond to boundaries of the 22-group structure used in this report. Reference 1, however, provides fits for several fissioning nuclides.

The PEFPHYD library contains data generated for a pulse, that is, for an irradiation time of 10^{-4} s using ENDF/B-IV data. (NOTE: 10^{-4} s is arbitrary but is small compared to fission-product lifetimes, hence adequate for defining a pulse.) Analytic fits to this pulse data are very convenient for design applications, as these functions can be folded with a reactor power history, for example, so that decay spectra for irradiated fuel can be calculated as a function of cooling time. Simple approximations can be added to account for neutron absorption.¹⁻³ Such fitted functions have been provided for the American Nuclear Society standard for decay-heat power in light water reactors.⁴

II. OPERATION OF FITPULS

The FITPULS code can either take the aggregate of data for various cooling times t after a pulse irradiation and fit it with a linear combination of functions $f_c(t)$,

$$f_c(t) = \sum_{i=1}^n \alpha_i e^{-\lambda_i t} \quad , \quad (\text{MeV /fission-second}) \quad (1)$$

where the α_i and λ_i are determined by the code, or the code can take data following one or more finite irradiation times, reduce these to a single equivalent pulse, and obtain the α_i and λ_i for the result. [By an equivalent pulse we mean a function, as in Eq. (1), that will duplicate to great accuracy the initial input values when folded into the finite fission history. The function is not unique even for the case of a single input experiment.] Pulse fits are usually done for calculated data, as from the CINDER-10 code, whereas fits for experimental data generally require the finite irradiation time option. In fact, data from several experiments with different irradiation times can be entered into the code together; the resulting fit will converge to a minimum chi-square, and

percent deviations from the use of the pulse will be obtained for each experimental point.

Normally, experimental decay data are for relatively large energy bins or even for a single total summed over all energies, so that rebinning is unnecessary. For the calculated data, however, the 150-group energy bins (in equal widths of 0.05 MeV) need to be reduced to 25 or less by rebinning into wider bins in order to make the fits useful. Routines for doing this are contained in FITPULS in which the bounds of the subset groups need not coincide with those for the 150 fine groups. An option is also available for expressing the regrouped data in either MeV per fission-second or numbers of particles per fission-second.

FITPULS contains three options for obtaining the parameters for the fits to the rebinned decay-energy spectra. In the first option, both the α_i 's and λ_i 's are obtained by a simple stripping method beginning at the long cooling time end. Semi-log slopes ($\Delta \log FX / \Delta t$) where (t, FX) are the points to be fitted, and coefficients are calculated for pairs of points beginning with the two extreme cooling times. The contributions of the α and λ from a particular pair of points are removed from the remaining points before proceeding to the next pair. If a particular point is within 5% of the value calculated by using the current α and λ , it is considered to be "on the same slope" and is not used in a subsequent α , λ calculation. This stripping process continues automatically in the code until the data points are exhausted, but regions of data requiring negative coefficients as, for example, regions where the slope reverses, are skipped. These regions are subsequently handled with interactive graphics in another routine in the code as described in the example problem below.

The first fitting option does not require initial guesses for either α_i or λ_i , but input values for the λ_i are required for the second option. The method used in this single-parameter fit, that is, a least-squares fit of the α_i 's given adequately chosen λ_i 's, is described in Ref. 5. The λ_i 's can be taken from previously obtained fits for a similar problem; gamma-decay energy spectra for a different set of yields, for example; or the reciprocals of a number of cooling times taken over the range of interest can be used for input λ_i 's. The second option must be used if the data to be fit is for a finite irradiation time, as the first option only works for a pulse. Note that option 2 is not too efficient; and, as a matter of fact, this option should only be used if it is impossible to use either options 1 or 3.

In the third and final option, a non-linear least-squares routine⁶ is used. This routine requires fairly good guesses for both the α_i 's and λ_i 's in order to get good results. These can be obtained either from previous fits with similar shapes or from first running options one or perhaps two. As would be expected, running time for this option is an order of magnitude or more greater than the running time for options one and two, incurring that much greater expense. It is necessary, however, to exercise this option if fits to within a few per cent over large cooling time ranges (over about ten decades) are desired.

III. INPUT AND SAMPLE PROBLEMS

A description of the overlay structure and a listing of the FITPULS code is contained in Appendix A. A description of the FITPULS input specifications is given in Table I. Note that the input description given in Ref. 1 is now obsolete, as also is the description of running a sample problem.

As the first sample problem, consider a multigroup collapse of the PEFPYD data for the aggregate decay-energy gamma spectra of fission products produced by a pulse (10^{-4} s irradiation time) of thermal neutrons on ^{235}U . (MAT = 1261, MF=80, MT=803, see Table II for definition of MAT, MF, and MT numbers in PEFPYD.) The PEFPYD data used in this problem were processed from a CINDER-10 output run for a cooling time range from 0.0 to 10^{10} s in six time steps per decade. We shall specify a cooling time range of 0.1 to 10^9 s for this example and a broad-group structure containing groups 1-22 of the LASL decay energy-group structure shown in Table III.⁷ The group structure is truncated at group 22 since the PEFPYD library contains insufficient spectral data above 7 MeV to obtain realistic fits.

In this first example, we choose the units of MeV per fission-second and choose to use the first fitting option for the first pass, which calls for the use of interactive graphics. This is done by setting the input as follows.

Input to Program FITPULS

```
Card 1      NPUN = 20
            IRAD = 0
            NCORS = 0
            NIAPL = 1
```

Input to Subroutine CORSBIN

```
Card 1A     MAT1 = 1261
            MF1 = 80
            MT1 = 803
            MEVU = 0
```

TABLE I

FITPULS INPUT SPECIFICATIONS

<u>Card No.</u>	<u>Format</u>	<u>Variable</u>	<u>Comment</u>
1	12I6	NPUN	Set NPUN = 7 if rebinned data file wanted; otherwise set to 20.
		IRAD	Set IRAD = 0 for regular pulse fit. Set IRAD = 1 to reduce finite irradiation data to pulse.
		NCORS	Set NCORS = 0 to call subroutine CORSBIN. Set NCORS = 1 for no call, i.e., if input data is not to be rebinned, which is usually the case for fitting experimental data (IRAD = 1).
		NIAPL	Set NIAPL = 1 if first fitting option using interactive graphics is desired. Set NIAPL = 0 if second or third option using file 7 output from previous problem is desired. Otherwise, set NIAPL = -1.
(Input continued in OVRLAY1)			
2	8A10	TITL(I)	80 character title, if TITL(1) = SELECT, subroutine SELECT is called and this input goes here (see SELECT input). If TITL(1) = DO NOT GO, program stops.
3	12I6	IPROB	Problem No. Make negative if fit is to be made in segments. See conditional input below.
		NTOTER	Option to read experimental data. See subroutine RUNTOTS.
		NPUN	Flag for file 7 output. Set equal to 7 if file 7 output is desired, equal to 20 if file 7 output is not desired. In general file 7 output is needed for subsequent runs.
		NSTEP	Flag to call subroutine DHFIT, which calls the routine STEPIT that performs a non-linear least-squares fit. Routine usually not called until a couple of passes are made to get a coarse adjustment of the parameters using more rapid options. Set equal to zero if DHFIT is not desired,

			otherwise set to 1. Also note below option for calling DHFIT by group.
		NFINL	Flag for option to read all parameters for all groups from previous problem. Used when striving for final convergence. Set equal to 1 to activate, otherwise set equal to zero. See conditional input below.
4	6E12.5	DIFLIM	Maximum per cent deviation allowed in STEPIT. Set high on initial passes and tighten up as desired convergence is approached.
		RUNTIM	Running time. Make fraction of second less than execution time to get file 7 for subsequent run.
		TMIN	Minimum cooling time desired. If set to zero, code will choose minimum cooling time available on data file.
		TMAX	Maximum cooling time desired. If set to zero, code will choose maximum cooling time available on data file.
		GXMIN	Minimum allowed value of decay energy. Set so fit is limited to about 15 decades.
5	12 I6	KKN(I)	Flags for calling for fits by group. If call for a particular group, say Group IG, is desired, set KKN(IG) = IG. If call is not desired, set KKN(IG) = zero.

FITPULS Conditional Input

(Input for subroutine CORSBIN, after card 1 if NCORS = 0)

1A	6 I11	MAT1	MAT-No. of desired fissioning nuclide.
		MF1	MF desired (incident energy type).
		MT1	MT desired (particle/photon data type).
		MEVU	MEVU = 0, units are in MeV/fiss-s. MEVU = 1, units are in particles/fiss-s.
2A	6 I11	NE	No. of desired broad groups + 1.
3A	6E11.4	EB(I)	Energy bounds in MeV, including lower and upper bounds. Read low to high energy.

(Input for subroutine SELECT, after card 2 if TITL(1) = SELECT)

1B	12I6	ITS,ITP	No. of time steps desired, indexes of desired time steps. SELECT used if one wishes to fit a subset of particular data file, and this input follows the title card.
----	------	---------	---

(Input for subroutine RUNTOTS, after card 2 if NTOTER = 1)

The read statements in this subroutine should be changed to conform with format in which data is received. See subroutine.

If NIAPL = 0 or NFIN = 1, file 7 output from a previous problem must be attached after card 5. This file, in an ENDF-like format, contains alphas and lambdas for all groups.

(Input for subroutine TRMSEE, after file 7 output and for each group IG where KKN(IG) = -IG)

1C	12I6	MLT	Number of parameters to be changed.
2C	I6	L	Time step number of parameters to be changed.
	E12.5	ALF(K,L)	New value of alpha
	E12.5	ALAM(K,L)	New value of lambda
3C	12I6	LT	No. of terms to be removed.
		LTM(I)	Term nos. of terms removed.

IPROB set negative allows the data for the groups to be fitted in several segments, and card 6 is read after card 5.

6	12I6	NSEG	No. of segments plus 1.
		NS(I)	Breakpoints of segments.

(Input for subroutine PULSFIT, after card 5 or 6 if NIAPL = -1.)

1D	12I6	LWT	Weight function desired in single parameter fit. If LWT = 0, weight function = 1. If LWT = 2, weight function = 1/FX. If LWT = 2, weight function = $1/FX^2$. If LWT = 3, weight function = $1/FX^{1.5}$. (Here, FX = MeV/fiss-s values to be fitted.)
		KTRM	No. of lambdas to be read in.
		IPRT	Print flag; if IPRT = 1, print A matrix. If IPRT = 0, no print.

2D	12I6	IWANT	Select lambdas wanted by position number. If all are to be retained, as in a first pass, set equal to zero.
		KCAL(L)	Position nos. of lambdas to be kept. Do not enter if IWANT = 0.

TABLE II

DEFINITION OF MAT, MF, MT NUMBERS USED IN PEPFYD

- MAT: Mat-No. of target nucleus, same as in ENDF/B.
- MF: File No., used to identify energy type of incident neutron, defined as follows:
- MF=80 - fission induced by thermal neutrons.
 - MF=81 - fission induced by fast neutrons.
 - MF=82 - fission induced by high-energy (14-MeV) neutrons.
- MT: Section number used to describe data contents of the sections. MT numbers are as follows:
- MT=801 - delayed energy/fission for $\beta^- + \gamma$ summed over all fission products.
 - MT=802 - delayed energy/fission for β^- summed over all fission products.
 - MT=803 - delayed energy/fission for γ summed over all fission products.
 - MT=811 - delayed energy/fission for $\beta^- + \gamma$ summed over all gaseous fission products (halogens plus noble gases).
 - MT=812 - delayed energy/fission for β^- summed over all gaseous fission products.
 - MT=813 - delayed energy/fission for γ summed over all gaseous fission products.
 - MT=821 - delayed energy/fission for $\beta^- + \gamma$ summed over the noble gas fission products.
 - MT=822 - delayed energy/fission for β^- summed over noble gas fission products.
 - MT=823 - delayed energy/fission for γ summed over noble gas fission products.
 - MT=831 - delayed energy/fission for $\beta^- + \gamma$ summed over halogen fission products.
 - MT=832 - delayed energy/fission for β^- summed over halogen fission products.
 - MT=833 - delayed energy/fission for γ summed over halogen fission products.

TABLE III
LASL GROUP STRUCTURE FOR DECAY ENERGY

<u>Group No.</u>	<u>E-Low (MeV)</u>	<u>E-High (MeV)</u>	<u>Delta-E (MeV)</u>
1	0.00000	0.01000	0.01000
2	0.01000	0.10000	0.09000
3	0.10000	0.30000	0.20000
4	0.30000	0.40000	0.10000
5	0.40000	0.50000	0.10000
6	0.50000	0.70000	0.20000
7	0.70000	0.90000	0.20000
8	0.90000	1.00000	0.10000
9	1.00000	1.12500	0.12500
10	1.12500	1.33000	0.20500
11	1.33000	1.50000	0.17000
12	1.50000	1.66000	0.16000
13	1.66000	1.87500	0.21500
14	1.87500	2.00000	0.12500
15	2.00000	2.33300	0.33300
16	2.33300	2.66600	0.33300
17	2.66600	3.00000	0.33400
18	3.00000	3.50000	0.50000
19	3.50000	4.00000	0.50000
20	4.00000	5.00000	1.00000
21	5.00000	6.00000	1.00000
22	6.00000	7.00000	1.00000
23	7.00000	8.00000	1.00000
24	8.00000	9.00000	1.00000
25	9.00000	10.00000	1.00000

Card 2A NE = 23

Card 3A (Group bounds from Table III)

Input to OVLAY1

Card 2 Title Card

Card 3 IPROB = 1
 NTOTER = 0
 NPUN = 7
 NSTEP = 0
 NFINL = 0

Card 4 DIFLIM = 5.0 (used in second pass)
 RUNTIM = 295.0 (used in second pass)
 TMIN = 0.1
 TMAX = 1.0E+9
 GXMAX = 1.0E-21

Card 5 KKN(K) = group numbers, 1-22

If the first fitting option is specified as in this example (NIAPL=1), the code must be run from a graphics terminal so that displayed intermediate results can be viewed and acted upon. Although all groups are treated interactively, for purposes of illustration we will discuss the interactive graphics operation for only two groups, namely 12 and 16.

First, consider the fitting for group 12. Figure 1 shows the result of a fit in which only positive coefficients are allowed, which can be done by not entering data points requested from interactive graphics. In the figure, six point per decade data from the PEFPHYD library are represented by asterisks; the curve computed from the calculated parameters is represented by a solid line. Note that the fit overshoots in the region 6×10^4 to 4×10^5 s cooling time. As is evident from the figure, negative coefficients are needed in this region to correctly represent the reverse in slope. Table IV, taken from the code output File 20, shows the actual numerical values plotted in Fig. 1, and in addition, the per-cent difference between the computed and original values. As can be seen from this table, the difference exceeds 100% at a cooling time of 1×10^5 s. Note also in Table IV that the first three points overshoot by more than 10%. Parameters calculated using the first fitting option but bypassing the interactive graphics feature are the first 12 in Table V under the heading "Option I" values.

The first figure that appears on the graphics terminal screen for this group (12) is reproduced as Fig. 2. This is for the first "region" that contains at least three contiguous points for which differences between computed and original values exceed 10%, and these differences are plotted on a log scale against the representative cooling times on a linear scale. A vector is drawn between the last two points to aid the eye in selecting those points to be used in computing the parameters. Note in Fig. 2 that points 1 and 3 were selected. The code then computes the slope $[\Delta(\log FX)/\Delta t]$ between the selected points (1 and 3), and using this slope next computes the coefficients for the selected points (1,3) and each point in between (2). Finally, an average coefficient is calculated for this set by simply averaging the coefficients. The resulting α and λ are number 13 in Table V.

Fig. 1.

Fit without interactively generated parameters for group 12.

Fig. 2.

First display for group 12.

TABLE IV

GROUP 12 RESULTS WITH INTERACTIVE GRAPHICS BYPASSED

Step No.	Time	Original Value	Computed Value	Per cent Difference
1	0.0000E-01	1.18510E-02	1.49678E-02	-2.63002E+01
2	.50000E-01	1.13322E-02	1.37127E-02	-2.10069E+01
3	2.00000E-01	1.08687E-02	1.26723E-02	-1.65949E+01
4	4.00000E-01	9.43458E-03	9.96329E-03	-5.60400E+00
5	6.00000E-01	8.45173E-03	8.55738E-03	-1.24948E+00
6	8.00000E-01	7.73742E-03	7.73742E-03	0.
7	1.00000E+00	7.18978E-03	7.18978E-03	0.
8	1.50000E+00	6.22239E-03	6.28343E-03	-9.80949E-01
9	2.00000E+00	5.55506E-03	5.63502E-03	-1.43944E+00
10	4.00000E+00	4.02138E-03	4.04420E-03	-5.67343E-01
11	6.00000E+00	3.22970E-03	3.22970E-03	-3.93727E-09
12	8.00000E+00	2.73656E-03	2.73656E-03	-5.07125E-13
13	1.00000E+01	2.39237E-03	2.39485E-03	-1.03424E-01
14	1.50000E+01	1.84014E-03	1.84179E-03	-8.93647E-02
15	2.00000E+01	1.49834E-03	1.49846E-03	-7.90612E-03
16	4.00000E+01	8.43702E-04	8.46443E-04	-3.24903E-01
17	6.00000E+01	5.63688E-04	5.64056E-04	-6.52599E-02
18	8.00000E+01	4.04582E-04	4.04602E-04	-4.90849E-03
19	1.00000E+02	3.03230E-04	3.04000E-04	-2.53772E-01
20	1.50000E+02	1.67961E-04	1.68500E-04	-5.58601E-01
21	2.00000E+02	1.06700E-04	1.06783E-04	-7.76052E-02
22	4.00000E+02	3.86301E-05	3.92374E-05	-1.57219E+00
23	6.00000E+02	2.47972E-05	2.50615E-05	-1.06582E+00
24	8.00000E+02	1.91685E-05	1.91705E-05	-1.04180E-02
25	1.00000E+03	1.60403E-05	1.60404E-05	-4.68689E-04
26	1.50000E+03	1.18872E-05	1.19483E-05	-5.14086E-01
27	2.00000E+03	9.51152E-06	9.51636E-06	-5.09075E-02
28	4.00000E+03	4.62256E-06	4.57756E-06	9.73388E-01
29	6.00000E+03	2.57195E-06	2.56523E-06	2.61617E-01
30	8.00000E+03	1.61457E-06	1.61471E-06	-8.79782E-03
31	1.00000E+04	1.11886E-06	1.11887E-06	-7.91176E-04
32	1.50000E+04	5.72884E-07	5.76982E-07	-7.15375E-01
33	2.00000E+04	3.46863E-07	3.49321E-07	-7.08610E-01
34	4.00000E+04	9.85013E-08	9.85017E-08	-3.75236E-04
35	6.00000E+04	5.10354E-08	7.12370E-08	-3.95835E+01
36	8.00000E+04	3.71013E-08	6.75729E-08	-8.21308E+01
37	1.00000E+05	3.30575E-08	6.64363E-08	-1.00972E+02a
38	1.50000E+05	3.42913E-08	6.43559E-08	-8.76739E+01
39	2.00000E+05	3.85599E-08	6.23740E-08	-6.17589E+01
40	4.00000E+05	4.80559E-08	5.50389E-08	-1.45310E+01
41	6.00000E+05	4.75911E-08	4.85664E-08	-2.04917E+00
42	8.00000E+05	4.37704E-08	4.28550E-08	2.09144E+00
43	1.00000E+06	3.91830E-08	3.78153E-08	3.49055E+00
44	1.50000E+06	2.87345E-08	2.76587E-08	3.74380E+00
45	2.00000E+06	2.09018E-08	2.02301E-08	3.21381E+00
46	4.00000E+06	5.90419E-09	5.78983E-09	1.93694E+00
47	6.00000E+06	1.67887E-09	1.65715E-09	1.29384E+00
48	8.00000E+06	4.78413E-10	4.74402E-10	8.38398E-01
49	1.00000E+07	1.36585E-10	1.35904E-10	4.98015E-01
50	1.50000E+07	6.11894E-12	6.11894E-12	-1.68979E-12
51	2.00000E+07	4.15253E-13	4.15253E-13	-3.89061E-12
52	4.00000E+07	9.67216E-14	1.00144E-13	-3.53809E+00
53	6.00000E+07	6.55882E-14	6.48295E-14	1.15672E+00
54	8.00000E+07	4.28427E-14	4.19710E-14	2.03464E+00
55	1.00000E+08	2.75448E-14	2.71745E-14	1.34410E+00
56	1.50000E+08	9.19704E-15	9.17292E-15	2.62293E-01
57	2.00000E+08	3.10432E-15	3.10432E-15	-4.06587E-13
58	4.00000E+08	5.79643E-17	5.79643E-17	0.
59	6.00000E+08	1.85988E-17	1.86113E-17	-6.73276E-02
60	8.00000E+08	1.80882E-17	1.80948E-17	-3.67576E-02
61	1.00000E+09	1.80799E-17	1.80800E-17	-4.74956E-04

a - maximum difference

TABLE V

EXAMPLE 1: FIT TO SIX PT/DECADE DATA

Parameters from Option I			Parameters from Option III	
	<u>Alpha</u>	<u>Lambda</u>	<u>Alpha</u>	<u>Lambda</u>
1	1.8122E-17	2.3004E-12	1.8116E-17	2.2465E-12
2	2.3896E-13	2.1747E-08	2.3935E-13	2.1747E-08
3	7.0687E-08	6.2555E-07	7.1024E-08	6.2555E-07
4	2.5966E-06	1.1189E-04	2.0730E-06	1.1517E-04
5	1.6345E-05	4.4012E-04	1.6952E-05	4.3706E-04
6	9.4182E-06	1.3878E-03	8.3936E-06	1.3878E-03
7	1.2285E-04	5.0707E-03	1.2247E-04	5.0707E-03
8	9.9422E-04	1.6398E-02	9.9433E-04	1.6398E-02
9	1.3648E-03	4.8550E-02	1.3623E-03	4.8550E-02
10	2.3382E-03	1.4595E-01	2.3394E-03	1.4595E-01
11	4.3989E-03	5.2611E-01	4.4170E-03	5.3718E-01
12	9.0820E-03	4.1653E+00	9.1106E-03	4.1350E+00
13	-5.3861E-03	5.4701E+00	-5.4596E-03	5.5756E+00
14	-6.0494E-08	4.6613E-06	-6.0839E-08	4.7414E-06
15	3.0316E-07	4.1238E-05	3.0316E-07	4.1238E-05

Since the first region contained only three points, the next picture displayed on the graphics terminal for group 12 is for "region" or "set" number 2, which is shown in Fig. 3. This set contains five points from 6×10^4 to 2×10^5 s cooling time. Note that points 4 and 5 were selected for the calculation, and the resulting α and λ are numbered 14 in Table V under Option I values.

In the next picture displayed, the remaining three points from set 2 are plotted after removal of the contributions from the α and λ computed from points 4 and 5. This display is reproduced as Fig. 4. Although not evident from the figure, the negative coefficient calculated from points 4 and 5 will cause the fit to undershoot, so the coefficient calculated from points selected in Fig. 4 will be positive. Note that points 1 and 2 were selected, and the resulting parameters are numbered 15 in Table V under Option I values.

When in the interactive graphics mode, the code will automatically display the results of the fit compared with the original input data. This graphical comparison is shown in Fig. 5, and numerical values as well as per-cent differences are given in Table VI. Note that the maximum difference has been reduced from 101 to 23%, and that it now occurs at 2×10^4 s cooling time. These results are accurate enough to proceed to the second pass in which the third option, that for a non-linear least-squares fit, is specified.

Only minor input changes are needed to run the second pass for the non-linear least-squares fit, namely, set NIAPL=0, NSTEP=1, and NFINL=1. Also File 7 from the first pass must be attached to the input after card 5. Note that for this pass DIFLIM = 5.0 was specified. This means that the non-linear least-squares routine STEPIT will attempt to adjust the α_i and λ_i for a particular group until no calculated point differs from the input data point by more than 5% before proceeding to the next group. If the input guesses for α_i and λ_i supplied by the user are inadequate, STEPIT will continue to adjust the parameters until a minimum chi-square is reached, after which the calculation will proceed to the next group.

Figure 6 shows the per-cent deviation of the fitted data from the original input data. Note that it is within the input specification of 5% over the whole of the fitted cooling-time range. Figure 7 is a final plot of the fit for group 12.

GROUP, 12 SET, 2
 enter pair of points to calculate parameters
 ? 4,5

Fig. 3.
 Second display for group 12.

GROUP, 12 SET, 2
 enter pair of points to calculate parameters
 ? 1,2

Fig. 4.
 Third display for group 12.

Fig. 5.
First pass fit for group 12.

Fig. 6 .
Deviation from input for group 12.

TABLE VI

GROUP 12 RESULTS AFTER USING INTERACTIVE GRAPHICS

Step No.	Time	Original Value	Computed Value	Per cent Difference
1	1.00000E-01	1.18510E-02	1.18512E-02	-2.04759E-03
2	1.50000E-01	1.13322E-02	1.13420E-02	-8.63541E-02
3	2.00000E-01	1.08687E-02	1.08689E-02	-2.23264E-03
4	4.00000E-01	9.43458E-03	9.35955E-03	7.95284E-01
5	6.00000E-01	8.45178E-03	8.35537E-03	1.14073E+00
6	8.00000E-01	7.73742E-03	7.66993E-03	8.72224E-01
7	1.00000E+00	7.18978E-03	7.16734E-03	3.12085E-01
8	1.50000E+00	6.22239E-03	6.28220E-03	-9.61195E-01
9	2.00000E+00	5.55506E-03	5.63517E-03	-1.44209E+00
10	4.00000E+00	4.02138E-03	4.04444E-03	-5.73376E-01
11	6.00000E+00	3.22970E-03	3.22994E-03	-7.51114E-03
12	8.00000E+00	2.73656E-03	2.73680E-03	-8.86378E-03
13	1.00000E+01	2.39237E-03	2.39509E-03	-1.13562E-01
14	1.50000E+01	1.84014E-03	1.84203E-03	-1.02542E-01
15	2.00000E+01	1.49834E-03	1.49870E-03	-2.40851E-02
16	4.00000E+01	8.43702E-04	8.46685E-04	-3.53606E-01
17	6.00000E+01	5.63688E-04	5.64298E-04	-1.08179E-01
18	8.00000E+01	4.04582E-04	4.04843E-04	-6.46454E-02
19	1.00000E+02	3.03230E-04	3.04241E-04	-3.33395E-01
20	1.50000E+02	1.67961E-04	1.69140E-04	-7.01988E-01
21	2.00000E+02	1.06700E-04	1.07023E-04	-3.02747E-01
22	4.00000E+02	3.86301E-05	3.94753E-05	-2.18780E+00
23	6.00000E+02	2.47972E-05	2.52969E-05	-2.01520E+00
24	8.00000E+02	1.91685E-05	1.94035E-05	-1.22620E+00
25	1.00000E+03	1.60403E-05	1.62711E-05	-1.43869E+00
26	1.50000E+03	1.18872E-05	1.21732E-05	-2.40603E+00
27	2.00000E+03	9.51152E-06	9.73558E-06	-2.35572E+00
28	4.00000E+03	4.62256E-06	4.77524E-06	-3.30301E+00
29	6.00000E+03	2.57195E-06	2.74311E-06	-6.65453E+00
30	8.00000E+03	1.61457E-06	1.77440E-06	-9.89917E+00
31	1.00000E+04	1.11886E-06	1.26184E-06	-1.27792E+01
32	1.50000E+04	5.72884E-07	6.83888E-07	-1.93764E+01
33	2.00000E+04	3.46863E-07	4.27098E-07	-2.31315E+01a
34	4.00000E+04	9.85013E-08	1.06548E-07	-8.16881E+00
35	6.00000E+04	5.10354E-08	5.10354E-08	0.
36	8.00000E+04	3.71013E-08	3.71013E-08	0.
37	1.00000E+05	3.30575E-08	3.33870E-08	-9.96824E-01
38	1.50000E+05	3.42913E-08	3.49155E-08	-1.82011E+00
39	2.00000E+05	3.85599E-08	3.86393E-08	-2.05913E-01
40	4.00000E+05	4.80559E-08	4.56642E-08	4.97680E+00
41	6.00000E+05	4.75911E-08	4.48759E-08	5.70529E+00
42	8.00000E+05	4.37704E-08	4.14022E-08	5.41053E+00
43	1.00000E+06	3.91830E-08	3.72434E-08	4.95012E+00
44	1.50000E+06	2.87345E-08	2.76031E-08	3.93732E+00
45	2.00000E+06	2.09018E-08	2.02247E-08	3.23968E+00
46	4.00000E+06	5.90419E-09	5.78983E-09	1.93694E+00
47	6.00000E+06	1.67887E-09	1.65715E-09	1.29384E+00
48	8.00000E+06	4.78413E-10	4.74402E-10	8.38398E-01
49	1.00000E+07	1.36585E-10	1.35904E-10	4.98015E-01
50	1.50000E+07	6.11894E-12	6.11894E-12	-1.68979E-12
51	2.00000E+07	4.15253E-13	4.15253E-13	-3.89061E-13
52	4.00000E+07	9.67216E-14	1.00144E-13	-3.53809E+00
53	6.00000E+07	6.55882E-14	6.48295E-14	1.15672E+00
54	8.00000E+07	4.28427E-14	4.19710E-14	2.03464E+00
55	1.00000E+08	2.75448E-14	2.71745E-14	1.34410E+00
56	1.50000E+08	9.19704E-15	9.17292E-15	2.62293E-01
57	2.00000E+08	3.10432E-15	3.10432E-15	-4.06587E-13
58	4.00000E+08	5.79643E-17	5.79643E-17	0.
59	6.00000E+08	1.85988E-17	1.86113E-17	-6.73276E-02
60	8.00000E+08	1.80882E-17	1.80948E-17	-3.67576E-02
61	1.00000E+09	1.80799E-17	1.80800E-17	-4.74956E-04

a - maximum difference

Fig. 7.
Five percent fit for group 12.

It would seem that from the above description of the fitting for group 12 that interactive graphics are not needed and that the whole process could be easily automated. The example of the fitting for group 16, however, makes the need for the interactive graphics much clearer. Figure 8 shows the fit with the interactive graphics bypassed. At first sight, it appears that the fitting in the region 10^5 to 10^7 s cooling time would be similar to that for group 12 except that the set contains 13 rather than 5 points. If we proceed as we did in the fitting for group 5, we would choose the last two points for the parameter calculation that appear in each display of the set (Fig. 9-12). The result is seen in Fig. 13, which could not be fit with sufficient accuracy in STEPIT before this routine converged to minimum (high) chi-square.

Now consider a second attempt at obtaining a fit for group 16 (Fig. 14-17). Instead of choosing points 12 and 13 in the first display, we choose points 11 and 12. As a result, we obtain a first pass fit (Fig. 18) that can easily be brought to within the desired 5% accuracy by the non-linear least-squares routine (Figs. 19 and 20).

The parameters for the fits obtained for all 22 groups are given in Appendix B. The parameters for fits obtained for MAT 1261, MF=80, MT=802 (betas) are also given in Appendix B.

As a second example to illustrate the operation of the FITPULS code, consider an Oak Ridge National Laboratory (ORNL) irradiation experiment,⁸ the data for which are shown in Table VII. These experiments, in which ^{239}Pu was irradiated with thermal neutrons, were performed for three irradiation times, namely, 1, 5, and 100 s, and beta and gamma fission-product decay energy were measured. Note that other experiments at other laboratories could also be included in generating a combined pulse function in this example. The input routine RUNTOTS, which was altered to conform to the format in which the experimental data were received, is given in the listing of the code in Appendix A. The formats in the routine are for reading the data as shown in Table VII. Generally, it is more convenient to change the data formats in RUNTOTS than to change the data.

For this particular example, the total decay energy (sum of beta plus gamma) is to be fit and the non-linear least-squares option was chosen on the first pass since a very good guess for the input parameters is available. This is the fit for total decay energy from ^{239}Pu irradiated with a pulse of thermal neutrons as calculated for the ANS standard. These parameters are given in Table VIII under the column labeled "ANS Standard".

The input for this second example is as follows:

Input to Program FITPULS:

Card 1 NPUN = 20
 IRAD = 1
 NCORS = 1
 NIAPL = 0

Input to OVLAY1

Card 2 Title Card

Card 3 IPROB = 1
 NTOTER = 1
 NPUN = 7
 NSTEP = 1
 NFINL = 1

Input to Subroutine RUNTOTS

Card 1A (Data from Table VII)

Fig. 8.

Fit without interactive generated parameters for group 16.

Fig. 9.

First display, first attempt at group 16 fit.

GROUP 16 SET, 2
 enter pair of points to calculate parameters
 ? 10,11

Fig. 10.

Second display, first attempt at group 16 fit.

GROUP 16 SET, 2
 enter pair of points to calculate parameters
 ? 7,8

Fig. 11.

Third display, first attempt at group 16 fit.

GROUP 16 SET, 2
 enter pair of points to calculate parameters
 ? 3,4

Fig. 12.

Fourth display, first attempt at group 16 fit.

Fig. 13.

Unsuccessful first attempt at group 16 fit.

GROUP, 16 SET, 2
 enter pair of points to calculate parameters
 ? 11,12

Fig. 14.

First display, second attempt at group 16 fit.

GROUP, 16 SET, 2
 enter pair of points to calculate parameters
 ? 7,8

Fig. 15.

Second display, second attempt at group 16 fit.

GROUP, 16 SET, 2
 enter pair of points to calculate parameters
 ? 4,5

Fig. 16.

Third display, second attempt at group 16 fit.

GROUP, 16 SET, 2
 enter pair of points to calculate parameters
 ? 1,3

Fig. 17.

Fourth display, second attempt at group 16 fit.

Fig. 18.
Successful first pass group 16 fit.

Fig. 19.
Deviation from input for group 16.

Fig. 20.

Five percent fit for group 16.

Input to OVLAY1 cont'd.

Card 4 DIFLIM = 1.0
 RUNTIM = 295.0
 TMIN = 2.2
 TMAX = 1.195+4
 GXMAX = 0.

Card 5 KKN(1) = 1

The parameters for the ANS standard shown in Table VIII were placed in an ENDF-like format and attached after card 5.

The problem ran to a minimum chi-square convergence of 0.00175 before the input accuracy of 1% could be achieved. The results are given in Table IX, and, as can be seen from this table, the largest per-cent difference is 1.37% occurring at a cooling time of 20.2 s, so the experiment seems to be self-consistent to within at least this amount. The resulting parameters are given in Table VIII under the column labeled "ORNL Exp."

It is interesting to compare these results with the 1978-79 ANS 5.1 standard. It should be noted that the ORNL experiment used as Example 2 was one

of three experiments, along with calculated values, considered in formulating the ANS standard. The comparison is shown in Fig. 21. Note that the ORNL experiment lies well within the uncertainty band of the standard.

IV. SUMMARY

This report describes the FITPULS code, and examples are given in which the use of interactive graphics is illustrated. Useful fits for gamma and beta fission-product decay energy spectra in 22 neutron energy groups for ^{235}U fuel irradiated with a pulse of thermal neutrons are given in Appendix B. The fits are given for both units of MeV per fission-second and particles per fission-second.

Fig. 21.
ORNL experiment compared to standard.

TABLE VII

ORNL DATA FOR THREE IRRADIATION TIMES OF ^{239}Pu WITH THERMAL NEUTRONS

Irrad Time(s)	Waiting Time(s)	Counting Time(s)	MeV/fiss ^a	
			β	γ
1.0	1.7	1.0	0.1811	0.1346
1.0	2.7	1.0	0.1470	0.1044
1.0	3.7	1.0	0.1211	0.0865
1.0	4.7	2.0	0.1945	0.1380
1.0	6.7	3.0	0.2152	0.1537
1.0	9.7	5.0	0.2438	0.1848
1.0	14.7	5.0	0.1680	0.1362
1.0	19.7	5.0	0.1288	0.1094
1.0	24.7	10.0	0.1905	0.1713
1.0	34.7	10.0	0.1406	0.1321
1.0	44.7	15.0	0.1580	0.1558
1.0	59.7	15.0	0.1208	0.1217
1.0	74.7	15.0	0.0980	0.0986
1.0	90.0	20.0	0.1062	0.1056
1.0	110.0	20.0	0.0849	0.0844
5.0	17.7	5.0	0.1258	0.1086
5.0	22.7	10.0	0.1852	0.1698
5.0	32.7	10.0	0.1363	0.1324
5.0	42.7	15.0	0.1545	0.1550
5.0	57.7	15.0	0.1185	0.1208
5.0	72.7	15.0	0.0949	0.0976
5.0	88.0	20.0	0.1028	0.1049
5.0	108.0	20.0	0.0827	0.0846
5.0	128.0	40.0	0.1279	0.1291
5.0	168.0	60.0	0.1366	0.1375
5.0	228.0	70.0	0.1157	0.1163
5.0	298.0	100.0	0.1210	0.1252
5.0	398.0	200.0	0.1703	0.1805
5.0	598.0	200.0	0.1225	0.1347
5.0	798.0	400.0	0.1741	0.1969
100.0	250.0	100.0	0.1218	0.1272
100.0	350.0	200.0	0.1706	0.1823
100.0	550.0	200.0	0.1232	0.1348
100.0	750.0	400.0	0.1766	0.1984
100.0	1150.0	400.0	0.1228	0.1436
100.0	1550.0	400.0	0.0922	0.1112
100.0	1950.0	500.0	0.0867	0.1089
100.0	2450.0	500.0	0.0653	0.0860
100.0	2950.0	1000.0	0.0917	0.1287
100.0	3950.0	2000.0	0.1071	0.1607
100.0	5950.0	2000.0	0.0631	0.0983
100.0	7950.0	2000.0	0.0439	0.0677
100.0	9950.0	4000.0	0.0617	0.0872

^aSee Ref. 8 for a clarification of this unit.

TABLE VIII

EXAMPLE 2: FIT TO EXPERIMENTAL DATA (^{239}Pu THERMAL FISSION)

Parameters from ANS Standard		Fit to ORNL Exp.	
<u>Alpha</u>	<u>Lambda</u>	<u>Alpha</u>	<u>Lambda</u>
2.0830E-01	1.0020E+01	3.5696E+00	3.5491E+00
3.8530E-01	6.4330E-01	4.1004E-01	7.2551E-01
2.2130E-01	2.1860E-01	2.2288E-01	2.2181E-01
9.4600E-02	1.0040E-01	9.5227E-02	1.0367E-01
3.5310E-02	3.7280E-02	3.4997E-02	3.88334E-02
2.2920E-02	1.4350E-02	2.2816E-02	1.4790E-02
3.9460E-03	4.5490E-03	4.0597E-03	4.7821E-03
1.3170E-03	1.3280E-03	1.3783E-03	1.4102E-03
7.0520E-04	5.3560E-04	7.0010E-04	5.3448E-04
1.4320E-04	1.7300E-04	1.4553E-04	1.7380E-04
1.7650E-05	4.8810E-05	1.7797E-05	4.7344E-05
7.3470E-06	2.0060E-05	7.1997E-06	1.8562E-05
1.7470E-06	8.3190E-06	1.6824E-06	1.9636E-06
5.4810E-07	2.3580E-06	4.3891E-07	2.9475E-07
1.6710E-07	6.4500E-07	1.4408E-07	8.0625E-08
2.1120E-08	1.2780E-07	1.2289E-08	1.5975E-08
2.9960E-09	2.4660E-08	2.8362E-09	3.1109E-09
5.1070E-11	9.3780E-09	3.4834E-11	1.3855E-09
5.7300E-11	7.4500E-10	5.4918E-11	1.5831E-09
4.1380E-14	2.4260E-10	1.1226E-14	3.5460E-10
1.0880E-15	2.2100E-13	9.6156E-13	1.1673E-13
2.4540E-15	2.6400E-14	3.1984E-17	4.0494E-14
7.5570E-17	1.3800E-14	1.7054E-16	9.6888E-15

TABLE IX

FINAL FIT OF ORNL EXPERIMENT

Time	Original Value	Computed Value	Per cent Difference
.2200E+01	.3157E+00	.3158E+00	.2457E-01
.3200E+01	.2514E+00	.2509E+00	-.1963E+00
.4200E+01	.2076E+00	.2083E+00	.3527E+00
.5700E+01	.1663E+00	.1660E+00	-.1213E+00
.8200E+01	.1230E+00	.1232E+00	.1942E+00
.1220E+02	.8572E-01	.8543E-01	-.3377E+00
.1720E+02	.6084E-01	.6089E-01	.7794E-01
.2220E+02	.4764E-01	.4733E-01	-.6593E+00
.2970E+02	.3618E-01	.3573E-01	-.1248E+01
.3970E+02	.2727E-01	.2710E-01	-.6221E+00
.5220E+02	.2092E-01	.2080E-01	-.5785E+00
.6720E+02	.1617E-01	.1612E-01	-.3180E+00
.8220E+02	.1311E-01	.1300E-01	-.7953E+00
.1000E+03	.1059E-01	.1045E-01	-.1362E+01
.1200E+03	.8465E-02	.8454E-02	-.1269E+00
.2020E+02	.2344E+00	.2376E+00	.1368E+01 a
.2770E+02	.1775E+00	.1790E+00	.8632E+00
.3770E+02	.1344E+00	.1357E+00	.9736E+00
.5020E+02	.1032E+00	.1041E+00	.8689E+00
.6520E+02	.7977E-01	.8061E-01	.1057E+01
.8020E+02	.6417E-01	.6503E-01	.1348E+01
.9800E+02	.5193E-01	.5224E-01	.6079E+00
.1180E+03	.4183E-01	.4228E-01	.1084E+01
.1480E+03	.3213E-01	.3239E-01	.8367E+00
.1980E+03	.2284E-01	.2292E-01	.3217E+00
.2630E+03	.1657E-01	.1656E-01	-.7113E-01
.3480E+03	.1231E-01	.1236E-01	.3955E+00
.4980E+03	.8770E-02	.8801E-02	.3504E+00
.6980E+03	.6430E-02	.6462E-02	.4997E+00
.9980E+03	.4638E-02	.4640E-02	.5759E-01
.3000E+03	.2490E+00	.2495E+00	.2156E+00
.4500E+03	.1765E+00	.1767E+00	.1560E+00
.6500E+03	.1290E+00	.1295E+00	.4021E+00
.9500E+03	.9375E-01	.9291E-01	-.8932E+00
.1350E+04	.6660E-01	.6672E-01	.1783E+00
.1750E+04	.5085E-01	.5085E-01	.7817E-02
.2200E+04	.3912E-01	.3911E-01	-.1785E-01
.2700E+04	.3026E-01	.3039E-01	.4360E+00
.3450E+04	.2204E-01	.2205E-01	.5006E-01
.4950E+04	.1339E-01	.1330E-01	-.6353E+00
.6950E+04	.8070E-02	.8085E-02	.1868E+00
.8950E+04	.5580E-02	.5591E-02	.2058E+00
.1195E+05	.3723E-02	.3719E-02	-.9974E-01

a - maximum difference

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APPENDIX A

ORGANIZATION AND LISTING OF FITPULS CODE

The FITPULS code is organized into a main program (FITPULS) and three overlays (subroutine OVRLAY1, subroutine OVRLAY2, and subroutine OVRLAY3). The purpose of the main program is to read initial input and to call desired overlays.

The purpose of OVRLAY1 is to read additional input data and to rebin decay-energy input data if desired. This is done in subroutines CORSBIN and REBIN. OVRLAY1 also contains a subroutine, SELECT, for selecting a subset of the decay-energy input data to be fit and a subroutine, TRMSEE, used to aid the user in

adjusting parameters to improve the fit. Finally, the subroutine RUNTOTS in OVRLAY1 is used for reading in experimental data.

OVRLAY2 contains subroutines for fitting options 1 and 2. These include the routines PULSFIT, PDIF, and SEEFIT. This overlay also contains subroutines for placing the final output (the parameters for the fit) in an ENDF-like format, routines PCHOUT and CXFP, and the subroutines used in the interactive graphics, routines SETUP, YMMMX, DECBND, PTLPT, and PICTUR.

OVRLAY3 contains the subroutines used for fitting option 3, the non-linear least-squares option. These include DHFIT, FUNK, and STEPIT. This overlay also contains the subroutine FINECHK for graphically examining the accuracy of the fit.

Users of FITPULS should be warned that the version of the code for which the listing below is given is dependent upon the Los Alamos Scientific Laboratory operating system and that some changes would be necessary if the code is used at another installation. In particular, a local linear equation solver and local plotting routines are used in this version.

LASL Identification
No. LP-847

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PROGRAM FITPULS (TAPE5,TAPE6,TAPE7,TAPE10,TAPE20,OUTPUT,TTY,TAPE11FITP 10
1 =TTY) FITP 20
C THIS PROGRAM ACCEPTS FISSION-PRODUCT DATA (BETA AND GAMMA) IN FITP 30
C UNITS OF ENERGY /FISSION WHICH HAVE BEEN ENERGY BINNED INTO FINE FITP 40
C GROUPS(150)FOR A NUMBER OF COOLING TIME STEPS DERIVED AS FOLLOWS- FITP 50
C YIELD DATA FROM ENDF WERE FIRST PROCESSED BY THE FPCLS CODE TO FITP 60
C SUPPLY FINE GROUP INPUT FOR THE FPSPEC CODE. FPSPEC ALSO FITP 70
C REQUIRES OUTPUT FROM THE CINDER-10 CODE. FINALLY THE OUTPUT OF FITP 80
C FPSPEC WAS PROCESSED BY THE FOTOELF CODE WHICH PUTS THE DATA IN FITP 90
C AN ENDF-LIKE FORMAT WHICH IS THE INPUT DATA LIBRARY FOR THIS FITP 100
C CODE(FITPULS). FITP 110
C FITP 120
C FITP 130
C FITPULS REBINS THIS DATA INTO A USER CHOSEN BROAD GROUP STRUCTURE FITP 140
C (NOTE THAT THIS REBINNING CHANGES UNITS TO ENERGY/FISSION-SEC. FITP 150
C OR,OPTIONALLY,TO UNITS OF NUMBER OF PARTICLES PER FISSION) FITP 160
C AND FITS THE DATA FOR EACH GROUP WITH A LINEAR COMBINATION OF FITP 170
C FUNCTIONS AS FOLLOWS -- FITP 180
C FITP 190
C GXC(I,K)=SUM+ALF(L,K)*(EXP(-ALAM(L,K)*T(I)),SUM OVER L=1,KTRM, FITP 200
C WHERE KTRM IS THE NUMBER OF PAIRS OF PARAMETERS (ALF, FITP 210
C ALAM) FOR GROUP K. FITP 220
C FITP 230
C GXC(I,K)=ENERGY(MEV)/FISS-SEC FOR GROUP K AND COOLING TIME T(I). FITP 240
C GXC(I,K) CAN ALSO BE EXPRESSED AS PARTICLES/FISS BY SETTING THE FITP 250
C FLAG MEVU=1. FITP 260
C MAX.ALLOWED VALUE FOR KTRM(KTR(K)),NO. OF PARAM. PAIRS/GP=50. FITP 270
C MAX.ALLOWED NO. OF BROAD GROUPS,NERG=25. FITP 280
C MAX. ALLOWED NO. OF INPUT COOLING TIME STEPS,ITSP=70. FITP 290
C FITP 300
C THE CODE ALSO HAS AN OPTION OF REDUCING EXPERIMENTAL DATA FOR FITP 310
C A FINITE IRRADIATION TIME TO A PULSE AND OBTAINING A FIT FOR THE FITP 320
C EQUIVALENT PULSE. FOR THIS OPTION SET IRAD=1. FITP 330
C FITP 340
C THERE ARE THREE FITTING OPTIONS AVAILABLE IN FITPULS. THE FIRST FITP 350
C TWO RUN VERY FAST WHEREAS THE THIRD, A NON-LINEAR LEAST FITP 360
C SQUARES FITTING OPTION IS TIME CONSUMING. THESE OPTIONS ARE FITP 370
C SELECTED BY THE FLAG NIAPL AS FOLLOWS- FITP 380
C NIAPL=1 THE FIRST OPTION SELECTED. BEGINNING WITH LONGEST FITP 390
C COOLING TIME PARAMETERS ARE COMPUTED FOR PAIRS OF FITP 400
C USER SELECTED POINTS. INTERACTIVE GRAPHICS AID IN FITP 410
C POINT SELECTION. CANNOT BE USED FOR FINITE FITP 420
C IRRADIATION FIT. GOOD FOR PULSE FIT ONLY. FITP 430
C NIAPL=-1 THE SECOND OPTION IS SELECTED. ALAM VALUES MUST BE FITP 440
C INPUT AS THIS OPTION ONLY COMPUTES ALF VALUES GIVEN FITP 450
C ALAM VALUES. METHOD DESCRIBED IN LA-6684-MS. USE FITP 460
C THIS METHOD FOR FINITE IRRADIATION FITTING. FITP 470
C NIAPL=0 THE THIRD OPTION SELECTED. GOOD GUESSES FOR BOTH FITP 480
C ALF AND ALAM VALUES MUST BE INPUT AS THIS IS THE FITP 490
C NON-LINEAR LEAST-SQUARES FITTING OPTION. GUESSES FITP 500
C ARE OBTAINED BY FIRST RUNNING ONE OF THE FIRST TWO FITP 510
C OPTIONS. FITP 520
C COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB, FITP 530
C 1 NIN, NOUT FITP 540
C COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(2FITP 550
C 1 5,50) FITP 560
C LEVEL 2, A, B FITP 570
C COMMON /PULSCAL/ A(50,50), B(50,1) FITP 580
C COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100) FITP 590
C COMMON /MANI/ WX(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM FITP 600
C COMMON /ENDF/MEVU, MAT, MF, MT, RUNTIM, NPUN FITP 610
C COMMON /TRMOT/ TL(10), LTM(50), LT FITP 620
C COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200) FITP 630
C COMMON /COMO/ NP, TMN, TMAX, NSTEP, GXMN, TC(100), LXX(20), FITP 640
C 1 NFINL FITP 650
C DATA NIN, NOUT, NDT /5,6,10/ FITP 660
C C FITP 670
C CALL FILEREPA FITP 680
C READ (NIN,20) NPUN,IRAD,NCORS,NIAPL FITP 690
C C FITP 700
C SET NPUN=7 HERE IF REBINNED DATA FILE WANTED,OTHERWISE NPUN=20. FITP 710
C IRAD=0,REGULAR PULSE FIT REQUESTED, =1,FIT FOR FINITE IRRADIATION FITP 720
C TIME DATA WANTED. FITP 730
C NCOR=0,CALL CORSEBIN, =1,NO CALL. FITP 740
C NIAPL=1 FIT OPTION 1; NIAPL=-1 FIT OPTION 2; NIAPL=0 FIT OPTION 3 FITP 750

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C	NIAPL=1 INTERACTIVE POINT SELECTION	FITP 760
	IF (NIAPL.EQ.1) CALL GTEKT (1HU,4H4014,960)	FITP 770
	IF (NIAPL.NE.1) CALL GPLOT (1HU,7HFITPULS,7)	FITP 780
	CALL OVERLAY (5HOVLY1,1,0,0)	FITP 790
	IF (NFINL.EQ.1) GO TO 10	FITP 800
	CALL OVERLAY (5HOVLY2,2,0,0)	FITP 810
10	CONTINUE	FITP 820
	CALL OVERLAY (5HOVLY3,3,0,0)	FITP 830
	IF (NPUN.EQ.7) CALL PCHOUT (LXX)	FITP 840
	CALL DONEPL	FITP 850
	STOP	FITP 860
C		FITP 870
20	FORMAT (12I 6)	FITP 880
	END	FITP 890
	SUBROUTINE OVRLAY1	OVR1 10
C		OVR1 20
CC	OVRLAY 1 READS INPUT AND REBINS DATA	OVR1 30
C		OVR1 40
	COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	OVR1 50
	1 NIN, NOUT	OVR1 60
	COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NER, ALF(25,50), ALAM(20VR1 70	OVR1 70
	1 5,50)	OVR1 80
	LEVEL 2, A, B	OVR1 90
	COMMON /PULSCAL/ A(50,50), B(50,1)	OVR1 100
	COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100)	OVR1 110
	COMMON /MANI/ WX(100), TITL(8), KTR(50), NS(10), KKN(25), DIF LIM	OVR1 120
	COMMON /ENDF/MEVU, MAT, MF, MT, RUNTIM, NPUN	OVR1 130
	COMMON /TRMOT/ TL(10), LTM(50), LT	OVR1 140
	COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)	OVR1 150
	COMMON /COMO/ NP, TMN, TMAX, NSTEP, GXMN, TC(100), LXX(20),	OVR1 160
	1 NFINL	OVR1 170
	REAL TMN(20), TMX(20)	OVR1 180
C		OVR1 190
	IF (NCORS.LE.0) CALL CORSBIN	OVR1 200
C		OVR1 210
CC	SEE CORSBIN FOR MAT1,MF1,MT1 INPUT.	OVR1 220
C		OVR1 230
	READ (NIN,40) (TITL(I),I=1,8)	OVR1 240
C		OVR1 250
CC	TITL=EIGHTY CHARACTER(HOLLERITH) TITLE.	OVR1 260
CC		OVR1 270
CC	TITL(1)=CHARACTER FOR CALLING SUBROUTINE SELECT TO CHOOSE DATA	OVR1 280
CC	TO BE USED IN FIT. IF TITL(1)= SELECT ,SEE SUBROUTINE	OVR1 290
CC	SELECT FOR INPUT.	OVR1 300
CC	IF TITL(1)= DO NOT GO,PROGRAM STOPS. USED WHEN JUST	OVR1 310
CC	REBINNED DATA DESIRED.	OVR1 320
C		OVR1 330
	IF (TITL(1).EQ.10H SELECT) CALL SELECT	OVR1 340
	WRITE (NOUT,50) (TITL(I),I=1,8)	OVR1 350
	IF (TITL(1).EQ.10H DO NOT GO) STOP	OVR1 360
	REWIND NPUN	OVR1 370
	READ (NIN,60) IPROB,NTOTER,NPUN,NSTEP,NFINL	OVR1 380
C		OVR1 390
CC	IPROB = PROBLEM NO. MAKE NEGATIVE IF FIT IS MADE IN SEGMENTS.	OVR1 400
CC	NTOTER = FLAG TO DENOTE SPEC. OR TOTAL CALC.,=0,CODE READS SPECT.	OVR1 410
CC	DATA FROM TAPE FILE,=1,CODE READS DATA FROM INPUT FILE.	OVR1 420
CC	NPUN = FLAG FOR PARAMETERS OUTPUT IN ENDF-LIKE FORMAT,=7,OUTPUT,	OVR1 430
CC	=20 NO OUTPUT.	OVR1 440
CC	NSTEP = FLAG TO CALL NON-LINEAR LEAST SQUARES ROUTINE,=0,ROUTINE	OVR1 450
CC	NOT CALLED,=1, ROUTINE CALLED.	OVR1 460
CC	NFINL = FLAG FOR READING ALL PARAMETERS FROM PREVIOUS PROB,I.E.,	OVR1 470
CC	PULSFIT WILL NOT BE CALLED FOR ANY GROUP,=0,NO EFFECT,=1,	OVR1 480
CC	SEE READ,STATEMENTS BELOW.	OVR1 490
C		OVR1 500
	IF (NTOTER.GT.0) CALL RUNTOT5	OVR1 510
	READ (NIN,70) DIF LIM,RUNTIM,TMN,TMAX,GXMN	OVR1 520
C		OVR1 530
CC	DIF LIM = MAX. PERCENT POINTWISE DEVIATION ALLOWED IN STEPIT.	OVR1 540
CC	USUALLY SET HIGH ON INITIAL PASSES AND TIGHTENED UP IN	OVR1 550
CC	SUBSEQUENT PASSES.	OVR1 560
CC	RUNTIM = RUNNING TIME. MAKE FRAC. OF SECOND LESS THAN THAT USED	OVR1 570
C	ON CONTROL CARD TO GET OUTPUT FILE FOR SUBSEQUENT RUN.	OVR1 580

C	TMN = LOWEST COOLING TIME DESIRED.	OVR1 590
C	TMAX = HIGHEST COOLING TIME DESIRED.	OVR1 600
C	GXMIN = MINIMUM ALLOWED VALUE OF GX(I,K). THIS SHOULD BE SET	OVR1 610
C	SO NO FIT IS ATTEMPTED OVER MORE THAN ABOUT 15 DECADES.	OVR1 620
C	NP=ITSP	OVR1 630
	IF (T(1).LE.0.0) T(1)=1.E-4	OVR1 640
	IF (T(NP).LE.0.0) NP=NP-1	OVR1 650
	DO 10 N=1,NP	OVR1 660
	TC(N)=T(N)	OVR1 670
10	CONTINUE	OVR1 680
	NE=NERG	OVR1 690
	NBDS=NE+1	OVR1 700
	EB(NBDS)=7.5	OVR1 710
C		OVR1 720
C	KKN = FLAG FOR RUNNING CODE GROUP BY GROUP. =0, GROUP SKIPPED.	OVR1 730
C	=GROUP NUMBER, FIT COMPUTED FOR THAT GROUP. =NEGATIVE GROUP	OVR1 740
C	NO.. TERMSEE ROUTINE CALLED.	OVR1 750
C		OVR1 760
C	READ (NIN,60) (KKN(K),K=1,NERG)	OVR1 770
C		OVR1 780
C	OUTPUT FILE FROM PREVIOUS PROBLEM ARE READ HERE IF NFINL=1.	OVR1 790
C		OVR1 800
	IF (NFINL.NE.1) GO TO 30	OVR1 810
	READ (NIN,40) (TITL(I),I=1,8)	OVR1 820
	READ (NIN,80) C1,C2,NUL,NLU,NUL,NERG	OVR1 830
	DO 20 K=1,NERG	OVR1 840
	READ (NIN,80) EB(K),EB(K+1),NUL,NUL,NUL,KNG	OVR1 850
	READ (NIN,80) TMN(K),TMX(K),NUL,NUL,NUL,KTR(K)	OVR1 860
	KTRM=KTR(K)	OVR1 870
	READ (NIN,90) (ALF(K,L),ALAM(K,L),L=1,KTRM)	OVR1 880
	KKX=KKN(K)	OVR1 890
	IF (KKX.LT.0) CALL TRMSEE (K,1)	OVR1 900
	IF (KKX.LT.0) CALL TRMSEE (K,0)	OVR1 910
	KTR(K)=KTRM	OVR1 920
20	CONTINUE	OVR1 930
30	CONTINUE	OVR1 940
	RETURN	OVR1 950
C		OVR1 960
	40 FORMAT (8A10)	OVR1 970
	50 FORMAT (1H1,10X,8A10)	OVR1 980
	60 FORMAT (12I6)	OVR1 990
	70 FORMAT (6E12.5)	OVR1 1000
	80 FORMAT (2E11.4,4I11,14,12,13,15)	OVR1 1010
	90 FORMAT (6E11.4)	OVR1 1020
	END	OVR1 1030
		OVR1 1040

C	SUBROUTINE SELECT	SELE 10
C		SELE 20
C	THIS ROUTINE USED FOR SELECTING A SUBSET OF THE DATA TO BE FIT.	SELE 30
C		SELE 40
	COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	SELE 50
	1 NIN, NOUT	SELE 60
	COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(25,50)	SELE 70
	1 5,50)	SELE 80
	LEVEL 2, A, B	SELE 90
	COMMON /PULSCAL/ A(50,50), B(50,1)	SELE 100
C	COMMON /MANI/ WX(100), TITL(8), IPT(50), NS(10), KKN(25), DIF LIM	SELE 110
C		SELE 120
C	READ (NIN,50) ITS,(IPT(I),I=1,ITS)	SELE 130
C		SELE 140
C	ITS=NO OF TIME STEPS DESIRED.	SELE 150
C	IPT=INDEXES OF DESIRED TIME STEPS.	SELE 160
C		SELE 170
	DO 20 K=1,NERG	SELE 180
	DO 10 I=1,ITS	SELE 190
	I I=IPT(I)	SELE 200
	ALAMDA(I)=T(I I)	SELE 210
	A(K,I)=GX(K,I I)	SELE 220
10	CONTINUE	SELE 230
20	CONTINUE	SELE 240
	DO 40 K=1,NERG	SELE 250
	DO 30 I=1,ITS	SELE 260

	GX(K,I)=A(K,I)	SELE 270
	T(I)=ALAMDA(I)	SELE 280
30	CONTINUE	SELE 290
	WRITE (NOUT,60) (I,T(I),GX(K,I),I=1,ITS)	SELE 300
40	CONTINUE	SELE 310
	ITSP=ITS	SELE 320
	RETURN	SELE 330
C		SELE 340
	50 FORMAT (12I6)	SELE 350
	60 FORMAT (4H I=,13,3H T=,1E12.5,4H GX=,1E12.5)	SELE 360
	END	SELE 370
	SUBROUTINE TRMSEE (LK,KKX)	TRMS 10
C		TRMS 20
C	THIS ROUTINE IS CALLED IF KKN IS SET NEGATIVE FOR A GROUP.	TRMS 30
C	ROUTINE PRINTS OUT TERM BY TERM CALCULATION OF FX FOR USE IN	TRMS 40
C	ADJUSTING FITTING PARAMETERS. THIS DONE BY CHANGING AND/OR	TRMS 50
C	REMOVING PARAMETERS.	TRMS 60
	COMMON /MANI/ WX(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM	TRMS 70
	COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	TRMS 80
1	NIN, NOUT	TRMS 90
	COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(2	TRMS 100
1	5,50)	TRMS 110
	LEVEL 2, TRM, TPRT	TRMS 120
	COMMON /PULSCAL/ TRM(50,50), TPRT(50)	TRMS 130
	COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)	TRMS 140
	COMMON /TRMOT/ TL(10), LTM(50), LT	TRMS 150
C		TRMS 160
	K=LK	TRMS 170
	KTRM=KTR(K)	TRMS 180
	TL(1)=10HORIGIAL P	TRMS 190
	TL(2)=10HARAMATRS F	TRMS 200
	TL(3)=10HOR GROUP	TRMS 210
	IF (KKX.EQ.0) GO TO 10	TRMS 220
	WRITE (NOUT,150) (TL(I),I=1,3),K	TRMS 230
	WRITE (NOUT,160) (L,ALF(K,L),ALAM(K,L),L=1,KTRM)	TRMS 240
10	IF (KKX.GT.0) GO TO 90	TRMS 250
	DO 40 I=1,ITSP	TRMS 260
	FX(I)=0.	TRMS 270
	DO 30 L=1,KTRM	TRMS 280
	TRM(I,L)=ALF(K,L)*EXP(-ALAM(K,L)*T(I))	TRMS 290
	IF (IRAD.LE.0) GO TO 20	TRMS 300
	IF (TRM(I,L).LT.0.) TRM(I,L)=0.	TRMS 310
	COFF=ALF(K,L)/DELT(I)/ALAM(K,L)**2	TRMS 320
	XPO1=1.-EXP(-ALAM(K,L)*RADT(I))	TRMS 330
	XPO2=1.-EXP(-ALAM(K,L)*DELT(I))	TRMS 340
	XPO3=EXP(-ALAM(K,L)*(T(I)-DELT(I)/2.))	TRMS 350
20	CONTINUE	TRMS 360
	IF (IRAD.EQ.1) TRM(I,L)=COFF*XPO1*XPO2*XPO3	TRMS 370
	LTM(L)=L	TRMS 380
	FX(I)=FX(I)+TRM(I,L)	TRMS 390
30	CONTINUE	TRMS 400
40	CONTINUE	TRMS 410
	K1=1	TRMS 420
50	K2=K1+4	TRMS 430
	IF (K2.GT.KTRM) K2=KTRM	TRMS 440
	WRITE (NOUT,170) (LTM(L),L=K1,K2)	TRMS 450
	DO 60 I=1,ITSP	TRMS 460
	WRITE (NOUT,180) T(I),GX(K,I),(TRM(I,L),L=K1,K2)	TRMS 470
60	CONTINUE	TRMS 480
	K1=K2+1	TRMS 490
	IF (K1.LE.KTRM) GO TO 50	TRMS 500
	DO 80 I=1,ITSP	TRMS 510
	PCTDIF=0.	TRMS 520
	IF (GX(K,I).LE.0.) GO TO 70	TRMS 530
	PCTDIF=(GX(K,I)-FX(I))/GX(K,I)*100.	TRMS 540
70	CONTINUE	TRMS 550
	WRITE (NOUT,190) I,T(I),GX(K,I),FX(I),PCTDIF	TRMS 560
80	CONTINUE	TRMS 570
	IF (KKX.LE.0) RETURN	TRMS 580
90	CONTINUE	TRMS 590
	READ (NIN,210) MLT	TRMS 600
		TRMS 610

	IF (MLT.EQ.0) GO TO 110	TRMS 620
	DO 100 MM=1,MLT	TRMS 630
	READ (NIN,200) L,ALF(K,L),ALAM(K,L)	TRMS 640
100	CONTINUE	TRMS 650
110	CONTINUE	TRMS 660
	READ (NIN,210) LT,(LTM(JJ),JJ=1,LT)	TRMS 670
C		TRMS 680
C	MLT=NO OF PARAMETERS TO BE CHANGED	TRMS 690
C	LT = NUMBER OF TERMS TO BE REMOVED.	TRMS 700
C	LTM(L) = TERM NOS. OF TERMS TO BE REMOVED.	TRMS 710
	IF (LT.EQ.0) RETURN	TRMS 720
	LTX=0	TRMS 730
	LL=1	TRMS 740
	KTRM=KTR(K)	TRMS 750
	DO 130 L=1,KTRM	TRMS 760
	IF (LTM(LL).EQ.L) GO TO 120	TRMS 770
	LTX=LTX+1	TRMS 780
	TRM(1,LTX)=ALF(K,L)	TRMS 790
	TRM(2,LTX)=ALAM(K,L)	TRMS 800
	GO TO 130	TRMS 810
120	CONTINUE	TRMS 820
	LL=LL+1	TRMS 830
130	CONTINUE	TRMS 840
	KTRM=LTX	TRMS 850
	DO 140 L=1,KTRM	TRMS 860
	ALF(K,L)=TRM(1,L)	TRMS 870
	ALAM(K,L)=TRM(2,L)	TRMS 880
140	CONTINUE	TRMS 890
	TL(1)=10HREVISED PA	TRMS 900
	TL(2)=10HRAMETERS F	TRMS 910
	KTR(K)=KTRM	TRMS 920
	TL(3)=10HOR GROUP	TRMS 930
	WRITE (NOUT,150) (TL(I),I=1,3),K	TRMS 940
	WRITE (NOUT,160) (L,ALF(K,L),ALAM(K,L),L=1,KTRM)	TRMS 950
	RETURN	TRMS 960
C		TRMS 970
	150 FORMAT (1H1,5X,3A10,13)	TRMS 980
	160 FORMAT (1H0,3H L=,13,10H ALF(K,L)=,1PE11.4,11H ALAM(K,L)=,1PE11.4)	TRMS 990
	170 FORMAT (1H0,25H COOL TIME GX,5I15)	TRMS1000
	180 FORMAT (1P7E15.5)	TRMS1010
	190 FORMAT (1H0,3H I=,13,3H T=,1E12.5,4H GX=,1E12.5,4H FX=,1E12.5,8H PTRMS	TRMS1020
	1CTDIF=,1E12.5)	TRMS1030
	200 FORMAT (16,2E12.5)	TRMS1040
	210 FORMAT (12I6)	TRMS1050
	END	TRMS1060
		TRMS1070
	SUBROUTINE CORSBIN	CORS 10
C		CORS 20
C	ROUTINE FORMS COARSE GROUPS FROM FINE GROUP DATA IN ENDF-LIKE	CORS 30
C	FORMAT.	CORS 40
C		CORS 50
	COMMON /PULSIN/ AO(50), FX(200), T(401), KE, ITSP, IPROB, NIN,	CORS 60
	1 NOUT	CORS 70
	COMMON /PULSDAT/ NDF, EB(25), GB(25,400), NERG, EO(200), DUM(70),	CORS 80
	1 TOT(50)	CORS 90
	COMMON /ENDF/MEVU, MAT1, MF1, MT1, RUNTIM, NPUN	CORS 100
C	READ INPUT	CORS 110
	READ (NIN,90) MAT1,MF1,MT1,MEVU	CORS 120
C		CORS 130
C	MAT1=MAT NO. OF FISSIONING NUCLIDE DESIRED.	CORS 140
C	MF1=DATA TYPE DESIRED,MF1=80=F.P.DATA FOR THERMAL PULSE,MF1=81=	CORS 150
C	F.P. DATA FOR FAST PULSE,ETC.	CORS 160
C	MT1=TYPE OF F.P. WANTED,MT1=801=DATA FOR BETA- PLUS GAMMA,MT1=802=	CORS 170
C	DATA FOR GAMMA ONLY,MT1=803=DATA FOR BETA- ONLY,ETC.	CORS 180
C	MEVU=DATA,UNITS ARE MEV/FISS, =1,UNITS ARE PARTICLE/FISS.	CORS 190
C	SEARCH ENDF TAPE FOR DESIRED DATA.	CORS 200
C		CORS 210
	10 CONTINUE	CORS 220
	READ (NDF,100) (AO(I),I=1,7),MAT,MF,MT,NSEQ	CORS 230
	IF (MF.EQ.-0) MF=80	CORS 240
	IF (MAT.EQ.-1) WRITE (NOUT,110) MAT,NDF	CORS 250
	IF (MAT.EQ.-1) STOP	CORS 260

IF (MAT.LT.MAT1) GO TO 10	CORS 270
IF (MAT.EQ.MAT1) GO TO 20	CORS 280
WRITE (NOUT,110) MAT1,NDF	CORS 290
STOP	CORS 300
20 CONTINUE	CORS 310
IF (MF.LT.MF1) GO TO 10	CORS 320
IF (MF.EQ.MF1) GO TO 30	CORS 330
WRITE (NOUT,120) MF1,NDF	CORS 340
STOP	CORS 350
30 CONTINUE	CORS 360
IF (MT.LT.MT1) GO TO 10	CORS 370
IF (MT.EQ.MT1) GO TO 40	CORS 380
WRITE (NOUT,130) MT1,NDF	CORS 390
STOP	CORS 400
40 CONTINUE	CORS 410
READ (NDF,140) NT	CORS 420
READ (NDF,90) NCHT	CORS 430
ITSP=NT	CORS 440
C	CORS 450
READ BROAD GROUP STRUCTURE	CORS 460
C	CORS 470
READ (NIN,90) NE	CORS 480
READ (NIN,150) (EB(N),N=1,NE)	CORS 490
C	CORS 500
NE=NO OF BROAD GROUPS PLUS ONE.	CORS 510
C	CORS 520
EB=ENERGY BOUNDS INCLUDING UPPER AND LOWER BOUNDS IN MEV	CORS 530
NE=NE-1	CORS 540
NERG=NE	CORS 550
DO 70 IT=1,NT	CORS 560
READ (NDF,160) T(IT),KE	CORS 570
READ (NDF,90) NCHT	CORS 580
READ (NDF,150) (EO(K),FX(K),K=1,KE)	CORS 590
KE1=KE+1	CORS 600
EO(KE1)=(EO(KE)-EO(KE-1))+EO(KE)	CORS 610
C	CORS 620
THE FOLLOWING LOOP SELECTS THE CORRECT UNITS.	CORS 630
DO 50 K=1,KE	CORS 640
IF (MEVU.EQ.1) FX(K)=FX(K)/((EO(K)+EO(K+1))/2.0)*1.E+4	CORS 650
IF (MEVU.EQ.0) FX(K)=FX(K)*1.E+4	CORS 660
50 CONTINUE	CORS 670
CALL REBIN	CORS 680
DO 60 IE=1,NE	CORS 690
GB(IE,IT)=DUM(IE)	CORS 700
60 CONTINUE	CORS 710
70 CONTINUE	CORS 720
DO 80 IE=1,NE	CORS 730
WRITE (NOUT,170) IE,EB(IE),EB(IE+1)	CORS 740
WRITE (NOUT,180) (IT,T(IT),GB(IE,IT),IT=1,NT)	CORS 750
WRITE (NPUN,90) MAT1,MF1,MT1	CORS 760
WRITE (NPUN,90) NE,NT	CORS 770
WRITE (NPUN,190) IE,EB(IE),EB(IE+1)	CORS 780
WRITE (NPUN,190) (IT,T(IT),GB(IE,IT),IT=1,NT)	CORS 790
80 CONTINUE	CORS 800
REWIND 10	CORS 810
RETURN	CORS 820
C	CORS 830
90 FORMAT (6I11)	CORS 840
100 FORMAT (6A10,A6,I4,I2,I3,I5)	CORS 850
110 FORMAT (1H1,15H SORRY, MAT = ,I4,13H NOT ON TAPE ,I3)	CORS 860
120 FORMAT (1H1,14H SORRY, MF = ,I4,13H NOT ON TAPE ,I3)	CORS 870
130 FORMAT (1H1,14H SORRY, MT = ,I4,13H NOT ON TAPE ,I3)	CORS 880
140 FORMAT (55X,I11)	CORS 890
150 FORMAT (6E11,4)	CORS 900
160 FORMAT (11X,1E11,4,33X,I11)	CORS 910
170 FORMAT (1H0,17H ENERGY BIN NO. ,I3,6H FROM ,1PE12.5,8H MEV TO ,1PE12.5,5H MEV.)	CORS 920
180 FORMAT (1H ,13H TIME STEP = ,I3,16H COOLING TIME = ,1PE12.5,6H FX	CORS 930
1= ,1PE12.5)	CORS 940
190 FORMAT (2(I5,2E15.8))	CORS 950
END	CORS 960
C	
SUBROUTINE REBIN	REBI 10
	REBI 20

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C ROUTINE FOR BROAD GROUP BINNING. BOUNDARIES DO NOT HAVE TO REBI 30
C COINCIDE WITH FINE GROUP BOUNDARIES. WRITTEN BY GRAHAM REBI 40
C FOSTER,LASL,1975. REBI 50
C CHANGED OCT, 1977, LASL, D. GEORGE REBI 60
C REBI 70
COMMON /PULSIN/ AO(50), Y(200), T(401), NX, ITSP, IPROB, NIN, NOUTREBI 80
COMMON /PULSDAT/ NDT, U(25), GB(25,400), NU, X(200), V(70), TOT(50REBI 90
1 ) REBI 100
SUM1=SUM2=0. REBI 110
NU1=NU+1 REBI 120
NX1=NX+1 REBI 130
DO 10 IU=1,NU1 REBI 140
10 V(IU)=0. REBI 150
DO 20 IX=1,NX REBI 160
IF (X(IX).LT.U(1)) GO TO 20 REBI 170
IF (X(IX).GT.U(NU1)) GO TO 20 REBI 180
SUM1=SUM1+Y(IX) REBI 190
20 CONTINUE REBI 200
C FIND THE FIRST BIN REBI 210
DO 30 IX=1,NX REBI 220
IF (X(IX).EQ.U(1)) GO TO 50 REBI 230
30 IF (X(IX).GT.U(1)) GO TO 40 REBI 240
WRITE (NOUT,110) REBI 250
RETURN REBI 260
40 V(1)=Y(IX-1)*(X(IX)-U(1))/(X(IX)-X(IX-1)) REBI 270
50 IX=IX+1 REBI 280
DO 80 IU=1,NU REBI 290
60 IF (X(IX).GT.(U(IU+1)+1.0001)) GO TO 70 REBI 300
V(IU)=V(IU)+Y(IX-1) REBI 310
IF (IX.GT.NX) GO TO 90 REBI 320
IX=IX+1 REBI 330
GO TO 60 REBI 340
70 CRIN=Y(IX-1)*(U(IU+1)-X(IX-1))/(X(IX)-X(IX-1)) REBI 350
V(IU)=V(IU)+CRIN REBI 360
Y(IX-1)=Y(IX-1)-CRIN REBI 370
80 CONTINUE REBI 380
90 IF (X(NX1).GT.U(NU1)) WRITE (NOUT,120) X(NX1),U(NU1) REBI 390
DO 100 IU=1,NU REBI 400
100 SUM2=SUM2+V(IU) REBI 410
ERRD=0.001 REBI 420
IF (ABS(SUM2-SUM1).GT.ERRD*SUM1) WRITE (NOUT,130) SUM1,SUM2 REBI 430
C IF (SUM2.GT.SUM1) WRITE (NOUT,101) (I,X(I),Y(I),I=1,NX) REBI 440
C IF (SUM2.GT.SUM1) WRITE (NOUT,102) (N,U(N),V(N),N=1,NU) REBI 450
RETURN REBI 460
C REBI 470
110 FORMAT (29H CANT FIND FIRST ENERGY BOUND) REBI 480
120 FORMAT (17H0***** LAST DATUME10.3,27H EXTENDS BEYOND END OF GRID) REBI 490
1 0.3,6H *****/) REBI 500
130 FORMAT (32H0***** INTEGRAL BEFORE REBINNING E10.3,41H DOES NOT EQUAREBI 510
1L INTEGRAL AFTER REBINNING E10.3,6H *****/) REBI 520
END REBI 530

SUBROUTINE RUNTOTS RUNT 10
C RUNT 20
C ROUTINE TO READ TOTALS, I.E.,GX(K,I) SUMMED OVER ENERGY. RUNT 30
C RUNT 40
COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB, RUNT 50
1 NIN, NOUT RUNT 60
COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(2RUNT 70
1 5.50) RUNT 80
COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100) RUNT 90
COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200) RUNT 100
C RUNT 110
C THIS SUBROUTINE IS USED FOR READING EXPERIMENTAL DATA. RUNT 120
C UNFORTUNATELY, THIS CAN BE RECEIVED IN A VARIETY OF FORMATS,SO RUNT 130
C THIS ROUTINE MUST BE CONTINUALLY CHANGED TO ACCOMADATE WHATEVER RUNT 140
C FORMAT THS DATA IS IN. THE FUNNY LOOKING STATEMENTS BELOW ARE RUNT 150
C FOR READING SOME ORNL DATA IN THE WHITTEMORE JUNK FORMAT. RUNT 160
C RUNT 170
C DIMENSION HDR(8) RUNT 180
READ (NIN,30) NP,NE,NHD RUNT 190
DO 10 L=1,NHD RUNT 200
READ (NIN,50) (HDR(I),I=1,8) RUNT 210

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	WRITE (NOUT,50) (HDR(I),I=1,8)	RUNT 220
10	CONTINUE	RUNT 230
	DO 20 I=1,NP	RUNT 240
	IF (I.LE.NE) EB(I)=0.0	RUNT 250
	READ (NIN,40) (GX(K,I),K=10,15)	RUNT 260
	WRITE (NOUT,40) (GX(K,I),K=10,15)	RUNT 270
	RADT(I)=GX(10,I)	RUNT 280
	T(I)=GX(11,I)+GX(12,I)/2.0	RUNT 290
	DELT(I)=1.0	RUNT 300
	GX(1,I)=(GX(13,I)+GX(14,I))*GX(10,I)/GX(12,I)	RUNT 310
20	CONTINUE	RUNT 320
	ITSP=NP	RUNT 330
	NE=1	RUNT 340
	NERG=1	RUNT 350
	RETURN	RUNT 360
C		RUNT 370
30	FORMAT (12I6)	RUNT 380
40	FORMAT (6E12.5)	RUNT 390
50	FORMAT (8A10)	RUNT 400
	END	RUNT 410
	SUBROUTINE OVRLAY2	OVR2 10
C		OVR2 20
C	OVRLAY2 IS ROUTINE FOR FITTING OPTIONS 1 AND 2	OVR2 30
C		OVR2 40
	COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	OVR2 50
	1 NIN, NOUT	OVR2 60
	COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(20	OVR2 70
	1 5,50)	OVR2 80
	LEVEL 2, A, B	OVR2 90
	COMMON /PULSCAL/ A(50,50), B(50,1)	OVR2 100
	COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100)	OVR2 110
	COMMON /MANI/ WX(100), TITL(8), KTR(50), NS(10), KKN(25), DIF LIM	OVR2 120
	COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)	OVR2 130
	COMMON /COMO/ NP, TMIN, TMAX, NSTEP, GXMIN, TC(100), LXX(20),	OVR2 140
	1 NFINL	OVR2 150
	COMMON /CLWT/ LWTR	OVR2 160
	LWTR=0	OVR2 170
	DO 70 K=1,NERG	OVR2 180
	IF (KKN(K).NE.K) GO TO 70	OVR2 190
C		OVR2 200
C	THIS PORTION OF ROUTINE ALLOWS FIT IN SEVERAL SEGMENTS. TO	OVR2 210
C	ACTIVATE, SET IPROB NEGATIVE. NOTE - INPUT NEEDED FOR EA. GROUP.	OVR2 220
C		OVR2 230
C	NSEG = NUMBER OF SEGMENTS + 1	OVR2 240
C	NS = BREAKPOINTS OF SEGMENTS.	OVR2 250
C		OVR2 260
	NSEG=2	OVR2 270
	NS(1)=1	OVR2 280
C	IF (IPROB.LT.0) READ (NIN,80) NSEG,(NS(LX),LX=2,NSEG)	OVR2 290
		OVR2 300
	IF (NSEG.LE.2) NS(2)=NP	OVR2 310
	NSEG1=NSEG-1	OVR2 320
	LTRM=0	OVR2 330
	KTR(K)=0	OVR2 340
	DO 40 N=1,NSEG1	OVR2 350
	N1=NS(N)	OVR2 360
	N2=NS(N+1)	OVR2 370
	ITP=N2-N1+1	OVR2 380
	ITSP=0	OVR2 390
	IX=0	OVR2 400
	IF (TMIN.LT.TC(1)) TMIN=TC(1)	OVR2 410
	IF (TMAX.LE.0.0) TMAX=TC(NP)	OVR2 420
	IF (TMAX.GT.TC(NP)) TMAX=TC(NP)	OVR2 430
	DO 10 I=1,ITP	OVR2 440
	NN=N1+I-1	OVR2 450
	IF (GX(K,NN).LT.GXMIN) GO TO 10	OVR2 460
	IF (TC(NN).LT.TMIN) GO TO 10	OVR2 470
	IF (TC(NN).GT.TMAX) GO TO 10	OVR2 480
	IX=IX+1	OVR2 490
	ITSP=IX	OVR2 500
	LXX(K)=IX	OVR2 510
	FX(IX)=GX(K,NN)	OVR2 520

	T(IX)=TC(NN)	OVR2 530
10	CONTINUE	OVR2 540
	CALL PULSFIT (K)	OVR2 550
	IF (N.NE.NSEG1) KTRM=KTRM-1	OVR2 560
	IX=0	OVR2 570
	DO 20 I=1,ITP	OVR2 580
	NN=N1+I-1	OVR2 590
	IF (GX(K,NN).LT.GXMN) GO TO 20	OVR2 600
	IF (TC(NN).LT.TMN) GO TO 20	OVR2 610
	IF (TC(NN).GT.TMAX) GO TO 20	OVR2 620
	IX=IX+1	OVR2 630
	ITSP=IX	OVR2 640
	LXX(K)=IX	OVR2 650
	FX(IX)=GX(K,NN)	OVR2 660
	T(IX)=TC(NN)	OVR2 670
20	CONTINUE	OVR2 680
	IF (NIAPL.EQ.1) CALL SEEFIT (K)	OVR2 690
	DO 30 J=1,KTRM	OVR2 700
	LTRM=LTRM+1	OVR2 710
	ALF(K,LTRM)=B(J,1)	OVR2 720
	ALAM(K,LTRM)=ALAMDA(J)	OVR2 730
30	CONTINUE	OVR2 740
	KTR(K)=KTR(K)+KTRM	OVR2 750
40	CONTINUE	OVR2 760
	KTRM=KTR(K)	OVR2 770
	DO 50 J=1,KTRM	OVR2 780
	ALAMDA(J)=ALAM(K,J)	OVR2 790
	B(J,1)=ALF(K,J)	OVR2 800
50	CONTINUE	OVR2 810
	WRITE (NOUT,90) K,EB(K),EB(K+1)	OVR2 820
	DO 60 J=1,KTRM	OVR2 830
	WRITE (NOUT,100) J,ALAMDA(J),B(J,1)	OVR2 840
60	CONTINUE	OVR2 850
70	CONTINUE	OVR2 860
	RETURN	OVR2 870
C		OVR2 880
	80 FORMAT (12I6)	OVR2 890
	90 FORMAT (1H1,24H RESULTS FOR GROUP NO. ,I3,11H E-LOWER = ,1PE12.5,	OVR2 900
	1 17H MEV. E-UPPER = ,1PE12.5,5H MEV.)	OVR2 910
100	FORMAT (1H0,4H J =,I3,9H ALAMDA =,1PE12.5,4H B =,1PE12.5)	OVR2 920
	END	OVR2 930
	SUBROUTINE PULSFIT (KKF)	PULS 10
C		PULS 20
C	THIS ROUTINE PROVIDES 1 AND 2 PARAMETER FITS FOR A COMBINATION	PULS 30
C	OF LINEAR FUNCTIONS OF THE FORM --	PULS 40
C		PULS 50
C	FX(I)=SUM+ALPHA(K)*EXP(-ALAMDA(K)*T(I)),SUM OVER K=1,KTRM,	PULS 60
C	THE NUMBER OF TERMS USED TO REPRESENT FX.	PULS 70
C		PULS 80
	COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	PULS 90
1	NIN, NOUT	PULS 100
	LEVEL 2, A, B	PULS 110
	COMMON /PULSCAL/ A(50,50), B(50,1)	PULS 120
	COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100)	PULS 130
	COMMON /MANI/ W(100), TITL(8), KTR(50), NS(10), KKN(25), DIF LIM	PULS 140
	COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)	PULS 150
	COMMON /CLWT/ LWTR	PULS 160
	DIMENSION KCAL(71), IPV(50)	PULS 170
	ITS=1	PULS 180
	IPRO=KKF	PULS 190
	IF (NIAPL.EQ.1) GO TO 10	PULS 200
	IF (NIAPL.EQ.0) RETURN	PULS 210
C	INPUT TO THIS SUBROUTINE NEEDED ONLY IF NIAPL=-1.	PULS 220
	READ (NIN,220) LWT,KTRM,IPRT	PULS 230
	READ (NIN,230) (ALAMDA(K),K=1,KTRM)	PULS 240
C		PULS 250
C	LWT=WT FCN DESIRED.=0,W=1,=1,W=1/FX,=2,W=1/FX**2,=3,W=1/FX**1.5.	PULS 260
C	KTRM=NO. OF ALAMDAS USED IN FIT.	PULS 270
C	IPRT=1,PRINT A-MATRIX,=0,NO PRINT.	PULS 280
C	ALAMDA(K) = LAMDAS PROVIDED BY USER, AS THIS OPTION ONLY FITS	PULS 290
C	COEFFICIENTS.	PULS 300
	GO TO 50	PULS 310

10	CONTINUE	PULS 320
	I 1=I T SP	PULS 330
	KK=1	PULS 340
20	I 2=I 1-1	PULS 350
C	IF ((FX(I 2)/FX(I 1)).LT.5.0) I 2=I 1-2	PULS 360
	ALAMDA(KK)=ALOG(FX(I 2)/FX(I 1))/(T(I 1)-T(I 2))	PULS 370
	B(KK,1)=FX(I 1)/EXP(-ALAMDA(KK)*T(I 1))	PULS 380
	IT 1=I 2-1	PULS 390
	FT1=FX(IT 1)-(B(KK,1)*EXP(-ALAMDA(KK)*T(IT 1)))	PULS 400
	IF (-FT1.LT.FX(IT 1)) GO TO 30	PULS 410
	IF (KGFL.NE.IPRO) GO TO 30	PULS 420
	I 1=I 2	PULS 430
	GO TO 20	PULS 440
30	CONTINUE	PULS 450
	I 3=I 2-1	PULS 460
	IFLG=0	PULS 470
	DO 40 I =1,I 3	PULS 480
	FT=FX(I)	PULS 490
	FX(I)=FX(I)-(B(KK,1)*EXP(-ALAMDA(KK)*T(I)))	PULS 500
	ATST=FX(I)/FT	PULS 510
	IF (ATST.GT.0.05) GO TO 40	PULS 520
	IFLG=IFLG+1	PULS 530
	WRITE (NOUT,180) I,FT,FX(I)	PULS 540
40	CONTINUE	PULS 550
	I 1=I 3-IFLG	PULS 560
	KK=KK+1	PULS 570
	IF (I 1.GE.2) GO TO 20	PULS 580
	KTRM=KK-1	PULS 590
	RETURN	PULS 600
50	CONTINUE	PULS 610
C	WRITE OUT INPUT FOR DEBUG	PULS 620
C	WRITE (NOUT,240) (K,ALAMDA(K),K=1,KTRM)	PULS 630
	WRITE (NOUT,250) (I,T(I),FX(I),I=1,IT SP)	PULS 640
	DO 60 I =1,IT SP	PULS 650
	W(I)=1./FX(I)**2	PULS 660
	IF (LWT.EQ.3) W(I)=1./FX(I)**1.5	PULS 670
	IF (LWT.EQ.1) W(I)=1./FX(I)	PULS 680
	IF (LWT.LE.0) W(I)=1.	PULS 690
60	CONTINUE	PULS 700
	WRITE (NOUT,260) LWT	PULS 710
C		PULS 720
C	REORDER ALAMDAS HI TO LO	PULS 730
C		PULS 740
	CALL QOSORT (KTRM,ALAMDA,PCT(1),PCT(50),PCT(50))	PULS 750
	NTRM=KTRM/2	PULS 760
	DO 70 K=1,NTRM	PULS 770
	TEMP=ALAMDA(K)	PULS 780
	ALAMDA(K)=ALAMDA(KTRM-K+1)	PULS 790
70	ALAMDA(KTRM-K+1)=TEMP	PULS 800
C		PULS 810
C	CALCULATE B MATRIX	PULS 820
C		PULS 830
	DO 100 K=1,KTRM	PULS 840
	B(K,1)=0.	PULS 850
	DO 90 I =1,IT SP	PULS 860
	IF (IRAD.LE.0) GO TO 80	PULS 870
	XP1=EXP(-ALAMDA(K)*RADT(I))	PULS 880
	XP2=EXP(-ALAMDA(K)*DELT(I))	PULS 890
	XP3=EXP(-ALAMDA(K)*(T(I)-DELT(I)/2.))	PULS 900
	B(K,1)=B(K,1)+FX(I)*1./DELT(I)/ALAMDA(K)**2*(1.-XP1)*(1.-XP2)*XP3	PULS 910
	1 *W(I)	PULS 920
	GO TO 90	PULS 930
80	CONTINUE	PULS 940
	B(K,1)=B(K,1)+FX(I)*EXP(-ALAMDA(K)*T(I))*W(I)	PULS 950
90	CONTINUE	PULS 960
100	CONTINUE	PULS 970
C		PULS 980
C	CALCULATE A MATRIX	PULS 990
C		PULS 1000
	DO 110 I =1,KTRM	PULS 1010
	DO 110 J =1,KTRM	PULS 1020
	A(I,J)=0.	PULS 1030
110	CONTINUE	PULS 1040
	DO 150 K=1,KTRM	PULS 1050
		PULS 1060

ALAM=ALAMDA(K)	PULS1070
DO 140 L=1,KTRM	PULS1080
DO 130 I=1,ITSP	PULS1090
IF (IRAD.LE.0) GO TO 120	PULS1100
XPO1=1.-EXP(-ALAMDA(K)*RADT(I))	PULS1110
XPO2=1.-EXP(-ALAMDA(L)*RADT(I))	PULS1120
XPO3=1.-EXP(-ALAMDA(K)*DELT(I))	PULS1130
XPO4=1.-EXP(-ALAMDA(L)*DELT(I))	PULS1140
XPO5=EXP(-ALAMDA(K)*(T(I)-DELT(I))/2.))	PULS1150
XPO6=EXP(-ALAMDA(L)*(T(I)-DELT(I))/2.))	PULS1160
COFF=1./DELT(I)/ALAMDA(K)**2	PULS1170
COFT=1./DELT(I)/ALAMDA(L)**2	PULS1180
A(K,L)=A(K,L)+COFF*COFT*XPO1*XPO2*XPO3*XPO4*XPO5*XPO6*W(I)	PULS1190
GO TO 130	PULS1200
120 CONTINUE	PULS1210
A(K,L)=EXP(-(ALAM+ALAMDA(L))*T(I))*W(I)+A(K,L)	PULS1220
130 CONTINUE	PULS1230
140 CONTINUE	PULS1240
150 CONTINUE	PULS1250
C PRINT A MATRIX	PULS1260
C	PULS1270
IF (IPRT.LT.1) GO TO 170	PULS1280
WRITE (NOUT,270) IPRO	PULS1290
DO 160 K=1,KTRM	PULS1300
WRITE (NOUT,280) (A(K,L),L=1,KTRM)	PULS1310
160 CONTINUE	PULS1320
170 CONTINUE	PULS1330
WRITE (NOUT,290) IPRO	PULS1340
WRITE (NOUT,280) (B(K,1),K=1,KTRM)	PULS1350
C SUBROUTINE LCMLSS SOLVES THE SET OF LINEAR EQUATIONS AX=B	PULS1360
CALL LCMLSS (KTRM,1,A,50,B,50,IPVT,DET,PCT(1),PCT(50))	PULS1370
WRITE (NOUT,290) IPRO	PULS1380
WRITE (NOUT,280) (B(K,1),K=1,KTRM)	PULS1390
CALL PDIF	PULS1400
WRITE (NOUT,190) IPRO	PULS1410
WRITE (NOUT,200) (I,T(I),FX(I),FXC(I),PCT(I),I=1,ITSP)	PULS1420
RETURN	PULS1430
WRITE (NOUT,210)	PULS1440
STOP	PULS1450
C	PULS1460
180 FORMAT (1H0,14H POINT AT I =,I3,14H ON SLOPE FT =,E12.6,5H FX =	PULS1470
1.E12.6)	PULS1480
190 FORMAT (109H1 STEP NO. TIME ORIGINAL VALUE COMPUT	PULS1490
1ED VALUE PERCENT DIFFERENCE IPROB= .13)	PULS1500
200 FORMAT (16,1P4E18.5)	PULS1510
210 FORMAT (16H SINGULAR SYSTEM)	PULS1520
220 FORMAT (12I6)	PULS1530
230 FORMAT (3(11X,E11.4))	PULS1540
240 FORMAT (3H K=,I3,11H ALAMDA(K)=,1PE12.5)	PULS1550
250 FORMAT (4H I=,I3,6H T(I)=,1PE12.5,7H FX(I)=,1PE12.5)	PULS1560
260 FORMAT (1H0,6H LWT=,I3)	PULS1570
270 FORMAT (16H0 A-MATRIX FOR ,I6)	PULS1580
280 FORMAT (2X,10E12.3)	PULS1590
290 FORMAT (15H0 B-MATRIX FOR,I6)	PULS1600
END	PULS1610
	PULS1620
C SUBROUTINE PDIF	PDIF 10
C	PDIF 20
C ROUTINE CALCULATES PER CENT DIFFERENCES BETWEEN CALCULATED AND INPPDIF	PDIF 30
C DATA.	PDIF 40
C	PDIF 50
COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	PDIF 60
1 NIN, NOOT	PDIF 70
LEVEL 2, A, B	PDIF 80
COMMON /PULSCAL/ A(50,50), B(50,1)	PDIF 90
COMMON /PULSOUT/ ALPHA(50), FXC(100), PCTDIF(100)	PDIF 100
COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)	PDIF 110
DO 30 I=1,ITSP	PDIF 120
PCTDIF(I)=0.	PDIF 130
FXC(I)=0.	PDIF 140
DO 20 K=1,KTRM	PDIF 150
IF ((-ALAMDA(K)*T(I)).GT.300.) ALAMDA(K)=-300.0/T(I)	PDIF 160

```

170 PDIF
180 PDIF
190 PDIF
200 PDIF
210 PDIF
220 PDIF
230 PDIF
240 PDIF
250 PDIF
260 PDIF
270 PDIF
280 PDIF
290 PDIF
300 PDIF
IF (IRAD.LE.0) GO TO 10
COFF=B(K)/DEL T(1)/ALAMDA(K)**2
XPO1=1.-EXP(-ALAMDA(K)*RADT(1))
XPO2=1.-EXP(-ALAMDA(K)*DEL T(1))
XPO3=EXP(-ALAMDA(K)*(T(1)-DEL T(1))/2.))
FXC(1)=FXC(1)+COFF*XPO1*XPO2*XPO3
GO TO 20
10 CONTINUE
FXC(1)=FXC(1)+B(K)*EXP(-ALAMDA(K)*T(1))
ALPHA(K)=B(K)*EXP(-ALAMDA(K)*T(1))
20 CONTINUE
30 PCTDIF(1)=(FX(1)-FXC(1))/FX(1)*100.
RETURN
END

```

SUBROUTINE SEEFIT (IP)

ROUTINE DOES INTERACTIVE GRAPHICS.

```

C
C
COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB.
1 NIN, NOUT
LEVEL 2, A, B
COMMON /PULSCAL/ A(50,50), B(50,100), PCTDIF(100)
COMMON /PULSOUT/ ALPHA(50), FXC(100), NCORS, RADT(200), DELT(200)
DIMENSION TI(10), XL(10), YL(10)
10 CONTINUE
NOUT=20
M=1
N=0
DO 10 JUX=1,5
NS(JUX)=1
10 CONTINUE
CALL PDIF
DO 40 I=1,ITSP
IF (ABS(PCTDIF(I)).LT.10.) GO TO 40
DIF F=FX(I)-FXC(I)
TXT=ABS(PCTDIF(I))
IF (TXT.LT.20) GO TO 220
IF (N.LT.20) N=N+1
NS(M)=N
IF (N.LE.1) GO TO 30
IF (I.EQ.1-1) GO TO 30
IF (N.LE.3) GO TO 20
M=M+1
20 N=1
30 CONTINUE
WRITE (NOUT,190) IP,1,PCTDIF(I),DIF F
I I=1
TNG(M,N)=T(I)
FNG(M,N)=DIF F
M=M+1
40 CONTINUE
IF (MM.EQ.0) GO TO 140
MUM=KTRM
DO 130 M=1,MM
NM=NS(M)-1
WRITE (NOUT,200) (M,N,TNG(M,N),FNG(M,N),N=1,NM)
IF (NM.LE.2) GO TO 130
C FIND MINS AND MAXS
50 FNGMX=FNG(M,1)
TMX=TNG(M,1)
FNGMN=FNG(M,1)
TMN=TNG(M,1)
DO 60 N=1,NM
IF (TNG(M,N).GT.TMX) TMX=TNG(M,N)
IF (TNG(M,N).LT.TMN) TMN=TNG(M,N)
IF (FNG(M,N).GT.FNGMX) FNGMX=FNG(M,N)
IF (FNG(M,N).LT.FNGMN) FNGMN=FNG(M,N)
XP(N)=TNG(M,N)
YP(N)=FNG(M,N)
60 CONTINUE
C DRAW PICTURE

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CALL PTPLT (XP,YP,NN,TMN,TMX,FNGMN,FNGMX,IP,M)
WRITE (11,210)
READ (11,*) JB,NN
IF (JB.EQ.0) GO TO 130
IF (FNG(M,JB)/FNG(M,NN).GE.0.) GO TO 70
WRITE (NOUT,220) FNG(M,JB),FNG(M,NN),M
GO TO 130
70 IF (TNG(M,NN).GT.TNG(M,JB)) GO TO 80
IZ=JB
JB=NN
NN=IZ
GO TO 80
C INTERACTIVE - USE POINTS ENTERED FROM TERMINAL
80 DECA=ALOG(FNG(M,JB)/FNG(M,NN))/(TNG(M,NN)-TNG(M,JB))
COEF=FNG(M,NN)/EXP(-DECA*TNG(M,NN))
NN=JB-1
C RECALCULATE REMAINING POINTS IF 3 OR MORE
IF (NN.LE.1) GO TO 120
IF (NN.GE.3) GO TO 100
COEF=0.
DO 90 N=1,NN
90 COEF=COEF+FNG(M,N)/EXP(-DECA*TNG(M,N))
COEF=COEF/FLOAT(NN)
GO TO 120
100 DO 110 N=1,NN
FNG(M,N)=FNG(M,N)-COEF*EXP(-DECA*TNG(M,N))
110 CONTINUE
120 WRITE (NOUT,230) COEF,DECA
MUM=MUM+1
B(MUM,1)=COEF
ALAMDA(MUM)=DECA
C IF THREE OR MORE POINTS LEFT THROW OUT POINTS USED IN LAST
C ITERATION AND LOOP.
IF (NN.GE.3) GO TO 50
130 CONTINUE
140 KTRM=MUM
CALL PDIF
IPRO=IP
WRITE (NOUT,240) IPRO
WRITE (NOUT,250) (I,T(I),FX(I),FXC(I),PCTDIF(I),I=1,ITSP)
RMS=0.
DO 150 I=1,ITSP
RMS=RMS+PCTDIF(I)**2
150 CONTINUE
RMS=RMS**0.5
WRITE (NOUT,260) RMS
AR1=0.
AR2=0.
DO 160 I=2,ITSP
AR1=AR1+(FX(I)+FX(I-1))/2.0*(T(I)-T(I-1))
AR2=AR2+(FXC(I)+FXC(I-1))/2.0*(T(I)-T(I-1))
160 CONTINUE
ARDIF=(AR1-AR2)/AR1*100.
WRITE (NOUT,270) AR1,AR2,ARDIF
FXMN=FX(1)
DO 170 I=1,ITSP
IF (FX(I).LE.0.0) FX(I)=FX(I-1)/10.
IF (FX(I).LT.FXMN) FXMN=FX(I)
170 CONTINUE
DO 180 I=1,ITSP
IF (FXC(I).LT.FXMN) FXC(I)=FXMN
180 CONTINUE
RETURN
C
190 FORMAT (1H0,* K=*I3,* I=*I3,* PCTDIF=*1PE12.5,* DIFF=*1PE12.5)
200 FORMAT (1H0,* M=*I3,* N=*I3,* TNG=*1PE12.5,* FNG=*1PE12.5)
210 FORMAT (* ENTER PAIR OF POINTS TO CALCULATE PARAMETERS*)
220 FORMAT (* SIGNS VARY ON POINT CHOSEN *,2E12.4/* SUBGROUP *,I2/* GOSEEF1260
1 TO NEXT SET*)
230 FORMAT (1H0,* COEF=*1PE12.5,* DECA=*1PE12.5)
240 FORMAT (107H1 STEP NO. TIME ORIGINAL VALUE COMPUTSEEF1290
1ED VALUE PERCENT DIFFERENCE IPROB=.13)
250 FORMAT (16,1P4E18.5)
260 FORMAT (21H0 ROOT-MEAN-SQUARE=1PE12.5)
270 FORMAT (13H0 ORIG INT =,1PE12.5,14H FITTED INT= ,1PE12.5,15H PERSEEF1330

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1CENT DIFF =.1PE12.5)
END

SEEF1340
SEEF1350

C	SUBROUTINE PCHOUT (LXX)	PCHO 10
C	ROUTINE PUNCHES OUT PARAMETERS IN ENDF-LIKE FORMAT.	PCHO 20
C	COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	PCHO 30
	1 NIN, NOUT	PCHO 40
	COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(25,50)	PCHO 50
	1 5,50)	PCHO 60
	COMMON /MANI/ TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM	PCHO 70
	COMMON /ENDF/MEVU, MAT, MF, MT, RUNTIM, NPUN	PCHO 80
	DIMENSION F(10), P(10), L(10), LXX(20)	PCHO 90
	NPUN=7	PCHO 100
	C1=0.	PCHO 110
	NUL=0	PCHO 120
	NSEQ=1	PCHO 130
	WRITE (NOUT,30) (TITL(I),I=1,7),MAT,MF,MT,NSEQ	PCHO 140
	WRITE (NPUN,30) (TITL(I),I=1,7),MAT,MF,MT,NSEQ	PCHO 150
	NSEQ=NSEQ+1	PCHO 160
	WRITE (NOUT,40) C1,C1,NUL,NUL,NUL,NERG,MAT,MF,MT,NSEQ	PCHO 170
	WRITE (NPUN,40) C1,C1,NUL,NUL,NUL,NERG,MAT,MF,MT,NSEQ	PCHO 180
	DO 20 K=1,NERG	PCHO 190
	NPX=KTR(K)	PCHO 200
	LPX=LXX(K)	PCHO 210
	EB1=EB(K)	PCHO 220
	EB2=EB(K+1)	PCHO 230
	CALL CXFP (EB1,F(1),P(1),L(1))	PCHO 240
	CALL CXFP (EB2,F(2),P(2),L(2))	PCHO 250
	NSEQ=NSEQ+1	PCHO 260
	WRITE (NOUT,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,K,MAT,MF,MT	PCHO 270
	1 ,NSEQ)	PCHO 280
	WRITE (NPUN,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,K,MAT,MF,MT	PCHO 290
	1 ,NSEQ)	PCHO 300
	EB1=T(1)	PCHO 310
	EB2=T(LPX)	PCHO 320
	CALL CXFP (EB1,F(1),P(1),L(1))	PCHO 330
	CALL CXFP (EB2,F(2),P(2),L(2))	PCHO 340
	NSEQ=NSEQ+1	PCHO 350
	WRITE (NOUT,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,NPX,MAT,MF,MT	PCHO 360
	1 ,NSEQ)	PCHO 370
	WRITE (NPUN,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,NPX,MAT,MF,MT	PCHO 380
	1 ,NSEQ)	PCHO 390
	ALF(K,NPX+1)=0.	PCHO 400
	ALF(K,NPX+2)=0.	PCHO 410
	ALAM(K,NPX+1)=0.	PCHO 420
	ALAM(K,NPX+2)=0.	PCHO 430
	J1=1	PCHO 440
10	CONTINUE	PCHO 450
	E1=ALF(K,J1)	PCHO 460
	E2=ALF(K,J1+1)	PCHO 470
	E3=ALF(K,J1+2)	PCHO 480
	FX1=ALAM(K,J1)	PCHO 490
	FX2=ALAM(K,J1+1)	PCHO 500
	FX3=ALAM(K,J1+2)	PCHO 510
	NSEQ=NSEQ+1	PCHO 520
	CALL CXFP (E1,F(1),P(1),L(1))	PCHO 530
	CALL CXFP (FX1,F(2),P(2),L(2))	PCHO 540
	CALL CXFP (E2,F(3),P(3),L(3))	PCHO 550
	CALL CXFP (FX2,F(4),P(4),L(4))	PCHO 560
	CALL CXFP (E3,F(5),P(5),L(5))	PCHO 570
	CALL CXFP (FX3,F(6),P(6),L(6))	PCHO 580
	WRITE (NOUT,60) (F(I),P(I),L(I),I=1,6),MAT,MF,MT,NSEQ	PCHO 590
	WRITE (NPUN,60) (F(I),P(I),L(I),I=1,6),MAT,MF,MT,NSEQ	PCHO 600
	IF ((J1+2).GE.NPX) GO TO 20	PCHO 610
	J1=J1+3	PCHO 620
	GO TO 10	PCHO 630
20	CONTINUE	PCHO 640
	MAT1=0	PCHO 650
	MF1=0	PCHO 660
	MT1=0	PCHO 670
	MEND=-1	PCHO 680
		PCHO 690
		PCHO 700

NSEQ=NSEQ+1	PCHO 710
WRITE (NOUT,70) MAT,MF,MT1,NSEQ	PCHO 720
WRITE (NPUN,70) MAT,MF,MT1,NSEQ	PCHO 730
NSEQ=NSEQ+1	PCHO 740
WRITE (NOUT,70) MAT,MF1,MT1,NSEQ	PCHO 750
WRITE (NPUN,70) MAT,MF1,MT1,NSEQ	PCHO 760
NSEQ=NSEQ+1	PCHO 770
WRITE (NOUT,70) MAT1,MF1,MT1,NSEQ	PCHO 780
WRITE (NPUN,70) MAT1,MF1,MT1,NSEQ	PCHO 790
WRITE (NOUT,70) MEND	PCHO 800
WRITE (NPUN,70) MEND	PCHO 810
RETURN	PCHO 820
C 30 FORMAT (6A10,A6,I4,I2,I3,I5)	PCHO 830
40 FORMAT (1P2E11.5,4I11,I4,I2,I3,I5)	PCHO 840
50 FORMAT (2(F8.5,A1,I2),4I11,I4,I2,I3,I5)	PCHO 850
60 FORMAT (6(F8.5,A1,I2),I4,I2,I3,I5)	PCHO 860
70 FORMAT (66X,I4,I2,I3,I5)	PCHO 870
END	PCHO 880
	PCHO 890

C SUBROUTINE CXFP (X,F,S,N)	CXFP 10
C	CXFP 20
C CONVERT X FOR PUNCHING	CXFP 30
C X - FLOATING POINT NUMBER = F*10.0**N	CXFP 40
C F - 0.999995 LE F LT 9.999995	CXFP 50
C S - SIGN (HOLLERITH + OR -) OF EXPONENT	CXFP 60
C N - EXPONENT	CXFP 70
C	CXFP 80
C DATA SP /1H+/, SM /1H-/	CXFP 90
C IF (X.NE.0.0) GO TO 10	CXFP 100
C F=0.0	CXFP 110
C S=SP	CXFP 120
C N=0	CXFP 130
C RETURN	CXFP 140
C 10 N=ALOG10(ABS(X))	CXFP 150
C IF (ABS(X)-1.0) 40,20,20	CXFP 160
C 20 F=X/10.0**N	CXFP 170
C S=SP	CXFP 180
C IF (ABS(F)-9.999995) 70,30,30	CXFP 190
C 30 F=F/10.0	CXFP 200
C N=N+1	CXFP 210
C GO TO 70	CXFP 220
C 40 N=1-N	CXFP 230
C F=X*10.0**N	CXFP 240
C S=SM	CXFP 250
C IF (ABS(F)-9.999995) 70,50,50	CXFP 260
C 50 F=F/10.0	CXFP 270
C N=N-1	CXFP 280
C IF (N) 60,60,70	CXFP 290
C 60 S=SP	CXFP 300
C 70 CONTINUE	CXFP 310
C RETURN	CXFP 320
C END	CXFP 330

SUBROUTINE SETUP (X1,Y1,L1,X2,Y2,L2,TL,NT,XL,NX,YL,NY,ITYPE,IFNO)	SETU 10
REAL X1(L1), X2(L2), Y1(L1), Y2(L2)	SETU 20
INTEGER TL(2), XL(2), YL(2)	SETU 30
DATA XPAGE, YPAGE /6.,6./	SETU 40
CALL BGNPL (-1)	SETU 50
CALL NOBRDR	SETU 60
CALL PAGE (XPAGE,YPAGE)	SETU 70
XG=XPAGE-1.7	SETU 80
YG=YPAGE-1.7	SETU 90
HITE=.03*YG	SETU 100
CALL HEIGHT (HITE)	SETU 110
CALL SCMPLEX	SETU 120
CALL MX1ALF (5HSTAND,1H)	SETU 130
CALL MX2ALF (5HL/CST,1H)	SETU 140
CALL YMMMX (X1,L1,X2,L2,XLEFT,XRIGHT)	SETU 150
CALL YMMMX (Y1,L1,Y2,L2,YBOT,YTOP)	SETU 160
IF (IFNO.NE.0) CALL PHYSOR (4.*HITE,1.4)	SETU 170

```

      IF (ITYPE.EQ.3) CALL DECBND (XLEFT,XRIGHT,2)
      IF (ITYPE.EQ.2.OR.ITYPE.EQ.4) CALL DECBND (YBOT,YTOP,2)
      IF (ITYPE.NE.1) GO TO 10
      CALL AXSPLT (YBOT,YTOP,YG,YORIG,YSTEP,YAXIS)
      YTOP=FIX((YTOP+YSTEP)/YSTEP)*YSTEP
      CALL AXSPLT (XLEFT,XRIGHT,XG,XORIG,XSTEP,XAXIS)
      XRIGHT=FIX((XRIGHT+XSTEP)/XSTEP)*XSTEP
      CALL TITLE (0.0,XL,NX,YL,NY,XG,YG)
      CALL YLOG (0.,1.,YORIG,YCYCLE)
      CALL XGRAXS (XORIG,XSTEP,XRIGHT,XG,XL,NX,0.,0.)
      GO TO 40
10  IF (ITYPE.NE.2) GO TO 20
      CALL AXSPLT (XLEFT,XRIGHT,XG,XORIG,XSTEP,XAXIS)
      XRIGHT=FIX((XRIGHT+XSTEP)/XSTEP)*XSTEP
      CALL ALGPLT (YBOT,YTOP,YG,YORIG,YCYCLE)
      CALL TITLE (0.0,0.0,XL,NY,XG,YG)
      CALL YLOG (0.,1.,YORIG,YCYCLE)
      CALL XGRAXS (XORIG,XSTEP,XRIGHT,XG,XL,NX,0.,0.)
      GO TO 40
20  CALL ALGPLT (XLEFT,XRIGHT,XG,XORIG,XCYCLE)
      IF (ITYPE.NE.3) GO TO 30
      CALL AXSPLT (YBOT,YTOP,YG,YORIG,YSTEP,YAXIS)
      YTOP=FIX((YTOP+YSTEP)/YSTEP)*YSTEP
      CALL TITLE (0.0,XL,NX,0.0,XG,YG)
      CALL XLOG (XORIG,XCYCLE,0.,1.)
      CALL YGRAXS (YORIG,YSTEP,YTOP,YG,YL,NY,0.,0.)
      GO TO 40
30  CALL ALGPLT (YBOT,YTOP,YG,YORIG,YCYCLE)
      CALL TITLE (0.0,XL,NX,YL,NY,XG,YG)
      CALL LOGLOG (XORIG,XCYCLE,YORIG,YCYCLE)
40  CALL FRAME
      CALL CURVE (X1,Y1,L1,0)
      IF (IFNO.EQ.0) GO TO 42
      CALL BSHFT(0.,-1,4)
      CALL MESSAGE(TL,NT.,9.,13)
      CALL MESSAGE(9HF,IG.,B-.9 (XPAGE-3,0)/2.,2,0*HITE+.13)
      CALL ININO(IFNO,4HABUT,4HABUT)
      CALL MESSAGE(1H.,1,4HABUT,4HABUT)
      CALL BSHFT(0.,0.)
      GO TO 45
42  CALL MESSAGE(TL,NT.,1,YPAGE-1.)
45  IF (L2.EQ.0) GO TO 50
      CALL MARKER (8)
50  CALL CURVE (X2,Y2,L2,-1)
      CALL ENDPL (0)
      RETURN
      END

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      SUBROUTINE YMMMX (AR1,L1,AR2,L2,BOT, TOP)
      REAL AR1(L1), AR2(L2)
      TOP=BOT+AR1(1)
      DO 10 I=2,L1
      IF (AR1(I).LT.BOT) BOT=AR1(I)
      IF (AR1(I).GT.TOP) TOP=AR1(I)
10  CONTINUE
      IF (L2.EQ.0) RETURN
      DO 20 I=1,L2
      IF (AR2(I).LT.BOT) BOT=AR2(I)
      IF (AR2(I).GT.TOP) TOP=AR2(I)
20  CONTINUE
      RETURN
      END

```

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      SUBROUTINE DECBND (BOT, TOP, IFF)
      CHANGE BOUNDS TO DECADE BOUNDARIES
      C IFF=0 LOWER ONLY
      C IFF=1 UPPER ONLY
      C IFF=2 BOTH
      IF (IFF.EQ.1) GO TO 10
      BOT=ALOG10(BOT)
      IF (BOT.GE.0.) BOT=10.*FIX (BOT)
      IF (BOT.LT.0.) BOT=10.*IFIX (BOT-.99)

```

10 IF (IFF.EQ.0) RETURN	DECB 100
TOP=ALOG10(TOP)	DECB 110
IF (TOP.GE.0.) TOP=10.**FIX(TOP+.99)	DECB 120
IF (TOP.LT.0.) TOP=10.**FIX(TOP)	DECB 130
RETURN	DECB 140
END	DECB 150
SUBROUTINE PTPLT (X,Y,NP,XMN,XX,YYN,YYX,IGR,ISET)	PTPL 10
COMMON /PIC/ IPT	PTPL 20
DIMENSION X(2), Y(2)	PTPL 30
INTEGER IT(2)	PTPL 40
C DO POINT PLOTS OF POINTS THAT DIFFER BY MORE THAN 10 PER CENT	PTPL 50
C COUNT POSITIVE AND NEGATIVE	PTPL 60
ENCODE (15,140,IT) IGR,ISET	PTPL 70
NSP=NSN=0	PTPL 80
NT=NP	PTPL 90
DO 20 N=1,NP	PTPL 100
IF (Y(N).GT.0) GO TO 10	PTPL 110
NSN=NSN+1	PTPL 120
GO TO 20	PTPL 130
10 NSP=NSP+1	PTPL 140
20 CONTINUE	PTPL 150
C REVERSE SIGNS IF MAJORITY ARE NEG	PTPL 160
IF (NSP.GE.NSN) GO TO 40	PTPL 170
DO 30 N=1,NP	PTPL 180
30 Y(N)=-Y(N)	PTPL 190
I=NSN	PTPL 200
NSN=NSP	PTPL 210
NSP=I	PTPL 220
Z=YYN	PTPL 230
YYN=-YYX	PTPL 240
YYX=-Z	PTPL 250
C THROW OUT NEGATIVE POINTS	PTPL 260
40 IF (NSN.EQ.0) GO TO 100	PTPL 270
DO 70 N=1,NP	PTPL 280
50 IF (Y(N).GT.0.) GO TO 70	PTPL 290
NT=NT-1	PTPL 300
IF (NT.LT.N) GO TO 80	PTPL 310
DO 60 NN=N,NT	PTPL 320
60 Y(N)=Y(NN+1)	PTPL 330
GO TO 50	PTPL 340
70 CONTINUE	PTPL 350
C RECALCULATE Y MAX Y MIN	PTPL 360
80 YYN=YYX=Y(1)	PTPL 370
DO 90 N=1,NT	PTPL 380
IF (Y(N).GT.YMX) YMX=Y(N)	PTPL 390
IF (Y(N).LT.YMN) YMN=Y(N)	PTPL 400
90 CONTINUE	PTPL 410
100 CALL BGNPL (-1)	PTPL 420
CALL NOBRDR	PTPL 430
CALL PAGE (11.,11.)	PTPL 440
CALL HEIGHT (.25)	PTPL 450
CALL AXSPLT (XMN,XX,9.,XORIG,XSTEP,XAXIS)	PTPL 460
CALL ALGPLT (YYN,YYX,8.,YORIG,YCYCLE)	PTPL 470
CALL TITLE (IT,15,0,0,10HDIFFERENCE,10,9.,8.)	PTPL 480
CALL YLOG (0.,1.,YORIG,YCYCLE)	PTPL 490
CALL XGRAXS (XORIG,XSTEP,XX,XAXIS,4HTIME,4,0.,0.)	PTPL 500
CALL FRAME	PTPL 510
IPT=0	PTPL 520
CALL MARKER (-1)	PTPL 530
CALL CURVE (X,Y,NT,-1)	PTPL 540
C DRAW VECTOR FROM POINT ONE THRU POINT TWO TO PLOT BOUNDARY	PTPL 550
P1X=XPOSN(X(NT),Y(NT))	PTPL 560
P1Y=YPOSN(X(NT),Y(NT))	PTPL 570
P2X=XPOSN(X(NT-1),Y(NT-1))	PTPL 580
P2Y=YPOSN(X(NT-1),Y(NT-1))	PTPL 590
IF (P2Y.LE.P1Y) GO TO 130	PTPL 600
SLOPE=(P2Y-P1Y)/(P2X-P1X)	PTPL 610
YCEPT=P1Y-SLOPE*P1X	PTPL 620
IF (YCEPT.GT.8.) GO TO 110	PTPL 630
P3X=0.	PTPL 640
P3Y=YCEPT	PTPL 650
GO TO 120	PTPL 660

```

110 P3X=(8.-YCEPT)/SLOPE
    P3Y=8.
120 CALL VECTOR (P1X,P1Y,P3X,P3Y,0)
130 CALL ENDPL (0)
    RETURN
C
140 FORMAT (6HGROUP,12,5H SET,12)
    END
PTPL 670
PTPL 680
PTPL 690
PTPL 700
PTPL 710
PTPL 720
PTPL 730
PTPL 740

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SUBROUTINE PICTUR (N)
COMMON /PIC/ IPT
C PRINT NUMBER N AS CURVE MARKER
CALL SYMORG (XD,YD)
IPT=IPT+1
CALL HEIGHT (.14)
CALL OOSYMB (3)
CALL HEIGHT (.25)
CALL INTNO (IPT,XD+.05,YD)
RETURN
END
PICT 10
PICT 20
PICT 30
PICT 40
PICT 50
PICT 60
PICT 70
PICT 80
PICT 90
PICT 100
PICT 110

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SUBROUTINE OVRLAY3
OVRLAY 3 IS NON-LINEAR LEAST-SQUARES ROUTINE
COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,
1 NIN, NOUT
COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(20V
1 5,50)
LEVEL 2, A, B
COMMON /PULSCAL/ A(50,50), B(50,1)
COMMON /MANI/ WX(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM
COMMON /ENDF/MEVU, MAT, MF, MT, RUNTIM, NPUN
COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)
COMMON /COMO/ NP, TMIN, TMAX, NSTEP, GXMIN, TC(100), LXX(20),
1 NFINL
DO 40 K=1,NERG
IF (KKN(K).NE.K) GO TO 40
IX=0
IF (TMIN,LT,TC(1)) TMIN=TC(1)
IF (TMAX,LE,0,0) TMAX=TC(NP)
IF (TMAX,GT,TC(NP)) TMAX=TC(NP)
DO 10 I=1,NP
IF (GX(K,I),LT,GXMIN) GO TO 10
IF (TC(I),LT,TMIN) GO TO 10
IF (TC(I),GT,TMAX) GO TO 10
IX=IX+1
ITSP=IX
LXX(K)=IX
FX(IX)=GX(K,I)
T(IX)=TC(I)
10 CONTINUE
KTRM=KTR(K)
DO 20 L=1,KTRM
ALAMDA(L)=ALAM(K,L)
B(L,1)=ALF(K,L)
20 CONTINUE
KK1=KKN(K)
KK2=-KKN(K)
IF (KK2.EQ,K) KK1=K
IF (K.NE,KK1) GO TO 30
IF (NSTEP,LE,0) GO TO 30
WRITE (NOUT,60) (TITL(I),I=1,8)
WRITE (NOUT,50) K
KTRM=KTR(K)
IF (NSTEP,GT,0) CALL DHFIT (K)
KTR(K)=KTRM
30 CONTINUE
CALL FINECHK (K)
40 CONTINUE
RETURN
OVR3 10
OVR3 20
OVR3 30
OVR3 40
OVR3 50
OVR3 60
OVR3 70
OVR3 80
OVR3 90
OVR3 100
OVR3 110
OVR3 120
OVR3 130
OVR3 140
OVR3 150
OVR3 160
OVR3 170
OVR3 180
OVR3 190
OVR3 200
OVR3 210
OVR3 220
OVR3 230
OVR3 240
OVR3 250
OVR3 260
OVR3 270
OVR3 280
OVR3 290
OVR3 300
OVR3 310
OVR3 320
OVR3 330
OVR3 340
OVR3 350
OVR3 360
OVR3 370
OVR3 380
OVR3 390
OVR3 400
OVR3 410
OVR3 420
OVR3 430
OVR3 440
OVR3 450
OVR3 460
OVR3 470
OVR3 480
OVR3 490
OVR3 500

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C	50 FORMAT (1H0.35H STEPIT HAS BEEN CALLED FOR GROUP ,I 3)	OVR3 510
	60 FORMAT (1H1.10X,8A10)	OVR3 520
	END	OVR3 530
		OVR3 540
	SUBROUTINE DHFIT (K)	DHFI 10
C		DHFI 20
C	ROUTINE WITH SUBROUTINES FUNK AND STEPIT PERFORM NON-LIN LST-SQ	DHFI 30
C	FITS, I.E. BOTH ALF AND ALAM. ADAPTATION OF STEPIT CODE BY	DHFI 40
C	M.G.STAMATALATOS,LASL,1976,FOR THIS APPLICATION.	DHFI 50
		DHFI 60
	COMMON /PULSIN/ ALAMDA(50), DH(200), T(100), NERS, PERDIF(100),	DHFI 70
	1 CALC(100), W(100), KTRM, ITSP, IPROB, NIN, NOUT	DHFI 80
	COMMON /PULSDAT/ NDT, EB(25), HOLD(25,100), NV, NTRACE, MASK(70),	DHFI 90
	1 X(70), XMAX(70), XMIN(70), DELTAX(70), DELMIN(70), DUMMY, MATRIX	DHFI 100
	2 ERR(70,70), CHISQ, BSAV(100), VEC(70), TRIAL(70), XSAVE(70), CHI	DHFI 110
	3 70), SECOND(2,2), OLDVEC(70), SALVO(70), XOSC(70,15), CHIOSC(15),	DHFI 120
	4 DUM(586), NERG, ALF(25,50), ALAM(25,50)	DHFI 130
	COMMON /MANI/ TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIF LIM	DHFI 140
	COMMON /ENDF/MEVU, MAT, MF, MT, RUNTIM, NPUN	DHFI 150
	COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)	DHFI 160
	DIMENSION TTL(10), XLL(10), YLL(10)	DHFI 170
	DO 10 KK=1,KTRM	DHFI 180
	I I=2*KK-1	DHFI 190
	I J=2*KK	DHFI 200
	X(I I)=ALF(K,KK)	DHFI 210
	X(I J)=ALAM(K,KK)	DHFI 220
10	CONTINUE	DHFI 230
	NV=2*KTRM	DHFI 240
	IF (NV.LE.70) GO TO 20	DHFI 250
	WRITE (NOUT,150) NV	DHFI 260
	RETURN	DHFI 270
20	CONTINUE	DHFI 280
	DO 30 I=1,NV,2	DHFI 290
	XMIN(I)=X(I)*0.1	DHFI 300
	IF (X(I).LT.0.) XMIN(I)=10.*X(I)	DHFI 310
	XMAX(I)=X(I)*10.	DHFI 320
	IF (X(I).LT.0.) XMAX(I)=X(I)*0.1	DHFI 330
	XMIN(I+1)=0.5*X(I+1)	DHFI 340
	XMAX(I+1)=2.0*X(I+1)	DHFI 350
30	CONTINUE	DHFI 360
	WRITE (NOUT,160)	DHFI 370
	WRITE (NOUT,170) (X(I),I=1,NV)	DHFI 380
	WRITE (NOUT,180)	DHFI 390
	WRITE (NOUT,170) (XMIN(I),I=1,NV)	DHFI 400
	WRITE (NOUT,190)	DHFI 410
	WRITE (NOUT,170) (XMAX(I),I=1,NV)	DHFI 420
	DO 40 I=1,NV	DHFI 430
	DELTAX(I)=0.1*X(I)	DHFI 440
	DELMIN(I)=0.001*X(I)	DHFI 450
40	MASK(I)=0	DHFI 460
	NERS=ITSP	DHFI 470
	DO 50 I=1,NERS	DHFI 480
	QW=1.	DHFI 490
50	W(I)=(1./DH(I))*QW	DHFI 500
	CHSQ=0.	DHFI 510
	DO 100 I=1,NERS	DHFI 520
	CALC(I)=0.	DHFI 530
	DO 90 J=1,NV,2	DHFI 540
	IF (IRAD.LE.0) GO TO 60	DHFI 550
	COFF=X(J)/DELT(I)/X(J+1)**2	DHFI 560
	XPO1=1.-EXP(-X(J+1)*RADT(I))	DHFI 570
	XPO2=1.-EXP(-X(J+1)*DELT(I))	DHFI 580
	XPO3=EXP(-X(J+1)*(T(I)-DELT(I)/2.))	DHFI 590
	CALC(I)=CALC(I)+COFF*XPO1*XPO2*XPO3	DHFI 600
	GO TO 90	DHFI 610
60	TEMP=X(J+1)*T(I)	DHFI 620
	IF (ABS(TEMP).LE.600) GO TO 70	DHFI 630
	XPO=0.	DHFI 640
	GO TO 80	DHFI 650
70	XPO=X(J)*EXP(-TEMP)	DHFI 660
80	CALC(I)=CALC(I)+XPO	DHFI 670
90	CONTINUE	DHFI 680

PERDIF(I)=100.*(CALC(I)/DH(I))-1.)	DHFI	690
100 CHSQ=CHSQ+(CALC(I)-DH(I))*(CALC(I)-DH(I))*W(I)*W(I)	DHFI	700
WRITE(NOUT,200) CHSQ	DHFI	710
WRITE(NOUT,210)	DHFI	720
WRITE(NOUT,220)	DHFI	730
WRITE(NOUT,230) (T(I),DH(I),CALC(I),PERDIF(I),I=1,NERS)	DHFI	740
CALL STEPIT	DHFI	750
DO 120 I=1,NERS	DHFI	760
CALC(I)=0.	DHFI	770
DO 120 J=1,NV,2	DHFI	780
IF (IRAD.LE.0) GO TO 110	DHFI	790
COFF=X(J)/DELT(I)/X(J+1)*.2	DHFI	800
XPO1=1.-EXP(-X(J+1)*RADT(I))	DHFI	810
XPO2=1.-EXP(-X(J+1)*DELT(I))	DHFI	820
XPO3=EXP(-X(J+1)*(T(I)-DELT(I)/2.))	DHFI	830
CALC(I)=CALC(I)+COFF*XPO1*XPO2*XPO3	DHFI	840
GO TO 120	DHFI	850
110 TEMP=X(J+1)*T(I)	DHFI	860
IF (ABS(TEMP).GT.600) GO TO 120	DHFI	870
CALC(I)=CALC(I)+X(J)*EXP(-TEMP)	DHFI	880
120 CONTINUE	DHFI	890
DO 130 I=1,NERS	DHFI	900
130 PERDIF(I)=100.*(CALC(I)/DH(I))-1.)	DHFI	910
WRITE(NOUT,220)	DHFI	920
WRITE(NOUT,230) (T(I),DH(I),CALC(I),PERDIF(I),I=1,NERS)	DHFI	930
ENCODE(34,240,TTL(I)) K	DHFI	940
ENCODE(20,250,XLL)	DHFI	950
ENCODE(20,260,YLL)	DHFI	960
CALL SETUP(T,PERDIF,NERS,0,0,0,TTL,34,XLL,20,YLL,20,3)	DHFI	970
DO 140 J=1,KTRM	DHFI	980
I I=2*J-1	DHFI	990
I J=2*J	DHFI	1000
ALF(K,J)=X(I I)	DHFI	1010
ALAM(K,J)=X(I J)	DHFI	1020
140 CONTINUE	DHFI	1030
RETURN	DHFI	1040
C	DHFI	1050
150 FORMAT(24H0 TOO MANY TERMS. NV=.13)	DHFI	1060
160 FORMAT(1H0,10X,18HINITIAL PARAMETERS,/))	DHFI	1070
170 FORMAT(1H .20X,6E12.4)	DHFI	1080
180 FORMAT(1H .10X,12HLOWER LIMITS,/))	DHFI	1090
190 FORMAT(1H .10X,12HUPPER LIMITS,/))	DHFI	1100
200 FORMAT(1H .10X,36HCHI-SQUARE WITH ORIGINAL GUESSES IS ,E12.4)	DHFI	1110
210 FORMAT(1H0,10X,31HCOMPARISON WITH INITIAL GUESSES,/))	DHFI	1120
220 FORMAT(1H0,10X,1HT,10X,2HDH,9X,4HCALC,7X,6HPERDIF,/))	DHFI	1130
230 FORMAT(1H .4E12.4)	DHFI	1140
240 FORMAT(32HPERCENT DEVIATION FOR GROUP NO. ,I2)	DHFI	1150
250 FORMAT(20H TIME IN SECONDS)	DHFI	1160
260 FORMAT(20H PERCENT DEVIATION)	DHFI	1170
END	DHFI	1180

SUBROUTINE FUNK	FUNK	10
COMMON/PULSIN/ALAMDA(50), DH(200), T(100), NERS, PERDIF(100),	FUNK	20
1 CALC(100), W(100), KTRM, ITSP, IPROB, NIN, NOUT	FUNK	30
COMMON/PULSDAT/NDT, EB(25), HOLD(25,100), NV, NTRACE, MASK(70),	FUNK	40
1 X(70), XMAX(70), XMIN(70), DELTAX(70), DELMIN(70), DUMMY, MATRIX,	FUNK	50
2 ERR(70,70), CHISQ, BSAV(100), VEC(70), TRIAL(70), XSAVE(70), CHI	FUNK	60
3 70), XECOND(2,2), OLDVEC(70), SALVO(70), XOSC(70,15), CHIOSC(15),	FUNK	70
4 DUM(586), NERG, ALF(25,50), ALAM(25,50)	FUNK	80
COMMON/MANI/TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM	FUNK	90
COMMON/ENDF/MEVU, MAT, MF, MT, TLIMIT, NPUN	FUNK	100
COMMON/FINRAD/NIAPL, IRAD, NCORS, RADT(200), DELT(200)	FUNK	110
DIMENSION LXX(20)	FUNK	120
CHISQ=0.	FUNK	130
DO 50 I=1,NERS	FUNK	140
CALC(I)=0.	FUNK	150
DO 40 J=1,NV,2	FUNK	160
IF (IRAD.LE.0) GO TO 10	FUNK	170
COFF=X(J)/DELT(I)/X(J+1)*.2	FUNK	180
XPO1=1.-EXP(-X(J+1)*RADT(I))	FUNK	190
XPO2=1.-EXP(-X(J+1)*DELT(I))	FUNK	200
XPO3=EXP(-X(J+1)*(T(I)-DELT(I)/2.))	FUNK	210
CALC(I)=CALC(I)+COFF*XPO1*XPO2*XPO3	FUNK	220


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      GO TO 40
10  TEMP=X(J+1)*T(I)
   IF (ABS(TEMP).LE.600.) GO TO 20
      XPO=0.
      GO TO 30
20  XPO=X(I)*EXP(-TEMP)
30  CALC(I)=CALC(I)+XPO
40  CONTINUE
50  CHISQ=CHISQ+BSAV(I)*BSAV(I)
   DIFMAX=0.
   DO 60 I=1,NERS
      PERDIF(I)=100.*(CALC(I)/DH(I))-1.)
      TSTLIM=ABS(PERDIF(I))
   IF (DIFMAX.LT.TSTLIM) DIFMAX=TSTLIM
60  CONTINUE
   IF (DIFMAX.LE.DIFLIM) CHISQ=1.E-20
      CALL SECOND(TYM)
   IF (TLIMIT.LT.1) TLIMIT=299.5
   IF (TYM.LT.TLIMIT) GO TO 80
      WRITE (NOUT,100)
      WRITE (NOUT,110)
      WRITE (NOUT,120) (X(I),I=1,NV)
      WRITE (NPUN,90) (X(I),I=1,NV)
      WRITE (NOUT,130)
      WRITE (NOUT,140)
      WRITE (NOUT,150) (T(I),DH(I),CALC(I),PERDIF(I),I=1,NERS)
      DO 70 KX=1,NERG
         LXX(KX)=TSP
70  CONTINUE
      CALL PCHOUT(LXX)
      CALL DONEPL
      STOP
80  CONTINUE
      RETURN

90  FORMAT (1P6E11.4)
100  FORMAT (1H0,10X,22HTIME LIMIT WAS REACHED/)
110  FORMAT (1H ,10X,30HTHE LAST SET OF PARAMETERS WAS./)
120  FORMAT (1H ,20X,6E12.4)
130  FORMAT (1H ,10X,29HCOMPARISON AT EXPIRATION TIME./)
140  FORMAT (1H0,///,9X,1HT,10X,2HDH,9X,4HCALC,7X,6HPERDIF./)
150  FORMAT (1H ,4E12.4)
      END

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C

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SUBROUTINE STEP1T
COMMON /PULSIN/ ALAMDA(50), DH(200), T(100), NERS, PERDIF(100),
1  CALC(100), W(100), KTRM, ITSP, IPROB, NIN, NOUT
COMMON /PULSDAT/ NDT, EB(25), HOLD(25,100), NV, NTRACE, MASK(70),
1  X(70), XMAX(70), XMIN(70), DELTAX(70), DELMIN(70), DUMAY, MATRIX,
2  ERR(70,70), CHISQ, BSAV(100), VEC(70), TRIAL(70), XSAVE(70), CHI
3  70), SECOND(2,2), OLDFEC(70), SALVO(70), XOSC(70,15), CHIOSC(15),
4  DUM(586), NERG, ALF(25,50), ALAM(25,50)
COMMON /MANI/ DX(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM
NVMAX=70
MOSQUE=15
KW=6
RATIO=10.0
COLIN=0.99
NCOMP=5
ACK=2.0
SIGNIF=2.E8
HUGE=1.E37
   IF (NV) 1310,1310,10
10  NACTIV=0
   DO 90 I=1,NV
   IF (MASK(I)) 90,20,90
20  IF (DELTAX(I)) 60,30,60
30  IF (X(I)) 50,40,50
40  DELTAX(I)=0.01
   GO TO 60
50  DELTAX(I)=0.01*X(I)
60  IF (XMAX(I)-XMIN(I)) 70,70,80

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```

STEP 10
STEP 20
STEP 30
STEP 40
STEP 50
STEP 60
STEP 70
STEP 80
STEP 90
STEP 100
STEP 110
STEP 120
STEP 130
STEP 140
STEP 150
STEP 160
STEP 170
STEP 180
STEP 190
STEP 200
STEP 210
STEP 220
STEP 230
STEP 240
STEP 250
STEP 260
STEP 270
STEP 280

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70	XMAX(I)=HUGE	STEP 290
	XMIN(I)=-HUGE	STEP 300
80	NACTIV=NACTIV+1	STEP 310
	X(I)=AMAX1(XMIN(I),AMIN1(XMAX(I),X(I)))	STEP 320
90	CONTINUE	STEP 330
	COMPAR=0.0	STEP 340
	IF (NACTIV-1) 100,130,120	STEP 350
100	DO 110 J=1,NV	STEP 360
110	MASK(J)=0	STEP 370
	GO TO 10	STEP 380
120	A=NACTIV	STEP 390
	SUB=2.0/(A-1.0)	STEP 400
	P=2.0*(1.0/SQRT(A)/(1.0-0.5*SUB)-1.0)	STEP 410
	COMPAR=AMIN1(.999,ABS((1.-(1.-COLIN)*SUB)*(1.+P*(1.-COLIN))))	STEP 420
130	CALL FUNK	STEP 430
	NF=1	STEP 440
	IF (NV) 1310,1310,140	STEP 450
140	DO 150 I=1,NV	STEP 460
150	DX(I)=DELTAX(I)	STEP 470
	CHOLD=CHISQ	STEP 480
	NOSC=0	STEP 490
160	NCIRC=0	STEP 500
	NZIP=0	STEP 510
C	MAIN DO LOOP FOR CYCLING THROUGH THE VARIABLES.	STEP 520
C	FIRST TRIAL STEP WITH EACH VARIABLE IS SEPARATE.	STEP 530
170	NACK=0	STEP 540
	DO 940 I=1,NV	STEP 550
	OLDVEC(I)=VEC(I)	STEP 560
	VEC(I)=0.0	STEP 570
	TRIAL(I)=0.0	STEP 580
	IF (MASK(I)) 180,190,180	STEP 590
180	VEC(I)=-0.0	STEP 600
	GO TO 940	STEP 610
190	NACK=NACK+1	STEP 620
	XSAVE(1)=X(I)	STEP 630
	IF (SIGNIF*ABS(DX(I))-ABS(X(I))) 340,340,200	STEP 640
200	X(I)=XSAVE(1)+DX(I)	STEP 650
	NFLAG=1	STEP 660
	IF (X(I)-XMIN(I)) 220,210,210	STEP 670
210	IF (X(I)-XMAX(I)) 230,230,220	STEP 680
220	NFLAG=NFLAG+3	STEP 690
	GO TO 250	STEP 700
230	CALL FUNK	STEP 710
	NF=NF+1	STEP 720
	CHIME=CHISQ	STEP 730
	IF (CHISQ-CHOLD) 380,240,250	STEP 740
240	NFLAG=NFLAG+1	STEP 750
250	X(I)=XSAVE(1)-DX(I)	STEP 760
	IF (X(I)-XMIN(I)) 350,260,260	STEP 770
260	IF (X(I)-XMAX(I)) 270,270,350	STEP 780
270	CALL FUNK	STEP 790
	NF=NF+1	STEP 800
	IF (CHISQ-CHOLD) 370,280,290	STEP 810
280	NFLAG=NFLAG+1	STEP 820
290	IF (NFLAG-3) 300,340,350	STEP 830
300	TRIAL(I)=DX(I)*0.5*(CHISQ-CHIME)/(CHIME-2.0*CHOLD+CHISQ)	STEP 840
	IF (TRIAL(I)) 310,350,310	STEP 850
310	VEC(I)=TRIAL(I)/ABS(DX(I))	STEP 860
	X(I)=XSAVE(1)+TRIAL(I)	STEP 870
	CALL FUNK	STEP 880
	NF=NF+1	STEP 890
	IF (CHISQ-CHOLD) 320,330,330	STEP 900
320	CHOLD=CHISQ	STEP 910
	GO TO 360	STEP 920
330	TRIAL(I)=0.0	STEP 930
	VEC(I)=0.0	STEP 940
	GO TO 350	STEP 950
340	VEC(I)=-0.0	STEP 960
350	X(I)=XSAVE(1)	STEP 970
360	NCIRC=NCIRC+1	STEP 980
	IF (NCIRC-NACTIV) 450,950,950	STEP 990
370	DX(I)=-DX(I)	STEP1000
C	A LOWER VALUE HAS BEEN FOUND. HENCE THIS VARIABLE WILL CHANGE.	STEP1010
380	NCIRC=0	STEP1020
	DEL=DX(I)	STEP1030

390	CHIME=CHIO LD	STEP1040
	CHIO LD=CHIS Q	STEP1050
	VEC(I)=VEC(I)+DEL/ABS(DX(I))	STEP1060
	TRIAL(I)=TRIAL(I)+DEL	STEP1070
	DEL=ACK*DEL	STEP1080
	XSAVE(1)=X(I)	STEP1090
	X(I)=XSAVE(1)+DEL	STEP1100
	IF (X(I)-XMIN(I)) 440,400,400	STEP1110
400	IF (X(I)-XMAX(I)) 410,410,440	STEP1120
410	CALL FUNK	STEP1130
	NF=NF+1	STEP1140
	IF (CHIS Q-CHIO LD) 390,420,420	STEP1150
420	CINDER=0.5/ACK*(ACK**2*CHIME-(ACK**2-1.0)*CHIO LD-CHIS Q)/(ACK*CHIME	STEP1160
	1-(ACK+1.0)*CHIO LD+CHIS Q)	STEP1170
	X(I)=XSAVE(1)+CINDER*DEL	STEP1180
	CALL FUNK	STEP1190
	NF=NF+1	STEP1200
	IF (CHIS Q-CHIO LD) 430,440,440	STEP1210
430	CHIO LD=CHIS Q	STEP1220
	TRIAL(I)=TRIAL(I)+CINDER*DEL	STEP1230
	VEC(I)=VEC(I)+CINDER*DEL/ABS(DX(I))	STEP1240
	GO TO 450	STEP1250
440	X(I)=XSAVE(1)	STEP1260
450	IF (NZIP-1) 930,460,460	STEP1270
460	IF (ABS(VEC(I))-ACK) 490,470,470	STEP1280
470	DX(I)=ACK*ABS(DX(I))	STEP1290
	VEC(I)=VEC(I)/ACK	STEP1300
	OLDVEC(I)=OLDVEC(I)/ACK	STEP1310
	DO 480 J=1,MOSQUE	STEP1320
480	ERR(I,J)=ERR(I,J)/ACK	STEP1330
490	SUM0=0.0	STEP1340
	SUMV=0.0	STEP1350
	DO 500 J=1,NV	STEP1360
	SUM0=SUM0+OLDVEC(J)**2	STEP1370
500	SUMV=SUMV+VEC(J)**2	STEP1380
	IF (SUM0*SUMV) 930,930,510	STEP1390
510	SUM0=SQRT(SUM0)	STEP1400
	SUMV=SQRT(SUMV)	STEP1410
	COSINE=0.0	STEP1420
	DO 520 J=1,NV	STEP1430
520	COSINE=COSINE+OLDVEC(J)/SUM0*VEC(J)/SUMV	STEP1440
	IF (NZIP-1) 930,530,540	STEP1450
530	IF (NACK-NACTIV) 930,560,560	STEP1460
540	IF (NACK-NACTIV) 560,550,550	STEP1470
550	IF (NZIP-NCOMP) 560,570,570	STEP1480
560	IF (COSINE-COMPAR) 930,570,570	STEP1490
C	SIMON SAYS, TAKE AS MANY GIANT STEPS AS POSSIBLE...	STEP1500
570	NGIANT=0	STEP1510
	NTRY=0	STEP1520
	NRETRY=0	STEP1530
	KL=1	STEP1540
	NOSC=NOSC+1	STEP1550
	IF (NOSC-MOSQUE) 600,600,580	STEP1560
580	NOSC=MOSQUE	STEP1570
	DO 590 K=2,MOSQUE	STEP1580
	CHIOSC(K-1)=CHIOSC(K)	STEP1590
	DO 590 J=1,NV	STEP1600
	XOSC(J,K-1)=XOSC(J,K)	STEP1610
590	ERR(J,K-1)=ERR(J,K)	STEP1620
600	DO 610 J=1,NV	STEP1630
	XOSC(J,NOSC)=X(J)	STEP1640
610	ERR(J,NOSC)=VEC(J)/SUMV	STEP1650
	CHIOSC(NOSC)=CHIO LD	STEP1660
	IF (NOSC-3) 670,620,620	STEP1670
C	SEARCH FOR A PREVIOUS SUCCESSFUL GIANT STEP IN A DIRECTION MORE	STEP1680
C	NEARLY PARALLEL TO THE DIRECTION OF THE PROPOSED STEP THAN WAS THE	STEP1690
C	IMMEDIATELY PREVIOUS ONE.	STEP1700
620	COXCOM=0.0	STEP1710
	DO 630 J=1,NV	STEP1720
630	COXCOM=COXCOM+ERR(J,NOSC)*ERR(J,NOSC-1)	STEP1730
	NAH=NOSC-2	STEP1740
640	NTRY=0	STEP1750
	DO 660 K=KL,NAH	STEP1760
	NRETRY=NAH-K	STEP1770
	COSINE=0.0	STEP1780

DO 650 J=1,NV	STEP1790
650 COSINE=COSINE+ERR(J,NOSC)*ERR(J,K)	STEP1800
IF (COSINE-COXC0M) 660,660,680	STEP1810
660 CONTINUE	STEP1820
670 CHIBAK=CHI(I)	STEP1830
GO TO 700	STEP1840
680 NTRY=1	STEP1850
KL=K+1	STEP1860
DO 690 J=1,NV	STEP1870
SALVO(J)=TRIAL(J)	STEP1880
690 TRIAL(J)=(X(J)-XOSC(J,K))/ACK	STEP1890
CHIBAK=CHIOLD+(CHIOSC(K)-CHIOLD)/ACK	STEP1900
700 DO 720 J=1,NV	STEP1910
XSAVE(J)=X(J)	STEP1920
TRIAL(J)=ACK*TRIAL(J)	STEP1930
IF (MASK(J)) 720,710,720	STEP1940
710 X(J)=AMAX1(AMIN1(X(J)+TRIAL(J),XMAX(J)),XMIN(J))	STEP1950
720 CONTINUE	STEP1960
CALL FUNK	STEP1970
NF=NF+1	STEP1980
IF (CHISQ-CHIOLD) 730,740,740	STEP1990
730 CHIBAK=CHIOLD	STEP2000
CHIOLD=CHISQ	STEP2010
NGIANT=NGIANT+1	STEP2020
GO TO 700	STEP2030
740 IF (NRETRY) 760,760,750	STEP2040
750 IF (NGIANT) 810,810,760	STEP2050
760 CINDER=0.5/ACK*(ACK**2*CHIBAK-(ACK**2-1.0)*CHIOLD-CHISQ)/(ACK	STEP2060
1*CHIBAK-(ACK+1.0)*CHIOLD+CHISQ)	STEP2070
DO 780 J=1,NV	STEP2080
IF (MASK(J)) 780,770,780	STEP2090
770 X(J)=AMAX1(AMIN1(XSAVE(J)+CINDER*TRIAL(J),XMAX(J)),XMIN(J))	STEP2100
780 CONTINUE	STEP2110
CALL FUNK	STEP2120
NF=NF+1	STEP2130
IF (CHISQ-CHIOLD) 890,790,790	STEP2140
790 IF (NGIANT) 830,800,830	STEP2150
800 IF (NTRY) 810,830,810	STEP2160
810 DO 820 J=1,NV	STEP2170
TRIAL(J)=SALVO(J)	STEP2180
820 X(J)=XSAVE(J)	STEP2190
GO TO 850	STEP2200
830 DO 840 J=1,NV	STEP2210
TRIAL(J)=TRIAL(J)/ACK	STEP2220
840 X(J)=XSAVE(J)	STEP2230
850 IF (NGIANT) 860,860,900	STEP2240
860 IF (NRETRY) 870,870,640	STEP2250
870 IF (NTRY) 880,920,880	STEP2260
880 NTRY=0	STEP2270
GO TO 670	STEP2280
890 CHIOLD=CHISQ	STEP2290
900 IF (NTRY) 910,160,910	STEP2300
910 NOSC=0	STEP2310
GO TO 160	STEP2320
920 NOSC=MAX0(NOSC-1.0)	STEP2330
930 CHI(I)=CHIOLD	STEP2340
940 CONTINUE	STEP2350
C ANOTHER CYCLE THROUGH THE VARIABLES HAS BEEN COMPLETED.	STEP2360
C PRINT ANOTHER LINE OF TRACES.	STEP2370
NZIP=NZIP+1	STEP2380
GO TO 170	STEP2390
C A MINIMUM HAS BEEN FOUND. PRINT THE REMAINING TRACES.	STEP2400
950 NOSC=0	STEP2410
DO 960 I=1,NV	STEP2420
(STEPIT 4.6 ... STEPIT WITH OSCILLATION SEARCH, MATRIX INVERSION,	STEP2430
C AND AUTOMATIC STEP SIZE ADJUSTMENT. CHANDLER 27	STEP2440
IF (AMAX1(VEC(I),SIGN(1.0,VEC(I)))) 970,960,970	STEP2450
960 CONTINUE	STEP2460
GO TO 1010	STEP2470
970 NGATE=1	STEP2480
DO 1000 I=1,NV	STEP2490
IF (MASK(I)) 1000,980,1000	STEP2500
980 IF (ABS(DX(I))-ABS(DELMIN(I))) 1000,990,990	STEP2510
990 NGATE=0	STEP2520
1000 DX(I)=DX(I)/RATIO	STEP2530

IF (NGATE) 160,160,1010	STEP2540
1010 CHISQ=CHIO LD	STEP2550
IF (IABS(MATRIX-100)-50) 1020,1020,1310	STEP2560
1020 IF (NACTIV-NV) 1310,1030,1310	STEP2570
C COMPUTE THE STANDARD ERRORS AND THE CORRELATIONS.	STEP2580
1030 FAC=RATIO**(MATRIX-100)	STEP2590
ESUM=0.0	STEP2600
DO 1090 I=1,NV	STEP2610
IF (DELMIN(I)) 1040,1050,1040	STEP2620
1040 DX(I)=ABS(FAC*DELMIN(I))	STEP2630
GO TO 1060	STEP2640
1050 DX(I)=ABS(FAC*DX(I))	STEP2650
1060 IF (DX(I)) 1310,1310,1070	STEP2660
1070 XSAVE(I)=X(I)	STEP2670
DO 1080 J=1,2	STEP2680
X(I)=XSAVE(I)+DX(I)	STEP2690
CALL FUNK	STEP2700
NF=NF+1	STEP2710
SECOND(1,J)=CHISQ	STEP2720
1080 DX(I)=-DX(I)	STEP2730
ERR(I,1)=(SECOND(1,1)-2.0*CHIO LD+SECOND(1,2))/DX(I)**2	STEP2740
1090 ESUM=ESUM+ABS(ERR(I,1))	STEP2750
DO 1120 I=2,NV	STEP2760
IM=I-1	STEP2770
DO 1120 J=1,IM	STEP2780
DO 1110 K=1,2	STEP2790
X(I)=XSAVE(I)+DX(I)	STEP2800
DO 1100 L=1,2	STEP2810
X(J)=XSAVE(J)+DX(J)	STEP2820
CALL FUNK	STEP2830
NF=NF+1	STEP2840
SECOND(K,L)=CHISQ	STEP2850
X(J)=XSAVE(J)	STEP2860
1100 DX(J)=-DX(J)	STEP2870
X(I)=XSAVE(I)	STEP2880
1110 DX(I)=-DX(I)	STEP2890
ERR(I,J)=0.25*(SECOND(1,1)-SECOND(1,2)-SECOND(2,1)+SECOND(2,2))	STEP2900
1 /ABS(DX(I)*DX(J))	STEP2910
ESUM=ESUM+ABS(ERR(I,J))	STEP2920
1120 ERR(I,J)=ERR(I,J)	STEP2930
BRAAAK=ABS(ESUM)/FLOAT(NV)**2	STEP2940
NGRAPE=0	STEP2950
DO 1140 I=1,NV	STEP2960
DO 1140 J=1,NV	STEP2970
IF (ERR(I,J)) 1140,1130,1140	STEP2980
1130 NGRAPE=1	STEP2990
1140 ERR(I,J)=ERR(I,J)/BRAAAK	STEP3000
DET=1.0	STEP3010
DO 1150 J=1,NV	STEP3020
1150 SALVO(J)=1.0	STEP3030
DO 1300 I=1,NV	STEP3040
BIGAJJ=0.0	STEP3050
DO 1180 J=1,NV	STEP3060
IF (SALVO(J)) 1160,1180,1160	STEP3070
1160 IF (ABS(ERR(J,J))-BIGAJJ) 1180,1180,1170	STEP3080
1170 BIGAJJ=ABS(ERR(J,J))	STEP3090
K=J	STEP3100
1180 CONTINUE	STEP3110
IF (BIGAJJ) 1200,1190,1200	STEP3120
1190 DET=0.0	STEP3130
GO TO 1310	STEP3140
1200 SALVO(K)=0.0	STEP3150
DET=DET*ERR(K,K)	STEP3160
TRIAL(K)=1.0/ERR(K,K)	STEP3170
ERR(K,K)=0.0	STEP3180
XSAVE(K)=1.0	STEP3190
M=K-1	STEP3200
IF (M) 1240,1240,1210	STEP3210
1210 DO 1230 J=1,M	STEP3220
XSAVE(J)=ERR(K,J)	STEP3230
TRIAL(J)=ERR(K,J)*TRIAL(K)	STEP3240
IF (SALVO(J)) 1190,1230,1220	STEP3250
1220 TRIAL(J)=-TRIAL(J)	STEP3260
1230 ERR(K,J)=0.0	STEP3270
1240 M=K+1	STEP3280

	IF (M-NV) 1250,1250,1290	STEP3290
1250	DO 1280 J=M,NV	STEP3300
	XSAVE(J)=ERR(J,K)	STEP3310
	IF (SALVO(J)) 1190,1260,1270	STEP3320
1260	XSAVE(J)=-XSAVE(J)	STEP3330
1270	TRIAL(J)=-ERR(J,K)*TRIAL(K)	STEP3340
1280	ERR(J,K)=0.0	STEP3350
1290	DO 1300 J=1,NV	STEP3360
	DO 1300 K=J,NV	STEP3370
1300	ERR(K,J)=ERR(K,J)+XSAVE(J)*TRIAL(K)	STEP3380
1310	CALL FUNK	STEP3390
	WRITE (NOUT,1320)	STEP3400
	WRITE (NOUT,1330) (X(I),I=1,NV)	STEP3410
	IF (CHISQ.GT.1.E-20) WRITE (NOUT,1340) CHISQ	STEP3420
	IF (CHISQ.LE.1.E-20) WRITE (NOUT,1350) DIF LIM	STEP3430
	RETURN	STEP3440
C		STEP3450
1320	FORMAT (///1X,22H FINAL VALUES OF X(I))	STEP3460
1330	FORMAT (1X,10H X = ,10E12.4/(10X,10E12.4))	STEP3470
1340	FORMAT (///1X,23HFINAL VALUE OF CHISQ = ,E15.8///)	STEP3480
1350	FORMAT (1H0,1X,10H DIF LIM = E15.8)	STEP3490
	END	STEP3500
	SUBROUTINE FINECHK (KL)	FINE 10
C		FINE 20
C	ROUTINE CALCULATES INTERMEDIATE POINTS AND CHECKS FOR	FINE 30
C	REASONABLENESS.	FINE 40
C		FINE 50
	COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,	FINE 60
	1 NIN, NOUT	FINE 70
	COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(2	FINE 80
	1 5,50)	FINE 90
	COMMON /MANI/ TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIF LIM	FINE 100
	COMMON /FINRAD/ NIAPL, IRAD, NCORS, RADT(200), DELT(200)	FINE 110
	COMMON/ENDF/MEVU,MAT,MF,MT,RUM,NUN	FINE 120
	DIMENSION FXP(700), TP(700), TI(10), XL(10), YL(10), TPF(700)	FINE 130
C	IF NO IS FIRST FIGURE NUMBER FOR REPORT	FINE 140
C	SET TO ZERO IF NOT WANTED	FINE 150
	DATA IFNO,ICT/1,0/	FINE 160
	K=KL	FINE 170
	ENCODE (21,180,TI(1)) K	FINE 180
	IF (MT.EQ.802) ENCODE (20,185,TI(1)) K	FINE 190
	ENCODE (20,200,XL)	FINE 200
	IF (MEVU.EQ.1) ENCODE (31,210,YL)	FINE 210
	IF (MEVU.EQ.0) ENCODE(31,215,YL)	FINE 220
	FXMIN=FX(1)	FINE 230
	DO 10 I=1,ITSP	FINE 240
	IF (FX(I).LT.FXMIN) FXMIN=FX(I)	FINE 250
10	CONTINUE	FINE 260
	NK=ITSP	FINE 270
	IF (IRAD.GT.0) GO TO 70	FINE 280
	DELF=0.	FINE 290
	L=0	FINE 300
	TP(1)=T(1)	FINE 310
	DEC=T(1)	FINE 320
20	CONTINUE	FINE 330
	L=L+1	FINE 340
	DELF=DELF+1.0	FINE 350
	TP(L)=DELF*DEC	FINE 360
	IF ((TP(L).GE.T(ITSP)) GO TO 30	FINE 370
	IF ((TP(L)/DEC).GE.10.0) DELF=1.0	FINE 380
	IF ((TP(L)/DEC).GE.10.0) DEC=DEC*10.0	FINE 390
	GO TO 20	FINE 400
30	CONTINUE	FINE 410
	NK=L	FINE 420
C		FINE 430
C	THIS LOOP IS TO INCREASE TIME MESH BY FACTOR OF FIVE.	FINE 440
C		FINE 450
	NPF=1	FINE 460
	TPF(NPF)=TP(1)	FINE 470
	DO 50 N=2,NK	FINE 480
	IF (NPF.GT.700) GO TO 50	FINE 490
	DELF=(TP(N)-TP(N-1))/5.0	FINE 500

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DO 40 NJ=1,5 FINE 510
NPF=NPF+1 FINE 520
TPF(NPF)=TPF(NPF-1)+DELF FINE 530
40 CONTINUE FINE 540
50 CONTINUE FINE 550
IF (NPF.GT.700) WRITE (NOUT,150) TPF(NPF) FINE 560
NK=NPF FINE 570
DO 60 N=1,NK FINE 580
TP(N)=TPF(N) FINE 590
60 CONTINUE FINE 600
70 WRITE (NOUT,190) K FINE 610
DO 100 N=1,NK FINE 620
FXP(N)=0 FINE 630
KTRM=KTR(K) FINE 640
DO 90 J=1,KTRM FINE 650
IF (IRAD.LE.0) GO TO 80 FINE 660
XPO=ALF(K,J)*EXP(-ALAM(K,J)*TP(N)) FINE 670
COFF=ALF(K,J)/DELT(N)/ALAM(K,J)**2 FINE 680
XPO1=1.-EXP(-ALAM(K,J)*RADT(N)) FINE 690
XPO2=1.-EXP(-ALAM(K,J)*DELT(N)) FINE 700
XPO3=EXP(-ALAM(K,J)*(T(N)-DELT(N)/2.)) FINE 710
FXP(N)=FXP(N)+COFF*XPO1*XPO2*XPO3 FINE 720
GO TO 90 FINE 730
80 TEMP=ALAM(K,J)*TP(N) FINE 740
IF (ABS(TEMP).GT.600) GO TO 90 FINE 750
FXP(N)=FXP(N)+ALF(K,J)*EXP(-TEMP) FINE 760
90 CONTINUE FINE 770
100 CONTINUE FINE 780
WRITE (NOUT,220) (N,TP(N),FXP(N),N=1,NK) FINE 790
C FINE 800
C TEST FOR POINT DEVIATION AND SLOPE REVERSAL. FINE 810
C FINE 820
NFLG=0 FINE 830
LFLG=0 FINE 840
NK1=NK-1 FINE 850
WRITE (NOUT,160) K FINE 860
DO 120 N=2,NK1 FINE 870
IF (FXP(N).GT.0.) GO TO 110 FINE 880
NFLG=NFLG+1 FINE 890
GO TO 120 FINE 900
110 CONTINUE FINE 910
IF (FXP(N-1).LE.0.0.OR.FXP(N+1).LE.0.0) GO TO 120 FINE 920
AVLG=(ALOG(FXP(N-1))+ALOG(FXP(N+1)))/2.0 FINE 930
FAVG=EXP(AVLG) FINE 940
FDIF=ABS((FXP(N)-FAVG)/FXP(N)) FINE 950
IF (FDIF.GE.1.0) LFLG=LFLG+1 FINE 960
IF (FDIF.GE.1.0) WRITE (NOUT,240) N FINE 970
IF (FDIF.GE.0.1) WRITE (NOUT,230) N,FDIF FINE 980
IF (FXP(N).GT.FXP(N-1)) WRITE (NOUT,170) N FINE 990
120 CONTINUE FINE 1000
IF (FXP(1).LE.0.) NFLG=NFLG+1 FINE 1010
IF (FXP(NK).LE.0.) NFLG=NFLG+1 FINE 1020
IF (NFLG.EQ.0) GO TO 130 FINE 1030
WRITE (NOUT,250) NFLG FINE 1040
RETURN FINE 1050
130 CONTINUE FINE 1060
IF (LFLG.EQ.0) GO TO 140 FINE 1070
WRITE (NOUT,260) LFLG FINE 1080
140 CONTINUE FINE 1090
NK=NK-1 FINE 1100
I I=0 FINE 1110
IF (IFNO.NE.0) I I=IFNO+ICT FINE 1120
ICT=ICT+1 FINE 1130
CALL SETUP (TP,FXP,NK,T,FX,ITSP,TI,23,XL,20,YL,31,4,I I) FINE 1140
RETURN FINE 1150
C FINE 1160
150 FORMAT (1H0,18H PLOTS CUT AT TP =1PE12.5,28H SEC AS POINT LIMIT REFIN FINE 1170
1ACHED.) FINE 1180
160 FORMAT (33H0 POINT DEVIATION CHECK FOR GROUP,13//51H NOTE - ONLY V FINE 1190
1ALUES GREATER THAN TEN PERCENT FOLLOW) FINE 1200
170 FORMAT (30H0 FUNCTION RISING AT POINT NO.,13) FINE 1210
180 FORMAT (18H0 GAMMA FIT, GROUP 12,1H.) FINE 1220
185 FORMAT (17H0 ETA FIT, GROUP 12,1H.) FINE 1230
190 FORMAT (26H FINE CHECK FOR GROUP NO.,12) FINE 1240
200 FORMAT (20H0 COOLING TIME (S) ) FINE 1250

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210	FORMAT (31HD ECAY P ARTICLES (NO./FIS-S))	FINE1260
215	FORMAT (31HD ECAY E NERGY (M E V /FIS-S))	FINE1270
220	FORMAT (4(2X,14,2X,E10.3,2X,E10.3))	FINE1280
230	FORMAT (19H0 AT POINT NUMBER ,13,8H FDIF = ,F6.3)	FINE1290
240	FORMAT (22H0 CHECK POINT NUMBER ,13)	FINE1300
250	FORMAT (12H0 THERE ARE ,13,30H NEG FXP VALUES. FIT NO GOOD.)	FINE1310
260	FORMAT (21H0 FIT RATHER POOR AT ,13,21H POINTS. CHECK PLOT.)	FINE1320
	END	FINE1330
	END	FINE1340

APPENDIX B

SOME USEFUL FITS

In this appendix, parameters are given for fits of aggregate-product decay data from ^{235}U fuel irradiated by a pulse (irradiation time = 10^{-4}s) of thermal neutrons. The parameters are given for both γ and β^- radiation in the 22-energy group structure shown in Table III and are given for fits in units of Mev per fission-second and number of particles per fission-second. The γ fits are given in Table B-I and the β^- fits are given in Table B-II. Figures B-1 through B-22 show the comparison of the γ fits for groups 1 through 22, respectively, with CINDER-10 data, and Figs. B-23 through B-44 show the same comparisons for the β^- fits. These figures are for units of MeV per fission-second; curves representing the data in units of particles per fission-second would be nearly identical in shape but different in magnitude. In general, the set of parameters in units of particles per fission-second can be approximated from those in units of MeV per fission-second by merely dividing the coefficients of the latter set by the midpoint energy of the group, but it was observed that the resulting parameters did not always give fits to within the desired 5% accuracy due to the fact that the midpoint energy is not necessarily the average energy of the group. Such derived parameters, however, proved very useful in providing input to the STEPIT routine (fitting option 3), which rapidly converged the parameters in this appendix which do provide the desired 5% accuracy.

Fig. B-1.
Gamma fit, group 1.

Fig. B-2.
Gamma fit, group 2.

Fig. B-3.
Gamma fit, group 3.

Fig. B-4.
Gamma fit, group 4.

Fig. B-5.
Gamma fit, group 5.

Fig. B-6.
Gamma fit, group 6.

Fig. B-7.
Gamma fit, group 7.

Fig. B-8.
Gamma fit, group 8.

Fig. B-9.
Gamma fit, group 9.

Fig. B-10.
Gamma fit, group 10.

Fig. B-11.
Gamma fit, group 11.

Fig. B-12.
Gamma fit, group 12.

Fig. B-13.
Gamma fit, group 13.

Fig. B-14.
Gamma fit, group 14.

Fig. B-15.
Gamma fit, group 15.

Fig. B-16.
Gamma fit, group 16.

Fig. B-17.
Gamma fit, group 17.

Fig. B-18.
Gamma fit, group 18.

Fig. B-19.
Gamma fit, group 19.

Fig. B-20.
Gamma fit, group 20.

Fig. B-21.
Gamma fit, group 21.

Fig. B-22.
Gamma fit, group 22.

Fig. B-23.
Beta fit, group 1.

Fig. B-24.
Beta fit, group 2.

Fig. B-25.
Beta fit, group 3.

Fig. B-26.
Beta fit, group 4.

Fig. B-27.
Beta fit, group 5

Fig. B-28.
Beta fit, group 6.

Fig. B-29.
Beta fit, group 7.

Fig. B-30.
Beta fit, group 8.

Fig. B-31.
Beta fit, group 9.

Fig. B-32.
Beta fit, group 10.

Fig. B-33.
Beta fit, group 11..

Fig. B-34.
Beta fit, group 12..

Fig. B-35.
Beta fit, group 13..

Fig. B-36.
Beta fit, group 14..

Fig. B-37.
Beta fit, group 15.

Fig. B-38.
Beta fit, group 16.

Fig. B-39.
Beta fit, group 17.

Fig. B-40.
Beta fit, group 18.

Fig. B-41.
Beta fit, group 19.

Fig. B-42.
Beta fit, group 20.

Fig. B-43.
Beta fit, group 21.

Fig. B-44.
Beta fit, group 22.

TABLE B-1

U-235 THERMAL FISSION - GAMMA FITS

PARAMETERS FOR GAMMA FIT FOR GROUP 1

ENERGY BOUNDS FOR GROUP - 0. MEV TO 1.0E-02 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
8.489E-07	2.329E+00	1.616E-10	2.591E-06
1.107E-06	5.000E-01	7.464E-11	5.573E-07
1.089E-06	4.674E-02	-6.946E-11	3.221E-07
1.189E-07	1.041E-02	9.018E-11	2.268E-07
2.036E-07	3.447E-03	9.244E-14	3.039E-08
8.739E-08	1.041E-03	2.289E-15	1.326E-08
2.052E-07	8.602E-04	6.184E-16	7.247E-09
8.866E-10	1.220E-04		

PARAMETERS FOR GAMMA FIT FOR GROUP 2

ENERGY BOUNDS FOR GROUP - 1.0E-02 MEV TO 1.0E-01 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
1.506E-04	2.073E+00	-1.437E-09	5.948E-06
1.692E-04	3.251E-01	4.008E-09	1.914E-06
1.050E-04	5.278E-02	1.915E-09	9.795E-07
5.619E-05	1.406E-02	2.267E-10	2.109E-07
8.765E-06	3.561E-03	3.775E-12	2.852E-08
1.661E-06	8.067E-04	5.561E-14	1.757E-08
3.423E-07	2.293E-04	2.336E-15	7.077E-09

TABLE B-1 (CONT.)

PARAMETERS FOR GAMMA FIT FOR GROUP 3

ENERGY BOUNDS FOR GROUP - 1.0E-01 MEV TO 3.0E-01 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
2.975E-02	2.350E+00	1.117E-01	6.285E+00
1.806E-02	5.166E-01	2.151E-01	1.363E+00
5.073E-03	9.340E-02	-2.860E-02	1.213E+00
1.038E-03	2.182E-02	7.532E-02	4.140E-01
1.194E-04	5.114E-03	2.265E-02	8.955E-02
2.729E-05	8.658E-04	5.156E-03	2.105E-02
6.840E-06	2.554E-04	4.675E-04	4.583E-03
		1.556E-06	4.563E-06

PARAMETERS FOR GAMMA FIT FOR GROUP 4

ENERGY BOUNDS FOR GROUP - 3.0E-01 MEV TO 4.0E-01 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
4.849E-03	1.854E+00	1.359E-02	1.969E+00
4.002E-03	3.468E-01	1.113E-02	3.402E-01
2.336E-03	7.178E-02	6.165E-03	7.033E-02
3.947E-04	1.380E-02	1.098E-03	1.377E-02
7.430E-05	9.081E-04	-2.116E-04	9.100E-04
9.750E-05	8.849E-04	2.791E-04	8.836E-04
1.743E-05	4.830E-04	5.278E-05	4.841E-04
		1.480E-15	4.449E-09

TABLE B-I (CONT.)

PARAMETERS FOR GAMMA FIT FOR GROUP 5

ENERGY BOUNDS FOR GROUP - 4.0E-01 MEV TO 5.0E-01 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
2.471E-02	2.610E+00	1.207E-05	2.488E-04	2.667E-05	2.488E-04
1.494E-02	5.332E-01	2.778E-07	4.560E-05	6.395E-07	4.562E-05
7.624E-03	1.910E-01	1.091E-08	5.951E-07	2.357E-08	5.978E-07
7.435E-04	3.666E-02	2.732E-09	2.004E-07	5.734E-09	2.004E-07
1.348E-04	4.401E-03	8.961E-14	1.100E-08	2.040E-13	1.099E-08
2.904E-05	7.355E-04	4.108E-13	7.824E-09	9.386E-13	7.824E-09

PARAMETERS FOR GAMMA FIT FOR GROUP 6

ENERGY BOUNDS FOR GROUP - 5.0E-01 MEV TO 7.0E-01 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
6.207E-02	2.748E+00	3.603E-06	1.055E-04	6.036E-06	1.042E-04
4.206E-02	5.967E-01	1.350E-06	1.387E-05	2.277E-06	1.375E-05
2.523E-02	2.144E-01	1.857E-07	3.475E-06	2.806E-07	3.407E-06
9.070E-03	7.546E-02	1.536E-08	9.300E-07	2.508E-08	8.962E-07
1.724E-03	1.840E-02	8.237E-10	2.855E-07	1.535E-09	2.968E-07
2.622E-04	5.746E-03	2.849E-11	2.159E-08	4.557E-11	2.100E-08
6.977E-05	1.207E-03	2.815E-11	7.327E-10	4.173E-11	7.340E-10
1.306E-05	2.672E-04				

PARAMETERS FOR GAMMA FIT FOR GROUP 9

UNITS IN MEV/FISS-S

LAMBDA

LAMBDA

LAMBDA

LAMBDA

ADULTS	ADULTS
7. 971E-07	2. 763E-05
1. 813E-07	1. 469E-05
4. 700E-09	3. 559E-06
1. 631E-09	1. 933E-06
5. 148E-11	5. 425E-07
1. 794E-12	2. 171E-08
1. 381E-17	4. 416E-10

ADULTA	LIANDELA
4. 977E-03	2. 910E+00
4. 527E-03	7. 058E-01
3. 349E-03	2. 086E-01
1. 879E-03	5. 760E-02
6. 890E-04	1. 632E-02
1. 039E-04	3. 771E-03
5. 636E-05	7. 384E-04
1. 006E-05	1. 942E-04

ALPHA	LAMBDA
7.584E-07	2.752E-05
1.754E-07	1.478E-05
4.075E-09	3.546E-06
1.497E-09	1.920E-06
4.930E-11	5.477E-07
1.716E-12	2.171E-08
1.166E-17	2.860E-10

PARAMETERS FOR GAMMA FIT FOR GROUP 10

UNITS IN MEV/FISS--S

LAMBDA

LAMBDA

LAMBDA

LAMBDA

	ALL	PER	THROWING
9.41B-08	1.078E-05		
1.065E-08	2.580E-06		
1.690E-10	8.708E-07		
1.055E-11	1.731E-07		
1.454E-11	1.311E-07		
3.218E-13	2.175E-08		
7.003E-18	1.686E-10		

ADL HA	LIWADUR
1. 903E-02	2. 879E+00
1. 587E-02	6. 353E-01
7. 587E-03	1. 452E-01
2. 421E-03	3. 388E-02
7. 277E-04	9. 438E-03
8. 249E-05	9. 664E-04
8. 058E-06	3. 039E-04
1. 083E-06	3. 444E-05

AUT 1A	LAMBDA
7.680E-08	1.077E-05
8.810E-09	2.580E-06
1.403E-10	8.706E-07
8.592E-12	1.730E-07
1.186E-11	1.311E-07
2.819E-13	2.175E-08
5.765E-18	1.598E-10

TABLE B-1 (CONT.)

PARAMETERS FOR GAMMA FIT FOR GROUP 11

ENERGY BOUNDS FOR GROUP - 1.3E+00 MEV TO 1.5E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
8.846E-03	3.198E+00	6.178E-06	7.991E-05	4.366E-06	7.991E-05
1.131E-02	6.197E-01	9.217E-07	3.541E-05	6.514E-07	3.541E-05
7.126E-03	1.175E-01	1.577E-08	3.349E-06	1.115E-08	3.349E-06
3.474E-03	2.509E-02	7.241E-09	2.035E-06	5.305E-09	2.035E-06
1.230E-03	7.920E-03	6.980E-12	2.775E-08	4.727E-12	2.775E-08
9.737E-05	4.690E-04	1.998E-17	2.379E-11	1.415E-17	2.238E-11
1.322E-04	4.088E-04				

PARAMETERS FOR GAMMA FIT FOR GROUP 12

ENERGY BOUNDS FOR GROUP - 1.5E+00 MEV TO 1.7E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
3.015E-03	3.366E+00	1.813E-05	4.232E-04	1.147E-05	4.230E-04
3.042E-03	9.810E-01	1.362E-06	1.361E-04	9.257E-07	1.398E-04
3.279E-03	3.204E-01	8.038E-07	5.959E-05	5.127E-07	5.959E-05
2.127E-03	8.610E-02	-5.683E-08	4.112E-06	-3.657E-08	4.112E-06
1.210E-03	2.466E-02	7.300E-08	6.279E-07	4.664E-08	6.285E-07
3.848E-04	9.671E-03	2.386E-13	2.174E-08	1.518E-13	2.174E-08
4.560E-05	3.064E-03	1.882E-17	4.873E-11	1.193E-17	4.216E-11

TABLE B-1 (CONT.)

PARAMETERS FOR GAMMA FIT FOR GROUP 13

ENERGY BOUNDS FOR GROUP - 1.7E+00 MEV TO 1.9E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
2.553E-03	3.228E+00	1.445E-03	3.228E+00
2.476E-03	9.572E-01	1.401E-03	9.572E-01
2.695E-03	2.766E-01	1.525E-03	2.766E-01
1.425E-03	6.478E-02	8.060E-04	6.478E-02
8.723E-04	1.992E-02	4.935E-04	1.992E-02
1.498E-04	5.505E-03	8.473E-05	5.505E-03
4.683E-05	1.092E-03	2.650E-05	1.092E-03
7.018E-06	3.447E-04	3.971E-06	3.447E-04

PARAMETERS FOR GAMMA FIT FOR GROUP 14

ENERGY BOUNDS FOR GROUP - 1.9E+00 MEV TO 2.0E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
1.048E-03	4.092E+00	5.371E-04	3.961E+00
1.220E-03	1.262E+00	6.267E-04	1.266E+00
1.360E-03	3.684E-01	6.996E-04	3.666E-01
8.896E-04	1.022E-01	3.546E-04	1.021E-01
6.337E-04	3.050E-02	3.253E-04	3.048E-02
3.913E-04	1.115E-02	2.006E-04	1.116E-02
1.948E-05	3.284E-03	1.010E-05	3.293E-03
7.297E-06	6.772E-04	3.832E-06	6.763E-04

TABLE B-1 (CONT.)

PARAMETERS FOR GAMMA FIT FOR GROUP 15

ENERGY BOUNDS FOR GROUP - 2.0E+00 MEV TO 2.3E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
2.983E-03	2.375E+00	1.379E-03	2.375E+00
2.815E-03	4.044E-01	1.299E-03	4.044E-01
1.638E-03	7.845E-02	7.611E-04	7.845E-02
1.179E-03	1.554E-02	5.388E-04	1.554E-02
1.056E-04	3.302E-03	4.799E-05	3.301E-03
5.115E-05	6.234E-04	2.424E-05	6.234E-04
1.214E-05	2.397E-04	5.608E-06	2.397E-04
7.658E-06	1.219E-04	-3.554E-06	1.219E-04
		4.073E-06	9.943E-05
		5.147E-08	3.120E-05
		-1.275E-09	3.999E-06
		4.312E-09	2.849E-06
		3.455E-10	6.842E-07
		1.210E-11	2.786E-08
		5.336E-18	7.374E-11

PARAMETERS FOR GAMMA FIT FOR GROUP 16

ENERGY BOUNDS FOR GROUP - 2.3E+00 MEV TO 2.7E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
7.474E-03	2.189E+00	2.990E-03	2.189E+00
6.632E-03	3.211E-01	2.654E-03	3.211E-01
2.969E-03	5.662E-02	1.188E-03	5.662E-02
1.459E-03	1.389E-02	5.836E-04	1.389E-02
1.377E-04	4.717E-03	5.508E-05	4.717E-03
2.202E-05	5.991E-04	8.811E-06	5.991E-04
9.539E-06	1.566E-04	3.816E-06	1.566E-04
		1.330E-06	7.207E-05
		-6.482E-09	2.096E-06
		6.476E-09	1.716E-06
		-1.219E-08	7.264E-07
		1.303E-08	7.023E-07
		4.465E-14	2.167E-08
		5.133E-18	1.224E-11

TABLE B-I (CONT.)

PARAMETERS FOR GAMMA FIT FOR GROUP 17

ENERGY BOUNDS FOR GROUP - 2.7E+00 MEV TO 3.0E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S				
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA		
5.101E-03	2.779E+00	2.061E-06	1.318E-04	1.964E-03	2.571E+00	6.812E-07	1.260E-04
5.030E-03	5.816E-01	1.968E-07	7.023E-05	1.844E-03	4.995E-01	5.625E-08	6.755E-05
3.016E-03	1.493E-01	-6.597E-11	6.864E-06	1.038E-03	1.197E-01	-2.478E-11	7.292E-06
1.514E-03	4.370E-02	1.017E-10	6.529E-07	4.557E-04	3.365E-02	3.555E-11	6.535E-07
6.603E-04	1.334E-02	1.528E-14	2.159E-08	1.770E-04	1.101E-02	5.471E-15	2.158E-08
1.079E-04	3.948E-03	2.035E-18	2.112E-11	2.849E-05	3.324E-03	7.111E-19	1.056E-11
7.562E-06	8.983E-04			1.769E-06	6.674E-04		

PARAMETERS FOR GAMMA FIT FOR GROUP 18

ENERGY BOUNDS FOR GROUP - 3.0E+00 MEV TO 3.5E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S				UNITS IN PARTICLES/FISS-S			
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
1.090E-03	3.662E+00	1.654E-06	1.456E-04	3.353E-04	3.662E+00	5.091E-07	1.456E-04
1.245E-03	1.181E+00	2.083E-07	7.766E-05	3.830E-04	1.181E+00	6.478E-08	7.766E-05
1.245E-03	3.541E-01	-2.983E-11	3.856E-06	3.832E-04	3.541E-01	-9.178E-12	3.857E-06
7.198E-04	8.726E-02	2.190E-11	1.611E-06	2.215E-04	8.726E-02	6.672E-12	1.600E-06
6.347E-04	2.717E-02	4.042E-11	8.556E-07	1.953E-04	2.717E-02	1.240E-11	8.556E-07
2.695E-04	7.074E-03	1.927E-11	5.992E-07	8.294E-05	7.074E-03	6.181E-12	5.992E-07
1.058E-04	3.098E-03	5.109E-17	8.938E-08	3.256E-05	3.098E-03	1.636E-17	8.938E-08
4.229E-06	6.105E-04	1.737E-18	3.091E-13	1.301E-06	6.105E-04	5.401E-19	5.254E-13

TABLE B-1 (CONT.)

PARAMETERS FOR GAMMA FIT FOR GROUP 19

ENERGY BOUNDS FOR GROUP - 3.5E+00 MEV TO 7.5E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
1.531E-03	3.902E+00	4.211E-04	3.882E+00
1.957E-03	1.038E+00	5.357E-04	1.038E+00
2.191E-03	2.879E-01	6.001E-04	2.887E-01
1.498E-03	5.653E-02	4.130E-04	5.730E-02
1.171E-03	1.609E-02	3.248E-04	1.611E-02
2.371E-04	5.809E-03	6.485E-05	5.800E-03
2.086E-05	1.713E-03	5.874E-06	1.718E-03
		2.770E-19	6.105E-13

PARAMETERS FOR GAMMA FIT FOR GROUP 20

ENERGY BOUNDS FOR GROUP - 4.0E+00 MEV TO 5.0E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
2.410E-03	2.849E+00	5.225E-04	3.753E+00
1.870E-03	1.129E+00	4.829E-04	1.035E+00
2.800E-03	2.865E-01	6.360E-04	3.123E-01
1.611E-03	5.852E-02	4.061E-04	5.624E-02
7.522E-04	1.396E-02	1.663E-04	1.319E-02
3.001E-04	4.297E-03	6.864E-05	4.260E-03
2.267E-06	1.281E-03	3.766E-07	1.058E-03
		1.334E-20	6.236E-13

PARAMETERS FOR GAMMA FIT FOR GROUP 21

	ENERGY BOUNDS FOR GROUP	-	5.0E+00 MEV	TO	6.0E+00 MEV
	COOLING TIME RANGE OF FIT	-	1.0E-01 S	TO	2.0E+07 S

UNITS IN MEV/FISS-S						UNITS IN PARTICLES/FISS-S									
ALPHA		LAMBDA	ALPHA		LAMBDA	ALPHA		LAMBDA	ALPHA		LAMBDA				
3.	209E-03	2.	985E+00	2.	768E-05	3.	966E-03	6.	130E-04	3.	104E+00	4.	875E-06	3.	902E-03
2.	613E-03	7.	926E-01	7.	840E-08	8.	529E-04	5.	531E-04	6.	171E-01	1.	497E-08	8.	524E-04
2.	313E-03	2.	024E-01	-2.	870E-12	1.	114E-06	3.	949E-04	1.	591E-01	-5.	285E-13	1.	116E-06
4.	903E-04	6.	619E-02	8.	248E-12	1.	064E-06	3.	910E-05	4.	098E-02	1.	559E-12	1.	064E-06
8.	976E-05	1.	150E-02	1.	220E-13	6.	197E-07	1.	293E-05	9.	722E-03	2.	249E-14	6.	199E-07

PARAMETERS FOR GAMMA FIT FOR GROUP 22

	ENERGY BOUNDS FOR GROUP	6.0E+00 MEV TO	7.5E+00 MEV
	COOLING TIME RANGE OF FIT	-1.0E-01 S TO	2.0E+07 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
7.029E-04	2.155E+00	5.054E-10	1.999E-03	1.170E-04	8.215E-11
5.129E-04	3.320E-01	1.487E-10	1.252E-03	8.436E-05	2.370E-11
1.1704E-04	9.631E-02	1.081E-14	1.249E-04	2.822E-05	1.685E-15
1.447E-05	1.413E-02	2.327E-14	1.040E-06	-2.365E-06	3.765E-15
2.815E-05	1.404E-02	1.911E-14	6.165E-07	4.569E-06	3.133E-15
5.906E-07	8.515E-03			9.442E-08	8.515E-03

TABLE B-II

U-235 THERMAL FISSION - BETA FITS

PARAMETERS FOR BETA FIT FOR GROUP 1

ENERGY BOUNDS FOR GROUP - 0. MEV TO 1.0E-02 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
3.318E-06	3.131E+00	1.970E-09	1.689E-05	1.327E-04	3.131E+00
2.390E-06	7.942E-01	4.262E-10	3.493E-06	9.561E-05	7.942E-01
1.955E-06	2.281E-01	3.333E-10	1.274E-06	7.818E-05	2.281E-01
1.497E-06	4.798E-02	5.425E-11	1.297E-07	5.990E-05	4.798E-02
6.679E-07	1.011E-02	5.313E-12	3.870E-08	2.672E-05	1.012E-02
1.587E-07	1.228E-03	7.313E-13	1.041E-08	6.346E-06	1.228E-03
4.895E-08	3.239E-04	9.703E-14	9.084E-10	1.958E-06	3.239E-04
8.335E-09	7.503E-05			3.334E-07	7.503E-05

PARAMETERS FOR BETA FIT FOR GROUP 2

ENERGY BOUNDS FOR GROUP - 1.0E-02 MEV TO 1.0E-01 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
7.350E-05	2.778E+00	6.930E-08	2.640E-05	1.342E-03	2.778E+00
5.542E-05	6.002E-01	1.153E-08	3.360E-06	1.021E-03	6.002E-01
3.223E-05	1.590E-01	3.765E-09	9.926E-07	6.005E-04	1.628E-01
2.483E-05	4.152E-02	8.177E-10	1.378E-07	4.641E-04	4.257E-02
1.042E-05	1.292E-02	8.013E-11	3.877E-08	1.978E-04	1.332E-02
4.468E-06	3.880E-03	9.962E-12	1.029E-08	8.582E-05	4.032E-03
2.357E-06	6.746E-04	1.748E-12	8.779E-10	4.493E-05	6.746E-04
3.886E-07	1.469E-04			7.472E-06	1.514E-04

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 3

ENERGY BOUNDS FOR GROUP - 1.0E-01 MEV TO 3.0E-01 MEV
 COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
8.527E-04	2.641E+00	6.021E-07	3.158E-05	4.191E-03	2.641E+00
6.604E-04	5.829E-01	1.364E-07	7.224E-06	3.214E-03	5.758E-01
3.925E-04	1.355E-01	2.429E-08	9.792E-07	1.893E-03	1.316E-01
2.659E-04	3.046E-02	3.144E-09	1.984E-07	1.284E-03	2.996E-02
8.359E-05	6.512E-03	2.916E-10	6.837E-08	4.034E-04	6.410E-03
1.804E-05	1.220E-03	5.671E-11	1.933E-08	8.928E-05	1.211E-03
1.027E-05	4.772E-04	1.036E-11	8.134E-10	5.110E-05	4.772E-04
2.082E-06	1.382E-04			1.067E-05	1.382E-04

PARAMETERS FOR BETA FIT FOR GROUP 4

ENERGY BOUNDS FOR GROUP - 3.0E-01 MEV TO 4.0E-01 MEV
 COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
8.795E-04	3.815E+00	8.037E-07	6.550E-05	2.513E-03	3.815E+00
6.124E-04	9.837E-01	2.352E-07	1.419E-05	1.750E-03	9.837E-01
5.366E-04	3.055E-01	3.230E-08	4.371E-06	1.534E-03	3.055E-01
3.585E-04	7.075E-02	-9.417E-09	9.549E-07	1.024E-03	7.075E-02
1.666E-04	1.697E-02	1.876E-08	8.436E-07	4.761E-04	1.697E-02
4.993E-05	4.408E-03	1.014E-09	2.263E-07	1.427E-04	4.409E-03
2.437E-05	1.475E-03	3.522E-10	1.223E-07	-6.964E-05	1.475E-03
3.644E-05	1.095E-03	1.839E-11	2.582E-08	1.041E-04	1.095E-03
4.260E-06	2.966E-04	4.744E-12	7.960E-10	1.217E-05	2.966E-04

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 5									
ENERGY BOUNDS FOR GROUP - 4.0E-01 MEV TO 5.0E-01 MEV COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S									
UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S						
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
8.949E-04	4.338E+00	7.908E-07	6.275E-05	1.989E-03	4.338E+00	1.757E-06	6.275E-05	1.757E-06	6.275E-05
1.194E-03	1.238E+00	2.733E-07	1.412E-05	2.653E-03	1.238E+00	6.074E-07	1.412E-05	6.074E-07	1.412E-05
8.905E-04	2.929E-01	3.577E-08	4.360E-06	1.979E-03	2.929E-01	7.949E-08	4.360E-06	7.949E-08	4.360E-06
4.978E-04	5.951E-02	-1.025E-08	9.524E-07	1.106E-03	5.951E-02	-2.278E-08	9.524E-07	-2.278E-08	9.524E-07
1.779E-04	1.474E-02	1.967E-08	8.418E-07	3.953E-04	1.474E-02	4.372E-08	8.418E-07	4.372E-08	8.418E-07
6.394E-05	4.483E-03	1.063E-09	1.892E-07	1.421E-04	4.483E-03	2.362E-09	1.892E-07	2.362E-09	1.892E-07
2.524E-05	1.442E-03	1.509E-10	9.630E-08	-5.608E-05	1.442E-03	3.353E-10	9.630E-08	3.353E-10	9.630E-08
3.953E-05	1.056E-03	2.383E-11	2.549E-08	8.785E-05	1.056E-03	5.296E-11	2.549E-08	5.296E-11	2.549E-08
4.751E-06	2.904E-04	2.773E-12	8.162E-10	1.056E-05	2.904E-04	6.161E-12	8.162E-10	6.161E-12	8.162E-10

PARAMETERS FOR BETA FIT FOR GROUP 6									
ENERGY BOUNDS FOR GROUP - 5.0E-01 MEV TO 7.0E-01 MEV COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S									
UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S						
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
5.381E-03	2.360E+00	1.723E-06	7.409E-05	8.968E-03	2.360E+00	2.872E-06	7.409E-05	2.872E-06	7.409E-05
3.768E-03	3.858E-01	7.898E-07	1.773E-05	6.281E-03	3.858E-01	1.316E-06	1.773E-05	1.316E-06	1.773E-05
1.665E-03	6.170E-02	9.356E-08	4.412E-06	2.775E-03	6.170E-02	1.559E-07	4.412E-06	1.559E-07	4.412E-06
4.462E-04	1.340E-02	1.043E-08	1.005E-06	7.437E-04	1.340E-02	1.739E-08	1.005E-06	1.739E-08	1.005E-06
1.611E-04	4.533E-03	6.707E-09	4.796E-07	2.685E-04	4.533E-03	1.118E-08	4.796E-07	1.118E-08	4.796E-07
5.423E-05	1.423E-03	1.697E-09	1.363E-07	-9.039E-05	1.424E-03	2.828E-09	1.363E-07	2.828E-09	1.363E-07
8.332E-05	1.053E-03	8.376E-11	2.707E-08	1.389E-04	1.053E-03	1.396E-10	2.708E-08	1.396E-10	2.708E-08
1.186E-05	2.946E-04	4.180E-12	7.952E-10	1.977E-05	2.946E-04	6.967E-12	7.952E-10	6.967E-12	7.952E-10

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 7

ENERGY BOUNDS FOR GROUP - 7.0E-01 MEV TO 9.0E-01 MEV
 COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
7.184E-03	2.665E+00	6.323E-07	1.611E-05	8.979E-03	2.665E+00
5.876E-03	5.562E-01	6.356E-08	4.254E-06	7.345E-03	5.562E-01
2.567E-03	1.354E-01	7.161E-09	1.012E-06	3.209E-03	1.354E-01
1.547E-03	3.640E-02	3.735E-09	4.671E-07	1.934E-03	3.640E-02
5.106E-04	8.239E-03	2.015E-09	1.391E-07	6.383E-04	8.239E-03
6.206E-05	1.082E-03	1.294E-10	2.750E-08	7.758E-05	1.082E-03
1.293E-05	2.632E-04	5.563E-12	7.799E-10	1.616E-05	2.632E-04
1.884E-06	6.440E-05			2.355E-06	6.440E-05

PARAMETERS FOR BETA FIT FOR GROUP 8

ENERGY BOUNDS FOR GROUP - 9.0E-01 MEV TO 1.0E+00 MEV
 COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
4.495E-03	4.141E+00	1.058E-06	6.438E-05	4.732E-03	4.141E+00
4.765E-03	6.270E-01	2.675E-07	1.630E-05	5.016E-03	6.270E-01
1.752E-03	1.357E-01	2.125E-08	4.151E-06	1.844E-03	1.357E-01
8.155E-04	3.981E-02	2.421E-09	1.021E-06	8.584E-04	3.981E-02
3.390E-04	1.345E-02	8.888E-10	3.927E-07	3.568E-04	1.345E-02
9.076E-05	4.249E-03	9.044E-10	1.371E-07	9.553E-05	4.250E-03
2.266E-05	9.461E-04	8.060E-11	2.746E-08	2.386E-05	9.461E-04
7.300E-06	2.768E-04	3.227E-12	7.813E-10	7.684E-06	2.768E-04

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 9

ENERGY BOUNDS FOR GROUP - 1.0E+00 MEV TO 1.1E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
8.854E-04	6.503E+00	8.334E-04	6.503E+00
6.976E-03	2.307E+00	6.565E-03	2.307E+00
5.275E-03	5.196E-01	4.965E-03	5.196E-01
2.451E-03	1.285E-01	2.307E-03	1.285E-01
1.093E-03	3.925E-02	1.029E-03	3.925E-02
5.021E-04	1.291E-02	4.725E-04	1.291E-02
1.004E-04	3.127E-03	9.454E-05	3.127E-03
2.349E-05	5.496E-04	2.211E-05	5.496E-04
3.183E-06	1.169E-04	2.995E-06	1.169E-04
5.587E-07	2.368E-05	5.259E-07	2.368E-05
-6.323E-08	2.128E-05	-5.951E-08	2.128E-05
5.025E-08	7.469E-06	4.729E-08	7.469E-06
3.507E-09	1.421E-06	3.300E-09	1.421E-06
1.026E-09	4.623E-07	9.653E-10	4.623E-07
9.985E-10	1.412E-07	9.398E-10	1.412E-07
1.180E-10	2.769E-08	1.111E-10	2.769E-08
4.322E-12	7.855E-10	4.068E-12	7.855E-10

PARAMETERS FOR BETA FIT FOR GROUP 10

ENERGY BOUNDS FOR GROUP - 1.1E+00 MEV TO 1.3E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
1.387E-02	3.040E+00	1.130E-02	3.040E+00
1.114E-02	7.032E-01	9.074E-03	7.032E-01
6.617E-03	1.718E-01	5.391E-03	1.718E-01
2.643E-03	3.610E-02	2.153E-03	3.610E-02
6.319E-04	1.035E-02	5.148E-04	1.035E-02
1.376E-04	3.136E-03	1.121E-04	3.136E-03
4.434E-05	7.119E-04	3.613E-05	7.119E-04
7.837E-06	1.786E-04	6.384E-06	1.786E-04
1.911E-07	1.206E-05	1.069E-06	3.910E-05
3.909E-09	1.155E-06	1.557E-07	1.206E-05
5.342E-10	2.542E-07	3.185E-09	1.155E-06
7.281E-10	1.262E-07	4.787E-10	2.542E-07
2.171E-10	2.743E-08	6.095E-10	1.291E-07
7.346E-12	7.859E-10	1.784E-10	2.743E-08
		5.999E-12	7.859E-10

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 11

ENERGY BOUNDS FOR GROUP - 1.3E+00 MEV TO 1.5E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
9.638E-03	4.263E+00	1.849E-06	6.776E-05	6.812E-03	4.263E+00
1.218E-02	1.179E+00	4.222E-07	2.015E-05	8.609E-03	1.179E+00
8.104E-03	3.134E-01	7.753E-09	4.005E-06	5.727E-03	3.134E-01
3.606E-03	7.854E-02	9.015E-10	6.654E-07	2.548E-03	7.854E-02
1.457E-03	2.207E-02	1.737E-10	1.305E-07	1.030E-03	2.207E-02
2.998E-04	5.766E-03	2.011E-10	2.745E-08	2.119E-04	5.766E-03
5.496E-05	1.211E-03	5.785E-12	7.821E-10	3.884E-05	1.211E-03
1.408E-05	3.321E-04			9.948E-06	3.321E-04

PARAMETERS FOR BETA FIT FOR GROUP 12

ENERGY BOUNDS FOR GROUP - 1.5E+00 MEV TO 1.7E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
1.597E-02	2.611E+00	1.126E-06	4.693E-05	1.011E-02	2.611E+00
1.250E-02	5.746E-01	1.939E-07	1.668E-05	7.912E-03	5.746E-01
5.657E-03	1.273E-01	2.832E-09	2.858E-06	3.580E-03	1.273E-01
2.131E-03	3.143E-02	3.706E-10	6.189E-07	1.349E-03	3.143E-02
4.131E-04	6.359E-03	2.010E-10	2.767E-08	2.614E-04	6.359E-03
4.832E-05	8.928E-04	4.660E-12	7.820E-10	3.058E-05	8.928E-04
6.090E-06	2.205E-04			3.854E-06	2.205E-04

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 13

ENERGY BOUNDS FOR GROUP -- 1.7E+00 MEV TO 1.9E+00 MEV		COOLING TIME RANGE OF FIT -- 1.0E-01 S TO 1.0E+09 S		UNITS IN PARTICLES/FISS-S			
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
2.169E-02	4.425E+00	1.598E-05	3.482E-04	1.227E-02	4.425E+00	9.043E-06	3.482E-04
1.975E-02	1.099E+00	1.610E-06	5.129E-05	1.117E-02	1.099E+00	9.109E-07	5.129E-05
1.162E-02	2.934E-01	2.580E-07	1.852E-05	6.572E-03	2.934E-01	1.460E-07	1.852E-05
5.272E-03	7.082E-02	2.413E-09	3.404E-06	2.983E-03	7.082E-02	1.365E-09	3.404E-06
1.671E-03	2.028E-02	3.920E-10	7.189E-07	9.452E-04	2.028E-02	2.218E-10	7.189E-07
3.480E-04	5.961E-03	2.599E-10	2.739E-08	1.969E-04	5.961E-03	1.470E-10	2.739E-08
7.362E-05	1.287E-03	4.431E-12	7.824E-10	4.165E-05	1.287E-03	2.507E-12	7.824E-10

PARAMETERS FOR BETA FIT FOR GROUP 14

ENERGY BOUNDS FOR GROUP -- 1.9E+00 MEV TO 2.0E+00 MEV		COOLING TIME RANGE OF FIT -- 1.0E-01 S TO 1.0E+09 S		UNITS IN PARTICLES/FISS-S			
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
1.362E-02	2.847E+00	1.419E-05	4.615E-04	7.030E-03	2.847E+00	7.324E-06	4.615E-04
9.922E-03	8.443E-01	8.545E-07	5.502E-05	5.121E-03	8.443E-01	4.424E-07	5.502E-05
6.479E-03	2.821E-01	1.698E-07	2.063E-05	3.344E-03	2.821E-01	8.789E-08	2.063E-05
3.370E-03	8.706E-02	6.029E-10	2.962E-06	1.739E-03	8.706E-02	3.123E-10	2.962E-06
1.253E-03	2.446E-02	9.987E-11	7.578E-07	6.467E-04	2.446E-02	5.212E-11	7.578E-07
2.365E-04	7.498E-03	1.438E-10	2.764E-08	1.221E-04	7.498E-03	7.440E-11	2.764E-08
5.910E-05	1.972E-03	1.488E-12	7.937E-10	3.051E-05	1.972E-03	7.721E-13	7.937E-10

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 17

ENERGY BOUNDS FOR GROUP - 2.7E+00 MEV TO 3.0E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
4.535E-02	2.536E+00	1.115E-06	4.948E-05	1.601E-02	2.536E+00
3.305E-02	5.948E-01	3.631E-09	1.477E-05	1.166E-02	5.948E-01
1.267E-02	1.483E-01	3.013E-11	9.328E-07	4.474E-03	1.483E-01
4.306E-03	5.174E-02	-1.923E-11	4.177E-08	1.520E-03	5.174E-02
1.474E-03	1.556E-02	3.907E-11	3.418E-08	5.204E-04	1.556E-02
2.418E-04	4.412E-03	1.712E-11	2.262E-08	8.536E-05	4.412E-03
5.439E-05	1.123E-03	-6.255E-17	4.118E-09	1.920E-05	1.123E-03
8.254E-06	4.214E-04	2.029E-17	1.319E-09	2.914E-06	4.214E-04

PARAMETERS FOR BETA FIT FOR GROUP 18

ENERGY BOUNDS FOR GROUP - 3.0E+00 MEV TO 3.5E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
5.793E-02	2.500E+00	2.163E-06	2.554E-04	1.788E-02	2.501E+00
4.192E-02	5.898E-01	1.103E-06	5.576E-05	1.298E-02	5.898E-01
1.600E-02	1.336E-01	2.010E-09	2.232E-05	4.957E-03	1.337E-01
3.680E-03	4.195E-02	3.639E-11	1.095E-06	1.148E-03	4.195E-02
1.367E-03	1.334E-02	3.914E-12	2.172E-08	4.250E-04	1.335E-02
2.153E-04	3.712E-03	-3.305E-17	2.381E-09	6.712E-05	3.712E-03
4.863E-05	9.220E-04	2.435E-17	1.216E-09	1.515E-05	9.220E-04
				6.737E-07	2.554E-04
				3.446E-07	5.576E-05
				6.384E-10	2.232E-05
				1.139E-11	1.095E-06
				1.246E-12	2.172E-08
				-1.023E-17	2.381E-09
				7.552E-18	1.217E-09

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 17

ENERGY BOUNDS FOR GROUP - 2.7E+00 MEV TO 3.0E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
4.535E-02	2.536E+00	1.115E-06	4.948E-05	1.601E-02	2.536E+00
3.305E-02	5.948E-01	3.631E-09	1.477E-05	1.166E-02	5.948E-01
1.267E-02	1.483E-01	3.013E-11	9.328E-07	4.474E-03	1.483E-01
4.306E-03	5.174E-02	-1.923E-11	4.177E-08	1.520E-03	5.174E-02
1.474E-03	1.556E-02	3.907E-11	3.418E-08	5.204E-04	1.556E-02
2.418E-04	4.412E-03	1.712E-11	2.262E-08	8.536E-05	4.412E-03
5.439E-05	1.128E-03	-6.255E-17	4.118E-09	1.920E-05	1.128E-03
8.254E-06	4.214E-04	2.029E-17	1.319E-09	2.914E-06	4.214E-04

PARAMETERS FOR BETA FIT FOR GROUP 18

ENERGY BOUNDS FOR GROUP - 3.0E+00 MEV TO 3.5E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S			UNITS IN PARTICLES/FISS-S		
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
5.793E-02	2.500E+00	2.163E-06	2.554E-04	1.788E-02	2.501E+00
4.192E-02	5.898E-01	1.103E-06	5.576E-05	1.298E-02	5.898E-01
1.600E-02	1.336E-01	2.010E-09	2.232E-05	4.957E-03	1.337E-01
3.680E-03	4.195E-02	3.639E-11	1.095E-06	1.148E-03	4.195E-02
1.367E-03	1.334E-02	3.914E-12	2.172E-08	4.250E-04	1.335E-02
2.153E-04	3.712E-03	-3.305E-17	2.381E-09	6.712E-05	3.712E-03
4.863E-05	9.220E-04	2.435E-17	1.216E-09	1.515E-05	9.220E-04
				6.737E-07	2.554E-04
				3.446E-07	5.576E-05
				6.384E-10	2.232E-05
				1.139E-11	1.095E-06
				1.246E-12	2.172E-08
				-1.023E-17	2.381E-09
				7.552E-18	1.217E-09

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 19

ENERGY BOUNDS FOR GROUP - 3.5E+00 MEV TO 4.0E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
3.713E-02	2.768E+00	9.957E-03	2.768E+00
2.932E-02	7.651E-01	7.867E-03	7.652E-01
1.210E-02	2.290E-01	3.245E-03	2.290E-01
6.566E-03	8.293E-02	1.762E-03	8.293E-02
1.264E-03	1.983E-02	3.394E-04	1.983E-02
2.904E-04	6.564E-03	7.826E-05	6.564E-03
3.566E-05	1.603E-03	9.589E-06	1.603E-03
			5.737E-19

PARAMETERS FOR BETA FIT FOR GROUP 20

ENERGY BOUNDS FOR GROUP - 4.0E+00 MEV TO 5.0E+00 MEV
COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S

UNITS IN MEV/FISS-S		UNITS IN PARTICLES/FISS-S	
ALPHA	LAMBDA	ALPHA	LAMBDA
2.597E-02	3.219E+00	6.011E-03	3.532E+00
3.326E-02	1.096E+00	7.633E-03	1.096E+00
1.863E-02	2.390E-01	4.240E-03	2.458E-01
8.618E-03	8.850E-02	1.981E-03	8.850E-02
9.566E-04	1.692E-02	2.178E-04	1.692E-02
1.685E-04	5.976E-03	3.846E-05	5.976E-03
8.092E-06	1.591E-03	1.945E-06	1.591E-03
5.586E-07	3.697E-04	1.336E-07	3.679E-04
			3.024E-19

TABLE B-11 (CONT.)

PARAMETERS FOR BETA FIT FOR GROUP 21									
ENERGY BOUNDS FOR GROUP - 5.0E+00 MEV TO 6.0E+00 MEV					COOLING TIME RANGE OF FIT - 1.0E-01 S TO 1.0E+09 S				
UNITS IN MEV/FISS-S					UNITS IN PARTICLES/FISS-S				
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
1.670E-02	2.790E+00	6.410E-06	3.557E-03	3.074E-03	2.790E+00	1.200E-06	3.557E-03		
1.146E-02	8.676E-01	1.332E-08	6.882E-05	2.132E-03	8.812E-01	2.620E-09	6.882E-05		
1.048E-02	1.853E-01	9.197E-13	1.036E-06	1.919E-03	1.853E-01	1.732E-13	1.036E-06		
2.681E-03	9.035E-02	1.244E-18	1.742E-07	5.068E-04	9.035E-02	2.452E-19	1.742E-07		
3.052E-04	2.273E-02	1.999E-20	1.834E-12	5.626E-05	2.273E-02	3.936E-21	3.668E-12		
5.736E-05	8.377E-03			1.106E-05	8.377E-03				
PARAMETERS FOR BETA FIT FOR GROUP 22									
ENERGY BOUNDS FOR GROUP - 6.0E+00 MEV TO 7.5E+00 MEV					COOLING TIME RANGE OF FIT - 1.0E-01 S TO 2.0E+07 S				
UNITS IN MEV/FISS-S					UNITS IN PARTICLES/FISS-S				
ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA	ALPHA	LAMBDA
6.104E-03	3.534E+00	2.844E-07	4.332E-03	9.921E-04	3.647E+00	4.660E-08	4.331E-03		
7.056E-03	8.843E-01	1.028E-09	1.190E-03	1.096E-03	8.699E-01	1.680E-10	1.190E-03		
4.457E-03	1.473E-01	1.395E-10	7.437E-04	6.967E-04	1.471E-01	2.296E-11	7.443E-04		
1.079E-04	3.623E-02	2.021E-14	1.036E-06	1.708E-05	3.631E-02	3.289E-15	1.036E-06		
1.199E-05	1.325E-02			1.903E-06	1.327E-02				