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THE APPLICATION OF A LIBRARY OF PROCESSED ENDF/B-IV FISSION-PRODUCT AGGREGATE DECAY DATA IN THE CALCULATION OF DECAY-ENERGY SPECTRA

by

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ABSTRACT

Results from summation calculations by the CINDER-10 code and ENDF/B-IV decay, cross-section, and yield data for fission pulses have been incorporated into an ENDF/B-type format. The organization and content of this basic fine-group source-term library is described. In addition, two codes are described that provide pulse functions as fits to a user-specified multigrouping of the fine-group library. These can be readily used, essentially as Green's functions, to produce the spectra following any specific reactor power history. A particular set of fitted beta and gamma spectra having wide utility is described. Absorption effects are incorporated.

I. INTRODUCTION

The ENDF/B-IV fission-product files contain neutron cross sections, decay constants, decay energies, and other decay data for 824 important fission products. They also contain fission yields for these fission products produced by one or more fission-neutron energies (14 MeV, fast, and thermal fission) of six important nuclides: ^{232}Th, ^{233}U, ^{235}U, ^{238}U, ^{239}Pu, and ^{241}Pu. Also, spectral data (i.e., beta end-point energies and intensities, gamma-line energies and intensities) exist for the most important decay-heat contributors among the 824 nuclides. In ENDF/B-IV, beta-spectral data exist for 163 fission products, and gamma-spectral data exist for 172 nuclides (nuclides emitting both beta and gamma radiation are included separately in both types of radiation counts). The contents of the ENDF/B-IV fission-product file are detailed in Refs. 1-3 and summarized in Table I.

In recent years, great emphasis has been placed on obtaining experimental and computational information on delayed energy release at short cooling times for nuclear reactor safety studies of the hypothetical loss-of-coolant-accident (LOCA). There is, however, also interest in long cooling times. A computer code system[4,5] has been developed at the Los Alamos Scientific Laboratory (LASL) that uses the ENDF/B-IV fission-product data to calculate cumulative delayed beta and gamma spectra on arbitrary energy grids for arbitrary irradiation histories and cooling times. This code system is shown in Fig. 1.

It can be noted in the figure that the basic ENDF/B-IV fission-product data library is accessed along three paths. The center path, after the preparation of an input library, proceeds via the CINDER-10 code. CINDER-10 is the latest and most versatile version of CINDER, a well-known fission-product and depletion code. The most recent documentation on CINDER is Ref. 4 (for Version 7), but the additional features of Version 10 are discussed in Ref. 6. CINDER-10 calculates fission-product and actinide concentrations, activities, gaseous contents, energy releases, effective group absorption cross sections, etc. for any fissionable nuclide mixture irradiated in arbitrary neutron fluxes for arbitrary intervals of time followed by arbitrary cooling times. The neutron cross sections[7,8] used in CINDER-10 are generated by spectrum collapse of multigroup data generated with the NJOY code.[9] This input path to CINDER-10 is the lower path shown in the figure. Spectrum collapse is achieved with the TOAFEW[8] code.

The ENDF/B-IV data is also accessed by the FPDCYS code along the upper processing path shown in Fig. 1. This code is used to generate multigroup beta and gamma spectra for individual nuclides for which spectral data exist on the ENDF/B-IV file. FPDCYS incorporates four options for calculating beta spectra and two options for calculating gamma spectra. The differences among the four beta-spectrum options are mainly in the ways in which the Fermi function F(Z,W) is represented and calculated. The first of the two gamma-spectrum options consists of incorporating the unbroadened lines weighted by their intensities into an arbitrary number of energy groups. Alternatively, gamma lines are broadened according to detector resolutions before multigrouping in the second option.

The output of FPDCYS and the output of CINDER-10 are input to the FPSPEC code. Actually, only a small portion of the CINDER-10 output is utilized, namely, fission-product activities and total decay energies at the instant of time when corresponding spectra are sought. FPSPEC combines the individual

TABLE I

SUMMARY OF ENDF/B-IV FISSION-PRODUCT DATA FILE CONTENT

824	Nuclides (total)
181	Have differential cross sections
180	Have individual β and γ "lines" (spectral data consisting of energies and intensities)
712	Are unstable and each has an average β, γ, and α energy and branching fraction
10	Yield sets for 6 fissionable nuclides (∿10 000 yields)

(∿310 000 Data entries required in ENDF/B-IV)

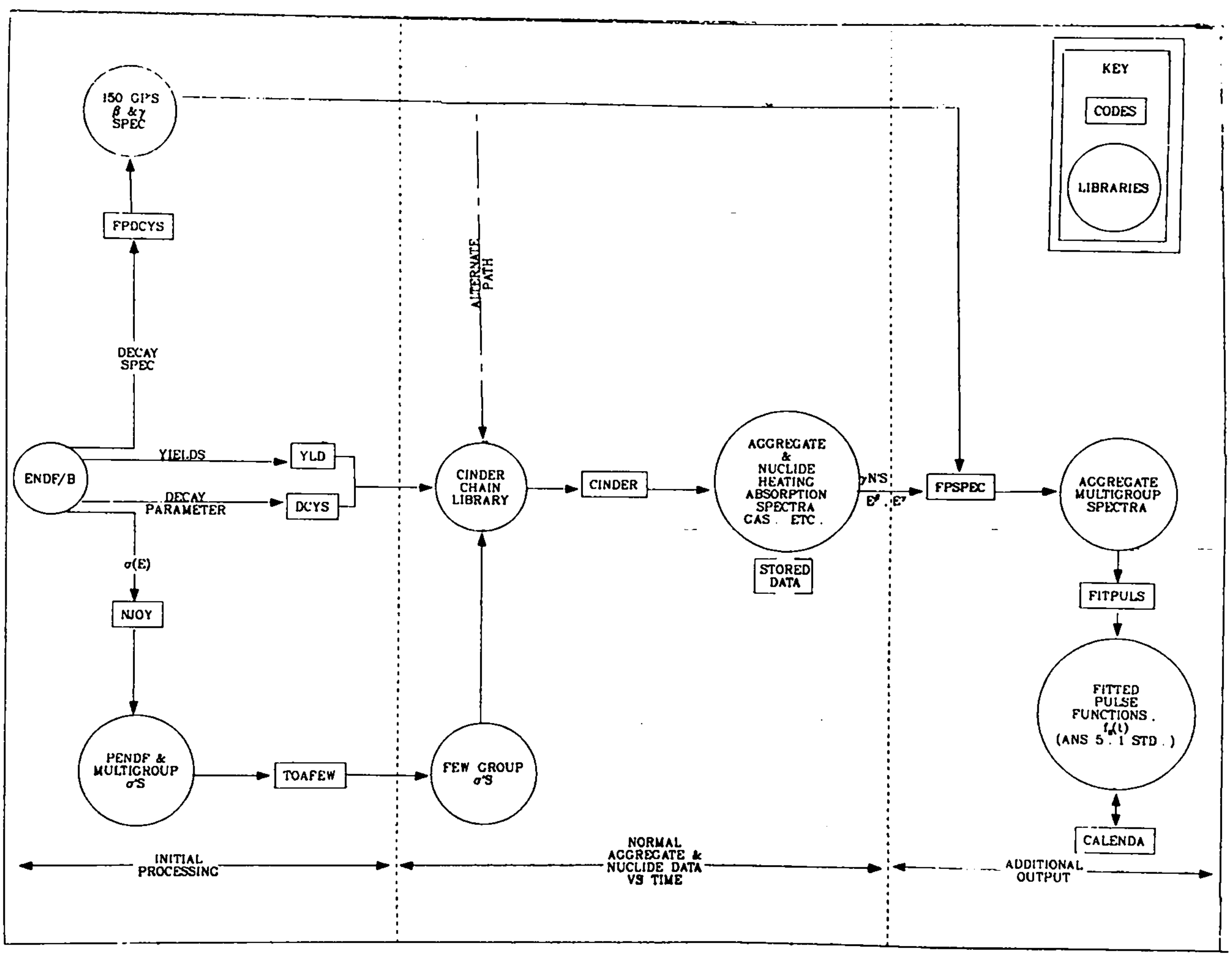

Fig. 1.
LASL nuclide processing codes and libraries.

spectra from FPDCYS and the nuclide activities from CINDER-10 to generate aggregate fission-product spectra for each irradiation and shutdown time. Note that CINDER-10 also incorporates a spectral subroutine capable of utilizing the multigroup data produced by the FPDCYS code. Plots of sample output from FPSPEC are shown in Figs. 2-5. In these illustrations, the calculated spectra are compared with the LASL experiment cited in Ref. 10.

As indicated above, spectral data are not available for all 824 fission products in ENDF/B-IV, and missing spectra must be approximately constructed. This is done for a particular nuclide by assuming that the shape of the beta (or gamma) spectrum for the nuclide is approximated by the spectrum shape of the aggregate 181 nuclides from a pulse after a cooling time approximately equal to the half-life of the nuclide in question. This shape is then normalized to the average beta- (gamma-) decay energy of the nuclide. Figures 6 and 7, respectively, compare the gamma spectra of ^{139}Cs with those constructed for a hypothetical nuclide having the same half-life and average gamma- and beta-decay energies as ^{139}Cs. The nuclide ^{139}Cs is a relatively important nuclide in the 0.1-s cooling time bin for 20 000-h thermal irradiation of ^{235}U. *However, it should be noted that such constructed individual spectra are used only in the aggregate.*

The libraries used in the CINDER-10 and auxiliary codes FPDCYS and FPSPEC are extensive and the codes are designed to use the libraries for any specified irradiation history. However, for many users the scope of application is unnecessary and aggregate results, rather than the detailed nuclide-by-nuclide output, are needed. The purpose of this report and the associated codes described is to eliminate the need for extensive summation code calculations for a wide range of problems. The summation codes and libraries have been used to produce multigroup beta and gamma spectra vs time following fission pulses, including the components of the spectra due to halogens and noble gases for a wide range of applications.

We have used the summation codes and libraries to produce secondary aggregate libraries and pulse functions shown as "additional output" in Fig. 1, which can be used directly or incorporated into neutronics codes. In particular, we have

- Used the summation codes to produce beta- and gamma-temporal spectra in 150 groups following fission pulses for each fuel and fission neutron energy in ENDF/B-IV and stored the results in formats similar to ENDF/B. These files delineate the noble gas and halogen spectra. Users can readily collapse the results to other multigroup spectra.

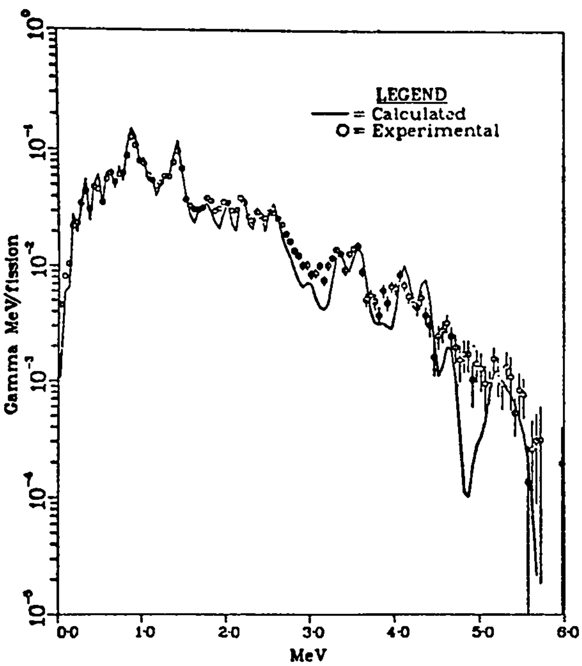

Fig. 2.
Gamma spectrum 5.56-h irradiation of ^{235}U, 70-s cooling.

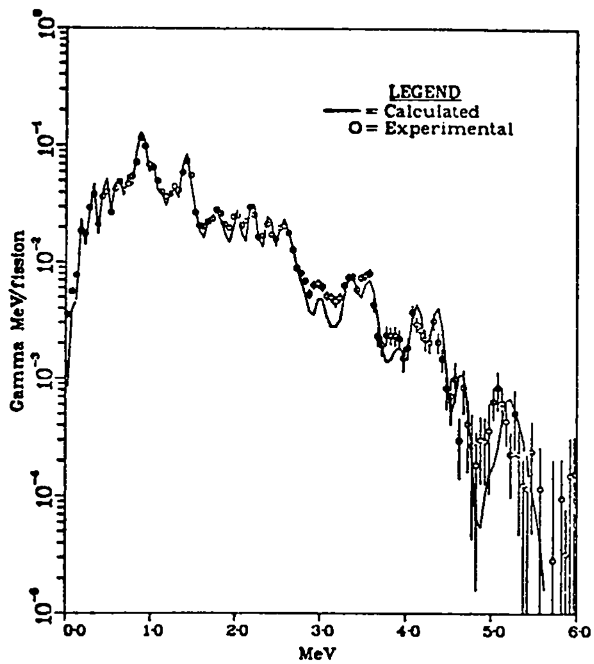

Fig. 3.
Gamma spectrum, 5.56-h irradiation of ^{235}U, 199-s cooling.

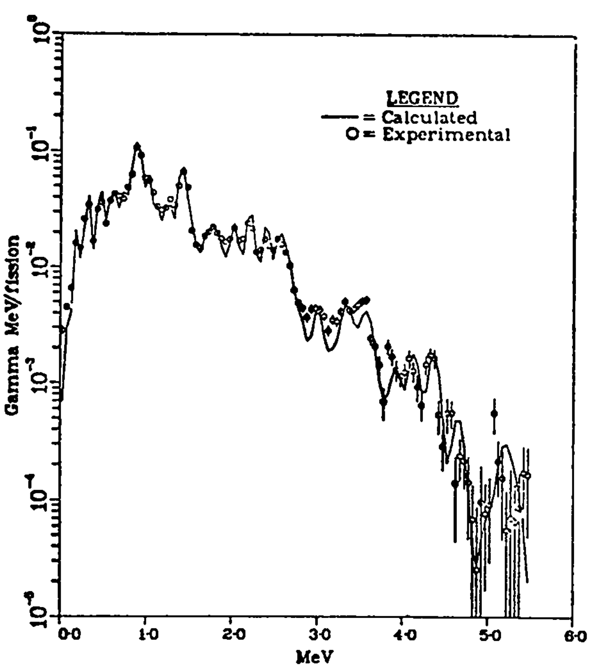

Fig. 4.
Gamma spectrum, 5.56-h irradiation of ^{235}U, 388-s cooling.

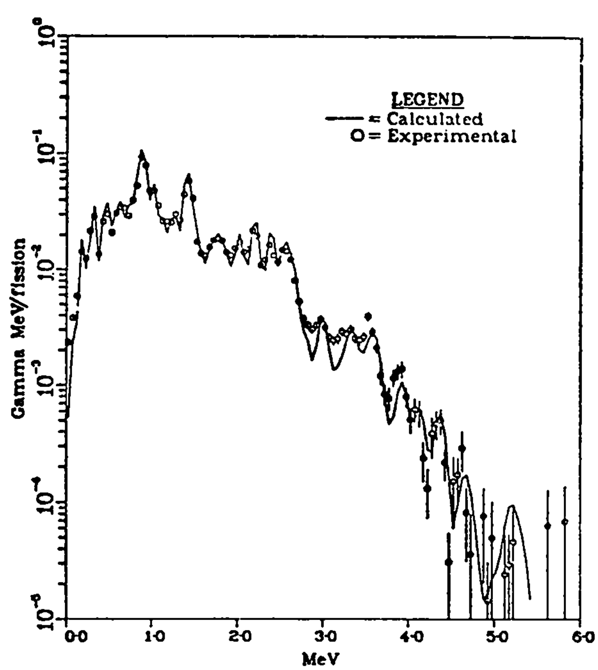

Fig. 5
Gamma spectrum, 5.56-h irradiation of ^{235}U, 660-s cooling.

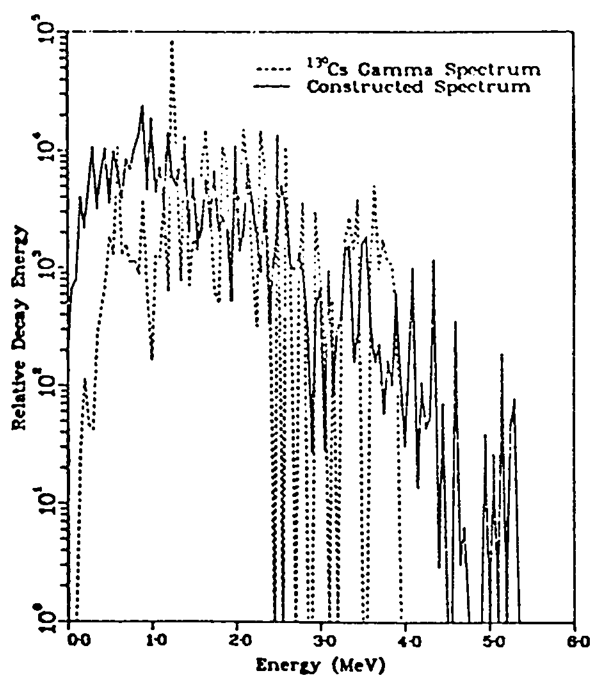

Fig. 6.
^{139}Cs gamma spectrum compared with constructed spectrum.

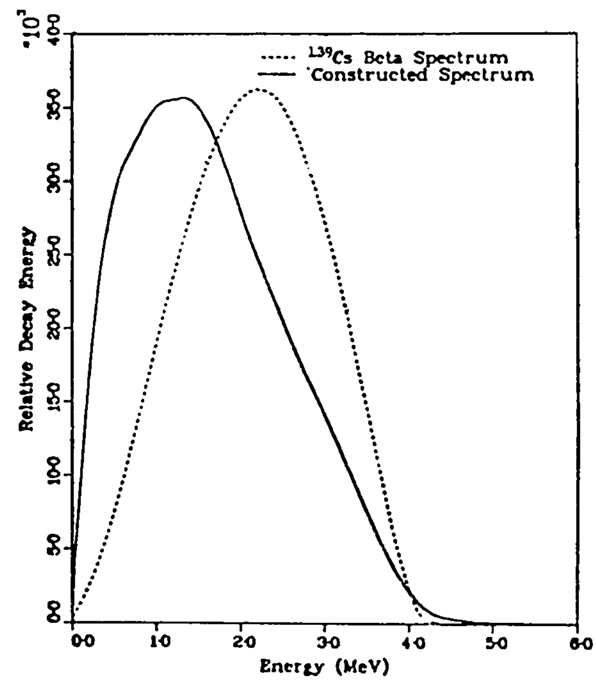

Fig. 7.
^{139}Cs beta spectrum compared with constructed spectrum.

- Collapsing and exponential fitting and folding codes are also described, the latter being useful for generation of spectra following finite power histories.
- For immediate use, exponential fits to a particular few-group spectra are provided in this report.

Because the spectra are based on fission pulses, the libraries have a general utility. The exponential fits, for example, can be folded into any power (fission) history that can be described analytically or by a histogram representation. The effects of neutron absorption are also described and approximately accounted for in the methodology.

II. LIBRARY FOR PROCESSED ENDF/B AGGREGATE FISSION PRODUCT SPECTRA

Of particular interest is the application of the LASL code system to produce delayed beta- and gamma-spectral data on a fine energy grid (150 groups in 0.05 MeV steps from 0 to 7.5 MeV) for irradiation of the ENDF/B-IV fissionable nuclides with very short pulses (typically 10^{-4}-s irradiation time; shorter pulses do not alter the calculated spectra) of thermal, fast, and 14-MeV neutrons. The results can then be further processed into broad groups and fit with functions of the type $f_c(t) = \sum_{i=1}^{n} \alpha_i e^{-\lambda_i t}$, as described in Secs. III and IV.

The fine-group results from the LASL code system are assembled into a single library in an ENDF-like format.[11] Definitions for the format for this processed ENDF/B fission-product and energy-yield data (PEFPYD) library are as follows.

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.

Fission nuclide and energy combinations available in ENDF/B-IV are given in Table II.

MT: Section number used to describe data contents of the section. 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 $\gamma + \beta^-$ 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

Other MT-numbers can be defined as needed; for example, MT-numbers could be assigned to any of the above spectra summed over energy.

TABLE II

FISSION YIELD DATA IN ENDF/B-IV

Nuclide	Incident Neutron Energy Type: Thermal	Fast	High Energy (14 MeV)
^{232}Th	--	Yes	No
^{233}U	Yes	No	No
^{235}U	Yes	Yes	Yes
^{238}U	--	Yes	Yes
^{239}Pu	Yes	Yes	No
^{241}Pu	Yes	No	No

The data are given in a TAB2 record with tables of spectra (decay energy/fission vs energy) given for a number of cooling times. Standard ENDF/B interpolation schemes between cooling times (TAB2 interpolation) are not recommended and, in any case, would be of interest only for fission pulses. However, when the pulse data are placed on a broad-group mesh and fitted with parameters as described in Secs. III and IV, calculations for any irradiation-cooling time combinations are possible, precluding the need for interpolation on the fine grid. Histogram interpolation is assigned for TAB1 interpolations.

File 1 (MF=1) information is also included, giving some processing information and a "dictionary" of the data to follow. The structure of MF=1 is as described in ENDF-102.[11] The structure of a section containing the processed data is

[MAT,MF,MT/ZA,AWR,0,0,0,0] HEAD

[MAT,MF,MT/0.0,0.0,0,0,1,NTS/TS_{int}] TAB2

[MAT,MF,MT/0.0,TS_1,0,0,1,NP/E'_{int}/DE(E',TS_1)] TAB1

[MAT,MF,MT/0.0,TS_2,0,0,1,NP/E'_{int}/DE(E',TS_2)] TAB1

\- -

\- -

[MAT,MF,MT/0.0,TD_{NFS},0,0,1,NP/E'_{int}/DE(E',TS_{NTS})] TAB1

[MAT,MF,MT/0.0,0.0,0,0,0,0] SEND

where

TS = cooling time step in seconds

DE = decay energy in MeV/fission (MeV/s)/(fiss/s)

E' = energy of particle (β^-) [photon (γ)] in MeV

NTS = number of cooling time steps given for a particular MT

NP = number of DE,E' pairs given in a particular TAB1 record.

Other quantities are defined in ENDF-102. Note that interpolation along cooling-time steps (the TAB2 records) is always set to zero, meaning that interpolation is not recommended, and that interpolation is always set to one (histogram) for the TAB1 records. A sample PEFPYD listing is given in Appendix A.

III. REDUCING AND FITTING THE PEFPYD DATA -- THE FITPULS CODE

In general, the data in the PEFPYD library are too detailed along the energy axis and not detailed enough along the cooling-time axis for application to design problems. The FITPULS code is designed to access the PEFPYD library, collapse the 150 energy-group spectra into few groups (up to 25), and fit the resulting spectra along the cooling-time axis with a linear combination of functions of the type

$$fc(t) = \sum_{i=1}^{n} \alpha_i e^{-\lambda_i t} \quad \text{(MeV/fiss/s)} \ . \tag{1}$$

Note that there are two sets of parameters in Eq. (1), namely, the set of α_i and the set of λ_i. FITPULS contains options allowing either a least-squares single-parameter fit, that is, a fit of the α's, given a set of λ's, or a nonlinear least-squares two-parameter fit (a simultaneous fit of both the α's and λ's). The first option is described in detail in Ref. 12, and the second uses the nonlinear least-squares STEPIT routine described in Ref. 13.

In both fitting routines, comparisons between calculated and original values are made for every data point. This, however, is not sufficient to guarantee a good fit, because the function may oscillate wildly between data points. A subroutine called FINECHK detects such oscillations by calculating the function on a fine grid and printing out values differing more than 10% from those calculated using a simple semilog interpolation between points on either side. If this difference exceeds 100%, the point is additionally flagged by FINECHK; if negative values occur, the user is warned that a fit has not been achieved.

The percentage differences flagged are arbitrary and may be changed by the user. Also, it is suggested that the user insert a plotting option at this point in the code so that oscillations in the fit can be inspected visually. The LASL CDC-7600 version of FITPULS contains the LASL plotting routines that compare the fine-mesh points calculated in FINECHK with the original data. The FINECHK routine will also flag those calculated points where slopes are ascending, thus giving additional indications of possible problems with the functional fit.

Normally, the two-parameter nonlinear fitting routine STEPIT will run to convergence at minimum chi-square, but an option is in FITPULS to stop the calculation when an input maximum allowed percent deviation (DIFLIM) of the calculated values from all original values has been achieved. For efficiency of code operation, it is suggested that the user set DIFLIM high in early passes and tighten up as desired convergence is approached.

Although, in principal, a two-parameter fit can be made from scratch, given a reasonable set of parameters for a particular coarse group structure, a great saving in total problem running time can be attained by first running single-parameter fits. The code contains several options for selecting initial λ's, removing duplicate λ's, making adjustments for resulting negative coefficients with large values, etc. *In fact, this and other fitting codes can only be run effectively with a rather large amount of user interaction, as indicated by the discussion in Sec. IV.*

The FITPULS code also has an option for obtaining fitted pulse parameters from data given for finite-irradiation times (IRAD=1 option). This option is particularly useful for reducing data from a number of different experiments with different irradiation times to pulses for comparison purposes.

The technique of running FITPULS in the normal mode, for example, IRAD=0, is provided in the example problem sequence below. A listing of the FITPULS code is given in Appendix B and input specifications are listed in Table III.

IV. FITPULS INPUT AND SAMPLE PROBLEM: A USEFUL FITTED SPECTRUM

The input specifications for the FITPULS code are shown in Table III. As a sample problem, consider a multigroup collapse of the PEFPYD data for the gamma spectra of fission products produced by a pulse (10^{-4}-s irradiation time) of thermal neutrons on ^{233}U, (MAT1=1260, MF1=80, and MT1=803). Some of the PEFPYD data used in this example are shown in Appendix A. The broad-group structure used for this problem is shown in Table IV. Note that there are

TABLE III
FITPULS INPUT SPECIFICATIONS

Card No.	Format	Variable	Comment
(Input for Subroutine CORSBIN)			
1	6I11	MAT1	MAT-No of desired fissioning nuclide.
		MF1	MF desired (incident energy type).
		MT1	MT desired (particle/photon data type).
2	6I11	NE	No. of desired broad groups + 1.
3	6E11.4	EB(I)	Energy bounds in MeV, including lower and upper bounds. Read low to high energy.
(Input for Program FITPULS)			
1	12I6	NPUN	Set NPUN = 7 here if rebinned data cards wanted; otherwise set to zero.
		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).
2	8A10	TITL(I)	80 character title, if TITLE(1) = SELECT subroutine SELECT is called and this input goes here (see SELECT input). If TITLE(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 data from cards. Used for experimental data. See subroutine RUNTOTS.
		NPUN	Flag for punched output. Set equal to 7 if punched output is desired, equal to 20 if punched output not desired. In general, punched output is needed for subsequent runs.

TABLE III (cont)

Card No.	Format	Variable	Comment
3 (cont.)		NSTEP	Flag to call subroutine DHFIT, which calls the routine STEPIT, which performs a two-parameter fit. Routine usually not called until a couple of passes are made to get a coarse adjustment of the parameters with a single fit. Set equal to zero if call to 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 time limit set on control card to get punched cards 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	12I6	KKN(I)	Flags for calling STEPIT routine (two-parameter fit) 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

If NFINL = 1, cards ouput from previous problems are read here. These cards are the α's and λ's for all groups, and they are in an ENDF-like format. If NFINL = 1, no futher input is needed. Note, however, that α's and λ's for particular

TABLE III (cont)

Card No.	Format	Variable	Comment

groups can be entered in subroutine PULSFIT, distinct from this option in that they need not be entered for every group, thus permitting a mixture of options.

IPROB set negative allows the data for the groups to be fitted in several segments.

KKN is set negative for a particular group if a call to subroutine TRMSEE is desired. (See code listing in Appendix B.)

Card No.	Format	Variable	Comment
5	12I6	NSEG	Number of segments + 1
		NS(I)	Breakpoints of segments

(Input for subroutine PULSFIT)

Card No.	Format	Variable	Comment
1	12I6	LWT	Weight function desired in single parameter fit.
			If LWT = 0, Weight function = 1
			If LWT = 1, Weight function = 1/FX
			If LWT = 2, Weight function = $1/FX^2$
			If LWT = 3, Weight function = $1/FX^{1.5}$
		NOK	Flag for parameter selection
		KTRM	Flag for parameter selection.
			NOK, KTRM combination determines the option by which the initial λ's for the group are selected. See below.
		IPRT	Flag for print option. Set equal to 1 for complete print, otherwise set to zero.

NOK, KTRM specifications, NOK = 0, KTRM = number of λ's to be read in.

Card No.	Format	Variable	Comment
2	3(11X,E11.4)	ALAMDA(K)	Read in (ALAMDA(K),K = 1, KTRM)
			(Note from format that if cards from previous run are used, coefficients will not be read.)

NOK = 1, KTRM = 1, λ's calculated at every pair of cooling time-decay energy points. (No input is necessary, and card No. 2 does not exist.)

TABLE III (cont)

Card No.	Format	Variable	Comment
NOK = 1, KTRM = number of λ's to be calculated by code.			
2	12I6	KCAL(L)	Selects points between which λ's are to be calculated. First point is always selected by code. Read KCAL(L), L = 2, KTRM

NOK = 2, KTRM = 1, cards in ENDF-like format from previous problem for this group are read in here, and the subroutine returns immediately to main program. No further input is needed for this group. This option is used after a single-parameter fit has been made in a previous pass, and two-parameter fitting is now being done in STEPIT for this group. This is similar to the NFINL = 1 option in the main program, except that the two-parameter fits are allowed on a group-by-group basis.

Card No.	Format	Variable	Comment
3	12I6	IWANT	Select λ's wanted by position number. If all are to be retained, as in a first pass, set equal to zero.
		KCAL(L)	Position numbers of λ's to be kept. Do not enter if IWANT = 0.
(Input for subroutine SELECT)			
1	12I6	ITS,ITP	Number of time steps desired, indexes of desired time steps. SELECT used if one wishes to fit a subset of a particular data file, and this input follows the title code.
(Input for subroutine TRMSEE)			
1	12I6	MLT	Number of parameters to be changed
2	I6	L	Time step number of parameters to be changed
	E12.5	ALF(K,L)	New value of α
	E12.5	ALAM(K,L)	New value of λ
3	12I6	LT	Number of terms to be removed
		LTM(L)	Term numbers of terms removed

TABLE IV

GROUP STRUCTURE USED FOR SAMPLE PROBLEM

Group No.	Lower Energy Boundary (MeV)	Upper Energy Boundary (MeV)
1	0.10	0.40
2	0.40	0.90
3	0.90	1.35
4	1.35	1.80
5	1.80	2.20
6	2.20	2.60
7	2.60	3.00
8	3.00	4.00
9	4.00	5.00
10	5.00	6.00
11	6.00	7.00

NOTE: There are essentially no data on PEFPYS for E > 7.0 MeV negligible gammas above 7 MeV, the upper bound of the last group. Also note that in collapsing to the broad-group structure, the code changes the units of the fission-product decay energy from MeV/fission to MeV/fission-s, the standard units in use for pulse functions.

For the first pass, we make only a single-parameter fit[12] and allow the code to calculate initial λ's from semilog slopes between pairs of cooling-time and gamma-energy (MeV/fission-s) points. This is done by setting the input as follows:

Input to Program FITPULS

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

Input to Subroutine CORSBIN

```
Card 1    MAT1 = 1260
          MF1 = 80
          MT1 = 803

Card 2    NE = 12

Card 3    (group bounds from Table IV)
```

Input to Program FITPULS (cont.)

```
Card 2    IPROB = 1
          NTOTER = 0
          NPUN = 7
          NSTEP = 0
          NFINL = 0

Card 3    DIFLIM = 1.0 (not used in this run)
          RUNTIM = 29.9 (not needed in this run)
          TMIN = 0.1
          TMAX = 1.0E+9
          GXMAX = 1.0E-21

Card 4    KKN(K) = group numbers, although not used in this run as NSTEP = 0
```

Input to subroutine PULSFIT

```
Card 1    LWT = 1
          NOK = 1
          KTRM = 1
          IPRT = 0

Card 2    IWANT = 0
```

Repeat cards 1 and 2 for each energy group.

Examination of the results of pass No. 1 reveal that (a) groups 1, 2, 3, and 10 appear converged and plots are smooth; (b) although groups 4, 5, 6, 7, and 9 appear converged, plots show rather large reversals in shape; and (c) fits are not achieved by groups 8 and 11, as negative computed values occur between fitted points. This run took 30 s on the CDC-7600 computer.

For the second pass, we keep the same input as pass No. 1, except we set LWT = 3 for groups 4, 5, 6, 7, 8, and 9. As a result, all groups are apparently fitted to within 1% except group 9, but plots are not smooth for groups 4, 5, 6, 7, 8, and 9 as illustrated in Fig. 8 for group 4. Note the apparent reverse of slope near a cooling time of 100 s, not indicated by the input data points. Examination of the parameters for these indicates that there is a large negative value of α in the sixth pair of parameters for each group. These pairs of parameters are eliminated in the third pass. The running time for pass No. 2 was 25 s.

The input for pass No. 3 is the same as that for the second pass, except for groups 4, 5, and 6 in subroutine PULSFIT. This is now as follows.

```
Card 1   LWT = 3
         NOK = 1
         KTRM = 1
         IPRT = 0

Card 2   IWANT = 20

         KCAL(J) = 1,2,3,4,5,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21
                   (note parameter number 6 is omitted)
```

The results of the third pass indicate that plots for groups 4, 5, 6, 7, and 9 are now smooth, as illustrated in Fig. 9 for group 4. The running time for pass No. 3 was 31 s.

Smooth fits for groups 7, 8, and 9 were not obtained in the first three runs, as shown in Fig. 10 for group 8. An additional run (run No. 4) was made for these three groups in which the input was the same as that used in run No. 2 except that the option for selecting the points for the fit was used. This option is activated by setting the first characters of the title card to the word "SELECT." The input was set to remove the points at cooling-time steps of 0.5, 5, and 50 s. This effectively smoothed the fits for groups 7, 8, and 9, as shown in Fig. 11 for group 8.

The FITPULS input for pass No. 5 is the same as for the previous passes except NSTEP and NFINL are now both set to 1, and the card output from passes

No. 3 and 4 are added after card No. 3. No additional input is needed. The results of this run were that all groups were fitted to within 1% after 104 s of running time. The fits extend to >30 yr of cooling time. These are shown graphically in Figs. 12-22, and a comparison of the parameters for group 4 from the first run with those from the last run are given in Table V.

Note that these fits are not unique, and also that good fits can be obtained by using smaller numbers of parameters. The subroutine TRMSEE can be used to assist the user in reducing the number of parameters. It is called for a particular group by making KKN the negative of the group number.

Parameters for selected incident energy-fissioning nuclide combinations are given in Appendix C. The accuracy of these fits vary from about 2 to 5%, and although closer fits could be obtained, the extra effort hardly seems worthwhile for ENDF/B-IV data. An indication of the accuracy of the ENDF/B-IV fission-product decay and yield data can be obtained by comparison with another evaluated set,[14] as is done in Figs. 23-26, where the spectra are normalized to the same total values. More important validations are the comparisons with experiment.[15] The fits given in Appendix C are certainly as accurate as warranted by the ENDF/B-IV data.

V. APPLICATION OF FITTED PULSE TO CALCULATION OF DECAY-ENERGY SPECTRA AFTER EXTENDED IRRADIATION

The fitted pulse can be folded with a reactor power history so that decay spectra from irradiated fuel can be calculated as a function of cooling time. Consider a reactor operated at variable power P(t'), $0 \leq t' \leq T$, for a time interval T followed by a shutdown period t_s. In the following equations, given for a particular energy group,

t = time since fission pulse

P(t') = power in watts at time t'

$K = 0.32042 \times 10^{10}$ w-s/fission

T = total time at power

t_s = shutdown time of interest, measured from T, and

H(t,T) = decay-energy release at time $(T+t_s)$ for some energy bin (MeV/s).

$$fc = \sum_{k=1}^{L} \alpha_k e^{-\lambda_k t} \quad , \text{ MeV/fiss-s,} \qquad (2)$$

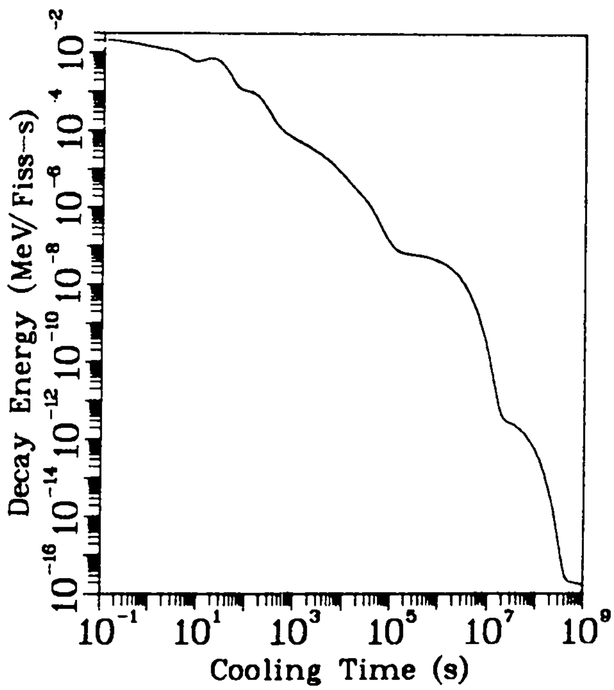

Fig. 8.
Fit for group 4 after second pass through FITPULS.

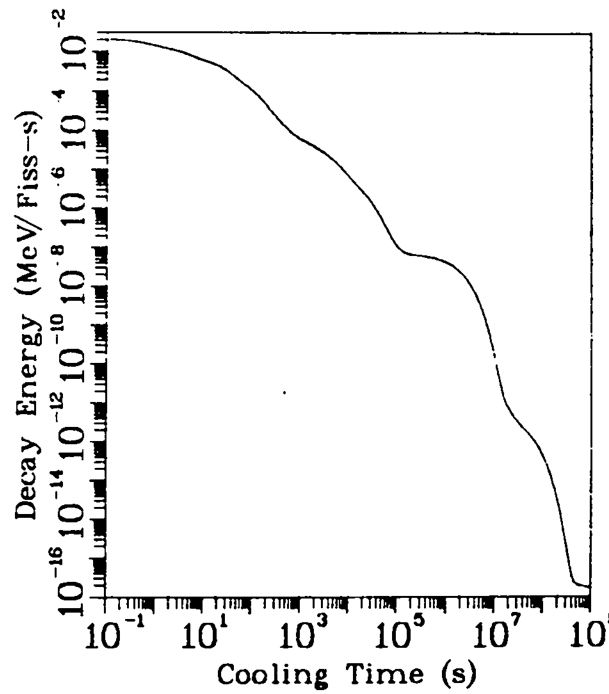

Fig. 9.
Fit for group 4 after final pass through FITPULS.

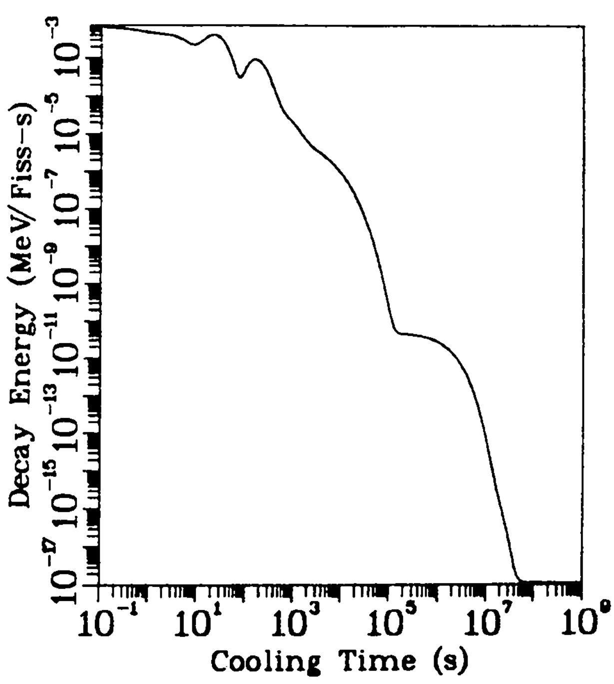

Fig. 10.
Fit for group 8 after second pass through FITPULS.

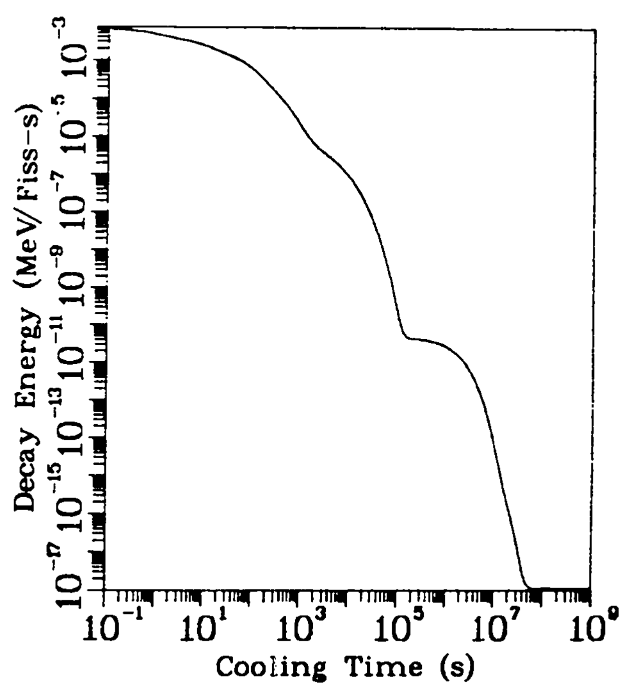

Fig. 11.
Fit for group 8 after final pass through FITPULS.

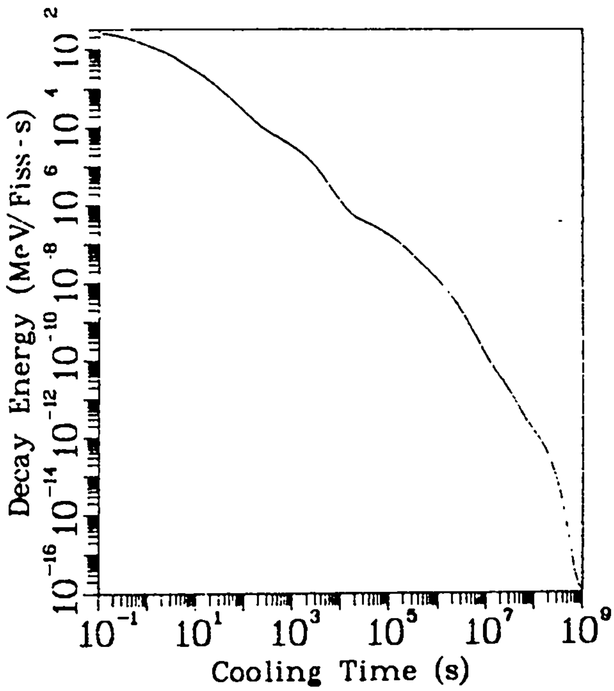

Fig. 12.
Final fit for group 1.

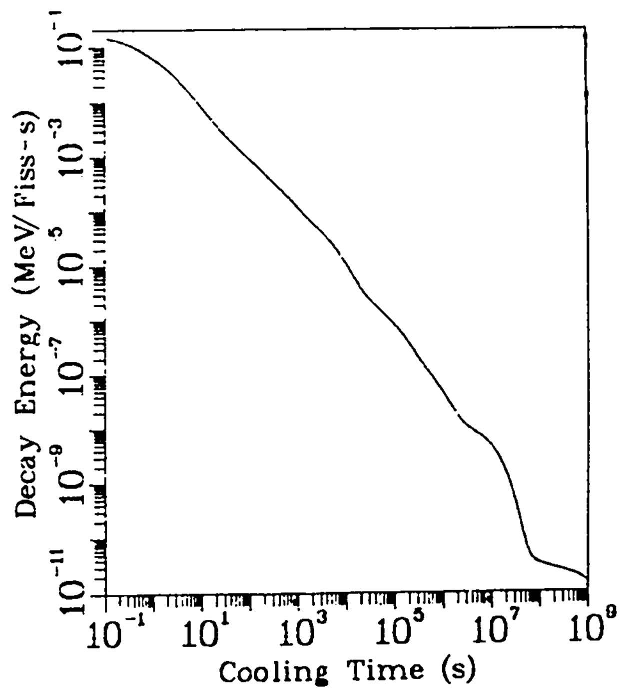

Fig. 13.
Final fit for group 2.

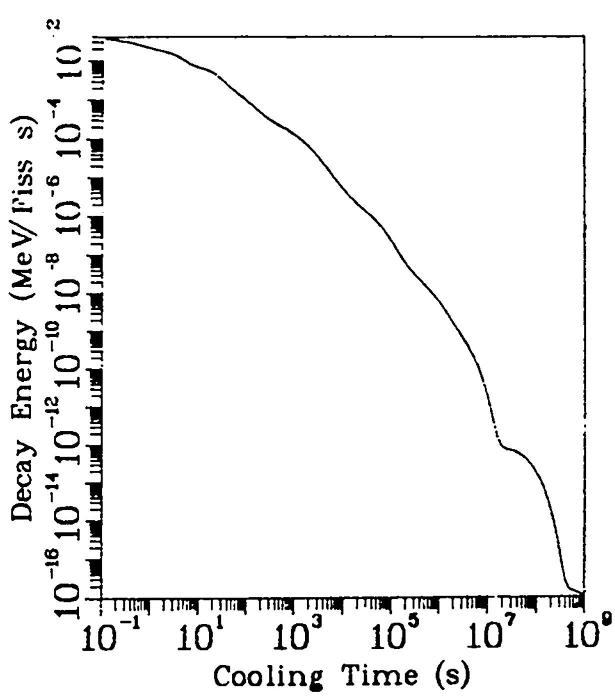

Fig. 14.
Final fit for group 3.

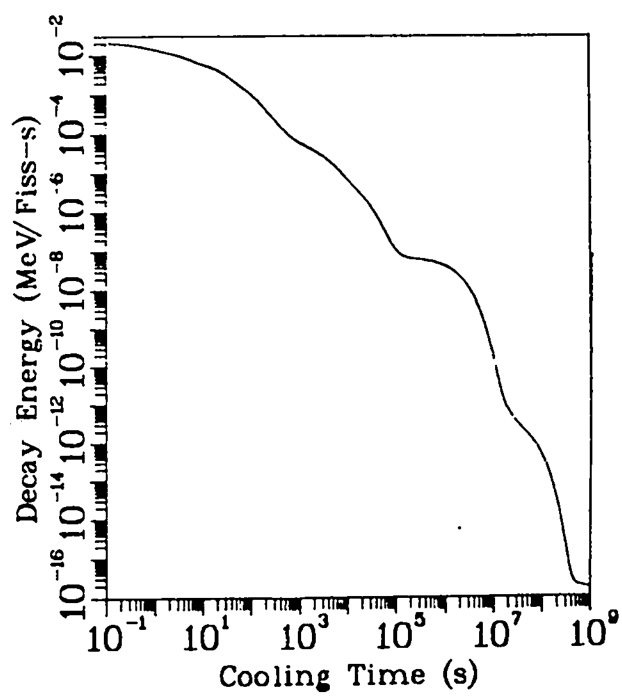

Fig. 15.
Final fit for group 4.

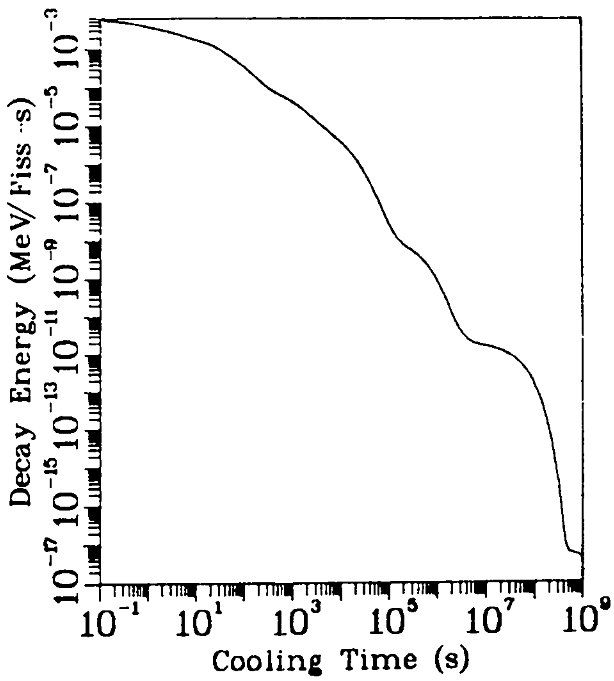

Fig. 16.
Final fit for group 5.

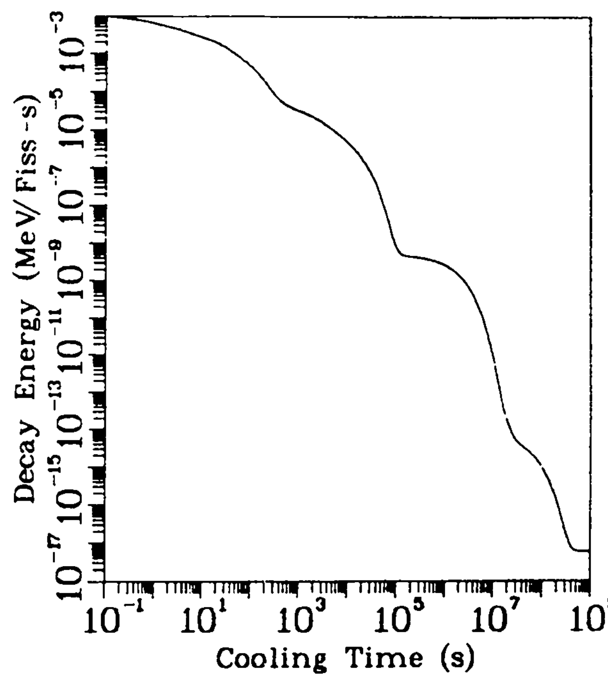

Fig. 17.
Final fit for group 6.

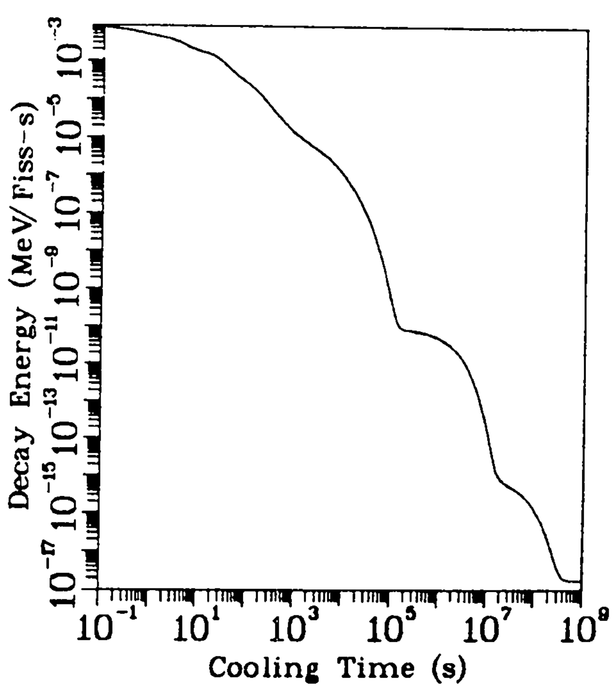

Fig. 18.
Final fit for group 7.

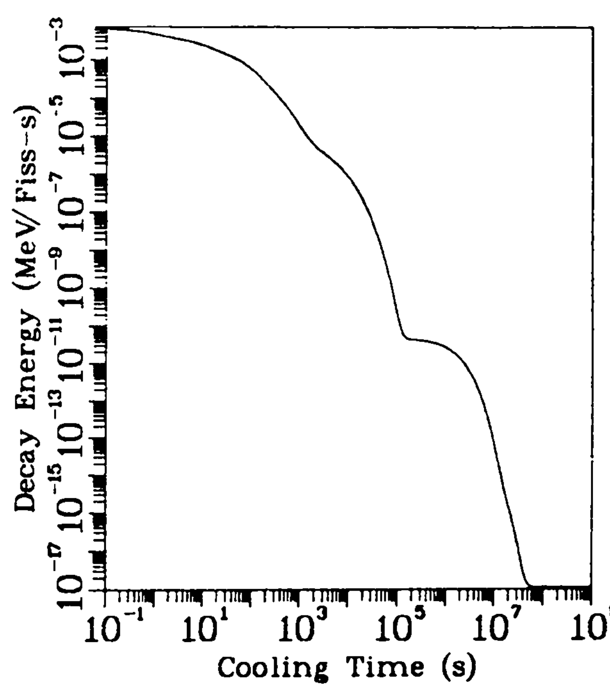

Fig. 19.
Final fit for group 8.

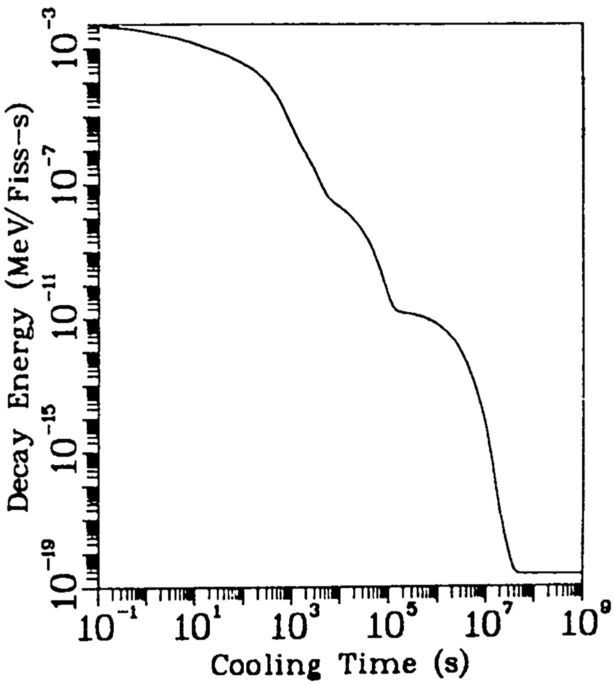

Fig. 20.
Final fit for group 9.

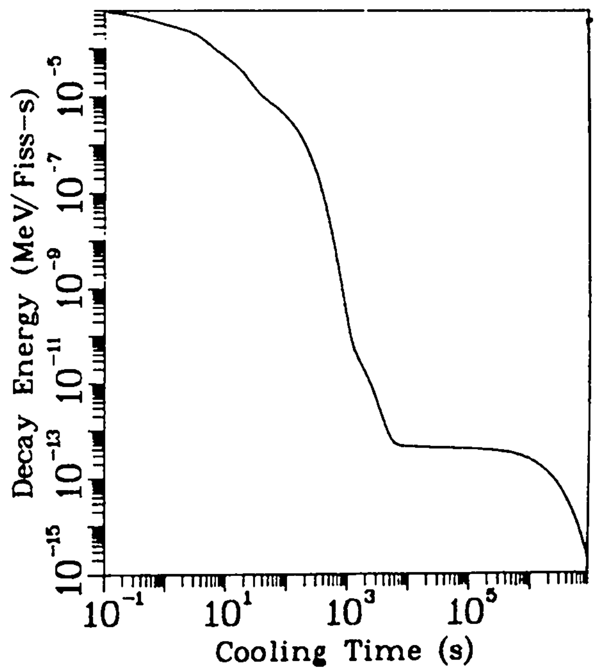

Fig. 21.
Final fit for group 10.

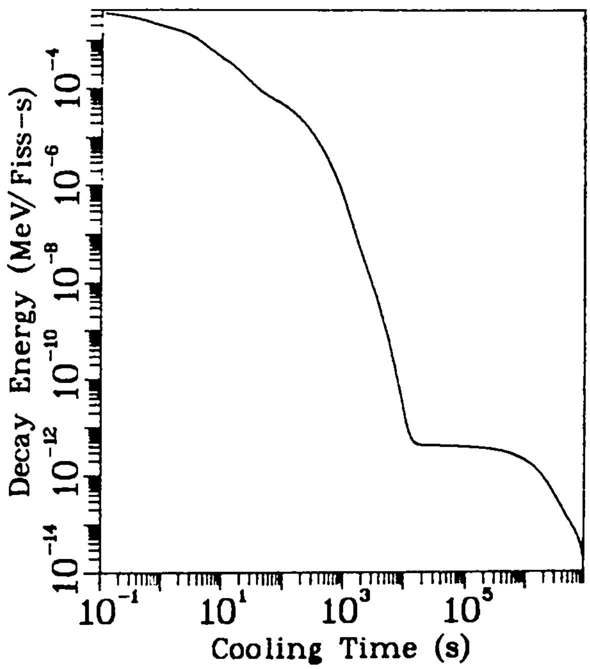

Fig. 22.
Final fit for group 11.

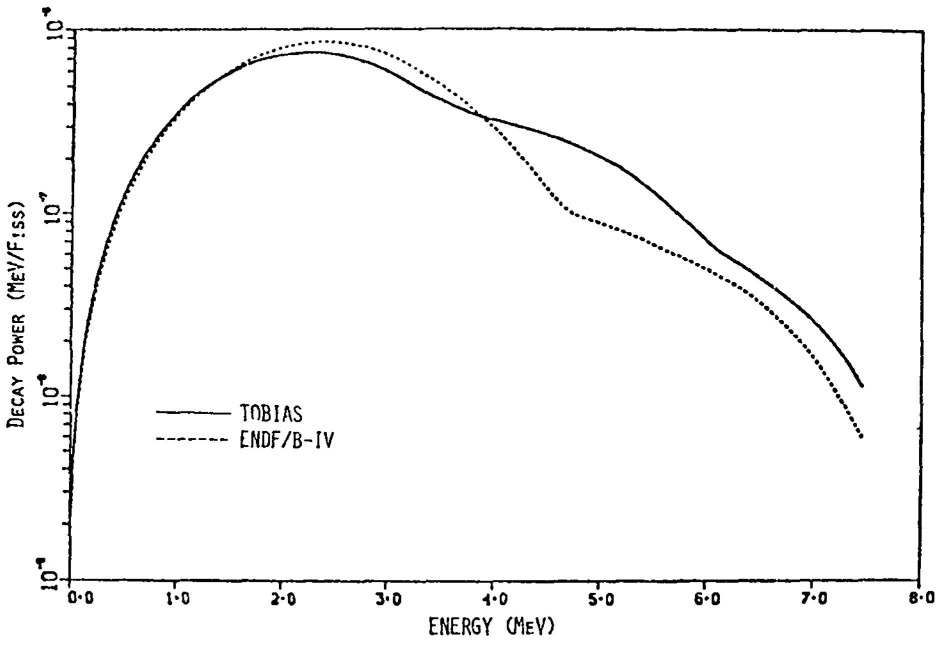

Fig. 23.
ENDF/B-IV beta-spectra comparison with UK Data File, all fission products, betas (cooling time 0.1 s).

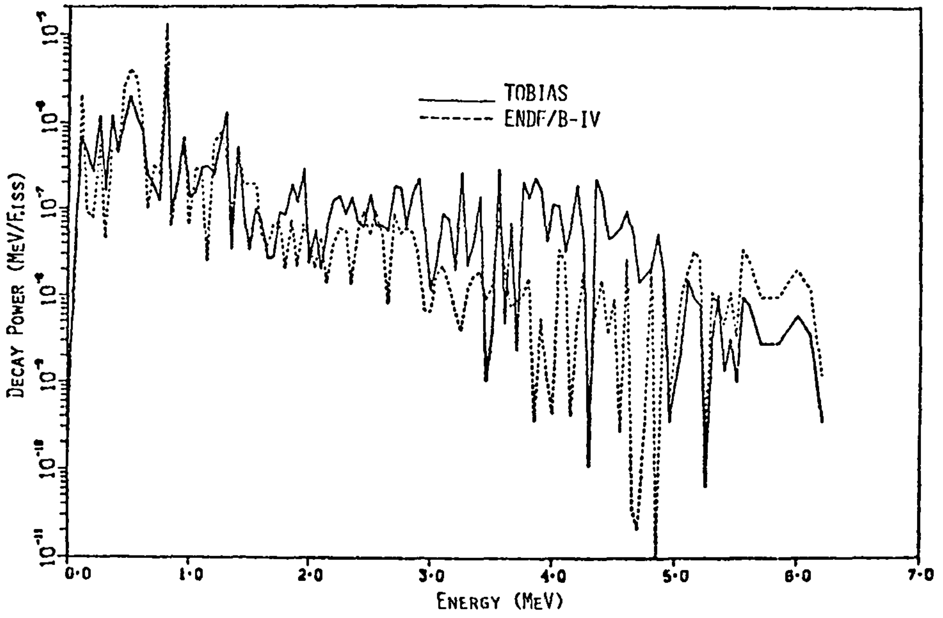

Fig. 24.
ENDF/B-IV gamma-spectra comparisons with UK Data File, all fission products, gammas (cooling time 0.1 s).

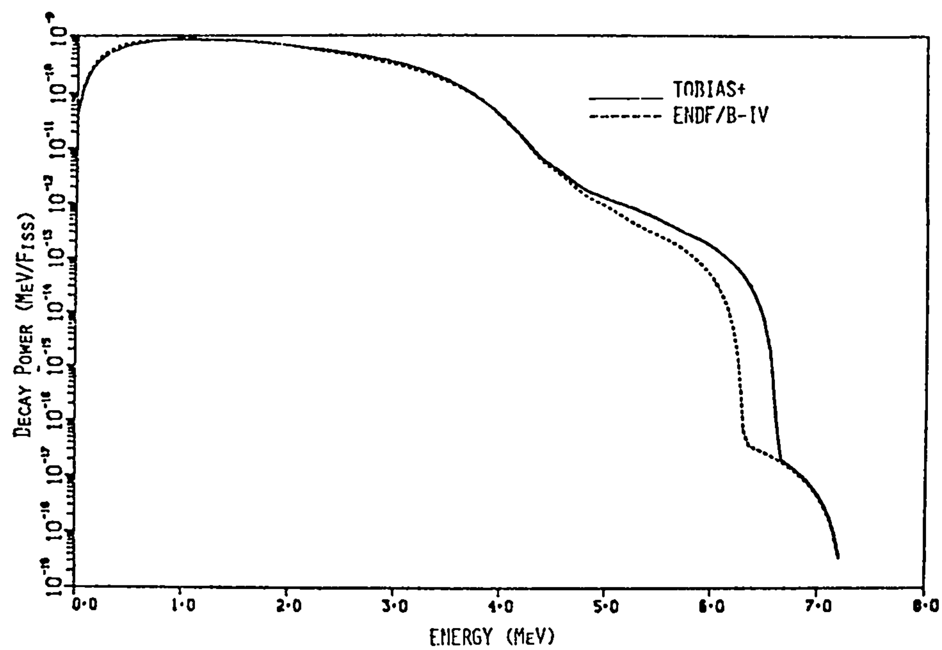

Fig. 25.
ENDF/B-IV beta-spectra comparison with UK Data File, all fission products, betas (cooling time 1000 s).

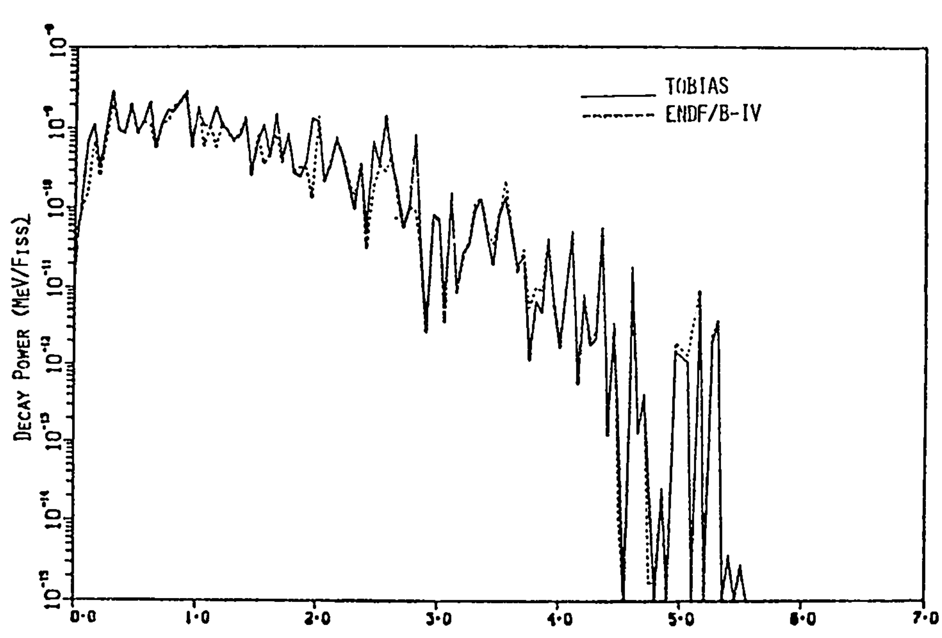

Fig. 26.
ENDF/B-IV gamma-spectra comparison with UK Data File, all fission products, gammas (cooling time 1000 s).

TABLE V

COMPARISON OF GROUP 4 PARAMETERS AFTER FIRST PASS WITH GROUP 4 PARAMETERS AFTER LAST PASS

Group 4 Parameters After First Pass		Group 4 Parameters After Last Pass	
α	λ	α	λ
3.912×10^{-2}	1.152	1.656×10^{-2}	1.297
-1.119×10^{-1}	5.760×10^{-1}	-2.081×10^{-2}	6.712×10^{-1}
1.408×10^{-1}	3.301×10^{-1}	2.335×10^{-2}	3.606×10^{-1}
-1.006×10^{-1}	1.329×10^{-1}	-9.164×10^{-3}	1.415×10^{-1}
6.292×10^{-2}	6.460×10^{-2}	9.333×10^{-3}	6.486×10^{-2}
-1.505×10^{-2}	2.611×10^{-2}		
6.710×10^{-3}	1.383×10^{-2}	2.427×10^{-3}	1.366×10^{-2}
4.864×10^{-4}	5.507×10^{-3}	5.633×10^{-4}	5.521×10^{-3}
5.344×10^{-5}	1.287×10^{-3}	5.195×10^{-5}	1.283×10^{-3}
4.883×10^{-5}	3.279×10^{-4}	4.965×10^{-5}	3.271×10^{-4}
2.318×10^{-6}	1.804×10^{-4}	1.624×10^{-6}	1.568×10^{-4}
7.550×10^{-6}	6.440×10^{-5}	7.552×10^{-6}	6.466×10^{-5}
6.540×10^{-7}	3.068×10^{-5}	6.660×10^{-7}	3.037×10^{-5}
-1.522×10^{-8}	1.722×10^{-6}	-1.297×10^{-8}	2.343×10^{-6}
1.141×10^{-7}	5.725×10^{-7}	8.819×10^{-9}	5.688×10^{-6}
5.353×10^{-7}	6.395×10^{-7}	1.596×10^{-7}	6.395×10^{-7}
-5.628×10^{-7}	6.215×10^{-7}	-8.615×10^{-8}	6.216×10^{-7}
-6.003×10^{-12}	1.127×10^{-7}	7.535×10^{11}	1.617×10^{-7}
6.433×10^{-12}	2.710×10^{-3}	5.539×10^{-12}	2.705×10^{-8}
-1.140×10^{-13}	1.903×10^{-8}	4.687×10^{-13}	2.437×10^{-8}
2.535×10^{-16}	4.419×10^{-10}	2.295×10^{-16}	3.424×10^{-10}

$H(t_s,T)$ is given by

$$H(t_s,T) = \int_0^T \frac{P(t')}{K} fc(T+t_s-t')dt' \qquad (MeV/s) \tag{3}$$

or

$$H(t_s,T) = \int_0^T \frac{P(t')}{K} \sum_{k=1}^{L} e^{-\lambda_k(T+t_s-t')}dt' \qquad (MeV/s) \quad . \tag{4}$$

Assume, for example, that the power history can be approximated by J histograms with a power of P_j at irradiation time T_j. Then,

$$H(t_s,T) = \sum_{j=1}^{J} \frac{P_j}{K} \sum_{k=1}^{L} \alpha_k \int_{T_{j-1}}^{T_j} e^{-\lambda_k(T+t_s-t')}dT \qquad (MeV/s) \tag{5}$$

or

$$H(t_s,T) = \sum_{j=1}^{L} \frac{P_j}{K} \sum_{k=1}^{L} \frac{\alpha_k}{\lambda_k} \left[e^{-\lambda_k(T+t_s-T_j)} - e^{-\lambda_k(T+t_s-T_{j-1})}\right] \qquad (MeV/s) \quad . \tag{6}$$

The above expressions, which are developed more generally in Appendix D, do not include the effects of neutron absorption by the fission products that become important for high flux levels and long cooling times (Figs. 27-29). There are two effects of absorption; namely, the flux level can reduce the density of directly yielded products in the fission pulse, significant for those nuclides having large cross sections and large yields; and nuclide coupling in stable and long-lived nuclides tends to build up the concentration of more unstable nuclides.

Positive effects are to be expected from shielded nuclides such as ^{134}Cs, ^{136}Cs, ^{148m}Pm, ^{148}Pm, and ^{154}Eu and, indeed, an examination of the CINDER-10 output of the problems illustrated in Figs. 27-29 reveals that the very large

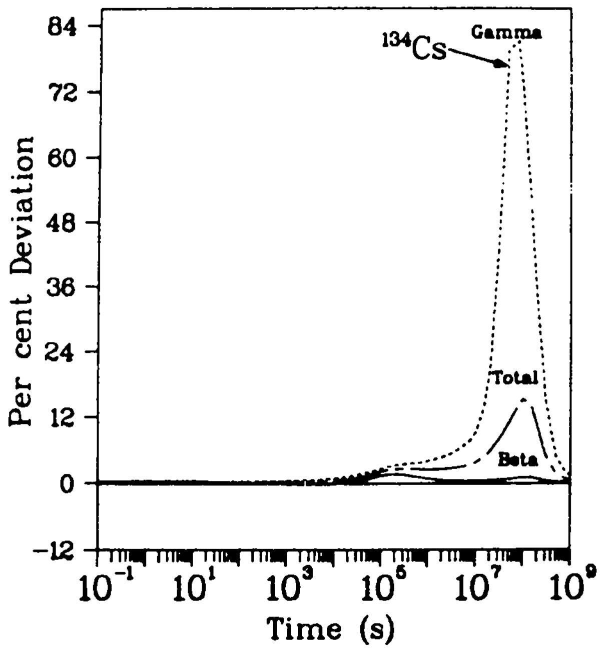

Fig. 27.
Per cent deviation of decay heating due to neutron absorption (^{235}U irradiation for 20 000 h, no depletion ($\phi = 10^{13}$).

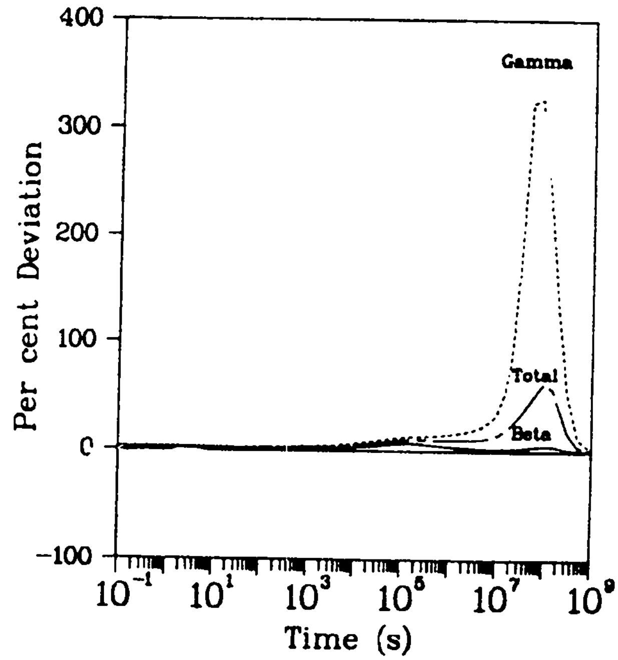

Fig. 28
Per cent deviation of decay heating due to neutron absorption (^{235}U irradiation for 20 000 h, no depletion ($\phi = 10^{14}$).

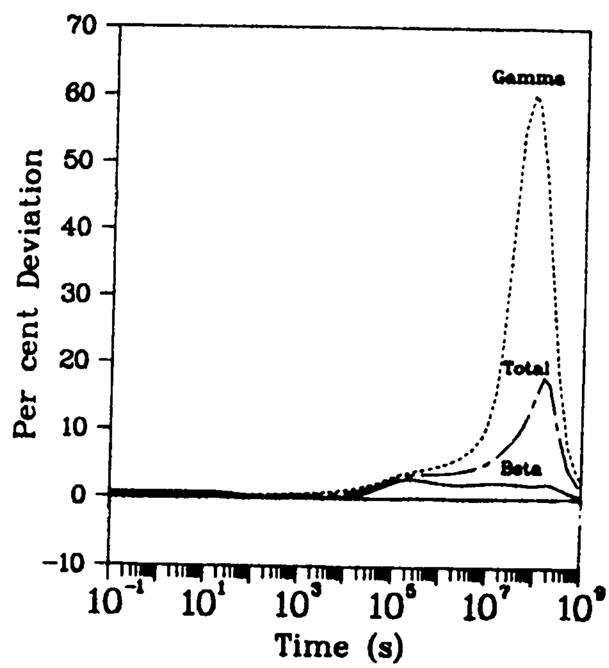

Fig. 29.
Per cent deviation of decay heating due to neutron absorption (^{239}Pu irradiation for 20 000 h, no depletion ($\phi = 10^{13}$).

effect at cooling times near 10^8 s is due to neutron absorption in the stable nuclide ^{133}Cs, which produces the shielded nuclide ^{134}Cs. Therefore, it is readily calculated by use of the simple two-nuclide chain ^{133}Cs(n,γ)^{134}Cs. Other reactions can be handled in a similar manner, and a list of the more important fission products contributing to absorption effects are given in Table VI. General equations are developed in Appendix D for approximating the effects of absorption with two-nuclide chains.

These equations for the computation of fission-product decay-energy spectra were incorporated into a code CALENDA (calculated decay energy spectra with absorption), which is useful for applying the fits to PEFPYD library data to obtain decay spectra after shutdown for reactor fuel irradiated for extended times at variable power. The present version of the code is limited to (a) a histogram representation of the power history, (b) expression of the neutron flux and cross-section data in two energy groups (fast and thermal), and (c) inclusion of the absorption effects of only those two-nuclide chains shown in Table VI flagged with an *.

In order to test the CALENDA code and, indeed, the practicability of applying the pulse fits to finite irradiation problems, calculations were made for a 20 000-h irradiation of ^{235}U fuel with thermal neutrons at constant fluxes of 10^4 n/cm^2/s (that is, negligible absorption) and 10^{14} n/cm^2/s. Fission product decay beta and gamma spectra were obtained in the 11-group structure for both cases, and these were compared with results obtained directly with the CINDER-10 code.

The parameters for the beta pulse fits used in the CALENDA calculation are those given in Appendix C. The fits for the beta spectra were to within 1% of the CINDER-10 pulse data for all groups except group 11, which was within 1.5%. The beta-spectra comparisons with CINDER-10 results for several groups, as well as the sum over all groups, are shown in Table VII for the 20 000-h irradiation at a constant flux of 10^4 n/cm^2/s (no absorption) case. Note in Table VII that, in general, agreement is remarkably good, even for cooling times less than 0.1 s, the minimum time for which the pulse was fit. Also note, however, the relatively large deviation for group 10 at 100 s. This is due to the fact that the PEFPYD data for the pulse is only given at two points in each cooling-time decade, and thus is insufficient for a more accurate description of the spectra.

To obtain parameters for the gamma fits for the ^{235}U thermal pulse, CINDER-10 data given at six points per decade are used as input to FITPULS. Although the

TABLE VI

FISSION PRODUCTS IMPORTANT IN DETERMINATION OF NEUTRON ABSORPTION EFFECTS ON DECAY POWER[a]

NUCLIDE	PRECURSOR(s)	COMMENTS
*^{90}Y	*^{89}Y,*^{90}Sr	
^{100}Tc	^{99}Tc	
^{104}Rh	^{103}Ru	
^{105}Rh	^{105}Ru	
^{116}In	^{115}In	Degree of importance (small) depends on uncertain branching fractions. Can be ignored based on ENDF/B-IV data.
^{130}I	^{129}I, ^{130m}I	
*^{134}Cs	*^{133}Cs	Very important at all shutdown times.
*^{135}Xe	*^{135}I	Major negative effect
^{136}Ca	^{135}Xe, ^{135}Cs	
*^{140}La	*^{140}Ba,*^{139}La	
^{142}Pr	^{141}Pr	
*^{144}Pr	*^{144}Ce,*^{143}Pr	
^{147}Nd	^{146}Nd	
^{148}Pm	^{147}Nd,*^{147}Pm	(n,γ) branching from ^{147}Pm 0.53.
*^{148m}Pm	^{147}Nd,*^{147}Pm	(n,γ) branching from ^{147}Pm 0.47.
^{149}Pm	^{147}Nd, ^{147}Pm, ^{148}Pm, ^{148m}Pm	
*^{150}Pm	^{147}Nd, ^{147}Pm, ^{148}Pm, ^{148m}Pm,*^{149}Pm	
^{151}Sm	^{150}Sm	
*^{153}Sm	*^{152}Sm	
^{154}Eu	^{153}Eu	
^{156}Eu	^{155}Eu	

[a] Only the listed presursors must be considered in determination of the neutron absorption effect, but cross sections must be included for all nuclides.

*Nuclides included in two-nuclide chains in CALENDA code as of June 1978.

TABLE VII

BETA ENERGY RELEASED FROM FISSION-PRODUCT DECAY AFTER
20 000 h THERMAL IRRADIATION OF ^{235}U
(% difference between CINDER-10 and approximate method calculations)

Flux = $10^4 n/cm^2$-s

Cooling Time(s)	Group 2 0.4-0.9 MeV	Group 4 1.35-1.8 MeV	Group 6 2.2-2.6 MeV	Group 8 3.0-4.0 MeV	Group 10 5.0-6.0 MeV	Total All Groups
1.0E-04	1.2	1.2	1.8	1.7	2.8	1.4
1.0E-01	1.2	1.1	1.6	1.5	2.5	1.3
1.0E+00	1.2	1.1	1.5	1.5	2.4	1.2
1.0E+01	1.4	1.1	1.5	1.3	3.5	1.2
1.0E+02	1.8	1.7	0.8	2.5	11.5	1.6
1.0E+03	2.1	1.7	0.9	3.6	4.1	1.7
1.0E+04	1.9	1.8	0.6	0.8	1.2	1.3
1.0E+05	2.2	1.5	1.6	- 0.3	0.5	1.5
1.0E+06	2.9	0.0	- 0.1	- 0.3	0.6	1.1
1.0E+07	2.7	0.0	0.1	0.0	3.1	0.2
1.0E+08	- 6.9	- 2.1	0.5	1.1	---	- 4.1
1.0E+09	- 0.7	0.4	0.5	3.5	---	- 0.1

fits could not be made as accurate as for the beta spectra fitted at two points per decade as shown in Table VIII, the comparison with CINDER-10 for the 20 000-h irradiation at $\phi = 10^4$ n/cm^2/s case is much better, as can be seen in Table IX. In general, the deviation is less than that for the pulse fit for a particular cooling time.

Comparison results for the case with a flux of 10^{14} n/cm^2/s, a case for which the effects of neutron absorption are very significant, are shown in Table X for the beta spectra and Table XI for the gamma spectra. As noted previously, only the "two-chain" reactions flagged with an * in Table VI were included in the CALENDA calculation. Note, however, from the total sum over the energy groups that most of the important absorption effects have been included for both the beta and gamma totals.

Some rather marked deviations of the approximate spectra from the CINDER-10 calculations can be seen for the individual beta and gamma spectra. For example, group 10 at 10^7 s, may indicate an inconsistency in the way missing spectra were constructed, but note that these large percentage differences are due to differences between very small numbers that contribute little to the total. Also note significant differences in some of the other groups for several cooling times, indicating a need for including additional two-nuclide chains.

It is interesting to compare spectral absorption effects graphically, that is, as a per cent deviation from the case without absorption, as was done in

TABLE VIII

MAXIMUM PER CENT GAMMAS DIFFERENCE

Group No.	Pulse: Maximum % Dev	Pulse: Cooling Time	20 000-h Irr (10^4 flux): Maximum % Dev	20 000-h Irr (10^4 flux): Cooling Time
1	3.8	4.0+7	-2.0	1.0+7
2	3.8	3.0+7	2.0	1.0+7
3	8.8	4.0+7	-1.8	1.0+7
4	13.5	2.0+5	3.1	5.0+5
5	2.1	1.0+9	-3.5	1.0+7
6	4.3	2.0+7	2.4	5.0+7
7	12.6	1.5+5	3.5	5.0+5
8	6.0	1.5+5	2.2	1.0+7
9	-2.1	1.0+7	3.6	1.0+7
10	-2.4	4.0+5	1.3	1.0+3
11	4.7	2.0+2	3.2	5.0+2

TABLE IX

GAMMA ENERGY RELEASED FROM FISSION PRODUCT DECAY AFTER
20 000-h THERMAL IRRADIATION OF ^{235}U
(% difference between CINDER-10 and approximate method calculations)

Flux = $10^4 n/cm^2$-s

Cooling Time(s)	Group 2 0.4-0.9 MeV	Group 4 1.35-1.8 MeV	Group 6 2.2-2.6 MeV	Group 8 3.0-4.0 MeV	Group 10 5.0-6.0 MeV	Total All Groups
1.0E-04	- 0.1	0.1	0.2	0.4	0.3	0.1
1.0E-01	- 0.1	0.1	0.2	0.4	0.3	0.1
1.0E+00	- 0.2	0.1	0.2	0.4	0.4	0.1
1.0E+01	- 0.3	0.2	0.2	0.5	0.6	0.1
1.0E+02	- 0.3	0.2	0.3	0.7	0.9	0.1
1.0E+03	- 0.2	0.4	0.5	0.9	1.3	0.1
1.0E+04	0.0	0.9	0.8	1.4	- 0.6	0.2
1.0E+05	0.4	1.7	- 0.5	0.3	0.4	0.5
1.0E+06	0.6	2.3	- 1.9	- 0.8	- 0.7	0.9
1.0E+07	2.0	- 1.3	1.1	2.2	1.1	1.8
1.0E+08	- 0.6	- 0.4	1.4	- 0.4	---	- 0.6
1.0E+09	- 0.3	1.7	0.6	0.5	---	- 0.3

TABLE X

BETA ENERGY RELEASED FROM FISSION PRODUCT DECAY AFTER 20 000 h THERMAL IRRADIATION OF ^{235}U
(% difference between CINDER-10 and approximate method calculations)

Flux = 10^{14}n/cm^2-s

Cooling Time(s)	Group 2 0.4-0.9 MeV	Group 4 1.35-1.8 MeV	Group 6 2.2-2.6 MeV	Group 8 3.0-4.0 MeV	Group 10 5.0-6.0 MeV	Total All Groups
1.0E-04	4.5	3.8	3.2	2.9	3.4	3.4
1.0E-01	4.5	3.7	3.0	2.7	3.0	3.3
1.0E+00	4.5	3.7	2.9	2.8	3.1	3.3
1.0E+01	4.7	3.7	3.0	2.7	4.7	3.4
1.0E+02	4.5	2.9	1.2	2.8	13.1	3.0
1.0E+03	5.3	3.0	1.4	4.3	4.7	3.7
1.0E+04	6.5	4.4	1.6	1.1	1.5	4.7
1.0E+05	7.6	7.5	3.7	4.9	4.8	6.3
1.0E+06	5.1	5.1	0.9	- 0.1	0.7	3.7
1.0E+07	3.3	0.7	0.6	0.1	318.3	0.9
1.0E+08	- 5.1	- 1.4	0.8	0.8	---	- 2.6
1.0E+09	0.2	0.7	0.7	5.6	---	0.1

TABLE XI

GAMMA ENERGY RELEASED FROM FISSION PRODUCT DECAY AFTER 20 000 h THERMAL IRRADIATION OF ^{235}U
(% difference between CINDER-10 and approximate method calculations)

Flux = 10^{14}n/cm^2-s

Cooling Time(s)	Group 2 0.4-0.9 MeV	Group 4 1.35-1.8 MeV	Group 6 2.2-2.6 MeV	Group 8 3.0-4.0 MeV	Group 10 5.0-6.0 MeV	Total All Groups
1.0E-04	0.6	0.6	0.4	0.5	0.4	0.9
1.0E-01	0.6	0.6	0.4	0.5	0.4	0.9
1.0E+00	0.7	0.7	0.5	0.5	0.5	1.0
1.0E+01	0.8	0.8	0.5	0.6	0.6	1.1
1.0E+02	1.0	1.0	0.6	0.7	0.9	1.5
1.0E+03	1.3	1.4	1.0	1.0	3.4	2.1
1.0E+04	1.5	2.5	2.1	1.7	56.4	3.1
1.0E+05	1.2	3.6	5.5	4.7	60.1	3.7
1.0E+06	2.1	3.0	4.0	2.5	84.1	6.1
1.0E+07	1.0	- 2.3	13.3	10.0	1161.4	1.0
1.0E+08	- 0.6	- 2.8	- 7.2	- 8.7	---	- 0.8
1.0E+09	2.0	17.1	0.4	0.1	---	2.0

Figs. 27-29. The comparisons for groups 1 and 2 of the beta spectra are shown in Figs. 30 and 31; and groups 1, 2, 4, 5, of the gamma spectra are shown in Figs. 32-35, respectively. Figure 36 shows the comparison for the total beta release summed over all groups, and, finally, Fig. 37 gives the same for the gammas. In all figures, the solid curve is the approximate CALENDA calculation and the open circles are from CINDER-10. The large peaks at about 10^8 s cooling time occurring in beta groups 1 and 2 and in gamma group 2 are due to the $^{133}Cs(n,\gamma)^{134}Cs$ reaction. The very large peaks in gamma groups 3 and 4 are also due to this reaction, but the large percentage differences seen are again due to differences in small numbers, as practically all of the gamma energy is contained in group 2. This is evident from Fig. 37, which shows that the sum over all the groups in this cooling-time domain is about the same as for group 2. Figure 32 for group 1 gammas shows the negative effects of the ^{135}Xe.

A large deviation of about 400% near a cooling time of 10^6 s is seen in group 5 (Fig. 35) for the CINDER-10 calculation that is not accounted for in the approximate method. The precursor of the missing reaction would probably have a half-life of about 1.5×10^6 s, and the product nuclide would emit relatively strong gammas in the energy region from 1.8 to 2.2 MeV. As indicated by the other figures, additional reactions could be included to increase the accuracy of the approximate method.

VI. SUMMARY

The results of the pulse calculations (10^{-4} s irradiation time) from the CINDER-10 code have been collected and organized into a library of aggregate fission-product release-energy spectra on a fine multigroup energy mesh. These data are given for cooling times from 10^{-4} to 10^{13} s at two steps per time decade. This library of processed ENDF/B-IV fission product yield and decay data (PEFPYD) contains spectral data for all ten yield sets given in ENDF/B-IV and is organized in an ENDF-like format. The library can be obtained from the National Nuclear Data Center (NNDC) at Brookhaven National Library (BNL).

A method has been developed for using the PEFPYD data in approximate calculations of fission-product decay-energy spectra resulting from nuclear fuels irradiated for a finite time. The pulse data is first collapsed to a coarse-group structure and the decay-energy vs cooling-time data points of the resulting broad groups are fit with a sum of exponentials. This is done with the FITPULS code, which contains a nonlinear least-squares routine for making the fits.

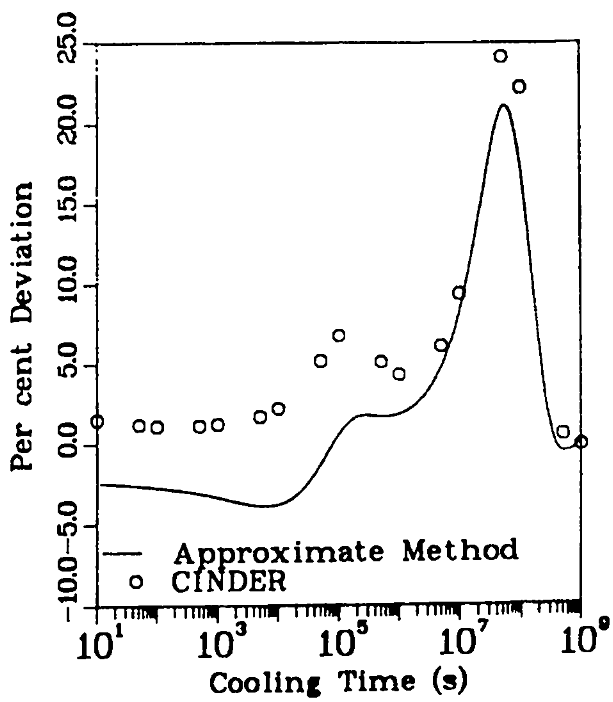

Fig. 30.
Per cent deviation due to absorption for group 1 betas.

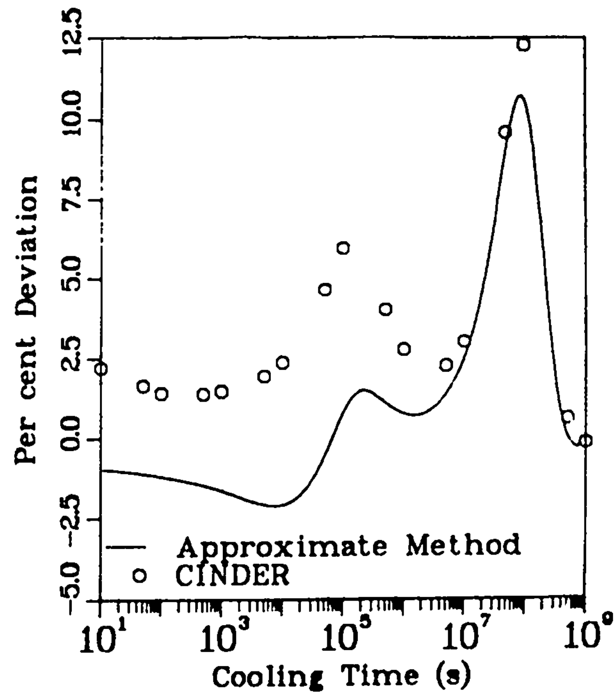

Fig. 31.
Per cent deviation due to absorption for group 2 betas.

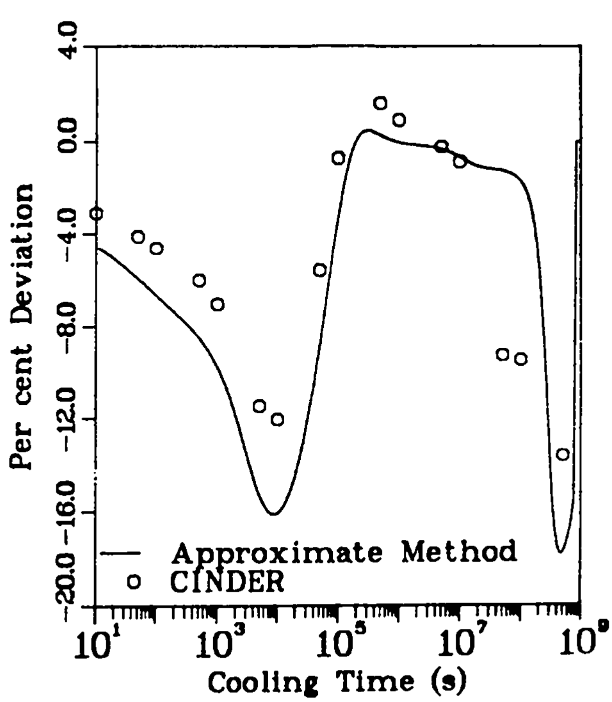

Fig. 32.
Per cent deviation due to absorption for group 1 gammas.

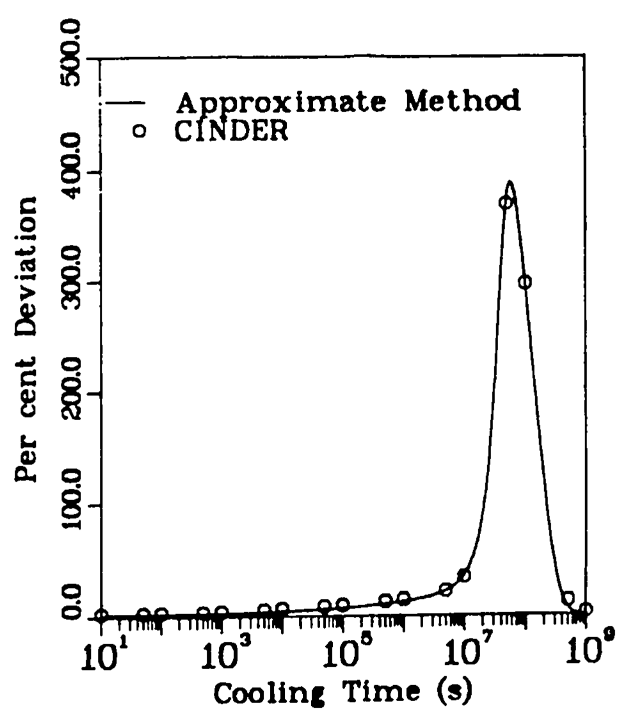

Fig. 33.
Per cent deviation due to absorption for group 2 gammas.

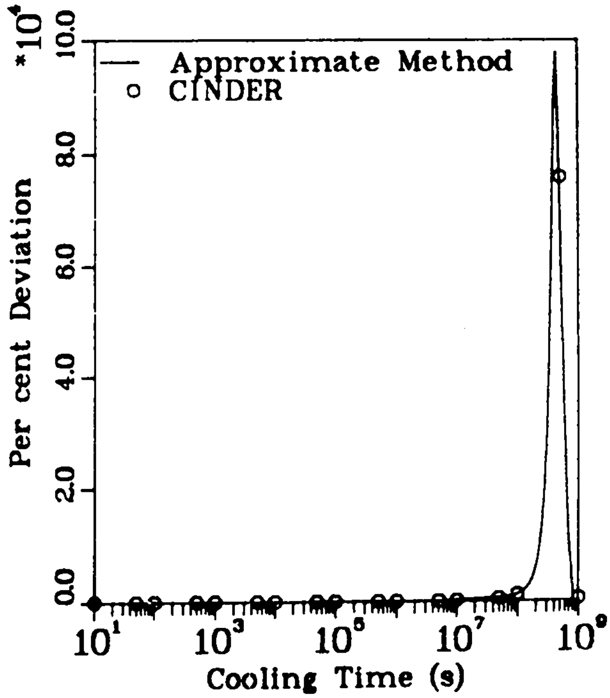

Fig. 34.
Per cent deviation due to absorption for group 4 gammas.

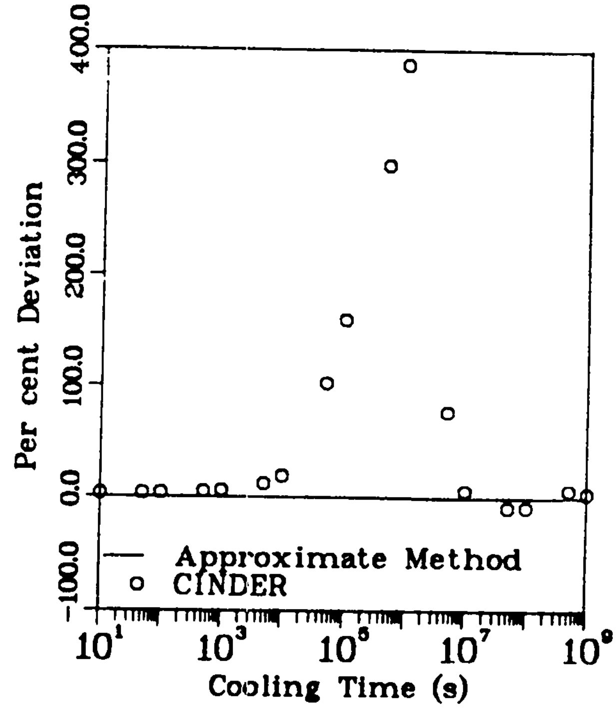

Fig. 35.
Per cent deviation due to absorption for group 5 gammas.

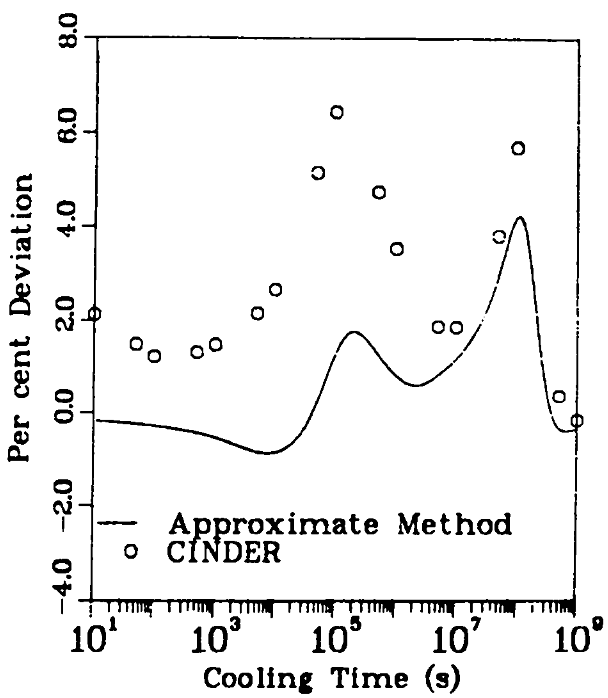

Fig. 36.
Per cent deviation due to absorption, total betas.

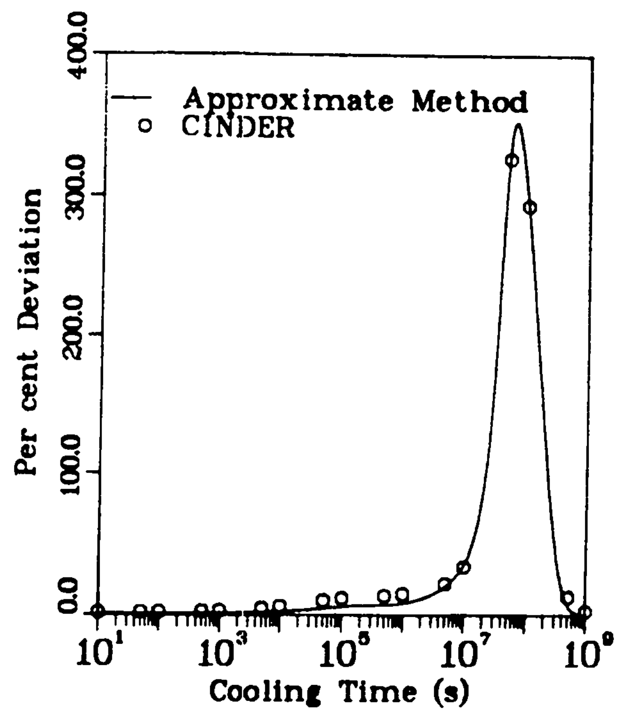

Fig. 37.
Per cent deviation due to absorption, total gammas.

It is also worth noticing that FITPULS has the option of reducing data for a finite irradiation time to a pulse. This option, which is not discussed in this report, is useful for comparing different experiments run with different irradiation times.

Finally, broad-group spectra for finite irradiation times can be generated by simply folding the irradiation time into the analytic fits for the pulse spectra. This is done using the CALENDA code, which also has an option for including the effects of neutron absorption by approximating the more important reactions with two-nuclide chains. Given the fits for the pulse groups, the CALENDA calculation is very rapid, and thus the method provides an inexpensive way of calculating fission-product decay-energy spectra for a variety of problems. Such a set of useful pulse fits are provided in this report.

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APPENDIX A

SAMPLE PEFPYD-LIB LISTING

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         0          0          0          0          0             01260 1451     2
         0          0          0          0          6            131260 1451     3
92 U 233 LASL PROCESSED MARCH 78, R.J. LABAUVE, D.C. GEORGE             1260 1451     4
THERMAL BURST                                                           1260 1451     5
                                                                        1260 1451     6
U-233  FISSION PRODUCT DECAY SPECTRA PROCESSED FROM ENDF/B-IV           1260 1451     7
IN 150 ENERGY GROUPS                                                    1260 1451     8
                                                                        1260 1451     9
                               1        451         22                  1260 1451    10
                              80        801       1202                  1260 1451    11
                              80        802       1208                  1260 1451    12
                              80        803       1029                  1260 1451    13
                              80        811        866                  1260 1451    14
                              80        812        858                  1260 1451    15
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                              80        821        793                  1260 1451    17
                              80        822        725                  1260 1451    18
                              80        823        705                  1260 1451    19
                              80        831        816                  1260 1451    20
                              80        832        817                  1260 1451    21
                              80        833        711                  1260 1451    22
                                                                        1260 1  0    23
                                                                        1260 0  0    24
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        24          0          0          0          0             0126080801    27
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       151          1          0          0          0             0126080801    29
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1.50000- 1 1.29132- 7 2.00000- 1 2.00277- 7 2.50000- 1 5.24900- 7126080801    31
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5.55000+	0	1.53411-	7	5.60000+	0	1.37958-	7	5.65000+	0	8.42893-	8126080801	67
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1.50000+	0	7.59974-	7	1.55000+	0	6.81608-	7	1.60000+	0	5.94550-	7126080801	93
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3.00000+	0	5.81519-	7	3.05000+	0	5.75780-	7	3.10000+	0	5.81924-	7126080801	103
3.15000+	0	5.46665-	7	3.20000+	0	5.19562-	7	3.25000+	0	5.02102-	7126080801	104
3.30000+	0	5.01930-	7	3.35000+	0	5.08229-	7	3.40000+	0	4.90539-	7126080801	105
3.45000+	0	4.45334-	7	3.50000+	0	4.53535-	7	3.55000+	0	6.06356-	7126080801	106
3.60000+	0	4.45248-	7	3.65000+	0	3.88778-	7	3.70000+	0	3.85434-	7126080801	107
3.75000+	0	3.66869-	7	3.80000+	0	3.72868-	7	3.85000+	0	3.19040-	7126080801	108
3.90000+	0	3.14778-	7	3.95000+	0	2.94852-	7	4.00000+	0	2.78479-	7126080801	109
4.05000+	0	3.57605-	7	4.10000+	0	3.41649-	7	4.15000+	0	2.39684-	7126080801	110
4.20000+	0	2.34814-	7	4.25000+	0	2.65876-	7	4.30000+	0	2.05854-	7126080801	111
4.35000+	0	2.24058-	7	4.40000+	0	2.08020-	7	4.45000+	0	1.85383-	7126080801	112
4.50000+	0	1.77894-	7	4.55000+	0	1.58358-	7	4.60000+	0	2.01107-	7126080801	113
4.65000+	0	1.44771-	7	4.70000+	0	1.37300-	7	4.75000+	0	1.35261-	7126080801	114
4.80000+	0	1.72003-	7	4.85000+	0	1.27719-	7	4.90000+	0	1.46036-	7126080801	115
4.95000+	0	1.22569-	7	5.00000+	0	1.17626-	7	5.05000+	0	1.32343-	7126080801	116
5.10000+	0	1.10689-	7	5.15000+	0	1.63524-	7	5.20000+	0	1.49543-	7126080801	117
5.25000+	0	1.01508-	7	5.30000+	0	1.16525-	7	5.35000+	0	1.06498-	7126080801	118
5.40000+	0	1.02971-	7	5.45000+	0	1.05369-	7	5.50000+	0	9.30944-	8126080801	119
5.55000+	0	1.36378-	7	5.60000+	0	1.22646-	7	5.65000+	0	7.49731-	8126080801	120
5.70000+	0	8.80978-	8	5.75000+	0	6.93523-	8	5.80000+	0	6.66790-	8126080801	121
5.85000+	0	8.04595-	8	5.90000+	0	8.35016-	8	5.95000+	0	5.92657-	8126080801	122
6.00000+	0	9.04858-	8	6.05000+	0	5.47146-	8	6.10000+	0	7.27049-	8126080801	123
6.15000+	0	5.01629-	8	6.20000+	0	5.11212-	8	6.25000+	0	4.55597-	8126080801	124
6.30000+	0	4.32583-	8	6.35000+	0	4.09564-	8	6.40000+	0	3.86528-	8126080801	125
6.45000+	0	3.63701-	8	6.50000+	0	3.40807-	8	6.55000+	0	3.18309-	8126080801	126
6.60000+	0	2.96220-	8	6.65000+	0	2.74348-	8	6.70000+	0	2.52832-	8126080801	127
6.75000+	0	2.31802-	8	6.80000+	0	2.11409-	8	6.85000+	0	1.91540-	8126080801	128
6.90000+	0	1.72328-	8	6.95000+	0	1.53840-	8	7.00000+	0	1.36197-	8126080801	129
7.05000+	0	1.19424-	8	7.10000+	0	1.03587-	8	7.15000+	0	8.88554-	9126080801	130
7.20000+	0	7.52336-	9	7.25000+	0	6.28258-	9	7.30000+	0	5.17476-	9126080801	131
7.35000+	0	4.20781-	9	7.40000+	0	3.38746-	9	7.45000+	0	2.72853-	9126080801	132

7.50000+	0	0.00000+	0	0.00000+	0	0.00000+	0	0.00000+	0	0.00000+	0126080801	133
0.		5.00000E-01			0		0		1		151126080801	134
151		1			0		0		0		0126080801	135
0.00000+	0	2.63077-	9	5.00000-	2	2.47022-	8	1.00000-	1	7.81174-	7126080801	136
1.50000-	1	9.11359-	8	2.00000-	1	1.42424-	7	2.50000-	1	3.71510-	7126080801	137
3.00000-	1	9.83881-	8	3.50000-	1	3.62260-	7	4.00000-	1	2.78953-	7126080801	138
4.50000-	1	1.02792-	6	5.00000-	1	1.93354-	6	5.50000-	1	1.29272-	6126080801	139
6.00000-	1	7.12655-	7	6.50000-	1	2.05551-	7	7.00000-	1	3.49458-	7126080801	140
7.50000-	1	2.79559-	7	8.00000-	1	4.18924-	6	8.50000-	1	2.53794-	7126080801	141
9.00000-	1	3.23443-	7	9.50000-	1	4.92605-	7	1.00000+	0	2.89703-	7126080801	142
1.05000+	0	3.98011-	7	1.10000+	0	8.02091-	7	1.15000+	0	2.86120-	7126080801	143
1.20000+	0	8.08981-	7	1.25000+	0	6.51911-	7	1.30000+	0	7.26538-	7126080801	144
1.35000+	0	4.03648-	7	1.40000+	0	9.75694-	7	1.45000+	0	5.04917-	7126080801	145
1.50000+	0	5.66813-	7	1.55000+	0	5.02920-	7	1.60000+	0	4.35995-	7126080801	146
1.65000+	0	4.40911-	7	1.70000+	0	4.60458-	7	1.75000+	0	5.34549-	7126080801	147
1.80000+	0	4.39172-	7	1.85000+	0	4.93761-	7	1.90000+	0	4.54248-	7126080801	148
1.95000+	0	5.38394-	7	2.00000+	0	4.92727-	7	2.05000+	0	4.61637-	7126080801	149
2.10000+	0	5.07979-	7	2.15000+	0	4.63642-	7	2.20000+	0	4.92530-	7126080801	150
2.25000+	0	5.10027-	7	2.30000+	0	5.23134-	7	2.35000+	0	4.74446-	7126080801	151
2.40000+	0	5.13710-	7	2.45000+	0	6.32814-	7	2.50000+	0	5.15984-	7126080801	152
2.55000+	0	6.51948-	7	2.60000+	0	5.09995-	7	2.65000+	0	4.53874-	7126080801	153
2.70000+	0	6.09057-	7	2.75000+	0	5.17803-	7	2.80000+	0	4.90420-	7126080801	154
2.85000+	0	5.06331-	7	2.90000+	0	4.60818-	7	2.95000+	0	4.05879-	7126080801	155
3.00000+	0	4.03010-	7	3.05000+	0	3.97749-	7	3.10000+	0	4.03107-	7126080801	156
3.15000+	0	3.74443-	7	3.20000+	0	3.57603-	7	3.25000+	0	3.44476-	7126080801	157
3.30000+	0	3.46412-	7	3.35000+	0	3.55180-	7	3.40000+	0	3.41514-	7126080801	158
3.45000+	0	3.05710-	7	3.50000+	0	3.14559-	7	3.55000+	0	4.45890-	7126080801	159
3.60000+	0	3.12349-	7	3.65000+	0	2.65416-	7	3.70000+	0	2.66305-	7126080801	160
3.75000+	0	2.53515-	7	3.80000+	0	2.60270-	7	3.85000+	0	2.18023-	7126080801	161
3.90000+	0	2.15051-	7	3.95000+	0	2.02274-	7	4.00000+	0	1.90847-	7126080801	162
4.05000+	0	2.59938-	7	4.10000+	0	2.48693-	7	4.15000+	0	1.65216-	7126080801	163
4.20000+	0	1.62644-	7	4.25000+	0	1.91800-	7	4.30000+	0	1.43424-	7126080801	164
4.35000+	0	1.02265-	7	4.40000+	0	1.40022-	7	4.45000+	0	1.31976-	7126080801	165
4.50000+	0	1.27368-	7	4.55000+	0	1.12258-	7	4.60000+	0	1.44314-	7126080801	166
4.65000+	0	1.03180-	7	4.70000+	0	9.94552-	8	4.75000+	0	9.66990-	8126080801	167
4.80000+	0	1.22519-	7	4.85000+	0	9.13387-	8	4.90000+	0	1.04040-	7126080801	168
4.95000+	0	8.76978-	8	5.00000+	0	8.39033-	8	5.05000+	0	9.43336-	8126080801	169
5.10000+	0	7.89059-	8	5.15000+	0	1.16959-	7	5.20000+	0	1.06166-	7126080801	170
5.25000+	0	7.25074-	8	5.30000+	0	8.31927-	8	5.35000+	0	7.57192-	8126080801	171
5.40000+	0	7.51120-	8	5.45000+	0	7.48414-	8	5.50000+	0	6.75483-	8126080801	172
5.55000+	0	9.66006-	8	5.60000+	0	8.68936-	8	5.65000+	0	5.32864-	8126080801	173
5.70000+	0	6.24912-	8	5.75000+	0	4.92499-	8	5.80000+	0	4.73248-	8126080801	174
5.85000+	0	5.69817-	8	5.90000+	0	5.90706-	8	5.95000+	0	4.19484-	8126080801	175
6.00000+	0	5.38761-	8	6.05000+	0	3.86347-	8	6.10000+	0	5.12524-	8126080801	176
6.15000+	0	3.53311-	8	6.20000+	0	3.64562-	8	6.25000+	0	3.19966-	8126080801	177
6.30000+	0	3.03333-	8	6.35000+	0	2.86708-	8	6.40000+	0	2.70078-	8126080801	178
6.45000+	0	2.53607-	8	6.50000+	0	2.37110-	8	6.55000+	0	2.20914-	8126080801	179
6.60000+	0	2.05022-	8	6.65000+	0	1.89296-	8	6.70000+	0	1.73852-	8126080801	180
6.75000+	0	1.58779-	8	6.80000+	0	1.44168-	8	6.85000+	0	1.29962-	8126080801	181
6.90000+	0	1.16249-	8	6.95000+	0	1.03078-	8	7.00000+	0	9.05254-	9126080801	182
7.05000+	0	7.86258-	9	7.10000+	0	6.74297-	9	7.15000+	0	5.70479-	9126080801	183
7.20000+	0	4.74928-	9	7.25000+	0	3.88349-	9	7.30000+	0	3.11546-	9126080801	184
7.35000+	0	2.45098-	9	7.40000+	0	1.89511-	9	7.45000+	0	1.45745-	9126080801	185
7.50000+	0	0.00000+	0	0.00000+	0	0.00000+	0	0.00000+	0	0.00000+	0126080801	186
0.		1.0000E+00			0		0		1		151126080801	187
151		1			0		0		0		0126080801	188
0.00000+	0	2.26492-	9	5.00000-	2	2.15502-	8	1.00000-	1	4.84493-	7126080801	189
1.50000-	1	7.56973-	8	2.00000-	1	1.18797-	7	2.50000-	1	3.05972-	7126080801	190
3.00000-	1	7.99345-	8	3.50000-	1	2.97594-	7	4.00000-	1	2.12042-	7126080801	191
4.50000-	1	7.47052-	7	5.00000-	1	1.46985-	6	5.50000-	1	9.40471-	7126080801	192
6.00000-	1	5.83778-	7	6.50000-	1	1.64459-	7	7.00000-	1	2.86716-	7126080801	193
7.50000-	1	2.28526-	7	8.00000-	1	2.49908-	6	8.50000-	1	2.02954-	7126080801	194
9.00000-	1	2.65891-	7	9.50000-	1	4.00354-	7	1.00000+	0	2.29798-	7126080801	195
1.05000+	0	3.21108-	7	1.10000+	0	6.53587-	7	1.15000+	0	2.28254-	7126080801	196
1.20000+	0	5.73030-	7	1.25000+	0	5.17760-	7	1.30000+	0	5.97338-	7126080801	197
1.35000+	0	3.16793-	7	1.40000+	0	8.11975-	7	1.45000+	0	4.05593-	7126080801	198
1.50000+	0	4.55505-	7	1.55000+	0	4.00287-	7	1.60000+	0	3.45367-	7126080801	199
1.65000+	0	3.46689-	7	1.70000+	0	3.60276-	7	1.75000+	0	4.22214-	7126080801	200
1.80000+	0	3.41701-	7	1.85000+	0	3.84276-	7	1.90000+	0	3.52331-	7126080801	201

1.95000+ 0	4.23325- 7	2.00000+ 0	3.81795- 7	2.05000+ 0	3.53866- 7	126080801	202
2.10000+ 0	3.93804- 7	2.15000+ 0	3.55441- 7	2.20000+ 0	3.79168- 7	126080801	203
2.25000+ 0	3.93734- 7	2.30000+ 0	4.04943- 7	2.35000+ 0	3.61324- 7	126080801	204
2.40000+ 0	3.93488- 7	2.45000+ 0	4.81048- 7	2.50000+ 0	3.97479- 7	126080801	205
2.55000+ 0	5.15620- 7	2.60000+ 0	3.91242- 7	2.65000+ 0	3.42648- 7	126080801	206
2.70000+ 0	4.64253- 7	2.75000+ 0	3.97334- 7	2.80000+ 0	3.68800- 7	126080801	207
2.85000+ 0	3.89169- 7	2.90000+ 0	3.49909- 7	2.95000+ 0	3.03171- 7	126080801	208
3.00000+ 0	3.01567- 7	3.05000+ 0	2.96855- 7	3.10000+ 0	3.01729- 7	126080801	209
3.15000+ 0	2.77193- 7	3.20000+ 0	2.65702- 7	3.25000+ 0	2.55193- 7	126080801	210
3.30000+ 0	2.58275- 7	3.35000+ 0	2.68215- 7	3.40000+ 0	2.56780- 7	126080801	211
3.45000+ 0	2.26613- 7	3.50000+ 0	2.35814- 7	3.55000+ 0	3.53606- 7	126080801	212
3.60000+ 0	2.30872- 7	3.65000+ 0	1.95900- 7	3.70000+ 0	1.99009- 7	126080801	213
3.75000+ 0	1.89504- 7	3.80000+ 0	1.96659- 7	3.85000+ 0	1.61249- 7	126080801	214
3.90000+ 0	1.60147- 7	3.95000+ 0	1.50372- 7	4.00000+ 0	1.41816- 7	126080801	215
4.05000+ 0	2.04587- 7	4.10000+ 0	1.96194- 7	4.15000+ 0	1.23773- 7	126080801	216
4.20000+ 0	1.22564- 7	4.25000+ 0	1.50287- 7	4.30000+ 0	1.08897- 7	126080801	217
4.35000+ 0	1.27949- 7	4.40000+ 0	1.11911- 7	4.45000+ 0	1.02566- 7	126080801	218
4.50000+ 0	9.65953- 8	4.55000+ 0	8.71000- 8	4.60000+ 0	1.13265- 7	126080801	219
4.65000+ 0	8.05929- 8	4.70000+ 0	7.78551- 8	4.75000+ 0	7.58134- 8	126080801	220
4.80000+ 0	9.56352- 8	4.85000+ 0	7.15442- 8	4.90000+ 0	8.12660- 8	126080801	221
4.95000+ 0	6.88224- 8	5.00000+ 0	6.56673- 8	5.05000+ 0	7.37341- 8	126080801	222
5.10000+ 0	6.17259- 8	5.15000+ 0	9.16173- 8	5.20000+ 0	8.26073- 8	126080801	223
5.25000+ 0	5.68298- 8	5.30000+ 0	6.51236- 8	5.35000+ 0	5.90620- 8	126080801	224
5.40000+ 0	5.99468- 8	5.45000+ 0	5.83105- 8	5.50000+ 0	5.36706- 8	126080801	225
5.55000+ 0	7.47781- 8	5.60000+ 0	6.74761- 8	5.65000+ 0	4.15881- 8	126080801	226
5.70000+ 0	4.86349- 8	5.75000+ 0	3.84118- 8	5.80000+ 0	3.68935- 8	126080801	227
5.85000+ 0	4.42823- 8	5.90000+ 0	4.58454- 8	5.95000+ 0	3.26280- 8	126080801	228
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6.45000+ 0	1.94814- 8	6.50000+ 0	1.81798- 8	6.55000+ 0	1.69027- 8	126080801	232
6.60000+ 0	1.56604- 8	6.65000+ 0	1.44118- 8	6.70000+ 0	1.31969- 8	126080801	233
6.75000+ 0	1.20126- 8	6.80000+ 0	1.08651- 8	6.85000+ 0	9.75117- 9	126080801	234
6.90000+ 0	8.67737- 9	6.95000+ 0	7.64753- 9	7.00000+ 0	6.66728- 9	126080801	235
7.05000+ 0	5.74013- 9	7.10000+ 0	4.87027- 9	7.15000+ 0	4.06578- 9	126080801	236
7.20000+ 0	3.32824- 9	7.25000+ 0	2.66288- 9	7.30000+ 0	2.07576- 9	126080801	237
7.35000+ 0	1.57180- 9	7.40000+ 0	1.15524- 9	7.45000+ 0	8.33118-10	126080801	238
7.50000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	126080801	239
0.	5.0000E+00	0	0	1	151	126080801	240
151	1	0	0	0	0	126080801	241
0.00000+ 0	1.46296- 9	5.00000- 2	1.38114- 8	1.00000- 1	9.15756- 8	126080801	242
1.50000- 1	4.20038- 8	2.00000- 1	6.67362- 8	2.50000- 1	1.51346- 7	126080801	243
3.00000- 1	4.44173- 8	3.50000- 1	1.49639- 7	4.00000- 1	8.69296- 8	126080801	244
4.50000- 1	2.40987- 7	5.00000- 1	5.54634- 7	5.50000- 1	3.04274- 7	126080801	245
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7.50000- 1	1.16736- 7	8.00000- 1	3.52332- 7	8.50000- 1	1.04405- 7	126080801	247
9.00000- 1	1.43014- 7	9.50000- 1	1.99142- 7	1.00000+ 0	1.15639- 7	126080801	248
1.05000+ 0	1.57736- 7	1.10000+ 0	3.41132- 7	1.15000+ 0	1.12787- 7	126080801	249
1.20000+ 0	2.05321- 7	1.25000+ 0	2.34661- 7	1.30000+ 0	3.26415- 7	126080801	250
1.35000+ 0	1.51108- 7	1.40000+ 0	4.55466- 7	1.45000+ 0	2.01683- 7	126080801	251
1.50000+ 0	2.26325- 7	1.55000+ 0	1.93334- 7	1.60000+ 0	1.66634- 7	126080801	252
1.65000+ 0	1.92419- 7	1.70000+ 0	1.64604- 7	1.75000+ 0	1.99717- 7	126080801	253
1.80000+ 0	1.53798- 7	1.85000+ 0	1.73723- 7	1.90000+ 0	1.56775- 7	126080801	254
1.95000+ 0	1.99278- 7	2.00000+ 0	1.69792- 7	2.05000+ 0	1.50396- 7	126080801	255
2.10000+ 0	1.74942- 7	2.15000+ 0	1.50933- 7	2.20000+ 0	1.63721- 7	126080801	256
2.25000+ 0	1.72893- 7	2.30000+ 0	1.79594- 7	2.35000+ 0	1.49536- 7	126080801	257
2.40000+ 0	1.67821- 7	2.45000+ 0	1.95726- 7	2.50000+ 0	1.73091- 7	126080801	258
2.55000+ 0	2.50043- 7	2.60000+ 0	1.66860- 7	2.65000+ 0	1.36929- 7	126080801	259
2.70000+ 0	1.92269- 7	2.75000+ 0	1.72207- 7	2.80000+ 0	1.45026- 7	126080801	260
2.85000+ 0	1.67376- 7	2.90000+ 0	1.45089- 7	2.95000+ 0	1.17078- 7	126080801	261
3.00000+ 0	1.17592- 7	3.05000+ 0	1.15113- 7	3.10000+ 0	1.18337- 7	126080801	262
3.15000+ 0	1.04262- 7	3.20000+ 0	1.01177- 7	3.25000+ 0	9.61246- 8	126080801	263
3.30000+ 0	1.00912- 7	3.35000+ 0	1.11176- 7	3.40000+ 0	1.03894- 7	126080801	264
3.45000+ 0	8.60818- 8	3.50000+ 0	9.47013- 8	3.55000+ 0	1.76015- 7	126080801	265
3.60000+ 0	9.96700- 8	3.65000+ 0	7.30367- 8	3.70000+ 0	7.86766- 8	126080801	266
3.75000+ 0	7.48733- 8	3.80000+ 0	8.12789- 8	3.85000+ 0	6.05087- 8	126080801	267
3.90000+ 0	6.19209- 8	3.95000+ 0	5.75163- 8	4.00000+ 0	5.39557- 8	126080801	268
4.05000+ 0	9.84064- 8	4.10000+ 0	9.55064- 8	4.15000+ 0	4.83740- 8	126080801	269
4.20000+ 0	4.88952- 8	4.25000+ 0	7.03755- 8	4.30000+ 0	4.46143- 8	126080801	270

4.35000+	0	6.17321-	8	4.40000+	0	4.68311-	8	4.45000+	0	4.57473-	8126080801	271
4.50000+	0	4.27203-	8	4.55000+	0	3.81608-	8	4.60000+	0	5.15210-	8126080801	272
4.65000+	0	3.60164-	8	4.70000+	0	3.50058-	8	4.75000+	0	3.42500-	8126080801	273
4.80000+	0	4.19498-	8	4.85000+	0	3.21769-	8	4.90000+	0	3.58711-	8126080801	274
4.95000+	0	3.12166-	8	5.00000+	0	2.94177-	8	5.05000+	0	3.25737-	8126080801	275
5.10000+	0	2.75827-	8	5.15000+	0	4.07517-	8	5.20000+	0	3.55721-	8126080801	276
5.25000+	0	2.56135-	8	5.30000+	0	2.90268-	8	5.35000+	0	2.59001-	8126080801	277
5.40000+	0	2.92285-	8	5.45000+	0	2.53801-	8	5.50000+	0	2.56807-	8126080801	278
5.55000+	0	3.17626-	8	5.60000+	0	3.87013-	8	5.65000+	0	1.83775-	8126080801	279
5.70000+	0	2.10723-	8	5.75000+	0	1.69412-	8	5.80000+	0	1.62510-	8126080801	280
5.85000+	0	1.90803-	8	5.90000+	0	1.96051-	8	5.95000+	0	1.42875-	8126080801	281
6.00000+	0	2.08499-	8	6.05000+	0	1.30738-	8	6.10000+	0	1.68135-	8126080801	282
6.15000+	0	1.18786-	8	6.20000+	0	1.30729-	8	6.25000+	0	1.06621-	8126080801	283
6.30000+	0	1.00893-	8	6.35000+	0	9.49786-	9	6.40000+	0	8.90746-	9126080801	284
6.45000+	0	8.32329-	9	6.50000+	0	7.73991-	9	6.55000+	0	7.16846-	9126080801	285
6.60000+	0	6.60876-	9	6.65000+	0	6.05579-	9	6.70000+	0	5.51459-	9126080801	286
6.75000+	0	4.98818-	9	6.80000+	0	4.47870-	9	6.85000+	0	3.98505-	9126080801	287
6.90000+	0	3.51146-	9	6.95000+	0	3.05797-	9	7.00000+	0	2.62775-	9126080801	288
7.05000+	0	2.22250-	9	7.10000+	0	1.84427-	9	7.15000+	0	1.49645-	9126080801	289
7.20000+	0	1.18001-	9	7.25000+	0	8.96825-	10	7.30000+	0	6.49335-	10126080801	290
7.35000+	0	4.39896-	10	7.40000+	0	2.70469-	10	7.45000+	0	1.43886-	10126080801	291
7.50000+	0	0.00000+	0	0.00000+	0	0.00000+	0	0.00000+	0	0.00000+	0126080801	292
0.		1.0000E+01			0		0		1		151126080801	293
	151		1		0		0		0		0126080801	294
0.00000+	0	1.14445-	9	5.00000-	2	1.05653-	8	1.00000-	1	4.11339-	8126080801	295
1.50000-	1	2.94744-	8	2.00000-	1	4.71157-	8	2.50000-	1	9.21991-	8126080801	296
3.00000-	1	3.24239-	8	3.50000-	1	9.39347-	8	4.00000-	1	4.98916-	8126080801	297
4.50000-	1	1.03016-	7	5.00000-	1	2.69604-	7	5.50000-	1	1.30296-	7126080801	298
6.00000-	1	1.87260-	7	6.50000-	1	6.59477-	8	7.00000-	1	1.00093-	7126080801	299
7.50000-	1	7.67201-	8	8.00000-	1	1.38208-	7	8.50000-	1	7.25144-	8126080801	300
9.00000-	1	9.93545-	8	9.50000-	1	1.27497-	7	1.00000+	0	7.97451-	8126080801	301
1.05000+	0	1.01220-	7	1.10000+	0	2.29878-	7	1.15000+	0	7.54811-	8126080801	302
1.20000+	0	1.17862-	7	1.25000+	0	1.39025-	7	1.30000+	0	2.29780-	7126080801	303
1.35000+	0	9.97138-	8	1.40000+	0	3.25173-	7	1.45000+	0	1.34108-	7126080801	304
1.50000+	0	1.49754-	7	1.55000+	0	1.26587-	7	1.60000+	0	1.10525-	7126080801	305
1.65000+	0	1.05426-	7	1.70000+	0	1.03849-	7	1.75000+	0	1.29433-	7126080801	306
1.80000+	0	9.74555-	8	1.85000+	0	1.09962-	7	1.90000+	0	9.87136-	8126080801	307
1.95000+	0	1.30557-	7	2.00000+	0	1.06931-	7	2.05000+	0	9.17704-	8126080801	308
2.10000+	0	1.10025-	7	2.15000+	0	9.23031-	8	2.20000+	0	1.00972-	7126080801	309
2.25000+	0	1.08342-	7	2.30000+	0	1.13504-	7	2.35000+	0	8.98342-	8126080801	310
2.40000+	0	1.03194-	7	2.45000+	0	1.12744-	7	2.50000+	0	1.08291-	7126080801	311
2.55000+	0	1.08792-	7	2.60000+	0	1.02232-	7	2.65000+	0	8.04228-	8126080801	312
2.70000+	0	1.13510-	7	2.75000+	0	1.08241-	7	2.80000+	0	8.28013-	8126080801	313
2.85000+	0	1.03230-	7	2.90000+	0	8.83452-	8	2.95000+	0	6.77710-	8126080801	314
3.00000+	0	6.86736-	8	3.05000+	0	6.71529-	9	3.10000+	0	6.93428-	8126080801	315
3.15000+	0	5.95547-	8	3.20000+	0	5.83092-	8	3.25000+	0	5.50250-	8126080801	316
3.30000+	0	5.97440-	8	3.35000+	0	6.88826-	8	3.40000+	0	6.28805-	8126080801	317
3.45000+	0	4.94767-	8	3.50000+	0	5.69214-	8	3.55000+	0	1.21471-	7126080801	318
3.60000+	0	6.17054-	8	3.65000+	0	4.06751-	8	3.70000+	0	4.61195-	8126080801	319
3.75000+	0	4.36021-	8	3.80000+	0	4.87602-	8	3.85000+	0	3.31685-	8126080801	320
3.90000+	0	3.46087-	8	3.95000+	0	3.15000-	8	4.00000+	0	2.90421-	8126080801	321
4.05000+	0	6.44595-	8	4.10000+	0	6.29013-	8	4.15000+	0	2.56813-	8126080801	322
4.20000+	0	2.60451-	8	4.25000+	0	4.36883-	8	4.30000+	0	2.37226-	8126080801	323
4.35000+	0	3.86109-	8	4.40000+	0	2.43057-	8	4.45000+	0	2.55153-	8126080801	324
4.50000+	0	2.26005-	8	4.55000+	0	2.00201-	8	4.60000+	0	2.81309-	8126080801	325
4.65000+	0	1.88086-	8	4.70000+	0	1.82288-	8	4.75000+	0	1.78325-	8126080801	326
4.80000+	0	2.11490-	8	4.85000+	0	1.65699-	8	4.90000+	0	1.80999-	8126080801	327
4.95000+	0	1.62305-	8	5.00000+	0	1.49756-	8	5.05000+	0	1.64887-	8126080801	328
5.10000+	0	1.39294-	8	5.15000+	0	2.09325-	8	5.20000+	0	1.72939-	8126080801	329
5.25000+	0	1.30304-	8	5.30000+	0	1.46737-	8	5.35000+	0	1.26846-	8126080801	330
5.40000+	0	1.06838-	8	5.45000+	0	1.22898-	8	5.50000+	0	1.42300-	8126080801	331
5.55000+	0	1.50060-	8	5.60000+	0	7.35753-	8	5.65000+	0	8.90035-	9126080801	332
5.70000+	0	1.00547-	8	5.75000+	0	8.15814-	9	5.80000+	0	7.80399-	9126080801	333
5.85000+	0	9.02742-	9	5.90000+	0	6.22291-	9	5.95000+	0	6.80883-	9126080801	334
6.00000+	0	9.71302-	9	6.05000+	0	6.20627-	9	6.10000+	0	7.85541-	9126080801	335
6.15000+	0	5.62463-	9	6.20000+	0	6.81018-	9	6.25000+	0	5.04784-	9126080801	336
6.30000+	0	4.76393-	9	6.35000+	0	4.48120-	9	6.40000+	0	4.19917-	9126080801	337
6.45000+	0	3.92037-	9	6.50000+	0	3.64221-	9	6.55000+	0	3.36998-	9126080801	338
6.60000+	0	3.10352-	9	6.65000+	0	2.84058-	9	6.70000+	0	2.58348-	9126080801	339

6.75000+ 0	2.33363- 9	6.80000+ 0	2.09209- 9	6.85000+ 0	1.85863- 9	126080801	340
6.90000+ 0	1.63438- 9	6.95000+ 0	1.42023- 9	7.00000+ 0	1.21743- 9	126080801	341
7.05000+ 0	1.02678- 9	7.10000+ 0	8.49295-10	7.15000+ 0	6.86582-10	126080801	342
7.20000+ 0	5.39062-10	7.25000+ 0	4.07319-10	7.30000+ 0	2.92402-10	126080801	343
7.35000+ 0	1.75298-10	7.40000+ 0	1.16893-10	7.45000+ 0	5.85000-11	126080801	344
7.50000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	126080801	345
0.	5.0000E+01	0	0	1	151	126080801	346
151	1	0	0	0	0	126080801	347
0.00000+ 0	5.42088-10	5.00000- 2	4.10100- 9	1.00000- 1	6.92609- 9	126080801	348
1.50000- 1	9.95872- 9	2.00000- 1	1.47726- 8	2.50000- 1	1.63049- 8	126080801	349
3.00000- 1	1.28174- 8	3.50000- 1	1.93069- 8	4.00000- 1	1.55290- 8	126080801	350
4.50000- 1	2.00740- 8	5.00000- 1	2.87334- 8	5.50000- 1	2.44852- 8	126080801	351
6.00000- 1	4.67742- 8	6.50000- 1	2.20933- 8	7.00000- 1	3.10538- 8	126080801	352
7.50000- 1	2.15074- 8	8.00000- 1	3.67353- 8	8.50000- 1	2.60645- 8	126080801	353
9.00000- 1	3.42889- 8	9.50000- 1	3.38541- 8	1.00000+ 0	2.84551- 8	126080801	354
1.05000+ 0	2.71914- 8	1.10000+ 0	6.37803- 8	1.15000+ 0	2.31293- 8	126080801	355
1.20000+ 0	3.34742- 8	1.25000+ 0	2.84013- 8	1.30000+ 0	7.51518- 8	126080801	356
1.35000+ 0	3.21817- 8	1.40000+ 0	1.12723- 7	1.45000+ 0	3.99422- 8	126080801	357
1.50000+ 0	4.24262- 8	1.55000+ 0	3.75932- 8	1.60000+ 0	3.33129- 8	126080801	358
1.65000+ 0	3.04665- 8	1.70000+ 0	2.65011- 8	1.75000+ 0	3.51183- 8	126080801	359
1.80000+ 0	2.05144- 8	1.85000+ 0	5.85620- 8	1.90000+ 0	2.62874- 8	126080801	360
1.95000+ 0	3.82181- 8	2.00000+ 0	2.88860- 8	2.05000+ 0	2.24246- 8	126080801	361
2.10000+ 0	2.89500- 8	2.15000+ 0	2.33209- 8	2.20000+ 0	2.53393- 8	126080801	362
2.25000+ 0	2.84692- 8	2.30000+ 0	3.06240- 8	2.35000+ 0	2.09647- 8	126080801	363
2.40000+ 0	2.55255- 8	2.45000+ 0	2.08879- 8	2.50000+ 0	2.81455- 8	126080801	364
2.55000+ 0	5.32835- 8	2.60000+ 0	2.34591- 8	2.65000+ 0	1.70086- 8	126080801	365
2.70000+ 0	2.28034- 8	2.75000+ 0	2.99265- 8	2.80000+ 0	1.67025- 8	126080801	366
2.85000+ 0	2.37528- 8	2.90000+ 0	2.14820- 8	2.95000+ 0	1.41543- 8	126080801	367
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3.45000+ 0	1.02132- 8	3.50000+ 0	1.50737- 8	3.55000+ 0	4.03640- 8	126080801	371
3.60000+ 0	1.59637- 8	3.65000+ 0	7.41062- 9	3.70000+ 0	1.02544- 8	126080801	372
3.75000+ 0	9.33700- 9	3.80000+ 0	1.17134- 8	3.85000+ 0	5.66208- 9	126080801	373
3.90000+ 0	6.42909- 9	3.95000+ 0	5.35782- 9	4.00000+ 0	4.46403- 9	126080801	374
4.05000+ 0	1.92192- 8	4.10000+ 0	2.06811- 8	4.15000+ 0	3.57680- 9	126080801	375
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4.80000+ 0	1.70998- 9	4.85000+ 0	1.54498- 9	4.90000+ 0	1.47871- 9	126080801	380
4.95000+ 0	1.75718- 9	5.00000+ 0	1.20856- 9	5.05000+ 0	1.42268- 9	126080801	381
5.10000+ 0	1.09477- 9	5.15000+ 0	5.64685- 9	5.20000+ 0	9.91870-10	126080801	382
5.25000+ 0	1.22902- 9	5.30000+ 0	1.44933- 9	5.35000+ 0	7.29095-10	126080801	383
5.40000+ 0	3.45429- 9	5.45000+ 0	6.10373-10	5.50000+ 0	2.56356- 9	126080801	384
5.55000+ 0	5.52564-10	5.60000+ 0	4.91942-10	5.65000+ 0	3.90697-10	126080801	385
5.70000+ 0	3.73580-10	5.75000+ 0	3.17068-10	5.80000+ 0	2.84153-10	126080801	386
5.85000+ 0	2.75581-10	5.90000+ 0	2.55693-10	5.95000+ 0	2.03012-10	126080801	387
6.00000+ 0	2.26837-10	6.05000+ 0	1.65571-10	6.10000+ 0	1.78138-10	126080801	388
6.15000+ 0	1.38825-10	6.20000+ 0	8.55565-10	6.25000+ 0	1.17591-10	126080801	389
6.30000+ 0	1.09014-10	6.35000+ 0	1.00942-10	6.40000+ 0	9.30038-11	126080801	390
6.45000+ 0	8.52567-11	6.50000+ 0	7.70853-11	6.55000+ 0	7.03836-11	126080801	391
6.60000+ 0	6.33432-11	6.65000+ 0	5.65607-11	6.70000+ 0	5.00557-11	126080801	392
6.75000+ 0	4.38613-11	6.80000+ 0	3.80184-11	6.85000+ 0	3.25259-11	126080801	393
6.90000+ 0	2.74132-11	6.95000+ 0	2.27114-11	7.00000+ 0	1.84589-11	126080801	394
7.05000+ 0	1.46902-11	7.10000+ 0	1.14390-11	7.15000+ 0	8.74676-12	126080801	395
7.20000+ 0	6.60483-12	7.25000+ 0	4.87460-12	7.30000+ 0	3.50683-12	126080801	396
7.35000+ 0	2.37780-12	7.40000+ 0	1.46427-12	7.45000+ 0	7.81888-13	126080801	397
7.50000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0	126080801	398
0.	1.0000E+02	0	0	1	151	126080801	399
151	1	0	0	0	0	126080801	400
0.00000+ 0	3.66060-10	5.00000- 2	2.24082- 9	1.00000- 1	2.75756- 9	126080801	401
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4.50000- 1	1.23463- 8	5.00000- 1	1.09917- 8	5.50000- 1	1.41351- 8	126080801	404
6.00000- 1	2.26078- 8	6.50000- 1	1.18543- 8	7.00000- 1	1.78782- 8	126080801	405
7.50000- 1	1.11777- 8	8.00000- 1	2.34913- 8	8.50000- 1	1.54903- 8	126080801	406
9.00000- 1	1.99899- 8	9.50000- 1	1.80565- 8	1.00000+ 0	1.63978- 8	126080801	407
1.05000+ 0	1.47367- 8	1.10000+ 0	2.73422- 8	1.15000+ 0	1.18610- 8	126080801	408

1.20000+ 0	1.81508- 8	1.25000+ 0	1.43272- 8	1.30000+ 0	3.61615- 8126080801	409
1.35000+ 0	1.74017- 8	1.40000+ 0	5.68669- 8	1.45000+ 0	1.95951- 8126080801	410
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1.80000+ 0	1.29195- 8	1.85000+ 0	1.35059- 8	1.90000+ 0	1.27106- 8126080801	413
1.95000+ 0	1.78452- 8	2.00000+ 0	1.47499- 8	2.05000+ 0	1.05498- 8126080801	414
2.10000+ 0	1.38419- 8	2.15000+ 0	1.19027- 8	2.20000+ 0	1.22199- 8126080801	415
2.25000+ 0	1.37952- 8	2.30000+ 0	1.43618- 8	2.35000+ 0	1.00579- 8126080801	416
2.40000+ 0	1.20250- 8	2.45000+ 0	9.35074- 9	2.50000+ 0	1.33794- 8126080801	417
2.55000+ 0	2.51112- 8	2.60000+ 0	1.10351- 8	2.65000+ 0	7.88205- 9126080801	418
2.70000+ 0	9.90450- 9	2.75000+ 0	1.51087- 8	2.80000+ 0	7.85663- 9126080801	419
2.85000+ 0	1.08654- 8	2.90000+ 0	9.82038- 9	2.95000+ 0	6.53593- 9126080801	420
3.00000+ 0	7.39681- 9	3.05000+ 0	6.73156- 9	3.10000+ 0	7.83418- 9126080801	421
3.15000+ 0	5.92115- 9	3.20000+ 0	5.73092- 9	3.25000+ 0	5.57419- 9126080801	422
3.30000+ 0	8.34706- 9	3.35000+ 0	1.22442- 8	3.40000+ 0	7.11747- 9126080801	423
3.45000+ 0	4.82966- 9	3.50000+ 0	8.99255- 9	3.55000+ 0	1.90899- 8126080801	424
3.60000+ 0	7.43972- 9	3.65000+ 0	3.51029- 9	3.70000+ 0	4.96278- 9126080801	425
3.75000+ 0	4.35633- 9	3.80000+ 0	5.69563- 9	3.85000+ 0	2.73207- 9126080801	426
3.90000+ 0	3.13952- 9	3.95000+ 0	2.01392- 9	4.00000+ 0	2.07494- 9126080801	427
4.05000+ 0	9.07508- 9	4.10000+ 0	1.22004- 8	4.15000+ 0	1.63791- 9126080801	428
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6.90000+ 0 1.57415-19 6.95000+ 0 1.20728-19 7.00000+ 0 8.82537-20126080801 606
7.05000+ 0 6.03046-20 7.10000+ 0 3.73085-20 7.15000+ 0 1.95212-20126080801 607
7.20000+ 0 7.31970-21 7.25000+ 0 1.04958-21 7.30000+ 0 0.00000+ 0126080801 608
0.         1.0000E+04          0          0          1       147126080801 609
       147          1          0          0          0         0126080801 610
0.00000+ 0 4.54929-12 5.00000- 2 1.54195-11 1.00000- 1 2.88344-11126080801 611
1.50000- 1 6.70472-11 2.00000- 1 5.80236-11 2.50000- 1 5.75879-11126080801 612
3.00000- 1 7.17102-11 3.50000- 1 5.32883-11 4.00000- 1 1.05617-10126080801 613
4.50000- 1 9.33607-11 5.00000- 1 1.11959-10 5.50000- 1 1.15957-10126080801 614
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6.00000- 1 1.79389-10 6.50000- 1 1.34855-10 7.00000- 1 1.61316-101260808Q1  615
7.50000- 1 1.40634-10 8.00000- 1 3.32075-10 8.50000- 1 2.90272-101260808Q1  616
9.00000- 1 1.89521-10 9.50000- 1 1.05797-10 1.00000+ 0 1.72893-101260808Q1  617
1.05000+ 0 1.05388-10 1.10000+ 0 1.45940-10 1.15000+ 0 7.86436-111260808Q1  618
1.20000+ 0 7.59878-11 1.25000+ 0 1.10855-10 1.30000+ 0 6.76353-111260808Q1  619
1.35000+ 0 3.77866-10 1.40000+ 0 1.65612-10 1.45000+ 0 8.44289-111260808Q1  620
1.50000+ 0 1.28086-10 1.55000+ 0 5.68259-11 1.60000+ 0 7.23490-111260808Q1  621
1.65000+ 0 8.13526-11 1.70000+ 0 8.13240-11 1.75000+ 0 7.85621-111260808Q1  622
1.80000+ 0 1.55586-10 1.85000+ 0 4.96228-11 1.90000+ 0 8.61609-111260808Q1  623
1.95000+ 0 3.71058-11 2.00000+ 0 1.06737-10 2.05000+ 0 5.61391-111260808Q1  624
2.10000+ 0 4.32847-11 2.15000+ 0 1.25728-10 2.20000+ 0 7.38399-111260808Q1  625
2.25000+ 0 2.95306-11 2.30000+ 0 2.58248-11 2.35000+ 0 2.98440-101260808Q1  626
2.40000+ 0 2.51963-11 2.45000+ 0 3.39183-11 2.50000+ 0 9.77686-111260808Q1  627
2.55000+ 0 6.91269-11 2.60000+ 0 3.77352-11 2.65000+ 0 5.06403-111260808Q1  628
2.70000+ 0 1.86400-11 2.75000+ 0 1.99808-11 2.80000+ 0 2.98285-111260808Q1  629
2.85000+ 0 1.52801-11 2.90000+ 0 1.46719-11 2.95000+ 0 4.68751-111260808Q1  630
3.00000+ 0 3.17131-11 3.05000+ 0 1.40181-11 3.10000+ 0 1.22954-111260808Q1  631
3.15000+ 0 1.55502-11 3.20000+ 0 1.86022-11 3.25000+ 0 1.17001-111260808Q1  632
3.30000+ 0 2.34946-11 3.35000+ 0 1.20500-11 3.40000+ 0 1.19617-111260808Q1  633
3.45000+ 0 1.31739-11 3.50000+ 0 8.29726-12 3.55000+ 0 7.76930-121260808Q1  634
3.60000+ 0 2.48399-11 3.65000+ 0 7.15257-12 3.70000+ 0 1.00268-111260808Q1  635
3.75000+ 0 6.54128-12 3.80000+ 0 6.26267-12 3.85000+ 0 8.34183-121260808Q1  636
3.90000+ 0 1.04894-11 3.95000+ 0 5.99532-12 4.00000+ 0 5.76602-121260808Q1  637
4.05000+ 0 5.18223-12 4.10000+ 0 4.62091-12 4.15000+ 0 4.32976-121260808Q1  638
4.20000+ 0 4.04522-12 4.25000+ 0 3.76099-12 4.30000+ 0 3.48298-121260808Q1  639
4.35000+ 0 3.21324-12 4.40000+ 0 2.93906-12 4.45000+ 0 2.67950-121260808Q1  640
4.50000+ 0 2.42993-12 4.55000+ 0 2.18723-12 4.60000+ 0 1.97757-121260808Q1  641
4.65000+ 0 1.71965-12 4.70000+ 0 2.59477-12 4.75000+ 0 1.28434-121260808Q1  642
4.80000+ 0 1.08156-12 4.85000+ 0 9.73191-13 4.90000+ 0 7.13264-131260808Q1  643
4.95000+ 0 5.51298-13 5.00000+ 0 4.05730-13 5.05000+ 0 2.79600-131260808Q1  644
5.10000+ 0 1.74105-13 5.15000+ 0 9.27846-14 5.20000+ 0 3.46850-141260808Q1  645
5.25000+ 0 5.25642-15 5.30000+ 0 4.44749-16 5.35000+ 0 3.74042-171260808Q1  646
5.40000+ 0 3.18643-17 5.45000+ 0 3.65098-17 5.50000+ 0 2.52952-171260808Q1  647
5.55000+ 0 6.25559-17 5.60000+ 0 5.19847-17 5.65000+ 0 1.39797-171260808Q1  648
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CARDS 649 TO 2392 DELETED

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      128          1          0          0          0          01260808Q2 2392
0.00000+ 0 2.02687-20 5.00000- 2 7.59349-20 1.00000- 1 1.18238-191260808Q2 2393
1.50000- 1 1.48846-19 2.00000- 1 1.64537-19 2.50000- 1 1.63824-191260808Q2 2394
3.00000- 1 1.47501-19 3.50000- 1 1.19179-19 4.00000- 1 8.56247-201260808Q2 2395
4.50000- 1 5.71523-20 5.00000- 1 4.64209-20 5.50000- 1 4.98998-201260808Q2 2396
6.00000- 1 5.50279-20 6.50000- 1 5.99656-20 7.00000- 1 6.46032-201260808Q2 2397
7.50000- 1 6.89034-20 8.00000- 1 7.28429-20 8.50000- 1 7.63553-201260808Q2 2398
9.00000- 1 7.94316-20 9.50000- 1 8.20473-20 1.00000+ 0 8.41913-201260808Q2 2399
1.05000+ 0 8.59344-20 1.10000+ 0 8.72411-20 1.15000+ 0 8.82190-201260808Q2 2400
1.20000+ 0 8.86887-20 1.25000+ 0 8.84739-20 1.30000+ 0 8.75936-201260808Q2 2401
1.35000+ 0 8.59763-20 1.40000+ 0 8.36650-20 1.45000+ 0 8.06610-201260808Q2 2402
1.50000+ 0 7.69882-20 1.55000+ 0 7.26689-20 1.60000+ 0 6.77931-201260808Q2 2403
1.65000+ 0 6.23865-20 1.70000+ 0 5.65152-20 1.75000+ 0 5.02984-201260808Q2 2404
1.80000+ 0 4.38504-20 1.85000+ 0 3.72042-20 1.90000+ 0 3.06780-201260808Q2 2405
1.95000+ 0 2.42776-20 2.00000+ 0 1.82263-20 2.05000+ 0 1.27069-201260808Q2 2406
2.10000+ 0 7.93938-21 2.15000+ 0 4.15731-21 2.20000+ 0 1.61147-211260808Q2 2407
2.25000+ 0 5.60890-22 2.30000+ 0 4.72857-22 2.35000+ 0 4.46707-221260808Q2 2408
2.40000+ 0 4.22678-22 2.45000+ 0 4.00006-22 2.50000+ 0 3.78048-221260808Q2 2409
2.55000+ 0 3.56966-22 2.60000+ 0 3.36820-22 2.65000+ 0 3.17824-221260808Q2 2410
2.70000+ 0 2.99892-22 2.75000+ 0 2.83290-22 2.80000+ 0 2.68235-221260808Q2 2411
2.85000+ 0 2.54542-22 2.90000+ 0 2.41618-22 2.95000+ 0 2.29227-221260808Q2 2412
3.00000+ 0 2.17305-22 3.05000+ 0 2.05657-22 3.10000+ 0 1.94060-221260808Q2 2413
3.15000+ 0 1.82617-22 3.20000+ 0 1.71378-22 3.25000+ 0 1.60396-221260808Q2 2414
3.30000+ 0 1.49924-22 3.35000+ 0 1.40013-22 3.40000+ 0 1.30714-221260808Q2 2415
3.45000+ 0 1.21927-22 3.50000+ 0 1.13704-22 3.55000+ 0 1.05940-221260808Q2 2416
3.60000+ 0 9.87862-23 3.65000+ 0 9.20381-23 3.70000+ 0 8.55944-231260808Q2 2417
3.75000+ 0 7.96074-23 3.80000+ 0 7.41277-23 3.85000+ 0 6.91554-231260808Q2 2418
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3.90000+ 0 6.46398-23 3.95000+ 0 6.03271-23 4.00000+ 0 5.61159-23126080802 2419
4.05000+ 0 5.19046-23 4.10000+ 0 4.78405-23 4.15000+ 0 4.38881-23126080802 2420
4.20000+ 0 4.00574-23 4.25000+ 0 3.63891-23 4.30000+ 0 3.29287-23126080802 2421
4.35000+ 0 2.96460-23 4.40000+ 0 2.66018-23 4.45000+ 0 2.37909-23126080802 2422
4.50000+ 0 2.12134-23 4.55000+ 0 1.87780-23 4.60000+ 0 1.64694-23126080802 2423
4.65000+ 0 1.43080-23 4.70000+ 0 1.22887-23 4.75000+ 0 1.04063-23126080802 2424
4.80000+ 0 8.68122-24 4.85000+ 0 7.12864-24 4.90000+ 0 5.70799-24126080802 2425
4.95000+ 0 4.41113-24 5.00000+ 0 3.24721-24 5.05000+ 0 2.23052-24126080802 2426
5.10000+ 0 1.39326-24 5.15000+ 0 7.34174-25 5.20000+ 0 2.77078-25126080802 2427
5.25000+ 0 3.99661-26 5.30000+ 0 1.72721-29 5.35000+ 0 1.54251-29126080802 2428
5.40000+ 0 1.38065-29 5.45000+ 0 1.24466-29 5.50000+ 0 1.12796-29126080802 2429
5.55000+ 0 1.01582-29 5.60000+ 0 9.06223-30 5.65000+ 0 7.99608-30126080802 2430
5.70000+ 0 6.97680-30 5.75000+ 0 5.99244-30 5.80000+ 0 5.06541-30126080802 2431
5.85000+ 0 4.19268-30 5.90000+ 0 3.38286-30 5.95000+ 0 2.64256-30126080802 2432
6.00000+ 0 1.97786-30 6.05000+ 0 1.39739-30 6.10000+ 0 9.06734-31126080802 2433
6.15000+ 0 5.15019-31 6.20000+ 0 2.28692-31 6.25000+ 0 5.62260-32126080802 2434
6.30000+ 0 1.35725-33 6.35000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0126080802 2435
                                                                 126080  0 2436
9.2233E+04 2.3104E+02           0          0          0        0126080803 2437
0.         0.                   0          0          1       24126080803 2438
        24          0           0          0          0        0126080803 2439
0.         0.                   0          0          1      126126080803 2440
       126          1           0          0          0        0126080803 2441
0.00000+ 0 1.00278- 9 5.00000- 2 2.39510- 8 1.00000- 1 1.58209- 6126080803 2442
1.50000- 1 1.05556- 7 2.00000- 1 1.67180- 7 2.50000- 1 4.81025- 7126080803 2443
3.00000- 1 9.04915- 8 3.50000- 1 4.47521- 7 4.00000- 1 3.74279- 7126080803 2444
4.50000- 1 1.69324- 6 5.00000- 1 3.02416- 6 5.50000- 1 2.11812- 6126080803 2445
6.00000- 1 8.74489- 7 6.50000- 1 1.26381- 7 7.00000- 1 3.14333- 7126080803 2446
7.50000- 1 1.94761- 7 8.00000- 1 8.61656- 6 8.50000- 1 1.33535- 7126080803 2447
9.00000- 1 1.92402- 7 9.50000- 1 4.23937- 7 1.00000+ 0 1.27350- 7126080803 2448
1.05000+ 0 2.47845- 7 1.10000+ 0 8.09259- 7 1.15000+ 0 4.74744- 8126080803 2449
1.20000+ 0 1.06273- 6 1.25000+ 0 5.54597- 7 1.30000+ 0 5.98311- 7126080803 2450
1.35000+ 0 1.55368- 7 1.40000+ 0 8.83268- 7 1.45000+ 0 2.38739- 7126080803 2451
1.50000+ 0 3.10599- 7 1.55000+ 0 2.07555- 7 1.60000+ 0 9.34039- 8126080803 2452
1.65000+ 0 9.01150- 8 1.70000+ 0 1.08041- 7 1.75000+ 0 1.95199- 7126080803 2453
1.80000+ 0 4.95068- 8 1.85000+ 0 1.20048- 7 1.90000+ 0 4.69708- 8126080803 2454
1.95000+ 0 1.59992- 7 2.00000+ 0 8.49840- 8 2.05000+ 0 3.64497- 8126080803 2455
2.10000+ 0 8.89522- 8 2.15000+ 0 2.36484- 8 2.20000+ 0 5.82171- 8126080803 2456
2.25000+ 0 7.86127- 8 2.30000+ 0 9.24277- 8 2.35000+ 0 3.00445- 8126080803 2457
2.40000+ 0 8.59120- 8 2.45000+ 0 2.88929- 7 2.50000+ 0 8.53716- 8126080803 2458
2.55000+ 0 2.67171- 7 2.60000+ 0 8.69149- 8 2.65000+ 0 1.88152- 8126080803 2459
2.70000+ 0 2.67302- 7 2.75000+ 0 1.20867- 7 2.80000+ 0 1.08168- 7126080803 2460
2.85000+ 0 1.18599- 7 2.90000+ 0 7.04789- 8 2.95000+ 0 9.35042- 9126080803 2461
3.00000+ 0 1.67824- 8 3.05000+ 0 2.54355- 8 3.10000+ 0 4.73117- 8126080803 2462
3.15000+ 0 2.53853- 8 3.20000+ 0 1.03002- 8 3.25000+ 0 8.00246- 9126080803 2463
3.30000+ 0 2.40287- 8 3.35000+ 0 4.64227- 8 3.40000+ 0 4.42208- 8126080803 2464
3.45000+ 0 1.18195- 8 3.50000+ 0 3.61110- 8 3.55000+ 0 2.14223- 7126080803 2465
3.60000+ 0 5.05414- 8 3.65000+ 0 1.51213- 8 3.70000+ 0 2.67114- 8126080803 2466
3.75000+ 0 2.24004- 8 3.80000+ 0 4.43083- 8 3.85000+ 0 1.58340- 9126080803 2467
3.90000+ 0 9.40201- 9 3.95000+ 0 4.61386- 9 4.00000+ 0 1.32300- 9126080803 2468
4.05000+ 0 9.95371- 8 4.10000+ 0 9.62082- 8 4.15000+ 0 9.59303-10126080803 2469
4.20000+ 0 8.90530- 9 4.25000+ 0 5.39655- 8 4.30000+ 0 1.78956- 9126080803 2470
4.35000+ 0 3.16658- 8 4.40000+ 0 2.71796- 8 4.45000+ 0 1.15920- 8126080803 2471
4.50000+ 0 1.56279- 8 4.55000+ 0 3.59493-10 4.60000+ 0 5.57777- 8126080803 2472
4.65000+ 0 1.41135-10 4.70000+ 0 8.09831-11 4.75000+ 0 5.02067-10126080803 2473
4.80000+ 0 4.58343- 8 4.85000+ 0 1.52613-13 4.90000+ 0 2.42415- 8126080803 2474
4.95000+ 0 1.54002- 9 5.00000+ 0 0.00000+ 0 5.05000+ 0 2.04205- 8126080803 2475
5.10000+ 0 0.00000+ 0 5.15000+ 0 6.39125- 8 5.20000+ 0 5.15273- 8126080803 2476
5.25000+ 0 1.18260- 9 5.30000+ 0 2.18161- 8 5.35000+ 0 1.44444- 8126080803 2477
5.40000+ 0 1.33185- 8 5.45000+ 0 2.05113- 8 5.50000+ 0 9.64536- 7126080803 2478
5.55000+ 0 6.24788- 8 5.60000+ 0 5.04117- 8 5.65000+ 0 0.00000+ 0126080803 2479
5.70000+ 0 1.79852- 8 5.75000+ 0 0.00000+ 0 5.80000+ 0 0.00000+ 0126080803 2480
5.85000+ 0 1.84244- 8 5.90000+ 0 2.46557- 8 5.95000+ 0 0.00000+ 0126080803 2481
6.00000+ 0 3.77199- 8 6.05000+ 0 0.00000+ 0 6.10000+ 0 2.28149- 8126080803 2482
6.15000+ 0 0.00000+ 0 6.20000+ 0 3.45399- 9 6.25000+ 0 0.00000+ 0126080803 2483
0.         1.00000E-01          0          0          1      126126080803 2484
       126          1           0          0          0        0126080803 2485
0.00000+ 0 9.47900-10 5.00000- 2 2.24606- 8 1.00000- 1 1.33762- 6126080803 2486
1.50000- 1 9.63787- 8 2.00000- 1 1.53026- 7 2.50000- 1 4.40207- 7126080803 2487
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3.00000- 1	8.11603- 8	3.50000- 1	4.08685- 7	4.00000- 1	3.28200-	7126080803	2488
4.50000- 1	1.47133- 6	5.00000- 1	2.67428- 6	5.50000- 1	1.84107-	6126080803	2489
6.00000- 1	7.97344- 7	6.50000- 1	1.16271- 7	7.00000- 1	2.87655-	7126080803	2490
7.50000- 1	1.78941- 7	8.00000- 1	7.23796- 6	8.50000- 1	1.19678-	7126080803	2491
9.00000- 1	1.79072- 7	9.50000- 1	3.87274- 7	1.00000+ 0	1.13461-	7126080803	2492
1.05000+ 0	2.25787- 7	1.10000+ 0	7.37350- 7	1.15000+ 0	4.40893-	8126080803	2493
1.20000+ 0	9.04235- 7	1.25000+ 0	5.01065- 7	1.30000+ 0	5.50340-	7126080803	2494
1.35000+ 0	1.38586- 7	1.40000+ 0	8.17702- 7	1.45000+ 0	2.20448-	7126080803	2495
1.50000+ 0	2.85848- 7	1.55000+ 0	1.90908- 7	1.60000+ 0	8.74013-	8126080803	2496
1.65000+ 0	8.34035- 8	1.70000+ 0	9.88193- 8	1.75000+ 0	1.79412-	7126080803	2497
1.80000+ 0	4.52166- 8	1.85000+ 0	1.09195- 7	1.90000+ 0	4.38746-	8126080803	2498
1.95000+ 0	1.39948- 7	2.00000+ 0	7.80210- 8	2.05000+ 0	3.30073-	8126080803	2499
2.10000+ 0	8.24105- 8	2.15000+ 0	2.22096- 8	2.20000+ 0	5.42050-	8126080803	2500
2.25000+ 0	7.30974- 8	2.30000+ 0	8.63695- 8	2.35000+ 0	2.78345-	8126080803	2501
2.40000+ 0	7.95526- 8	2.45000+ 0	2.57096- 7	2.50000+ 0	8.01738-	8126080803	2502
2.55000+ 0	2.49300- 7	2.60000+ 0	8.12703- 8	2.65000+ 0	1.78124-	8126080803	2503
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2.85000+ 0	1.10834- 7	2.90000+ 0	6.55727- 8	2.95000+ 0	8.74601-	9126080803	2505
3.00000+ 0	1.57947- 8	3.05000+ 0	2.30595- 8	3.10000+ 0	4.29939-	8126080803	2506
3.15000+ 0	2.20378- 8	3.20000+ 0	9.64940- 9	3.25000+ 0	7.30503-	9126080803	2507
3.30000+ 0	2.23519- 8	3.35000+ 0	4.39480- 8	3.40000+ 0	4.15002-	8126080803	2508
3.45000+ 0	1.11143- 8	3.50000+ 0	3.38102- 8	3.55000+ 0	2.01340-	7126080803	2509
3.60000+ 0	5.49951- 8	3.65000+ 0	1.34546- 8	3.70000+ 0	2.49056-	8126080803	2510
3.75000+ 0	2.10434- 8	3.80000+ 0	4.13932- 8	3.85000+ 0	1.50789-	9126080803	2511
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4.05000+ 0	9.35422- 8	4.10000+ 0	9.03821- 8	4.15000+ 0	9.00380-	10126080803	2513
4.20000+ 0	8.10373- 9	4.25000+ 0	5.07110- 8	4.30000+ 0	1.69697-	9126080803	2514
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4.50000+ 0	1.40228- 8	4.55000+ 0	3.37754-10	4.60000+ 0	5.01850-	8126080803	2516
4.65000+ 0	1.32383-10	4.70000+ 0	7.59928-11	4.75000+ 0	4.71706-	10126080803	2517
4.80000+ 0	4.07213- 8	4.85000+ 0	1.45534-13	4.90000+ 0	2.15235-	8126080803	2518
4.95000+ 0	1.56631- 9	5.00000+ 0	0.00000+ 0	5.05000+ 0	1.81852-	8126080803	2519
5.10000+ 0	0.00000+ 0	5.15000+ 0	5.62981- 8	5.20000+ 0	4.57501-	8126080803	2520
5.25000+ 0	1.13364- 9	5.30000+ 0	1.95142- 8	5.35000+ 0	1.28249-	8126080803	2521
5.40000+ 0	1.25797- 8	5.45000+ 0	1.82116- 8	5.50000+ 0	9.11029-	9126080803	2522
5.55000+ 0	5.54737- 8	5.60000+ 0	4.47597- 8	5.65000+ 0	0.00000+	0126080803	2523
5.70000+ 0	1.59689- 8	5.75000+ 0	0.00000+ 0	5.80000+ 0	0.00000+	0126080803	2524
5.85000+ 0	1.03587- 8	5.90000+ 0	2.18914- 8	5.95000+ 0	0.00000+	0126080803	2525
6.00000+ 0	3.34905- 8	6.05000+ 0	0.00000+ 0	6.10000+ 0	2.02551-	8126080803	2526
6.15000+ 0	0.00000+ 0	6.20000+ 0	3.26238- 9	6.25000+ 0	0.00000+	0126080803	2527
0.	5.0000E-01	0	0	1		126126080803	2528
120	1	0	0	0		0126080803	2529
0.00000+ 0	8.15100-10	5.00000- 2	1.87991- 8	1.00000- 1	7.70253-	7126080803	2530
1.50000- 1	7.44405- 8	2.00000- 1	1.19118- 7	2.50000- 1	3.40783-	7126080803	2531
3.00000- 1	5.95032- 8	3.50000- 1	3.14531- 7	4.00000- 1	2.21722-	7126080803	2532
4.50000- 1	9.60548- 7	5.00000- 1	1.85542- 6	5.50000- 1	1.20328-	6126080803	2533
6.00000- 1	6.11400- 7	6.50000- 1	9.20274- 8	7.00000- 1	2.23260-	7126080803	2534
7.50000- 1	1.40279- 7	8.00000- 1	4.03056- 6	8.50000- 1	8.74589-	8126080803	2535
9.00000- 1	1.43242- 7	9.50000- 1	2.98603- 7	1.00000+ 0	8.14227-	8126080803	2536
1.05000+ 0	1.75682- 7	1.10000+ 0	5.65783- 7	1.15000+ 0	3.58770-	8126080803	2537
1.20000+ 0	5.44968- 7	1.25000+ 0	3.74354- 7	1.30000+ 0	4.35672-	7126080803	2538
1.35000+ 0	9.97454- 8	1.40000+ 0	6.59104- 7	1.45000+ 0	1.76010-	7126080803	2539
1.50000+ 0	2.26002- 7	1.55000+ 0	1.50706- 7	1.60000+ 0	7.27988-	8126080803	2540
1.65000+ 0	6.72331- 8	1.70000+ 0	7.67980- 8	1.75000+ 0	1.41484-	7126080803	2541
1.80000+ 0	3.72471- 8	1.85000+ 0	8.35088- 8	1.90000+ 0	3.63455-	8126080803	2542
1.95000+ 0	1.13419- 7	2.00000+ 0	6.14774- 8	2.05000+ 0	2.49227-	8126080803	2543
2.10000+ 0	6.66550- 8	2.15000+ 0	1.87239- 8	2.20000+ 0	4.44710-	8126080803	2544
2.25000+ 0	5.98587- 8	2.30000+ 0	7.16689- 8	2.35000+ 0	2.25146-	8126080803	2545
2.40000+ 0	6.21398- 8	2.45000+ 0	1.82387- 7	2.50000+ 0	6.74070-	8126080803	2546
2.55000+ 0	2.05992- 7	2.60000+ 0	6.73208- 9	2.65000+ 0	1.52325-	8126080803	2547
2.70000+ 0	1.75228- 7	2.75000+ 0	8.96036- 8	2.80000+ 0	6.86210-	8126080803	2548
2.85000+ 0	9.16054- 8	2.90000+ 0	5.36608- 8	2.95000+ 0	7.27793-	9126080803	2549
3.00000+ 0	1.33531- 8	3.05000+ 0	1.75105- 8	3.10000+ 0	3.27997-	8126080803	2550
3.15000+ 0	1.43989- 8	3.20000+ 0	8.06604- 9	3.25000+ 0	5.67863-	9126080803	2551
3.30000+ 0	1.83771- 8	3.35000+ 0	3.79060- 9	3.40000+ 0	3.48333-	8126080803	2552
3.45000+ 0	9.39279- 9	3.50000+ 0	2.82651- 8	3.55000+ 0	1.69700-	7126080803	2553
3.60000+ 0	4.63088- 8	3.65000+ 0	9.57858- 9	3.70000+ 0	2.05425-	8126080803	2554
3.75000+ 0	1.77222- 8	3.80000+ 0	3.41796- 8	3.85000+ 0	1.32272-	9126080803	2555
3.90000+ 0	7.44450- 9	3.95000+ 0	3.63133- 9	4.00000+ 0	1.04277-	9126080803	2556

4.05000+	0	7.88514-	9	4.10000+	0	7.60458-	8	4.15000+	0	7.56604-	10	126080803	2557
4.20000+	0	6.07230-	9	4.25000+	0	4.27353-	8	4.30000+	0	1.47011-	9	126080803	2558
4.35000+	0	2.70584-	8	4.40000+	0	1.72268-	8	4.45000+	0	9.24326-	9	126080803	2559
4.50000+	0	1.02458-	8	4.55000+	0	2.84693-	10	4.60000+	0	3.70362-	8	126080803	2560
4.65000+	0	1.11065-	10	4.70000+	0	6.38434-	11	4.75000+	0	3.97601-	10	126080803	2561
4.80000+	0	2.87408-	8	4.85000+	0	1.28770-	13	4.90000+	0	1.51506-	8	126080803	2562
4.95000+	0	1.28539-	9	5.00000+	0	0.00000+	0	5.05000+	0	1.29313-	8	126080803	2563
5.10000+	0	0.00000+	0	5.15000+	0	4.05441-	8	5.20000+	0	3.22168-	8	126080803	2564
5.25000+	0	1.01298-	9	5.30000+	0	1.41115-	8	5.35000+	0	9.03131-	9	126080803	2565
5.40000+	0	1.07773-	8	5.45000+	0	1.28243-	8	5.50000+	0	7.80478-	9	126080803	2566
5.55000+	0	3.90640-	8	5.60000+	0	3.15198-	8	5.65000+	0	0.00000+	0	126080803	2567
5.70000+	0	1.12450-	8	5.75000+	0	0.00000+	0	5.80000+	0	0.00000+	0	126080803	2568
5.85000+	0	1.15107-	8	5.90000+	0	7.54160-	8	5.95000+	0	0.00000+	0	126080803	2569
6.00000+	0	2.35831-	8	6.05000+	0	0.00000+	0	6.10000+	0	1.42635-	8	126080803	2570
6.15000+	0	0.00000+	0	6.20000+	0	5.79495-	9	6.25000+	0	0.00000+	0	126080803	2571
0.		1.0000E+00			0		0		1		126	126080803	2572
126			1		0		0		0		0	126080803	2573
0.00000+	0	7.35883-	10	5.00000-	2	1.65434-	8	1.00000-	1	4.75355-	7	126080803	2574
1.50000-	1	6.17738-	8	2.00000-	1	9.94398-	8	2.50000-	1	2.80547-	7	126080803	2575
3.00000-	1	4.78762-	8	3.50000-	1	2.58384-	7	4.00000-	1	1.65188-	7	126080803	2576
4.50000-	1	6.72076-	7	5.00000-	1	1.40630-	6	5.50000-	1	8.67935-	7	126080803	2577
6.00000-	1	5.01897-	7	6.50000-	1	7.79116-	8	7.00000-	1	1.85215-	7	126080803	2578
7.50000-	1	1.16787-	7	8.00000-	1	2.37689-	6	8.50000-	1	7.01330-	8	126080803	2579
9.00000-	1	1.22312-	7	9.50000-	1	2.45959-	7	1.00000+	0	6.45606-	8	126080803	2580
1.05000+	0	1.45101-	7	1.10000+	0	4.67193-	7	1.15000+	0	3.09628-	8	126080803	2581
1.20000+	0	3.65307-	7	1.25000+	0	2.99822-	7	1.30000+	0	3.69399-	7	126080803	2582
1.35000+	0	7.91064-	8	1.40000+	0	5.04842-	7	1.45000+	0	1.49342-	7	126080803	2583
1.50000+	0	1.90486-	7	1.55000+	0	1.26910-	7	1.60000+	0	6.39902-	8	126080803	2584
1.65000+	0	5.77124-	8	1.70000+	0	6.41032-	8	1.75000+	0	1.19309-	7	126080803	2585
1.80000+	0	3.24894-	8	1.85000+	0	6.92114-	8	1.90000+	0	3.18362-	8	126080803	2586
1.95000+	0	9.78978-	8	2.00000+	0	5.20592-	8	2.05000+	0	2.04573-	8	126080803	2587
2.10000+	0	5.73782-	8	2.15000+	0	1.66398-	8	2.20000+	0	3.86391-	8	126080803	2588
2.25000+	0	5.21162-	8	2.30000+	0	6.28514-	8	2.35000+	0	1.93871-	8	126080803	2589
2.40000+	0	5.23239-	8	2.45000+	0	1.41236-	7	2.50000+	0	5.95396-	8	126080803	2590
2.55000+	0	1.80112-	7	2.60000+	0	5.86366-	8	2.65000+	0	1.34909-	8	126080803	2591
2.70000+	0	1.39131-	7	2.75000+	0	7.68465-	8	2.80000+	0	5.34918-	8	126080803	2592
2.85000+	0	7.95785-	8	2.90000+	0	4.65150-	8	2.95000+	0	6.39501-	9	126080803	2593
3.00000+	0	1.18287-	8	3.05000+	0	1.44865-	8	3.10000+	0	2.70875-	8	126080803	2594
3.15000+	0	1.05018-	8	3.20000+	0	7.11011-	9	3.25000+	0	4.79522-	9	126080803	2595
3.30000+	0	1.91231-	8	3.35000+	0	3.42213-	8	3.40000+	0	3.07637-	8	126080803	2596
3.45000+	0	8.34446-	9	3.50000+	0	2.49882-	8	3.55000+	0	1.50303-	7	126080803	2597
3.60000+	0	4.09861-	8	3.65000+	0	7.49189-	9	3.70000+	0	1.79534-	8	126080803	2598
3.75000+	0	1.56906-	8	3.80000+	0	2.98617-	8	3.85000+	0	1.20852-	9	126080803	2599
3.90000+	0	6.60155-	9	3.95000+	0	3.21000-	9	4.00000+	0	9.22213-	10	126080803	2600
4.05000+	0	6.98402-	8	4.10000+	0	6.73739-	8	4.15000+	0	6.69447-	10	126080803	2601
4.20000+	0	4.33708-	9	4.25000+	0	3.78431-	8	4.30000+	0	1.33103-	9	126080803	2602
4.35000+	0	2.50117-	8	4.40000+	0	1.33827-	8	4.45000+	0	8.22019-	9	126080803	2603
4.50000+	0	8.14649-	9	4.55000+	0	2.52395-	10	4.60000+	0	2.97419-	8	126080803	2604
4.65000+	0	9.01695-	11	4.70000+	0	5.65034-	11	4.75000+	0	3.52494-	10	126080803	2605
4.80000+	0	2.21571-	8	4.85000+	0	1.19310-	13	4.90000+	0	1.16600-	8	126080803	2606
4.95000+	0	1.17353-	9	5.00000+	0	0.00000+	0	5.05000+	0	1.00406-	8	126080803	2607
5.10000+	0	0.00000+	0	5.15000+	0	3.18536-	8	5.20000+	0	2.47845-	8	126080803	2608
5.25000+	0	9.37530-	10	5.30000+	0	1.11285-	8	5.35000+	0	6.94788-	9	126080803	2609
5.40000+	0	9.68201-	9	5.45000+	0	9.86578-	9	5.50000+	0	7.01173-	9	126080803	2610
5.55000+	0	3.00521-	8	5.60000+	0	2.42486-	8	5.65000+	0	0.00000+	0	126080803	2611
5.70000+	0	8.05154-	9	5.75000+	0	0.00000+	0	5.80000+	0	0.00000+	0	126080803	2612
5.85000+	0	8.86221-	9	5.90000+	0	1.18598-	8	5.95000+	0	0.00000+	0	126080803	2613
6.00000+	0	1.81423-	8	6.05000+	0	0.00000+	0	6.10000+	0	1.09730-	8	126080803	2614
6.15000+	0	0.00000+	0	6.20000+	0	5.51089-	9	6.25000+	0	0.00000+	0	126080803	2615
0.		5.0000E+00			0		0		1		126	126080803	2616
126			1		0		0		0		0	126080803	2617
0.00000+	0	5.41561-	10	5.00000-	2	1.08209-	8	1.00000-	1	8.61764-	8	126080803	2618
1.50000-	1	3.38740-	8	2.00000-	1	5.55726-	8	2.50000-	1	1.36872-	7	126080803	2619
3.00000-	1	2.64005-	8	3.50000-	1	1.27881-	7	4.00000-	1	6.12505-	8	126080803	2620
4.50000-	1	2.11218-	7	5.00000-	1	5.20619-	7	5.50000-	1	2.65879-	7	126080803	2621
6.00000-	1	2.51349-	7	6.50000-	1	4.59329-	8	7.00000-	1	9.76018-	8	126080803	2622
7.50000-	1	5.99754-	8	8.00000-	1	2.90032-	7	8.50000-	1	3.81452-	8	126080803	2623
9.00000-	1	7.19978-	8	9.50000-	1	1.23424-	7	1.00000+	0	3.52827-	8	126080803	2624
1.05000+	0	7.28555-	8	1.10000+	0	5.51835-	7	1.15000+	0	1.91931-	8	126080803	2625

1.20000+	0	1.07579-	7	1.25000+	0	1.32940-	7	1.30000+	0	2.20871-	7126080803	2026
1.35000+	0	4.19187-	8	1.40000+	0	3.42826-	7	1.45000+	0	8.58040-	8126080803	2027
1.50000+	0	1.07414-	7	1.55000+	0	7.10097-	8	1.60000+	0	4.22959-	8126080803	2028
1.65000+	0	3.50690-	8	1.70000+	0	3.56384-	8	1.75000+	0	6.87547-	8126080803	2029
1.80000+	0	2.10274-	8	1.85000+	0	3.93258-	8	1.90000+	0	2.09017-	8126080803	2030
1.95000+	0	6.21473-	8	2.00000+	0	3.16746-	8	2.05000+	0	1.15792-	8126080803	2031
2.10000+	0	3.57004-	8	2.15000+	0	1.15451-	8	2.20000+	0	2.44456-	8126080803	2032
2.25000+	0	3.39899-	8	2.30000+	0	4.13001-	8	2.35000+	0	1.21099-	8126080803	2033
2.40000+	0	3.14431-	8	2.45000+	0	6.06149-	8	2.50000+	0	3.94211-	8126080803	2034
2.55000+	0	1.17980-	7	2.60000+	0	3.65301-	9	2.65000+	0	8.51188-	9126080803	2035
2.70000+	0	6.59779-	8	2.75000+	0	4.82498-	8	2.80000+	0	2.35965-	8126080803	2036
2.85000+	0	4.86575-	8	2.90000+	0	2.92309-	8	2.95000+	0	4.21621-	9126080803	2037
3.00000+	0	7.65444-	9	3.05000+	0	8.58952-	9	3.10000+	0	1.51342-	8126080803	2038
3.15000+	0	4.43484-	9	3.20000+	0	4.73524-	9	3.25000+	0	3.07115-	9126080803	2039
3.30000+	0	1.11818-	8	3.35000+	0	2.46953-	8	3.40000+	0	2.05247-	8126080803	2040
3.45000+	0	5.67173-	9	3.50000+	0	1.70714-	8	3.55000+	0	1.01131-	7126080803	2041
3.60000+	0	2.75092-	8	3.65000+	0	3.56415-	9	3.70000+	0	1.18138-	8126080803	2042
3.75000+	0	1.05448-	8	3.80000+	0	1.93720-	8	3.85000+	0	9.03507-	10126080803	2043
3.90000+	0	4.48210-	9	3.95000+	0	5.16902-	9	4.00000+	0	6.22948-	10126080803	2044
4.05000+	0	4.67923-	8	4.10000+	0	4.58978-	8	4.15000+	0	4.51917-	10126080803	2045
4.20000+	0	2.53921-	9	4.25000+	0	2.54441-	8	4.30000+	0	9.68555-	10126080803	2046
4.35000+	0	1.92987-	8	4.40000+	0	5.56477-	9	4.45000+	0	5.61503-	9126080803	2047
4.50000+	0	3.77780-	9	4.55000+	0	1.70216-	10	4.60000+	0	1.45607-	8126080803	2048
4.65000+	0	6.52064-	11	4.70000+	0	3.84129-	11	4.75000+	0	2.37721-	10126080803	2049
4.80000+	0	8.85618-	9	4.85000+	0	9.93254-	14	4.90000+	0	4.60841-	9126080803	2050
4.95000+	0	8.72073-	10	5.00000+	0	0.00000+	0	5.05000+	0	4.17619-	9126080803	2051
5.10000+	0	0.00000+	0	5.15000+	0	1.40785-	8	5.20000+	0	9.79562-	9126080803	2052
5.25000+	0	7.25992-	10	5.30000+	0	5.01066-	9	5.35000+	0	2.74692-	9126080803	2053
5.40000+	0	6.91919-	9	5.45000+	0	3.89926-	9	5.50000+	0	5.01085-	9126080803	2054
5.55000+	0	1.18776-	8	5.60000+	0	9.58398-	9	5.65000+	0	0.00000+	0126080803	2055
5.70000+	0	3.41941-	9	5.75000+	0	0.00000+	0	5.80000+	0	0.00000+	0126080803	2056
5.85000+	0	3.50266-	9	5.90000+	0	4.68745-	9	5.95000+	0	0.00000+	0126080803	2057
6.00000+	0	7.17039-	9	6.05000+	0	0.00000+	0	6.10000+	0	4.33695-	9126080803	2058
6.15000+	0	0.00000+	0	6.20000+	0	1.79439-	9	6.25000+	0	0.00000+	0126080803	2059
0.		1.0000E+01			0		0		1		126126080803	2060
126			1		0		0		0		0126080803	2061
0.00000+	0	4.54140-	10	5.00000-	2	8.33129-	9	1.00000-	1	3.71192-	8126080803	2062
1.50000-	1	2.34575-	8	2.00000-	1	3.89077-	8	2.50000-	1	8.16332-	8126080803	2063
3.00000-	1	1.93673-	8	3.50000-	1	7.82809-	8	4.00000-	1	3.15504-	8126080803	2064
4.50000-	1	8.19035-	8	5.00000-	1	2.45647-	7	5.50000-	1	1.03435-	7126080803	2065
6.00000-	1	1.57465-	7	6.50000-	1	3.31992-	8	7.00000-	1	6.43714-	8126080803	2066
7.50000-	1	3.90020-	8	8.00000-	1	9.64970-	8	8.50000-	1	2.78215-	8126080803	2067
9.00000-	1	5.17103-	8	9.50000-	1	7.69082-	8	1.00000+	0	2.64056-	8126080803	2068
1.05000+	0	4.51720-	8	1.10000+	0	1.71224-	7	1.15000+	0	1.43278-	8126080803	2069
1.20000+	0	5.42753-	8	1.25000+	0	7.32562-	8	1.30000+	0	1.61893-	7126080803	2070
1.35000+	0	3.00448-	8	1.40000+	0	2.53466-	7	1.45000+	0	6.07769-	8126080803	2071
1.50000+	0	7.48324-	8	1.55000+	0	5.02849-	8	1.60000+	0	3.29789-	8126080803	2072
1.65000+	0	2.67682-	8	1.70000+	0	2.42039-	8	1.75000+	0	4.89357-	8126080803	2073
1.80000+	0	1.62178-	8	1.85000+	0	2.80850-	8	1.90000+	0	1.62729-	8126080803	2074
1.95000+	0	4.76678-	8	2.00000+	0	2.37609-	8	2.05000+	0	8.49306-	9126080803	2075
2.10000+	0	2.68047-	8	2.15000+	0	9.30278-	9	2.20000+	0	1.83383-	8126080803	2076
2.25000+	0	2.62214-	8	2.30000+	0	3.20254-	8	2.35000+	0	9.12482-	9126080803	2077
2.40000+	0	2.33662-	8	2.45000+	0	3.38963-	8	2.50000+	0	3.05022-	8126080803	2078
2.55000+	0	9.21337-	8	2.60000+	0	2.67481-	8	2.65000+	0	6.19893-	9126080803	2079
2.70000+	0	4.06609-	8	2.75000+	0	3.68762-	9	2.80000+	0	1.30235-	8126080803	2080
2.85000+	0	3.51365-	8	2.90000+	0	2.20097-	9	2.95000+	0	3.26292-	9126080803	2081
3.00000+	0	6.05893-	9	3.05000+	0	6.47923-	9	3.10000+	0	1.06609-	8126080803	2082
3.15000+	0	2.90803-	9	3.20000+	0	3.69186-	9	3.25000+	0	2.43595-	9126080803	2083
3.30000+	0	9.14242-	9	3.35000+	0	2.02241-	8	3.40000+	0	1.60841-	8126080803	2084
3.45000+	0	4.45619-	9	3.50000+	0	7.35743-	8	3.55000+	0	7.97786-	8126080803	2085
3.60000+	0	2.16526-	8	3.65000+	0	5.24411-	9	3.70000+	0	9.26847-	9126080803	2086
3.75000+	0	8.28995-	9	3.80000+	0	1.49282-	8	3.85000+	0	7.54235-	10126080803	2087
3.90000+	0	3.53862-	9	3.95000+	0	1.71949-	9	4.00000+	0	4.92717-	10126080803	2088
4.05000+	0	3.70674-	8	4.10000+	0	3.65868-	8	4.15000+	0	3.56410-	10126080803	2089
4.20000+	0	1.02156-	9	4.25000+	0	2.00643-	8	4.30000+	0	7.97792-	10126080803	2090
4.35000+	0	1.03369-	8	4.40000+	0	2.71282-	9	4.45000+	0	4.46846-	9126080803	2091
4.50000+	0	2.14046-	9	4.55000+	0	1.33002-	10	4.60000+	0	8.81105-	9126080803	2092
4.65000+	0	5.29474-	11	4.70000+	0	3.06117-	11	4.75000+	0	1.85749-	10126080803	2093

4.80000+	0	4.04240- 9	4.85000+	0	9.14829-14	4.90000+	0	2.06176- 9126080803	2694
4.95000+	0	7.23047-10	5.00000+	0	0.00000+ 0	5.05000+	0	2.03863- 9126080803	2695
5.10000+	0	0.00000+ 0	5.15000+	0	7.51731- 9	5.20000+	0	4.38290- 9126080803	2696
5.25000+	0	6.15654-10	5.30000+	0	2.74290- 9	5.35000+	0	1.22806- 9126080803	2697
5.40000+	0	5.98971- 9	5.45000+	0	1.74466- 9	5.50000+	0	4.12047- 9126080803	2698
5.55000+	0	5.31443- 9	5.60000+	0	4.26821- 9	5.65000+	0	0.00000+ 0126080803	2699
5.70000+	0	1.52996- 9	5.75000+	0	0.00000+ 0	5.80000+	0	0.00000+ 0126080803	2700
5.85000+	0	1.56720- 9	5.90000+	0	2.09733- 9	5.95000+	0	0.00000+ 0126080803	2701
6.00000+	0	3.20829- 9	6.05000+	0	0.00000+ 0	6.10000+	0	1.94051- 9126080803	2702
6.15000+	0	0.00000+ 0	6.20000+	0	1.47556- 9	6.25000+	0	0.00000+ 0126080803	2703
0.		5.0000E+01		0	0		1	126126080803	2704
126		1		0	0		0	0126080803	2705
0.00000+	0	2.55596-10	5.00000-	2	3.24122- 9	1.00000-	1	5.28984- 9126080803	2706
1.50000-	1	7.53818- 9	2.00000-	1	1.15206- 8	2.50000-	1	1.21877- 8126080803	2707
3.00000-	1	7.81576- 9	3.50000-	1	1.34138- 8	4.00000-	1	8.74547- 9126080803	2708
4.50000-	1	1.24013- 8	5.00000-	1	2.01761- 8	5.50000-	1	1.50522- 8126080803	2709
6.00000-	1	3.64856- 8	6.50000-	1	1.09726- 8	7.00000-	1	1.91172- 8126080803	2710
7.50000-	1	8.70752- 9	8.00000-	1	5.32146- 8	8.50000-	1	1.17860- 8126080803	2711
9.00000-	1	1.92832- 8	9.50000-	1	1.81632- 8	1.00000+	0	1.21250- 8126080803	2712
1.05000+	0	1.02726- 8	1.10000+	0	4.63253- 8	1.15000+	0	5.19075- 9126080803	2713
1.20000+	0	1.51043- 8	1.25000+	0	9.65372- 9	1.30000+	0	5.60746- 8126080803	2714
1.35000+	0	1.28251- 8	1.40000+	0	9.31378- 8	1.45000+	0	2.01833- 8126080803	2715
1.50000+	0	2.25472- 8	1.55000+	0	1.76413- 8	1.60000+	0	1.33297- 8126080803	2716
1.65000+	0	1.04871- 8	1.70000+	0	6.55530- 9	1.75000+	0	1.52368- 8126080803	2717
1.80000+	0	6.72004- 9	1.85000+	0	8.86835- 9	1.90000+	0	6.69616- 9126080803	2718
1.95000+	0	1.87439- 8	2.00000+	0	9.56600- 9	2.05000+	0	3.29654- 9126080803	2719
2.10000+	0	1.00478- 8	2.15000+	0	4.67390- 9	2.20000+	0	6.97338- 9126080803	2720
2.25000+	0	1.04091- 8	2.30000+	0	1.28882- 8	2.35000+	0	3.56932- 9126080803	2721
2.40000+	0	8.48186- 9	2.45000+	0	4.20455- 9	2.50000+	0	1.18223- 8126080803	2722
2.55000+	0	3.73189- 8	2.60000+	0	7.85551- 9	2.65000+	0	1.75023- 9126080803	2723
2.70000+	0	7.91637- 9	2.75000+	0	1.54244- 8	2.80000+	0	2.59768- 9126080803	2724
2.85000+	0	1.00560- 8	2.90000+	0	8.20004- 9	2.95000+	0	1.29344- 9126080803	2725
3.00000+	0	2.55778- 9	3.05000+	0	2.53493- 9	3.10000+	0	4.05539- 9126080803	2726
3.15000+	0	1.02020- 9	3.20000+	0	1.52515- 9	3.25000+	0	1.24081- 9126080803	2727
3.30000+	0	5.10109- 9	3.35000+	0	1.08517- 8	3.40000+	0	6.47220- 9126080803	2728
3.45000+	0	1.82773- 9	3.50000+	0	7.10543- 9	3.55000+	0	3.28099- 8126080803	2729
3.60000+	0	8.81799- 9	3.65000+	0	6.68713-10	3.70000+	0	3.90744- 9126080803	2730
3.75000+	0	3.37531- 9	3.80000+	0	6.12514- 9	3.85000+	0	4.33963-10126080803	2731
3.90000+	0	1.54606- 9	3.95000+	0	8.04619-10	4.00000+	0	2.25071-10126080803	2732
4.05000+	0	1.52752- 8	4.10000+	0	1.70121- 8	4.15000+	0	1.58003-10126080803	2733
4.20000+	0	5.56061-10	4.25000+	0	8.25138- 9	4.30000+	0	4.37602-10126080803	2734
4.35000+	0	9.85886- 9	4.40000+	0	2.40479-10	4.45000+	0	1.96786- 9126080803	2735
4.50000+	0	4.33270-10	4.55000+	0	5.28197-11	4.60000+	0	3.00104- 9126080803	2736
4.65000+	0	2.45490-11	4.70000+	0	1.47311-11	4.75000+	0	7.37674-11126080803	2737
4.80000+	0	1.27274-10	4.85000+	0	7.50792-14	4.90000+	0	2.83872-11126080803	2738
4.95000+	0	3.98732-10	5.00000+	0	0.00000+ 0	5.05000+	0	2.41920-10126080803	2739
5.10000+	0	0.00000+ 0	5.15000+	0	1.63522- 9	5.20000+	0	6.03368-11126080803	2740
5.25000+	0	3.74177-10	5.30000+	0	6.67705-10	5.35000+	0	1.69145-11126080803	2741
5.40000+	0	2.80734- 9	5.45000+	0	2.40202-11	5.50000+	0	2.03395- 9126080803	2742
5.55000+	0	7.31645-11	5.60000+	0	5.90371-11	5.65000+	0	0.00000+ 0126080803	2743
5.70000+	0	2.10642-11	5.75000+	0	0.00000+ 0	5.80000+	0	0.00000+ 0126080803	2744
5.85000+	0	2.15760-11	5.90000+	0	2.88715-11	5.95000+	0	0.00000+ 0126080803	2745
6.00000+	0	4.41670-11	6.05000+	0	0.00000+ 0	6.10000+	0	2.67160-11126080803	2746
6.15000+	0	0.00000+ 0	6.20000+	0	7.28066-10	6.25000+	0	0.00000+ 0126080803	2747
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4.50000-	1	7.97275- 9	5.00000-	1	6.16519- 9	5.50000-	1	8.86903- 9126080803	2753
6.00000-	1	1.69218- 8	6.50000-	1	5.76921- 9	7.00000-	1	1.14078- 8126080803	2754
7.50000-	1	4.33211- 9	8.00000-	1	1.62865- 8	8.50000-	1	7.94217- 9126080803	2755
9.00000-	1	1.21170- 8	9.50000-	1	9.88408- 9	1.00000+	0	7.95223- 9126080803	2756
1.05000+	0	9.04830- 9	1.10000+	0	1.84395- 8	1.15000+	0	2.77293- 9126080803	2757
1.20000+	0	8.91297- 9	1.25000+	0	4.95019- 9	1.30000+	0	2.66757- 8126080803	2758
1.35000+	0	7.83345- 9	1.40000+	0	4.72401- 8	1.45000+	0	9.93648- 9126080803	2759
1.50000+	0	1.00710- 8	1.55000+	0	8.50098- 9	1.60000+	0	6.55689- 9126080803	2760
1.65000+	0	6.27582- 9	1.70000+	0	3.11835- 9	1.75000+	0	6.61532- 9126080803	2761

1.80000+ 0	3.57978- 9	1.85000+ 0	4.25373- 9	1.90000+ 0	3.54927- 9	126080803	2762
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2.10000+ 0	5.11052- 9	2.15000+ 0	3.30991- 9	2.20000+ 0	3.77414- 9	126080803	2764
2.25000+ 0	5.50514- 9	2.30000+ 0	6.23327- 9	2.35000+ 0	2.09744- 9	126080803	2765
2.40000+ 0	4.23149- 9	2.45000+ 0	1.72616- 9	2.50000+ 0	5.92610- 9	126080803	2766
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2.70000+ 0	3.12087- 9	2.75000+ 0	8.55946- 9	2.80000+ 0	1.42492- 9	126080803	2768
2.85000+ 0	4.61303- 9	2.90000+ 0	3.74833- 9	2.95000+ 0	6.46097-10	126080803	2769
3.00000+ 0	1.69309- 9	3.05000+ 0	1.21883- 9	3.10000+ 0	2.51744- 9	126080803	2770
3.15000+ 0	5.05060-10	3.20000+ 0	8.22794-10	3.25000+ 0	8.64595-10	126080803	2771
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4.35000+ 0	7.82022- 9	4.40000+ 0	1.08126-10	4.45000+ 0	1.07622- 9	126080803	2779
4.50000+ 0	2.01556-10	4.55000+ 0	2.52444-11	4.60000+ 0	2.35008- 9	126080803	2780
4.65000+ 0	1.92798-11	4.70000+ 0	1.00534-11	4.75000+ 0	3.52559-11	126080803	2781
4.80000+ 0	4.12709-11	4.85000+ 0	7.11707-14	4.90000+ 0	3.10802-12	126080803	2782
4.95000+ 0	2.93364-10	5.00000+ 0	0.00000+ 0	5.05000+ 0	1.76970-10	126080803	2783
5.10000+ 0	0.00000+ 0	5.15000+ 0	1.25689- 9	5.20000+ 0	6.60644-12	126080803	2784
5.25000+ 0	2.98302-10	5.30000+ 0	5.16384-10	5.35000+ 0	1.85212-12	126080803	2785
5.40000+ 0	1.42417- 9	5.45000+ 0	2.62991-12	5.50000+ 0	1.03137- 9	126080803	2786
5.55000+ 0	8.01117-12	5.60000+ 0	6.46399-12	5.65000+ 0	0.00000+ 0	126090803	2787
5.70000+ 0	2.30640-12	5.75000+ 0	0.00000+ 0	5.80000+ 0	0.00000+ 0	126080803	2788
5.65000+ 0	2.36259-12	5.90000+ 0	3.16101-12	5.95000+ 0	0.00000+ 0	126080803	2789
6.00000+ 0	4.83577-12	6.05000+ 0	0.00000+ 0	6.10000+ 0	2.92510-12	126080803	2790
6.15000+ 0	0.00000+ 0	6.20000+ 0	3.69350-10	6.25000+ 0	0.00000+ 0	126080803	2791
0.	5.0000E+02	0	0	1	126	126080803	2792
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0.00000+ 0	6.30070-11	5.00000- 2	2.00888-10	1.00000- 1	1.63892-10	126080803	2794
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1.50000+ 0	1.43809- 9	1.55000+ 0	3.82532-10	1.60000+ 0	5.82747-10	126080803	2804
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2.25000+ 0	5.45480-10	2.30000+ 0	2.49790-10	2.35000+ 0	8.46549-10	126080803	2809
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2.70000+ 0	2.60834-10	2.75000+ 0	1.94935- 9	2.80000+ 0	3.07852-10	126080803	2812
2.85000+ 0	3.96659-10	2.90000+ 0	4.74286-11	2.95000+ 0	8.10226-11	126080803	2813
3.00000+ 0	3.39487-10	3.05000+ 0	2.19565-11	3.10000+ 0	5.80893-10	126080803	2814
3.15000+ 0	3.57645-11	3.20000+ 0	1.14834-10	3.25000+ 0	1.82005-10	126080803	2815
3.30000+ 0	1.03444- 9	3.35000+ 0	1.47031- 9	3.40000+ 0	5.36092-11	126080803	2816
3.45000+ 0	8.05190-11	3.50000+ 0	1.16478- 9	3.55000+ 0	6.17776-10	126080803	2817
3.60000+ 0	9.39791-11	3.65000+ 0	8.13321-11	3.70000+ 0	1.69170-10	126080803	2818
3.75000+ 0	4.42039-11	3.80000+ 0	1.76801-10	3.85000+ 0	6.99740-11	126080803	2819
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4.05000+ 0	1.76070-10	4.10000+ 0	1.26625- 9	4.15000+ 0	1.45956-11	126080803	2821
4.20000+ 0	8.79478-11	4.25000+ 0	8.06920-11	4.30000+ 0	6.25346-11	126080803	2822
4.35000+ 0	1.46177- 9	4.40000+ 0	4.08140-12	4.45000+ 0	8.80930-11	126080803	2823
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4.65000+ 0	3.20319-12	4.70000+ 0	2.85279-12	4.75000+ 0	4.10763-13	126080803	2825
4.80000+ 0	4.15837-13	4.85000+ 0	7.97652-14	4.90000+ 0	1.45502-15	126080803	2826
4.95000+ 0	4.56747-11	5.00000+ 0	0.00000+ 0	5.05000+ 0	3.27910-11	126080803	2827

5.10000+ 0	0.00000+ 0	5.15000+ 0	2.34868-10	5.20000+ 0	3.09285-15	126080803	2828
5.25000+ 0	5.90727-11	5.30000+ 0	9.65918-11	5.35000+ 0	8.66803-16	126080803	2829
5.40000+ 0	9.43865-12	5.45000+ 0	1.23096-15	5.50000+ 0	6.83532-12	126080803	2830
5.55000+ 0	3.14957-15	5.60000+ 0	3.02581-15	5.65000+ 0	0.00000+ 0	126080803	2831
5.70000+ 0	1.07945-15	5.75000+ 0	0.00000+ 0	5.80000+ 0	0.00000+ 0	126080803	2832
5.85000+ 0	1.10585-15	5.90000+ 0	1.48003-15	5.95000+ 0	0.00000+ 0	126080803	2833
6.00000+ 0	2.26402-15	6.05000+ 0	0.00000+ 0	6.10000+ 0	1.36906-15	126080803	2834
6.15000+ 0	0.00000+ 0	6.20000+ 0	2.44777-12	6.25000+ 0	0.00000+ 0	126080803	2835
0.	1.0000E+03	0	0	1	126	126080803	2836
126	1	0	0	0	0	126080803	2837
0.00000+ 0	2.62372-11	5.00000- 2	8.00217-11	1.00000- 1	1.06750-10	126080803	2838
1.50000- 1	5.92973-10	2.00000- 1	2.67171-10	2.50000- 1	6.83747-10	126080803	2839
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6.00000- 1	8.96740-10	6.50000- 1	5.64274-10	7.00000- 1	1.16260- 9	126080803	2842
7.50000- 1	1.04414- 9	8.00000- 1	1.97667- 9	8.50000- 1	2.14121- 9	126080803	2843
9.00000- 1	3.51666- 9	9.50000- 1	5.94984-10	1.00000+ 0	2.99105- 9	126080803	2844
1.05000+ 0	6.66198-10	1.10000+ 0	1.01069- 9	1.15000+ 0	4.58056-10	126080803	2845
1.20000+ 0	2.45465- 9	1.25000+ 0	8.17584-10	1.30000+ 0	5.74642-10	126080803	2846
1.35000+ 0	1.25259- 9	1.40000+ 0	1.37667- 9	1.45000+ 0	3.23236-10	126080803	2847
1.50000+ 0	8.28323-10	1.55000+ 0	1.95300-10	1.60000+ 0	2.88974-10	126080803	2848
1.65000+ 0	8.33942-10	1.70000+ 0	5.94134-10	1.75000+ 0	7.71131-10	126080803	2849
1.80000+ 0	3.45255-10	1.85000+ 0	4.20418-10	1.90000+ 0	3.13248-10	126080803	2850
1.95000+ 0	7.13253-11	2.00000+ 0	1.34498- 9	2.05000+ 0	1.79303-10	126080803	2851
2.10000+ 0	2.96721-10	2.15000+ 0	1.34314- 9	2.20000+ 0	4.91370-10	126080803	2852
2.25000+ 0	2.59771-10	2.30000+ 0	1.14639-10	2.35000+ 0	6.90742-10	126080803	2853
2.40000+ 0	4.16128-11	2.45000+ 0	1.85606-10	2.50000+ 0	3.71753-10	126080803	2854
2.55000+ 0	9.76042-10	2.60000+ 0	3.91841-10	2.65000+ 0	1.74569-10	126080803	2855
2.70000+ 0	1.74318-10	2.75000+ 0	2.45417-10	2.80000+ 0	1.51756-10	126080803	2856
2.85000+ 0	5.77193-11	2.90000+ 0	5.00117-12	2.95000+ 0	7.96489-11	126080803	2857
3.00000+ 0	1.13230-10	3.05000+ 0	4.56829-12	3.10000+ 0	1.61303-10	126080803	2858
3.15000+ 0	1.35954-11	3.20000+ 0	6.11526-11	3.25000+ 0	5.82113-11	126080803	2859
3.30000+ 0	2.79883-10	3.35000+ 0	2.64902-10	3.40000+ 0	1.88777-11	126080803	2860
3.45000+ 0	4.20450-11	3.50000+ 0	2.85563-10	3.55000+ 0	2.64405-10	126080803	2861
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3.90000+ 0	1.38002-10	3.95000+ 0	5.04829-11	4.00000+ 0	5.32778-12	126080803	2864
4.05000+ 0	2.99783-11	4.10000+ 0	1.64012-10	4.15000+ 0	2.37356-12	126080803	2865
4.20000+ 0	2.26812-11	4.25000+ 0	7.41582-12	4.30000+ 0	8.93317-12	126080803	2866
4.35000+ 0	1.92890-10	4.40000+ 0	5.16816-13	4.45000+ 0	1.18382-11	126080803	2867
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4.65000+ 0	5.29883-13	4.70000+ 0	1.56173-12	4.75000+ 0	5.56237-15	126080803	2869
4.80000+ 0	5.72154-15	4.85000+ 0	9.51299-14	4.90000+ 0	6.80320-17	126080803	2870
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5.25000+ 0	7.39298-12	5.30000+ 0	1.27352-11	5.35000+ 0	4.05379-17	126080803	2873
5.40000+ 0	7.45081-14	5.45000+ 0	5.75577-17	5.50000+ 0	5.39506-14	126080803	2874
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5.70000+ 0	5.04810-17	5.75000+ 0	0.00000+ 0	5.80000+ 0	0.00000+ 0	126080803	2876
5.85000+ 0	5.17124-17	5.90000+ 0	6.92272-17	5.95000+ 0	0.00000+ 0	126080803	2877
6.00000+ 0	1.05874-16	6.05000+ 0	0.00000+ 0	6.10000+ 0	6.40240-17	126080803	2878
6.15000+ 0	0.00000+ 0	6.20000+ 0	1.93214-14	6.25000+ 0	0.00000+ 0	126080803	2879
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1.50000- 1	1.00612-10	2.00000- 1	4.41612-11	2.50000- 1	5.91235-11	126080803	2883
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4.50000- 1	2.41434-10	5.00000- 1	1.24657-10	5.50000- 1	1.25069-10	126080803	2885
6.00000- 1	2.85466-10	6.50000- 1	1.12659-10	7.00000- 1	2.15455-10	126080803	2886
7.50000- 1	2.60445-10	8.00000- 1	5.98761-10	8.50000- 1	5.28409-10	126080803	2887
9.00000- 1	4.93951-10	9.50000- 1	9.52661-11	1.00000+ 0	3.72604-10	126080803	2888
1.05000+ 0	1.03764-10	1.10000+ 0	1.78244-10	1.15000+ 0	5.61759-11	126080803	2889
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1.50000+ 0	2.23397-10	1.55000+ 0	2.22341-11	1.60000+ 0	5.48553-11	126080803	2892
1.65000+ 0	8.45036-11	1.70000+ 0	7.68282-11	1.75000+ 0	8.44352-11	126080803	2893
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1.95000+ 0	1.03103-11	2.00000+ 0	1.78840-10	2.05000+ 0	5.34811-11	126080803	2895

2.10000+	0	3.20483-11	2.15000+	0	2.06538-10	2.20000+	0	1.99788-10126080803	2896
2.25000+	0	2.54611-11	2.30000+	0	9.15907-12	2.35000+	0	4.41797-10126080803	2897
2.40000+	0	6.94715-12	2.45000+	0	4.28658-11	2.50000+	0	1.44302-10126080803	2898
2.55000+	0	1.43042-10	2.60000+	0	1.05429-10	2.65000+	0	5.59234-11126080803	2899
2.70000+	0	1.11957-11	2.75000+	0	7.47287-12	2.80000+	0	3.31929-11126080803	2900
2.85000+	0	2.05783-13	2.90000+	0	3.88703-13	2.95000+	0	6.14180-11126080803	2901
3.00000+	0	3.92572-11	3.05000+	0	2.41241-12	3.10000+	0	1.90469-12126080803	2902
3.15000+	0	7.35739-12	3.20000+	0	1.88129-11	3.25000+	0	2.87548-12126080803	2903
3.30000+	0	2.79996-11	3.35000+	0	1.63786-11	3.40000+	0	6.43457-12126080803	2904
3.45000+	0	8.41839-12	3.50000+	0	6.35297-12	3.55000+	0	3.47547-12126080803	2905
3.60000+	0	3.28903-11	3.65000+	0	4.21307-13	3.70000+	0	6.16492-12126080803	2906
3.75000+	0	1.06541-13	3.80000+	0	2.27265-13	3.85000+	0	4.40534-12126080803	2907
3.90000+	0	2.93843-11	3.95000+	0	1.11122-12	4.00000+	0	1.05438-12126080803	2908
4.05000+	0	2.13408-12	4.10000+	0	3.17903-13	4.15000+	0	4.03480-15126080803	2909
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4.35000+	0	3.53904-13	4.40000+	0	8.96249-16	4.45000+	0	2.11370-14126080803	2911
4.50000+	0	6.05585-17	4.55000+	0	6.46541-18	4.60000+	0	1.42527-13126080803	2912
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4.80000+	0	4.22606-17	4.85000+	0	1.12025-13	4.90000+	0	1.77397-17126080803	2914
4.95000+	0	1.16875-14	5.00000+	0	0.00000+ 0	5.05000+	0	7.94879-15126080803	2915
5.10000+	0	0.00000+ 0	5.15000+	0	5.68735-14	5.20000+	0	3.77166-17126080803	2916
5.25000+	0	1.35683-14	5.30000+	0	2.33880-14	5.35000+	0	1.05715-17126080803	2917
5.40000+	0	9.29198-17	5.45000+	0	1.50164-17	5.50000+	0	6.72951-17126080803	2918
5.55000+	0	4.57216-17	5.60000+	0	3.68954-17	5.65000+	0	0.00000+ 0126080803	2919
5.70000+	0	1.31646-17	5.75000+	0	0.00000+ 0	5.80000+	0	0.00000+ 0126080803	2920
5.85000+	0	1.34875-17	5.90000+	0	7.80497-17	5.95000+	0	0.00000+ 0126080803	2921
6.00000+	0	2.76091-17	6.05000+	0	0.00000+ 0	6.10000+	0	1.66951-17126080803	2922
6.15000+	0	0.00000+ 0	6.20000+	0	2.40995-17	6.25000+	0	0.00000+ 0126080803	2923
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126		1		0	0		0	0126080803	2925
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3.00000-	1	2.86895-11	3.50000-	1	7.90357-12	4.00000-	1	5.87511-11126080803	2928
4.50000-	1	4.92550-11	5.00000-	1	6.20589-11	5.50000-	1	6.33547-11126080803	2929
6.00000-	1	1.24284-10	6.50000-	1	7.77346-11	7.00000-	1	1.02607-10126080803	2930
7.50000-	1	8.07049-11	8.00000-	1	2.71241-10	8.50000-	1	2.28799-10126080803	2931
9.00000-	1	1.26688-10	9.50000-	1	4.39150-11	1.00000+	0	1.11242-10126080803	2932
1.05000+	0	4.41570-11	1.10000+	0	8.52779-11	1.15000+	0	1.87144-11126080803	2933
1.20000+	0	1.98639-11	1.25000+	0	5.25573-11	1.30000+	0	1.01965-11126080803	2934
1.35000+	0	3.21444-10	1.40000+	0	1.10382-10	1.45000+	0	3.05371-11126080803	2935
1.50000+	0	7.56869-11	1.55000+	0	6.07858-12	1.60000+	0	2.34149-11126080803	2936
1.65000+	0	3.43622-11	1.70000+	0	3.63042-11	1.75000+	0	3.56500-11126080803	2937
1.80000+	0	1.14707-10	1.85000+	0	1.07791-11	1.90000+	0	4.93287-11126080803	2938
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2.10000+	0	1.37819-11	2.15000+	0	9.77958-11	2.20000+	0	4.73544-11126080803	2940
2.25000+	0	4.33354-12	2.30000+	0	1.81408-12	2.35000+	0	2.75508-10126080803	2941
2.40000+	0	3.20434-12	2.45000+	0	1.27759-11	2.50000+	0	7.74575-11126080803	2942
2.55000+	0	4.96264-11	2.60000+	0	1.90239-11	2.65000+	0	3.26893-11126080803	2943
2.70000+	0	1.42481-12	2.75000+	0	3.47326-12	2.80000+	0	1.39923-11126080803	2944
2.85000+	0	7.06934-14	2.90000+	0	5.77885-14	2.95000+	0	3.28554-11126080803	2945
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3.30000+	0	1.35567-11	3.35000+	0	2.64155-12	3.40000+	0	3.02247-12126080803	2948
3.45000+	0	4.67164-12	3.50000+	0	1.88605-13	3.55000+	0	2.14027-14126080803	2949
3.60000+	0	1.74133-11	3.65000+	0	2.59680-14	3.70000+	0	3.19658-12126080803	2950
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3.90000+	0	4.76924-12	3.95000+	0	5.45336-13	4.00000+	0	5.90306-13126080803	2952
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4.50000+	0	1.17209-17	4.55000+	0	3.23124-19	4.60000+	0	2.80999-14126080803	2956
4.65000+	0	1.52744-17	4.70000+	0	1.09709-12	4.75000+	0	4.51213-19126080803	2957
4.80000+	0	3.29496-17	4.85000+	0	8.24822-14	4.90000+	0	1.73746-17126080803	2958
4.95000+	0	2.00465-16	5.00000+	0	0.00000+ 0	5.05000+	0	1.50030-16126080803	2959
5.10000+	0	0.00000+ 0	5.15000+	0	1.01489-15	5.20000+	0	3.69404-17126080803	2960
5.25000+	0	2.32358-16	5.30000+	0	4.14465-16	5.35000+	0	1.03539-17126080803	2961
5.40000+	0	7.66365-18	5.45000+	0	1.47074-17	5.50000+	0	5.54876-18126080803	2962
5.55000+	0	4.47808-17	5.60000+	0	3.61362-17	5.65000+	0	0.00000+ 0126080803	2963

5.70000+ 0	1.28937-17	5.75000+ 0	0.00000+ 0	5.80000+ 0	0.00000+ 0	126080803	2964
5.85000+ 0	1.32100-17	5.90000+ 0	1.76783-17	5.95000+ 0	0.00000+ 0	126080803	2965
6.00000+ 0	2.70410-17	6.05000+ 0	0.00000+ 0	6.10000+ 0	1.63515-17	126080803	2966
6.15000+ 0	0.00000+ 0	6.20000+ 0	1.98730-18	6.25000+ 0	0.00000+ 0	126080803	2967
0.	5.0000E+04	0	0	1	126	126080803	2968
126	1	0	0	0	0	126080803	2969
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3.00000- 1	1.57657-12	3.50000- 1	1.93889-12	4.00000- 1	2.11481-12	126080803	2972
4.50000- 1	2.02422-12	5.00000- 1	2.46134-11	5.50000- 1	1.72111-11	126080803	2973
6.00000- 1	4.46314-12	6.50000- 1	3.91729-11	7.00000- 1	3.67924-11	126080803	2974
7.50000- 1	1.17990-11	8.00000- 1	8.50514-12	8.50000- 1	5.46351-12	126080803	2975
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1.35000+ 0	2.10478-11	1.40000+ 0	5.00523-12	1.45000+ 0	4.54962-12	126080803	2979
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1.65000+ 0	6.05029-12	1.70000+ 0	2.88803-12	1.75000+ 0	5.58935-12	126080803	2981
1.80000+ 0	6.42753-12	1.85000+ 0	5.11461-13	1.90000+ 0	2.29131-12	126080803	2982
1.95000+ 0	2.43018-14	2.00000+ 0	3.43028-12	2.05000+ 0	3.09732-13	126080803	2983
2.10000+ 0	3.13668-13	2.15000+ 0	4.72105-12	2.20000+ 0	1.05954-12	126080803	2984
2.25000+ 0	1.01415-13	2.30000+ 0	4.35599-14	2.35000+ 0	1.21214-11	126080803	2985
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2.55000+ 0	2.17809-13	2.60000+ 0	7.32039-15	2.65000+ 0	1.05498-12	126080803	2987
2.70000+ 0	6.07938-14	2.75000+ 0	7.21647-14	2.80000+ 0	9.85740-14	126080803	2988
2.85000+ 0	3.84758-15	2.90000+ 0	8.72974-17	2.95000+ 0	2.26251-13	126080803	2989
3.00000+ 0	2.55757-13	3.05000+ 0	7.83019-15	3.10000+ 0	8.58541-16	126080803	2990
3.15000+ 0	2.08416-14	3.20000+ 0	1.80288-13	3.25000+ 0	1.09506-14	126080803	2991
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3.45000+ 0	1.06734-13	3.50000+ 0	3.67074-15	3.55000+ 0	3.17358-16	126080803	2993
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4.05000+ 0	1.20893-16	4.10000+ 0	5.02863-16	4.15000+ 0	5.26849-18	126080803	2997
4.20000+ 0	2.91217-17	4.25000+ 0	4.74165-17	4.30000+ 0	2.30537-17	126080803	2998
4.35000+ 0	5.51021-16	4.40000+ 0	1.89612-17	4.45000+ 0	3.55972-17	126080803	2999
4.50000+ 0	1.04577-17	4.55000+ 0	2.56777-19	4.60000+ 0	1.89977-15	126080803	3000
4.65000+ 0	1.12543-18	4.70000+ 0	7.12183-14	4.75000+ 0	3.58552-19	126080803	3001
4.80000+ 0	3.02402-17	4.85000+ 0	5.35437-15	4.90000+ 0	1.59734-17	126080803	3002
4.95000+ 0	1.85641-17	5.00000+ 0	0.00000+ 0	5.05000+ 0	2.53697-17	126080803	3003
5.10000+ 0	0.00000+ 0	5.15000+ 0	1.26798-16	5.20000+ 0	3.39658-17	126080803	3004
5.25000+ 0	2.11289-17	5.30000+ 0	4.94467-17	5.35000+ 0	9.52024-18	126080803	3005
5.40000+ 0	6.76641-18	5.45000+ 0	1.35235-17	5.50000+ 0	4.89892-18	126080803	3006
5.55000+ 0	4.11752-17	5.60000+ 0	3.32268-17	5.65000+ 0	0.00000+ 0	126080803	3007
5.70000+ 0	1.18555-17	5.75000+ 0	0.00000+ 0	5.80000+ 0	0.00000+ 0	126080803	3008
5.85000+ 0	1.21465-17	5.90000+ 0	1.62551-17	5.95000+ 0	0.00000+ 0	126080803	3009
6.00000+ 0	2.48640-17	6.05000+ 0	0.00000+ 0	6.10000+ 0	1.50349-17	126080803	3010
6.15000+ 0	0.00000+ 0	6.20000+ 0	1.75459-18	6.25000+ 0	0.00000+ 0	126080803	3011
0.	1.0000E+05	0	0	1	126	126080803	3012
126	1	0	0	0	0	126080803	3013
0.00000+ 0	9.94728-14	5.00000- 2	3.48076-13	1.00000- 1	1.96674-12	126080803	3014
1.50000- 1	4.31175-13	2.00000- 1	8.78837-12	2.50000- 1	3.32693-12	126080803	3015
3.00000- 1	7.52446-13	3.50000- 1	1.39379-12	4.00000- 1	5.65305-13	126080803	3016
4.50000- 1	1.19552-12	5.00000- 1	1.42827-11	5.50000- 1	6.11087-12	126080803	3017
6.00000- 1	2.29585-12	6.50000- 1	2.37006-11	7.00000- 1	1.94298-11	126080803	3018
7.50000- 1	9.10843-12	8.00000- 1	2.28038-12	8.50000- 1	2.44121-12	126080803	3019
9.00000- 1	2.52588-12	9.50000- 1	1.99413-12	1.00000+ 0	7.57933-12	126080803	3020
1.05000+ 0	2.49885-13	1.10000+ 0	4.52433-12	1.15000+ 0	2.95470-13	126080803	3021
1.20000+ 0	1.08790-12	1.25000+ 0	4.36765-12	1.30000+ 0	1.08916-13	126080803	3022
1.35000+ 0	2.37747-12	1.40000+ 0	8.71778-13	1.45000+ 0	1.12995-12	126080803	3023
1.50000+ 0	2.70351-13	1.55000+ 0	2.71027-12	1.60000+ 0	1.34615-13	126080803	3024
1.65000+ 0	1.39322-12	1.70000+ 0	6.12946-13	1.75000+ 0	1.55175-12	126080803	3025
1.80000+ 0	3.12768-13	1.85000+ 0	2.63430-13	1.90000+ 0	8.83477-13	126080803	3026
1.95000+ 0	2.47580-15	2.00000+ 0	6.77556-13	2.05000+ 0	8.46648-14	126080803	3027
2.10000+ 0	1.53204-14	2.15000+ 0	3.90175-13	2.20000+ 0	7.63440-14	126080803	3028
2.25000+ 0	3.33546-14	2.30000+ 0	3.14881-14	2.35000+ 0	4.43142-13	126080803	3029
2.40000+ 0	1.83933-15	2.45000+ 0	1.01274-14	2.50000+ 0	1.60202-13	126080803	3030
2.55000+ 0	4.11226-15	2.60000+ 0	4.77120-16	2.65000+ 0	3.09957-14	126080803	3031
2.70000+ 0	2.28751-15	2.75000+ 0	2.50255-15	2.80000+ 0	1.86268-15	126080803	3032

2.85000+	0	3.14772-15	2.90000+	0	6.61347-17	2.95000+	0	6.09327-16126080803	3033
3.00000+	0	5.45986-15	3.05000+	0	4.99507-17	3.10000+	0	1.24574-15126080803	3034
3.15000+	0	1.14168-16	3.20000+	0	5.11245-15	3.25000+	0	3.36451-16126080803	3035
3.30000+	0	4.87183-16	3.35000+	0	1.07400-15	3.40000+	0	8.53056-17126080803	3036
3.45000+	0	2.81213-15	3.50000+	0	2.02895-16	3.55000+	0	2.98858-16126080803	3037
3.60000+	0	3.94832-16	3.65000+	0	3.82817-17	3.70000+	0	1.19155-16126080803	3038
3.75000+	0	2.28248-17	3.80000+	0	7.72609-17	3.85000+	0	6.43203-17126080803	3039
3.90000+	0	6.76466-17	3.95000+	0	1.63472-16	4.00000+	0	2.19182-16126080803	3040
4.05000+	0	9.29384-17	4.10000+	0	4.82821-16	4.15000+	0	5.06026-16126080803	3041
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4.35000+	0	5.29190-16	4.40000+	0	1.82675-17	4.45000+	0	3.41919-17126080803	3043
4.50000+	0	1.00731-17	4.55000+	0	5.46798-19	4.60000+	0	2.44530-16126080803	3044
4.65000+	0	1.08092-18	4.70000+	0	2.32062-15	4.75000+	0	3.44618-19126080803	3045
4.80000+	0	2.91424-17	4.85000+	0	1.74878-16	4.90000+	0	1.53958-17126080803	3046
4.95000+	0	1.78289-17	5.00000+	0	0.00000+ 0	5.05000+	0	2.44081-17126080803	3047
5.10000+	0	0.00000+ 0	5.15000+	0	1.21903-16	5.20000+	0	3.27336-17126080803	3048
5.25000+	0	2.02917-17	5.30000+	0	4.75312-17	5.35000+	0	9.17491-18126080803	3049
5.40000+	0	6.50440-18	5.45000+	0	1.30330-17	5.50000+	0	4.70920-18126080803	3050
5.55000+	0	3.96817-17	5.60000+	0	3.20215-17	5.65000+	0	0.00000+ 0126080803	3051
5.70000+	0	1.14255-17	5.75000+	0	0.00000+ 0	5.80000+	0	0.00000+ 0126080803	3052
5.85000+	0	1.17060-17	5.90000+	0	1.56655-17	5.95000+	0	0.00000+ 0126080803	3053
6.00000+	0	2.39622-17	6.05000+	0	0.00000+ 0	6.10000+	0	1.44895-17126080803	3054
6.15000+	0	0.00000+ 0	6.20000+	0	7.68664-18	6.25000+	0	0.00000+ 0126080803	3055
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9.00000-	1	3.62130-13	9.50000-	1	6.17375-13	1.00000+	0	7.87990-14126080803	3064
1.05000+	0	1.25696-14	1.10000+	0	2.82581-13	1.15000+	0	4.74805-14126080803	3065
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1.35000+	0	4.85821-13	1.40000+	0	7.39753-14	1.45000+	0	1.00911-14126080803	3067
1.50000+	0	1.06481-15	1.55000+	0	4.96026-12	1.60000+	0	8.08753-15126080803	3068
1.65000+	0	6.93022-16	1.70000+	0	8.31030-15	1.75000+	0	5.61163-15126080803	3069
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1.95000+	0	5.18651-16	2.00000+	0	1.34253-13	2.05000+	0	2.90824-14126080803	3071
2.10000+	0	2.71213-16	2.15000+	0	3.45287-14	2.20000+	0	1.62198-14126080803	3072
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2.40000+	0	1.36854-16	2.45000+	0	2.15532-16	2.50000+	0	2.59258-13126080803	3074
2.55000+	0	3.59531-16	2.60000+	0	1.92057-16	2.65000+	0	8.61027-17126080803	3075
2.70000+	0	1.76775-16	2.75000+	0	3.08196-16	2.80000+	0	1.32993-16126080803	3076
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3.00000+	0	5.66414-17	3.05000+	0	1.68477-17	3.10000+	0	2.14419-15126080803	3078
3.15000+	0	2.42587-17	3.20000+	0	2.64041-17	3.25000+	0	4.78010-17126080803	3079
3.30000+	0	2.01093-16	3.35000+	0	3.54347-16	3.40000+	0	2.59558-17126080803	3080
3.45000+	0	2.39962-17	3.50000+	0	2.68256-16	3.55000+	0	2.08072-16126080803	3081
3.60000+	0	3.70798-17	3.65000+	0	2.68481-17	3.70000+	0	4.54629-17126080803	3082
3.75000+	0	1.61036-17	3.80000+	0	5.37173-17	3.85000+	0	1.69139-17126080803	3083
3.90000+	0	4.12452-17	3.95000+	0	2.46114-17	4.00000+	0	6.09459-18126080803	3084
4.05000+	0	6.55005-17	4.10000+	0	3.28283-16	4.15000+	0	3.43938-18126080803	3085
4.20000+	0	1.94067-17	4.25000+	0	4.24523-17	4.30000+	0	1.49518-17126080803	3086
4.35000+	0	3.56809-16	4.40000+	0	1.43222-17	4.45000+	0	2.33853-17126080803	3087
4.50000+	0	7.85615-18	4.55000+	0	1.78009-19	4.60000+	0	1.30905-16126080803	3088
4.65000+	0	7.32593-19	4.70000+	0	9.09818-19	4.75000+	0	2.48565-19126080803	3089
4.80000+	0	2.31147-17	4.85000+	0	3.75933-20	4.90000+	0	1.22247-17126080803	3090
4.95000+	0	1.20371-17	5.00000+	0	0.00000+ 0	5.05000+	0	1.79563-17126080803	3091
5.10000+	0	0.00000+ 0	5.15000+	0	8.66059-17	5.20000+	0	2.59915-17126080803	3092
5.25000+	0	1.36806-17	5.30000+	0	3.35503-17	5.35000+	0	7.28515-18126080803	3093
5.40000+	0	4.77474-18	5.45000+	0	1.03486-17	5.50000+	0	3.45658-18126080803	3094
5.55000+	0	3.15084-17	5.60000+	0	5.54261-17	5.65000+	0	0.00000+ 0126080803	3095
5.70000+	0	9.07217-18	5.75000+	0	0.00000+ 0	5.80000+	0	0.00000+ 0126080803	3096
5.85000+	0	9.29491-18	5.90000+	0	7.24389-17	5.95000+	0	0.00000+ 0126080803	3097
6.00000+	0	1.90267-17	6.05000+	0	0.00000+ 0	6.10000+	0	1.15051-17126080803	3098
6.15000+	0	0.00000+ 0	6.20000+	0	1.23813-18	6.25000+	0	0.00000+ 0126080803	3099

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3.00000-	1	1.98457-13	3.50000-	1	4.41506-13	4.00000-	1	9.27729-14126080803	3104
4.50000-	1	6.84343-13	5.00000-	1	4.58250-13	5.50000-	1	3.62860-15126080803	3105
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9.00000-	1	2.30955-13	9.50000-	1	1.76388-13	1.00000+	0	4.00967-14126080803	3108
1.05000+	0	3.53931-15	1.10000+	0	6.19641-14	1.15000+	0	1.40787-14126080803	3109
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1.35000+	0	1.38411-13	1.40000+	0	2.15180-14	1.45000+	0	3.35213-15126080803	3111
1.50000+	0	2.71824-16	1.55000+	0	4.00443-12	1.60000+	0	4.16487-16126080803	3112
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1.80000+	0	1.25911-16	1.85000+	0	6.52478-16	1.90000+	0	2.94050-14126080803	3114
1.95000+	0	3.78977-16	2.00000+	0	3.58747-14	2.05000+	0	8.56847-15126080803	3115
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2.25000+	0	3.52664-16	2.30000+	0	4.64506-14	2.35000+	0	7.76842-15126080803	3117
2.40000+	0	8.54485-17	2.45000+	0	1.42861-16	2.50000+	0	2.05451-13126080803	3118
2.55000+	0	2.18336-16	2.60000+	0	1.15758-16	2.65000+	0	4.29324-17126080803	3119
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2.85000+	0	4.59623-15	2.90000+	0	5.12067-17	2.95000+	0	1.20498-17126080803	3121
3.00000+	0	5.07382-17	3.05000+	0	1.12105-17	3.10000+	0	1.70336-15126080803	3122
3.15000+	0	1.60795-17	3.20000+	0	1.52005-17	3.25000+	0	2.84349-17126080803	3123
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4.50000+	0	5.58864-18	4.55000+	0	1.16013-19	4.60000+	0	8.01989-17126080803	3132
4.65000+	0	4.34660-19	4.70000+	0	3.71397-19	4.75000+	0	1.62835-19126080803	3133
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4.95000+	0	7.10074-18	5.00000+	0	0.00000+ 0	5.05000+	0	1.19141-17126080803	3135
5.10000+	0	0.00000+ 0	5.15000+	0	5.49257-17	5.20000+	0	1.88094-17126080803	3136
5.25000+	0	8.05094-18	5.30000+	0	2.10921-17	5.35000+	0	5.27209-18126080803	3137
5.40000+	0	3.21444-18	5.45000+	0	7.48905-18	5.50000+	0	2.32722-18126080803	3138
5.55000+	0	2.28019-17	5.60000+	0	1.84002-17	5.65000+	0	0.00000+ 0126080803	3139
5.70000+	0	6.56532-18	5.75000+	0	0.00000+ 0	5.80000+	0	0.00000+ 0126080803	3140
5.85000+	0	6.72651-18	5.90000+	0	9.00174-18	5.95000+	0	0.00000+ 0126080803	3141
6.00000+	0	1.37692-17	6.05000+	0	0.00000+ 0	6.10000+	0	8.32599-18126080803	3142
6.15000+	0	0.00000+ 0	6.20000+	0	8.33532-19	6.25000+	0	0.00000+ 0126080803	3143
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126		1		0	0		0	0126080803	3145
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1.50000-	1	2.02592-15	2.00000-	1	5.54274-16	2.50000-	1	1.07955-15126080803	3147
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4.50000-	1	1.00191-13	5.00000-	1	2.56083-14	5.50000-	1	7.49906-16126080803	3149
6.00000-	1	6.25250-15	6.50000-	1	6.64259-15	7.00000-	1	1.35258-13126080803	3150
7.50000-	1	4.64244-13	8.00000-	1	3.79694-14	8.50000-	1	8.57980-15126080803	3151
9.00000-	1	1.62927-14	9.50000-	1	3.81827-17	1.00000+	0	2.83590-15126080803	3152
1.05000+	0	3.03902-16	1.10000+	0	1.10034-16	1.15000+	0	7.96094-17126080803	3153
1.20000+	0	2.14858-15	1.25000+	0	4.69553-17	1.30000+	0	1.73778-17126080803	3154
1.35000+	0	3.17445-17	1.40000+	0	3.61049-17	1.45000+	0	5.11378-16126080803	3155
1.50000+	0	9.03888-18	1.55000+	0	3.22556-13	1.60000+	0	3.07323-18126080803	3156
1.65000+	0	7.87044-18	1.70000+	0	4.15864-18	1.75000+	0	1.34505-17126080803	3157
1.80000+	0	3.58570-18	1.85000+	0	1.89742-17	1.90000+	0	2.28087-17126080803	3158
1.95000+	0	4.19051-17	2.00000+	0	6.23586-17	2.05000+	0	4.14206-17126080803	3159
2.10000+	0	6.71972-18	2.15000+	0	1.94052-15	2.20000+	0	3.26600-18126080803	3160
2.25000+	0	1.60024-17	2.30000+	0	3.73992-15	2.35000+	0	6.06427-18126080803	3161
2.40000+	0	4.86222-18	2.45000+	0	9.14505-18	2.50000+	0	1.63753-14126080803	3162
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5.25000+ 0 1.32812- 8 5.30000+ 0 1.52954- 8 5.35000+ 0 1.35138- 8126080811 3507
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                     REMAINDER OF CARDS IN FILE DELETED

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APPENDIX B

LASL Identification No. LP-0847

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      PROGRAM FITPULS (TAPE5,TAPE6,TAPE7,TAPE10,TAPE20)                 FIT
C                                                                       FIT
C     THIS PROGRAM ACCEPTS FISSION-PRODUCT DATA (BETA AND GAMMA) IN     FIT
C     UNITS OF ENERGY /FISSION WHICH HAS BEEN ENERGY BINNED INTO FINE   FIT
C     GROUPS(150)FOR A NUMBER OF COOLING TIME STEPS DERIVED AS FOLLOWS- FIT
C       YIELD DATA FROM ENDF WAS FIRST PROCESSED BY THE FPCYS CODE TO   FIT
C       SUPPLY FINE GROUP INPUT FOR THE FPSPEC CODE.  FPSPEC ALSO       FIT
C       REQUIRES OUTPUT FROM THE CINDER-10 CODE.  FINALLY THE OUTPUT OF FIT
C       FPSPEC WAS PROCESSED BY THE FOTOELF CODE WHICH PUTS THE DATA IN FIT
C       AN ENDF-LIKE FORMAT WHICH IS THE INPUT DATA LIBRARY FOR THIS    FIT
C       CODE(FITPULS).                                                  FIT
C                                                                       FIT
C     FITPULS REBINS THIS DATA INTO A USER CHOSEN BROAD GROUP STRUCTURE FIT
C     (NOTE THAT THIS REBINNING CHANGES UNITS TO ENERGY/FISSION-SEC.)   FIT
C     AND FITS THE DATA FOR EACH GROUP WITH A LINEAR COMBINATION OF     FIT
C     FUNCTIONS AS FOLLOWS --                                           FIT
C                                                                       FIT
C     GXC(I,K)=SUM*ALF(L,K)*(EXP(-ALAM(L,K)*T(I)),SUM OVER L=1,KTRM,    FIT
C              WHERE KTRM IS THE NUMBER OF PAIRS OF PARAMETERS (ALF,    FIT
C              ALAM) FOR GROUP K.                                       FIT
C                                                                       FIT
C     GXC(I,K)=ENERGY(MEV)/FISS-SEC FOR GROUP K AND COOLING TIME T(I).  FIT
C     MAX.ALLOWED VALUE FOR KTRM(KTR(K)),NO. OF PARAM. PAIRS/GP=50.     FIT
C     MAX.ALLOWED NO. OF BROAD GROUPS,NERG=25.                          FIT
C     MAX. ALLOWED NO. OF INPUT COOLING TIME STEPS,ITSP=70.             FIT
C                                                                       FIT
C     THIS CODE IS USUALLY RUN IN SEVERAL PASSES.  THE REASON FOR THIS  FIT
C     IS THAT ON THE INITIAL PASSES,SINGLE PARAMETER(ALF) FITS ARE      FIT
C     MADE FOR THE SPECTRA AND ON FINAL PASSES,FITS ARE MADE MORE       FIT
C     ACCURATE BY FITTING BOTH PARAMETERS.  AN EXCEPTION IS THE CASE    FIT
C     WHERE GOOD FITS HAVE PREVIOUSLY BEEN OBTAINED FOR A PARTICULAR    FIT
C     GROUP STRUCTURE FOR ONE NUCLIDE AND FITS ARE DESIRED FOR ANOTHER  FIT
C     NUCLIDE IN THE SAME GROUP STRUCTURE.  THEN,THE FIRST SET OF       FIT
C     PARAMETERS CAN BE APPLIED DIRECTLY TO THE SECOND PROBLEM.         FIT
C                                                                       FIT
C     THE CODE ALSO HAS AN OPTION OF REDUCING EXPERIMENTAL DATA FOR     FIT
C     A FINITE IRRADIATION TIME TO A PULSE AND OBTAINING A FIT FOR THE  FIT
C     EQUIVALENT PULSE.  FOR THIS OPTION SET IRAD=1.                    FIT
C                                                                       FIT
      COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, IISP, IPROB,   FIT
     1 NIN, NOUT                                                        FIT
      COMMON /PULSDAT/ NOT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(2FIT
     1 5,50)                                                            FIT
      COMMON /PULSCAL/ A(50,50), B(50,1)                                FIT
      COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100)                    FIT
      COMMON /MANI/ WX(100), ITTL(8), KTR(50), NS(10), KKN(25), DIFLIM  FIT
      DIMENSION TC(100), LXX(20), TMN(20), TMX(20)                      FIT
      COMMON /ENDF/ MAT, MF, MT, RUNTIM, NPUN                           FIT
      COMMON /TRMOT/ TL(10), LTM(50), LT                                FIT
      COMMON /FINRAD/ IRAD, NCOKS, RADT(200), DELT(200)                 FIT
```

```
C
      NIN=5
      NOUT=6
      NDT=10
      READ (NIN,170) NPUN,IRAD,NCORS
C
C     SET NPUN=7 HERE IF REBINNED DATA CARDS WANTED,OTHERWISE NPUN=20.
C     IRAD=0,REGULAR PULSE FIT REQUESTED, =1,FIT FOR FINITE IRRADIATION
C            TIME DATA WANTED.
C     NCOR=0,CALL CORSBIN, =1,NO CALL.
C
      IF (NCORS.LE.0) CALL CORSBIN
C
C     SEE CORSBIN FOR MAT1,MF1,MT1 INPUT.
C
      READ (NIN,150) (TITL(I),I=1,8)
C
C     TITL=EIGHTY CHARACTER(HOLLERITH) TITLE.
C
C     TITL(1)=CHARACTER FOR CALLING SUBROUTINE SELECT TO CHOOSE DATA
C             TO BE USED IN FIT.  IF TITL(1)= SELECT   ,SEE SUBROUTINE
C             SELECT FOR INPUT.
C             IF TITL(1)= DO NOT GO,PROGRAM STOPS.  USED WHEN JUST
C             REBINNED DATA DESIRED.
C
      IF (TITL(1).EQ.10H SELECT    ) CALL SELECT
      WRITE (NOUT,160) (TITL(I),I=1,8)
      IF (TITL(1).EQ.10H DO NOT GO) STOP
      READ (NIN,170) IPROB,NTOTER,NPUN,NSTEP,NFINL
C
C     IPROB = PROBLEM NO.  MAKE NEGATIVE IF FIT IS MADE IN SEGMENTS.
C     NTOTER = FLAG TO DENOTE SPEC. OR TOTAL CALC.,=0,CODE READS SPECT.
C               DATA FROM TAPE FILE,=1,CODE READS TOTAL DATA FROM CARDS.
C     NPUN = FLAG FOR PUNCH,=7,PUNCH ALPHAS AND LAMDAS,=20, NO PUNCH.
C     NSTEP = FLAG TO CALL OHFIT ROUTINE WHICH FITS BOTH ALPHAS AND
C             LAMDAS,=0,ROUTINE NOT CALLED,=1,ROUTINE CALLED.  ROUTINE
C             USUALLY NOT CALLED UNTIL A COUPLE OF PASSES ARE MADE TO
C             ADJUST THE PARAMETERS WITH THE SINGLE FIT ALONE.  SEE
C             SUBROUTINE PULSFIT WHERE POINTS ARE SELECTED FOR FIT.
C     NFINL = FLAG FOR READING ALL PARAMATERS FROM PREVIOUS PROB.I.E.,
C             PULSFIT WILL NOT BE CALLED FOR ANY GROUP,=0,NO EFFECT,=1,
C             SEE READ STATEMENTS BELOW.
C
      IF (NTOTER.GT.0) CALL RUNTOTS
      READ (NIN,180) DIFLIM,RUNTIM,TMIN,TMAX,GXMIN
C
C     DIFLIM = MAX. PERCENT POINTWISE DEVIATION ALLOWED IN STEPIT.
C               USUALLY SET HIGH ON INITIAL PASSES AND TIGHTENED UP  IN
C               SUBSEQUENT PASSES.
C     RUNTIM = RUNNING TIME.  MAKE FRACT. OF SECOND LESS THAN THAT USED
C               ON CONTROL CARD TO GET PUNCHED CARDS FOR SUBSEQUENT RUN.
C     TMIN = LOWEST COOLING TIME DESIRED.
C     TMAX = HIGHEST COOLING TIME DESIRED.
C     GXMIN = MINIMUM ALLOWED VALUE OF GX(I,K).  THIS SHOULD BE SET
C             SO NO FIT IS ATTEMPTED OVER MORE THAN ABOUT 15 DECADES.
C
      NP=ITSP
      IF (T(1).LE.0.0) T(1)=1.E-4
      IF (T(NP).LE.0.0) NP=NP-1
      DO 10 N=1,NP
      TC(N)=T(N)
   10 CONTINUE
      NE=NERG
      NBOS=NE+1
      EB(NBOS)=7.5
```

```
C
C     KKN = FLAG FOR CALLING STEPIT BY GROUP,=0,NO CALL,=GROUP NO.,
C           STEPIT ROUTINE CALLED,=NEGATIVE GROUP NO.,TRMSEE ROUTINE
C           CALLED.  NOTE IF NSTEP =0,KKN NOT ACTIVITATED.
C
      READ (NIN,170) (KKN(K),K=1,NERG)
C
C     OUTPUT CARDS FROM PREVIOUS PROBLEM ARE READ HERE IF NFINL=1.
C
      IF (NFINL.NE.1) GO TO 30
      READ (NIN,150) (TITL(I),I=1,8)
      READ (NIN,220) C1,C2,NUL,NLU,NUL,NERG
      DO 20 K=1,NERG
      READ (NIN,220) EB(K),EB(K+1),NUL,NUL,NUL,KNG
      READ (NIN,220) TMN(K),TMX(K),NUL,NUL,NUL,KTR(K)
      KTRM=KTR(K)
      READ (NIN,230) (ALF(K,L),ALAM(K,L),L=1,KTRM)
      KKX=KKN(K)
      IF (KKX.LT.0) CALL TRMSEE (K,1)
      IF (KKX.LT.0) CALL TRMSEE (K,0)
      KTR(K)=KTRM
   20 CONTINUE
      GO TO 100
   30 CONTINUE
      DO 90 K=1,NERG
C
C     THIS PORTION OF ROUTINE ALLOWS FIT IN SEVERAL SEGMENTS.  TO
C     ACTIVATE, SET IPROB NEGATIVE.  NOTE - INPUT NEEDED FOR EA. GROUP.
C
C     NSEG = NUMBER OF SEGMENTS + 1
C     NS = BREAKPOINTS OF SEGMENTS.
C
      NSEG=2
      NS(1)=1
      IF (IPROB.LT.0) READ (NIN,170) NSEG,(NS(LX),LX=2,NSEG)
C
      IF (NSEG.LE.2) NS(2)=NP
      NSEG1=NSEG-1
      LTRM=0
      KTR(K)=0
      DO 60 N=1,NSEG1
      N1=NS(N)
      N2=NS(N+1)
      ITP=N2-N1+1
      ITSP=0
      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 40 I=1,ITP
      NN=N1+I-1
      IF (GX(K,NN).LT.GXMIN) GO TO 40
      IF (TC(NN).LT.TMIN) GO TO 40
      IF (TC(NN).GT.TMAX) GO TO 40
      IX=IX+1
      ITSP=IX
      LXX(N)=IX
      FX(IX)=GX(K,NN)
      T(IX)=TC(NN)
   40 CONTINUE
      CALL PULSFIT (K)
      IF (N.NE.NSEG1) KTRM=KTRM-1
      DO 50 J=1,KTRM
      LTRM=LTRM+1
      ALF(K,LTRM)=B(J,1)
      ALAM(K,LTRM)=ALAMDA(J)
      IF (ALAMDA(KTRM).GT.ALAMDA(KTRM-1)) KTRM=KTRM-1
   50 CONTINUE
      KTR(K)=KTR(K)+KTRM
   60 CONTINUE
      KTRM=KTR(K)
```

```
      DO 70 J=1,KTRM
      ALAMDA(J)=ALAM(K,J)
      B(J,1)=ALF(K,J)
   70 CONTINUE
      WRITE (NOUT,190) K,EB(K),EB(K+1)
      DO 80 J=1,KTRM
      WRITE (NOUT,200) J,ALAMDA(J),B(J,1)
   80 CONTINUE
   90 CONTINUE
  100 CONTINUE
      DO 140 K=1,NERG
      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 110 I=1,NP
      IF (GX(K,I).LT.GXMIN) GO TO 110
      IF (TC(I).LT.TMIN) GO TO 110
      IF (TC(I).GT.TMAX) GO TO 110
      IX=IX+1
      ITSP=IX
      LXX(K)=IX
      FX(IX)=GX(K,I)
      T(IX)=TC(I)
  110 CONTINUE
      KTRM=KTR(K)
      DO 120 L=1,KTRM
      ALAMDA(L)=ALAM(K,L)
      B(L,1)=ALF(K,L)
  120 CONTINUE
      KK1=KKN(K)
      KK2=-KKN(K)
      IF (KK2.EQ.K) KK1=K
      IF (K.NE.KK1) GO TO 130
      IF (NSTEP.LE.0) GO TO 130
      WRITE (NOUT,160) (TITL(I),I=1,8)
      WRITE (NOUT,210) K
      KTRM=KTR(K)
      IF (NSTEP.GT.0) CALL DHFIT (K)
      KTR(K)=KTRM
  130 CONTINUE
      CALL FINECHK (K)
  140 CONTINUE
      IF (NPUN.EQ.7) CALL PCHOUT (LXX)
      STOP
C
  150 FORMAT (8A10)
  160 FORMAT (1H1,10X,8A10)
  170 FORMAT (12I6)
  180 FORMAT (6E12.5)
  190 FORMAT (1H1,24H  RESULTS FOR GROUP NO. ,I3,11H E-LOWER = ,1PE12.5,
     1 17H MEV,  E-UPPER = ,1PE12.5,5H MEV,)
  200 FORMAT (1H0,4H J =,I3,9H ALAMDA =,1PE12.5,4H B =,1PE12.5)
  210 FORMAT (1H0,35H  STEPIT HAS BEEN CALLED FOR GROUP ,I3)
  220 FORMAT (2E11.4,4I11,I4,I2,I3,I5)
  230 FORMAT (6E11.4)
      END


      SUBROUTINE SELECT
C
C     THIS ROUTINE USED FOR SELECTING A SUBSET OF THE DATA TO BE FIT.
C
      COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPRUB,
     1 NIN, NOUT
      COMMON /PULSDAT/ NOT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(2
     1 5,50)
      COMMON /PULSCAL/ A(50,50), B(50,1)
```

```
      COMMON /MANI/ WX(100), TITL(8), IPT(50), NS(10), KKN(25), DIFLIM
C
      READ (NIN,50) ITS,(IPT(I),I=1,ITS)
C
C     ITS=NO OF TIME STEPS DESIRED.
C     IPT=INDEXES OF DESIRED TIME STEPS.
C
      DO 20 K=1,NERG
      DO 10 I=1,ITS
      II=IPT(I)
      ALAMDA(I)=T(II)
      A(K,I)=GX(K,II)
   10 CONTINUE
   20 CONTINUE
      DO 40 K=1,NERG
      DO 30 I=1,ITS
      GX(K,I)=A(K,I)
      T(I)=ALAMDA(I)
   30 CONTINUE
      WRITE (NOUT,60) (I,T(I),GX(K,I),I=1,ITS)
   40 CONTINUE
      ITSP=ITS
      RETURN
C
   50 FORMAT (12I6)
   60 FORMAT (4H  I=,I3,3H T=,1E12.5,4H GX=,1E12.5)
      END


      SUBROUTINE TRMSEL (LK,KKX)
C
C     THIS ROUTINE IS CALLED IF KKN IS SET NEGATIVE FOR A GROUP.
C     ROUTINE PRINTS OUT TERM BY TERM CALCULATION OF FX FOR USE IN
C     ADJUSTING FITTING PARAMETERS.  THIS DONE BY CHANGING AND/OR
C     REMOVING PARAMETERS.
C
      COMMON /MANI/ WX(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM
      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(2
     1 5,50)
      COMMON /PULSCAL/ TRM(50,50), TPRT(50)
      COMMON /FINRAD/ IRAD, NCORS, RADT(200), DELT(200)
      COMMON /TRMOT/ TL(10), LTM(50), LT
C
      K=LK
      KTRM=KTR(K)
      TL(1)=10HORIGINAL P
      TL(2)=10HARAMATRS F
      TL(3)=10HOR GROUP
      IF (KKX.EQ.0) GO TO 10
      WRITE (NOUT,150) (TL(I),I=1,3),K
      WRITE (NOUT,160) (L,ALF(K,L),ALAM(K,L),L=1,KTRM)
   10 IF (KKX.GT.0) GO TO 90
      DO 40 I=1,ITSP
      FX(I)=0.
      DO 30 L=1,KTRM
      TRM(I,L)=ALF(K,L)*EXP(-ALAM(K,L)*T(I))
      IF (IRAD.LE.0) GO TO 20
      IF (TRM(I,L).LT.0.) TRM(I,L)=0.
      COFF=ALF(K,L)/DELT(I)/ALAM(K,L)**2
      XPO1=1.-EXP(-ALAM(K,L)*RADT(I))
      XPO2=1.-EXP(-ALAM(K,L)*DELT(I))
      XPO3=EXP(-ALAM(K,L)*(T(I)-DELT(I)/2.))
   20 CONTINUE
      IF (IRAD.EQ.1) TRM(I,L)=COFF*XPO1*XPO2*XPO3
      LTM(L)=L
      FX(I)=FX(I)+TRM(I,L)
```

```
   30 CONTINUE
   40 CONTINUE
      K1=1
   50 K2=K1+4
      IF (K2.GT.KTRM) K2=KTRM
      WRITE (NOUT,170) (LTM(L),L=K1,K2)
      DO 60 I=1,ITSP
      WRITE (NOUT,180) T(I),GX(K,I),(TRM(I,L),L=K1,K2)
   60 CONTINUE
      K1=K2+1
      IF (K1.LE.KTRM) GO TO 50
      DO 80 I=1,ITSP
      PCTDIF=0.
      IF (GX(K,I).LE.0.) GO TO 70
      PCTDIF=(GX(K,I)-FX(I))/GX(K,I)*100.
   70 CONTINUE
      WRITE (NOUT,190) I,T(I),GX(K,I),FX(I),PCTDIF
   80 CONTINUE
      IF (KKX.LE.0) RETURN
   90 CONTINUE
      READ (NIN,210) MLT
      IF (MLT.EQ.0) GO TO 110
      DO 100 MM=1,MLT
      READ (NIN,200) L,ALF(K,L),ALAM(K,L)
  100 CONTINUE
  110 CONTINUE
      READ (NIN,210) LT,(LTM(JJ),JJ=1,LT)
C
C     MLT=NO OF PARAMETERS TO BE CHANGED
C     LT = NUMBER OF TERMS TO BE REMOVED.
C     LTM(L) = TERM NOS. OF TERMS TO BE REMOVED.
C
      IF (LT.EQ.0) RETURN
      LTX=0
      LL=1
      KTRM=KTR(K)
      DO 130 L=1,KTRM
      IF (LTM(LL).EQ.L) GO TO 120
      LTX=LTX+1
      TRM(1,LTX)=ALF(K,L)
      TRM(2,LTX)=ALAM(K,L)
      GO TO 130
  120 CONTINUE
      LL=LL+1
  130 CONTINUE
      KTRM=LTX
      DO 140 L=1,KTRM
      ALF(K,L)=TRM(1,L)
      ALAM(K,L)=TRM(2,L)
  140 CONTINUE
      TL(1)=10HREVISED PA
      TL(2)=10HRAMETERS F
      KTR(K)=KTRM
      TL(3)=10HOR GROUP
      WRITE (NOUT,150) (TL(I),I=1,3),K
      WRITE (NOUT,160) (L,ALF(K,L),ALAM(K,L),L=1,KTRM)
      RETURN
C
  150 FORMAT (1H1,5X,3A10,I3)
  160 FORMAT (1H0,3H L=,I3,10H ALF(K,L)=,1PE11.4,11H ALAM(K,L)=,1PE11.4)
  170 FORMAT (1H0,25H     COUL TIME           GX,5I15)
  180 FORMAT (1P7E15.5)
  190 FORMAT (1H0,3H I=,I3,3H T=,1E12.5,4H GX=,1E12.5,4H FX=,1E12.5,8H P
     1CTDIF=,1E12.5)
  200 FORMAT (I6,2E12.5)
  210 FORMAT (12I6)
      END
```

```
      SUBROUTINE CORSBIN
C
C     ROUTINE FORMS COARSE GROUPS FROM FINE GROUP DATA IN ENDF-LIKE
C     FORMAT.
C
      COMMON /PULSIN/ A0(50), FX(200), T(401), KE, ITSP, IPROB, NIN,
     1 NOUT
      COMMON /PULSDAT/ NDF, EB(25), GB(25,400), NERG, E0(200), DUM(70),
     1 TOT(50)
      COMMON /ENDF/ MAT1, MF1, MT1, RUNTIM, NPUN
C     READ INPUT
      READ (NIN,90) MAT1,MF1,MT1
C
C     MAT1=MAT NO. OF FISSIONING NUCLIDE DESIRED.
C     MF1=DAT TYPE DESIRED,MF1=80=F.P.DATA FOR THERMAL PULSE,MF1=81=
C         F.P. DATA FOR FAST PULSE,ETC.
C     MT1=TYPE OF F.P. WANTED,MT1=801=DATA FOR BETA- PLUS GAMMA,MT1=802=
C         DATA FOR GAMMA ONLY,MT1=803=DATA FOR BETA- ONLY,ETC.
C
C     SEARCH ENDF TAPE FOR DESIRED DATA.
C
   10 CONTINUE
      READ (NDF,100) (A0(I),I=1,7),MAT,MF,MT,NSEQ
      IF (MF.EQ.-0) MF=80
      IF (MAT.EQ.-1) WRITE (NOUT,110) MAT,NDF
      IF (MAT.EQ.-1) STOP
      IF (MAT.LT.MAT1) GO TO 10
      IF (MAT.EQ.MAT1) GO TO 20
      WRITE (NOUT,110) MAT1,NDF
      STOP
   20 CONTINUE
      IF (MF.LT.MF1) GO TO 10
      IF (MF.EQ.MF1) GO TO 30
      WRITE (NOUT,120) MF1,NDF
      STOP
   30 CONTINUE
      IF (MT.LT.MT1) GO TO 10
      IF (MT.EQ.MT1) GO TO 40
      WRITE (NOUT,130) MT1,NDF
      STOP
   40 CONTINUE
      READ (NDF,140) NT
      READ (NDF,90) NICHT
      ITSP=NT
C
C     READ BROAD GROUP STRUCTURE
C
      READ (NIN,90) NE
      READ (NIN,150) (EB(N),N=1,NE)
C
C     NE=NO OF BROAD GROUPS PLUS ONE.
C     EB=ENERGY BOUNDS INCLUDING UPPER AND LOWER BOUNDS IN MEV
      NE=NE-1
      NERG=NE
      DO 70 IT=1,NT
      READ (NDF,160) T(IT),KE
      READ (NDF,90) NICHT
      READ (NDF,150) (E0(K),FX(K),K=1,KE)
      KE1=KE+1
      E0(KE1)=(E0(KE)-E0(KE-1))+E0(KE)
C
C     THE FOLLOWING LOOP CHANGES UNITS TO MEV/SEC.  THE TIME DURATION
C     OF THE PULSE IS ASSUMED TO BE 1.E-4 SEC.
C
      DO 50 K=1,KE
      FX(K)=FX(K)/1.E-4
   50 CONTINUE
      CALL REBIN
      DO 60 IE=1,NE
```

```
      GB(IE,IT)=DUM(IE)
   60 CONTINUE
   70 CONTINUE
      DO 80 IE=1,NE
      WRITE (NOUT,170) IE,EB(IE),EB(IE+1)
      WRITE (NOUT,180) (IT,T(IT),GB(IE,IT),IT=1,NT)
      WRITE (NPUN,90) MAT1,MF1,MT1
      WRITE (NPUN,90) NE,NT
      WRITE (NPUN,190) IE,EB(IE),EB(IE+1)
      WRITE (NPUN,190) (IT,T(IT),GB(IE,IT),IT=1,NT)
   80 CONTINUE
      REWIND 10
      RETURN
C
   90 FORMAT (6I11)
  100 FORMAT (6A10,A6,I4,I2,I3,I5)
  110 FORMAT (1H1,15H  SORRY, MAT = ,I4,13H NOT ON TAPE ,I3)
  120 FORMAT (1H1,14H  SORRY, MF = ,I4,13H NOT ON TAPE ,I3)
  130 FORMAT (1H1,14H  SORRY, MT = ,I4,13H NOT ON TAPE ,I3)
  140 FORMAT (55X,I11)
  150 FORMAT (6E11.4)
  160 FORMAT (11X,1E11.4,33X,I11)
  170 FORMAT (1H0,17H  ENERGY BIN NO. ,I3,6H FROM ,1PE12.5,8H MEV TO ,1P
     1 E12.5,5H MEV.)
  180 FORMAT (1H ,13H TIME STEP = ,I3,16H COOLING TIME = ,1PE12.5,6H FX
     1= ,1PE12.5)
  190 FORMAT (2(I11,2E11.4))
      END


      SUBROUTINE REBIN
C
C     ROUTINE FOR BROAD GROUP BINNING.  BOUNDARIES DO NOT HAVE TO
C     COINCIDE WITH FINE GROUP BOUNDARIES.  WRITTEN BY GRAHAM
C     FOSTER,LASL,1975.
C     CHANGED OCT. 1977, LASL, D. GEORGE
C
      COMMON /PULSIN/ A0(50), Y(200), T(401), NX, ITSP, IPROB, NIN, NOUT
      COMMON /PULSDAT/ NDT, U(25), GB(25,400), NU, X(200), V(70), IU1(50
     1 )
      SUM1=SUM2=0.
      NU1=NU+1
      NX1=NX+1
      DO 10 IU=1,NU1
   10 V(IU)=0.
      DO 20 IX=1,NX
      SUM1=SUM1+Y(IX)
   20 CONTINUE
C  FIND THE FIRST BIN
      DO 30 IX=1,NX
      IF (X(IX).EQ.U(1)) GO TO 50
   30 IF (X(IX).GT.U(1)) GO TO 40
      WRITE (NOUT,110)
      RETURN
   40 V(1)=Y(IX-1)*(X(IX)-U(1))/(X(IX)-X(IX-1))
   50 IX=IX+1
      DO 80 IU=1,NU
   60 IF (X(IX).GT.U(IU+1)) GO TO 70
      V(IU)=V(IU)+Y(IX-1)
      IF (IX.GT.NX) GO TO 90
      IX=IX+1
      GO TO 60
   70 V(IU)=V(IU)+Y(IX-1)*(U(IU+1)-X(IX-1))/(X(IX)-X(IX-1))
   80 CONTINUE
   90 IF (X(NX1).GT.U(NU1)) WRITE (NOUT,120) X(NX1),U(NU1)
      DO 100 IU=1,NU
  100 SUM2=SUM2+V(IU)
```

```
      ERRD=0.001
      IF (ABS(SUM2-SUM1).GT.ERRD*SUM1) WRITE (NOUT,130) SUM1,SUM2
      RETURN
C
  110 FORMAT (29H CANT FIND FIRST ENERGY BOUND)
  120 FORMAT (17H0***** LAST DATUME10.3,27H EXTENDS BEYOND END OF GRID,E1
     1 0.3,6H *****/)
  130 FORMAT (32H0***** INTEGRAL BEFORE REBINNINGE10.3,41H DOES NOT EQUAL
     1L INTEGRAL AFTER REBINNING E10.3,6H *****/)
      END


      SUBROUTINE RUNTOTS
C
C     ROUTINE TO READ TOTALS,I.E.,GX(K,I) SUMMED OVER ENERGY.
C
      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(2
     1 5,50)
      COMMON /PULSCAL/ A(50,50), B(50,1)
      COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100)
      COMMON /FINRAD/ IRAD, NCOMS, RADT(200), DELT(200)
C
C     THIS SUBROUTINE IS USED FOR READING EXPERIMENTAL DATA.
C     UNFORTUNATELY, THIS CAN BE RECEIVED IN A VARIETY OF FORMATS,SO
C     THIS ROUTINE MUST BE CONTINUALLY CHANGED TO ACCOMADATE WHATEVER
C     FORMAT THS DATA IS IN.  THE FUNNY LOOKING STATEMENTS BELOW ARE
C     FOR READING SOME ORNL DATA IN THE WHITTEMORE JUNK FORMAT.
C
      DIMENSION HDR(8)
      READ (NIN,30) NP,NE,NHD
      DO 10 L=1,NHD
      READ (NIN,50) (HDR(I),I=1,8)
      WRITE (NOUT,50) (HDR(I),I=1,8)
   10 CONTINUE
      DO 20 I=1,NP
      IF (I.LE.NE) EB(I)=0.0
      READ (NIN,40) (GX(K,I),K=10,15)
      WRITE (NOUT,40) (GX(K,I),K=10,15)
      RADT(I)=GX(10,I)
      T(I)=GX(11,I)*GX(12,I)/2.0
      DELT(I)=1.0
      GX(1,I)=(GX(13,I)+GX(14,I))*GX(10,I)/GX(12,I)
   20 CONTINUE
      ITSP=NP
      NE=1
      NERG=1
      RETURN
C
   30 FORMAT (12I6)
   40 FORMAT (6E12.5)
   50 FORMAT (8A10)
      END


      SUBROUTINE DHFIT (K)
C
C     ROUTINE WITH SUBROUTINES FUNK AND STEPIT PERFORM TWO PARAMETER
C     FITS,I.E. BOTH ALF AND ALAM.  ADAPTATION OF STEPIT CODE BY
C     M.G.STAMATALAIOS,LASL,1976,FOR THIS APPLICATION.
C
      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), DUMMY, MATRIX,
     2 ERR(70,70), CHISQ, BSAV(100), VEC(70), TRIAL(70), XSAVE(70), CHI(
```

```
3 70), SECOND(2,2), OLDVEC(70), SALVO(70), AOSC(70,15), CHIOSC(15),
4 DUM(586), NERG, ALF(25,50), ALAM(25,50)
  COMMON /MANI/ TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM
  COMMON /ENDF/ MAT, MF, MT, RUNTIM, NPUN
  COMMON /FINRAD/ IRAD, NCORS, RADT(200), DELT(200)
  DIMENSION TTL(10), XLL(10), YLL(10)
  DO 10 KK=1,KTRM
  II=2*KK-1
  IJ=2*KK
  X(II)=ALF(K,KK)
  X(IJ)=ALAM(K,KK)
10 CONTINUE
  NV=2*KTRM
  IF (NV.LE.70) GO TO 20
  WRITE (IOUT,150) NV
  RETURN
20 CONTINUE
  DO 30 I=1,NV,2
  XMIN(I)=X(I)*0.1
  IF (X(I).LT.0.) XMIN(I)=10.*X(I)
  XMAX(I)=X(I)*10.
  IF (X(I).LT.0.) XMAX(I)=X(I)*0.1
  XMIN(I+1)=0.5*X(I+1)
  XMAX(I+1)=2.0*X(I+1)
30 CONTINUE
  WRITE (NOUT,160)
  WRITE (NOUT,170) (X(I),I=1,NV)
  WRITE (NOUT,180)
  WRITE (NOUT,170) (XMIN(I),I=1,NV)
  WRITE (NOUT,190)
  WRITE (NOUT,170) (XMAX(I),I=1,NV)
  DO 40 I=1,NV
  DELTMA(I)=0.1*X(I)
  DELMIN(I)=0.001*X(I)
40 MASK(I)=0
  NERS=ITSP
  DO 50 I=1,NERS
  QW=1.
50 W(I)=(1./DH(I))**QW
  CHSQ=0.
  DO 100 I=1,NERS
  CALC(I)=0.
  DO 90 J=1,NV,2
  IF (IRAD.LE.0) GO TO 60
  COFF=X(J)/DELT(I)/X(J+1)**2
  XPO1=1.-EXP(-X(J+1)*RADT(I))
  XPO2=1.-EXP(-X(J+1)*DELT(I))
  XPO3=EXP(-X(J+1)*(T(I)-DELT(I)/2.))
  CALC(I)=CALC(I)+COFF*XPO1*XPO2*XPO3
  GO TO 90
60 TEMP=X(J+1)*T(I)
  IF (ABS(TEMP).LE.600) GO TO 70
  XPO=0.
  GO TO 80
70 XPO=X(J)*EXP(-TEMP)
80 CALC(I)=CALC(I)+XPO
90 CONTINUE
  PERDIF(I)=100.*(CALC(I)/DH(I)-1.)
100 CHSQ=CHSQ+(CALC(I)-DH(I))*(CALC(I)-DH(I))*W(I)*W(I)
  WRITE (NOUT,200) CHSQ
  WRITE (NOUT,210)
  WRITE (NOUT,220)
  WRITE (NOUT,230) (T(I),DH(I),CALC(I),PERDIF(I),I=1,NERS)
  CALL STEPIT
  DO 120 I=1,NERS
  CALC(I)=0.
  DO 120 J=1,NV,2
  IF (IRAD.LE.0) GO TO 110
  COFF=X(J)/DELT(I)/X(J+1)**2
```

```
      XPO1=1.-EXP(-X(J+1)*RADT(I))
      XPO2=1.-EXP(-X(J+1)*DELT(I))
      XPO3=EXP(-X(J+1)*(T(I)-DELT(I)/2.))
      CALC(I)=CALC(I)+COFF*XPO1*XPO2*XPO3
      GO TO 120
  110 TEMP=X(J+1)*T(I)
      IF (ABS(TEMP).GT.600) GO TO 120
      CALC(I)=CALC(I)+X(J)*EXP(-TEMP)
  120 CONTINUE
      DO 130 I=1,NERS
  130 PERDIF(I)=100.*(CALC(I)/DH(I)-1.)
      WRITE (NOUT,220)
      WRITE (NOUT,230) (T(I),DH(I),CALC(I),PERDIF(I),I=1,NERS)
      ENCODE (34,240,TTL(1)) K
      ENCODE (20,250,XLL)
      ENCODE (20,260,YLL)
C     CALL PLOTM (T,PERDIF,-NERS,1,0,0,0.,1.,1.,TTL,34,XLL,20,YLL,20)
      DO 140 J=1,KTRM
      II=2*J-1
      IJ=2*J
      ALF(K,J)=X(II)
      ALAM(K,J)=X(IJ)
  140 CONTINUE
      RETURN
C
  150 FORMAT (24H0  TOO MANY TERMS.  NV =,I3)
  160 FORMAT (1H0,10X,18HINITIAL PARAMETERS,/)
  170 FORMAT (1H ,20X,6E12.4)
  180 FORMAT (1H ,10X,12HLOWER LIMITS,/)
  190 FORMAT (1H ,10X,12HUPPER LIMITS,/)
  200 FORMAT (1H ,10X,36HCHI-SQUARE WITH ORIGINAL GUESSES IS ,E12.4)
  210 FORMAT (1H0,10X,31HCOMPARISON WITH INITIAL GUESSES,/)
  220 FORMAT (1H0,//,9X,1HT,10X,2HDH,9X,4HCALC,7X,6HPERDIF,/)
  230 FORMAT (1H ,4F12.4)
  240 FORMAT (32HPERCENT DEVIATION FOR GROUP NO. ,I2)
  250 FORMAT (20H   TIME IN SECONDS  )
  260 FORMAT (20H  PERCENT DEVIATION )
      END
```

```
      SUBROUTINE FUNK
      COMMON /PULSIN/ ALAMDA(50), DH(200), T(100), NERS, PERDIF(100),
     1 CALC(100), W(100), KTRM, ITSP, IPROB, NIN, NOUT
      COMMON /PULSDAT/ NOT, EB(25), HOLD(25,100), NV, NTRACE, MASK(70),
     1 X(70), XMAX(70), XMIN(70), DELTAX(70), DELMIN(70), DUMMY, MATRIX,
     2 ERR(70,70), CHISQ, BSAV(100), VEC(70), TRIAL(70), XSAVE(70), CHI(
     3 70), XECOND(2,2), OLDVEC(70), SALVO(70), AOSC(70,15), CHIOSC(15),
     4 DUM(586), NERG, ALF(25,50), ALAM(25,50)
      COMMON /MANI/ TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM
      COMMON /ENDF/ MAT, MF, MT, TLIMIT, NPUN
      COMMON /FINRAD/ IRAD, NCOHS, RADT(200), DELT(200)
      DIMENSION LXX(20)
      CHISQ=0.
      DO 50 I=1,NERS
      CALC(I)=0.
      DO 40 J=1,NV,2
      IF (IRAD.LE.0) GO TO 10
      COFF=X(J)/DELT(I)/X(J+1)**2
      XPO1=1.-EXP(-X(J+1)*RADT(I))
      XPO2=1.-EXP(-X(J+1)*DELT(I))
      XPO3=EXP(-X(J+1)*(T(I)-DELT(I)/2.))
      CALC(I)=CALC(I)+COFF*XPO1*XPO2*XPO3
      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(J)*EXP(-TEMP)
```

```
30 CALC(I)=CALC(I)+XPO
40 CONTINUE
   BSAV(I)=(CALC(I)-DH(I))*W(I)
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)=ITSP
70 CONTINUE
   CALL PCHOUT (LXX)
80 CONTINUE
   RETURN
C
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


   SUBROUTINE STEPIT
   COMMON /PULSIN/ ALAMDA(50), DH(200), T(100), NERS, PERDIF(100),
  1 CALC(100), W(100), KTKM, 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), DUMMY, MATRIX,
  2 ERR(70,70), CHISQ, BSAV(100), VEC(70), TRIAL(70), XSAVE(70), CHI(
  3 70), SECOND(2,2), OLDVEC(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
70 XMAX(I)=HUGE
   XMIN(I)=-HUGE
```

```
   80 NACTIV=NACTIV+1
      X(I)=AMAX1(XMIN(I),AMIN1(XMAX(I),X(I)))
   90 CONTINUE
      COMPAR=0.0
      IF (NACTIV-1) 100,130,120
  100 DO 110 J=1,NV
  110 MASK(J)=0
      GO TO 10
  120 A=NACTIV
      SUB=2.0/(A-1.0)
      P=2.0*(1.0/SQRT(A)/(1.0-0.5**SUB)-1.0)
      COMPAR=AMIN1(.999,ABS((1.-(1.-COLIN)**SUB)*(1.+P*(1.-COLIN))))
  130 CALL FUNK
      NF=1
      IF (NV) 1310,1310,140
  140 DO 150 I=1,NV
  150 DX(I)=DELTAX(I)
      CHIOLD=CHISQ
      NOSC=0
  160 NCIRC=0
      NZIP=0
C     MAIN DO LOOP FOR CYCLING THROUGH THE VARIABLES.
C     FIRST TRIAL STEP WITH EACH VARIABLE IS SEPARATE.
  170 NACK=0
      DO 940 I=1,NV
      OLDVEC(I)=VEC(I)
      VEC(I)=0.0
      TRIAL(I)=0.0
      IF (MASK(I)) 180,190,180
  180 VEC(I)=-0.0
      GO TO 940
  190 NACK=NACK+1
      XSAVE(I)=X(I)
      IF (SIGNIF*ABS(DX(I))-ABS(X(I))) 340,340,200
  200 X(I)=XSAVE(I)+DX(I)
      NFLAG=1
      IF (X(I)-XMIN(I)) 220,210,210
  210 IF (X(I)-XMAX(I)) 230,230,220
  220 NFLAG=NFLAG+3
      GO TO 250
  230 CALL FUNK
      NF=NF+1
      CHIME=CHISQ
      IF (CHISQ-CHIOLD) 380,240,250
  240 NFLAG=NFLAG+1
  250 X(I)=XSAVE(I)-DX(I)
      IF (X(I)-XMIN(I)) 350,260,260
  260 IF (X(I)-XMAX(I)) 270,270,350
  270 CALL FUNK
      NF=NF+1
      IF (CHISQ-CHIOLD) 370,280,290
  280 NFLAG=NFLAG+1
  290 IF (NFLAG-3) 300,340,350
  300 TRIAL(I)=DX(I)*0.5*(CHISQ-CHIME)/(CHIME-2.0*CHIOLD+CHISQ)
      IF (TRIAL(I)) 310,350,310
  310 VEC(I)=TRIAL(I)/ABS(DX(I))
      X(I)=XSAVE(I)+TRIAL(I)
      CALL FUNK
      NF=NF+1
      IF (CHISQ-CHIOLD) 320,330,330
  320 CHIOLD=CHISQ
      GO TO 360
  330 TRIAL(I)=0.0
      VEC(I)=0.0
      GO TO 350
  340 VEC(I)=-0.0
  350 X(I)=XSAVE(I)
  360 NCIRC=NCIRC+1
      IF (NCIRC-NACTIV) 450,950,950
  370 DX(I)=-DX(I)
```

```
C      A LOWER VALUE HAS BEEN FOUND.  HENCE THIS VARIABLE WILL CHANGE.
  380 NCTRC=0
      DEL=DX(I)
  390 CHIME=CHIOLD
      CHIOLD=CHISQ
      VEC(I)=VEC(I)+DEL/ABS(DX(I))
      TRIAL(I)=TRIAL(I)+DEL
      DEL=ACK*DEL
      XSAVE(I)=X(I)
      X(I)=XSAVE(I)+DEL
      IF (X(I)-XMIN(I)) 440,400,400
  400 IF (X(I)-XMAX(I)) 410,410,440
  410 CALL FUNK
      NF=NF+1
      IF (CHISQ-CHIOLD) 390,420,420
  420 CINDER=0.5/ACK*(ACK**2*CHIME-(ACK**2-1.0)*CHIOLD-CHISQ)/(ACK*CHIME
     1 -(ACK+1.0)*CHIOLD+CHISQ)
      X(I)=XSAVE(I)+CINDER*DEL
      CALL FUNK
      NF=NF+1
      IF (CHISQ-CHIOLD) 430,440,440
  430 CHIOLD=CHISQ
      TRIAL(I)=TRIAL(I)+CINDER*DEL
      VEC(I)=VEC(I)+CINDER*DEL/ABS(DX(I))
      GO TO 450
  440 X(I)=XSAVE(I)
  450 IF (NZIP-1) 930,460,460
  460 IF (ABS(VEC(I))-ACK) 490,470,470
  470 DX(I)=ACK*ABS(DX(I))
      VEC(I)=VEC(I)/ACK
      OLDVEC(I)=OLDVEC(I)/ACK
      DO 480 J=1,MOSQUE
  480 ERR(I,J)=ERR(I,J)/ACK
  490 SUMO=0.0
      SUMV=0.0
      DO 500 J=1,NV
      SUMO=SUMO+OLDVEC(J)**2
  500 SUMV=SUMV+VEC(J)**2
      IF (SUMO*SUMV) 930,930,510
  510 SUMO=SQRT(SUMO)
      SUMV=SQRT(SUMV)
      COSINE=0.0
      DO 520 J=1,NV
  520 COSINE=COSINE+OLDVEC(J)/SUMO*VEC(J)/SUMV
      IF (NZIP-1) 930,530,540
  530 IF (NACK-NACTIV) 930,560,560
  540 IF (NACK-NACTIV) 560,550,550
  550 IF (NZIP-NCOMP) 560,570,570
  560 IF (COSINE-COMPAR) 930,570,570
C      SIMON SAYS, TAKE AS MANY GIANT STEPS AS POSSIBLE...
  570 NGIANT=0
      NTRY=0
      NRETRY=0
      KL=1
      NOSC=NOSC+1
      IF (NOSC-MOSQUE) 600,600,580
  580 NOSC=MOSQUE
      DO 590 K=2,MOSQUE
      CHIOSC(K-1)=CHIOSC(K)
      DO 590 J=1,NV
      XOSC(J,K-1)=XOSC(J,K)
  590 ERR(J,K-1)=ERR(J,K)
  600 DO 610 J=1,NV
      XOSC(J,NOSC)=X(J)
  610 ERR(J,NOSC)=VEC(J)/SUMV
      CHIOSC(NOSC)=CHIOLD
      IF (NOSC-3) 670,620,620
C      SEARCH FOR A PREVIOUS SUCCESSFUL GIANT STEP IN A DIRECTION MORE
C      NEARLY PARALLEL TO THE DIRECTION OF THE PROPOSED STEP THAN WAS THE
```

```
C       IMMEDIATELY PREVIOUS ONE.
  620 COXCOM=0.0
      DO 630 J=1,NV
  630 COXCOM=COXCOM+ERR(J,NOSC)*ERR(J,NOSC-1)
      NAH=NOSC-2
  640 NTRY=0
      DO 660 K=KL,NAH
      NRETRY=NAH-K
      COSINE=0.0
      DO 650 J=1,NV
  650 COSINE=COSINE+ERR(J,NOSC)*ERR(J,K)
      IF (COSINE-COXCOM) 660,960,680
  660 CONTINUE
  670 CHIBAK=CHI(I)
      GO TO 700
  680 NTRY=1
      KL=K+1
      DO 690 J=1,NV
      SALVO(J)=TRIAL(J)
  690 TRIAL(J)=(X(J)-XOSC(J,K))/ACK
      CHIBAK=CHIOLD+(CHIOSC(K)-CHIOLD)/ACK
  700 DO 720 J=1,NV
      XSAVE(J)=X(J)
      TRIAL(J)=ACK*TRIAL(J)
      IF (MASK(J)) 720,710,720
  710 X(J)=AMAX1(AMIN1(X(J)+TRIAL(J),XMAX(J)),XMIN(J))
  720 CONTINUE
      CALL FUNK
      NF=NF+1
      IF (CHISQ-CHIOLD) 730,740,740
  730 CHIBAK=CHIOLD
      CHIOLD=CHISQ
      NGIANT=NGIANT+1
      GO TO 700
  740 IF (NRETRY) 760,760,750
  750 IF (NGIANT) 810,810,760
  760 CINDER=0.5/ACK*(ACK**2*CHIBAK-(ACK**2-1.0)*CHIOLD-CHISQ)/(ACK
     1 *CHIBAK-(ACK+1.0)*CHIOLD+CHISQ)
      DO 780 J=1,NV
      IF (MASK(J)) 780,770,780
  770 X(J)=AMAX1(AMIN1(XSAVE(J)+CINDER*TRIAL(J),XMAX(J)),XMIN(J))
  780 CONTINUE
      CALL FUNK
      NF=NF+1
      IF (CHISQ-CHIOLD) 890,790,790
  790 IF (NGIANT) 830,800,830
  800 IF (NTRY) 810,830,810
  810 DO 820 J=1,NV
      TRIAL(J)=SALVO(J)
  820 X(J)=XSAVE(J)
      GO TO 850
  830 DO 840 J=1,NV
      TRIAL(J)=TRIAL(J)/ACK
  840 X(J)=XSAVE(J)
  850 IF (NGIANT) 860,860,900
  860 IF (NRETRY) 870,870,640
  870 IF (NTRY) 880,920,880
  880 NTRY=0
      GO TO 670
  890 CHIOLD=CHISQ
  900 IF (NTRY) 910,160,910
  910 NOSC=0
      GO TO 160
  920 NOSC=MAX0(NOSC-1,0)
  930 CHI(I)=CHIOLD
  940 CONTINUE
C       ANOTHER CYCLE THROUGH THE VARIABLES HAS BEEN COMPLETED.
C       PRINT ANOTHER LINE OF TRACES.
      NZIP=NZIP+1
```

```
      GO TO 170
C     A MINIMUM HAS BEEN FOUND.  PRINT THE REMAINING TRACES.
  950 NOSC=0
      DO 900 I=1,NV
C     STEPIT 4.6 ...  STEPIT WITH OSCILLATION SEARCH, MATRIX INVERSION,
C                     AND AUTOMATIC STEP SIZE ADJUSTMENT.      CHANDLER 2/
      IF (AMAX1(VEC(I),SIGN(1.0,VEC(I)))) 970,960,970
  960 CONTINUE
      GO TO 1010
  970 NGATE=1
      DO 1000 I=1,NV
      IF (MASK(I)) 1000,980,1000
  980 IF (ABS(DX(I))-ABS(DELMIN(I))) 1000,990,990
  990 NGATE=0
 1000 DX(I)=DX(I)/RATIO
      IF (NGATE) 160,160,1010
 1010 CHISQ=CHIOLD
      IF (IABS(MATRIX-100)-50) 1020,1020,1310
 1020 IF (NACTIV-NV) 1310,1030,1310
C     COMPUTE THE STANDARD ERRORS AND THE CORRELATIONS.
 1030 FAC=RATIO**(MATRIX-100)
      ESUM=0.0
      DO 1090 I=1,NV
      IF (DELMIN(I)) 1040,1050,1040
 1040 DX(I)=ABS(FAC*DELMIN(I))
      GO TO 1060
 1050 DX(I)=ABS(FAC*DX(I))
 1060 IF (DX(I)) 1310,1310,1070
 1070 XSAVE(I)=X(I)
      DO 1080 J=1,2
      X(I)=XSAVE(I)+DX(I)
      CALL FUNK
      NF=NF+1
      SECOND(1,J)=CHISQ
 1080 DX(I)=-DX(I)
      ERR(I,I)=(SECOND(1,1)-2.0*CHIOLD+SECOND(1,2))/DX(I)**2
 1090 ESUM=ESUM+ABS(ERR(I,I))
      DO 1120 I=2,NV
      IM=I-1
      DO 1120 J=1,IM
      DO 1110 K=1,2
      X(I)=XSAVE(I)+DX(I)
      DO 1100 L=1,2
      X(J)=XSAVE(J)+DX(J)
      CALL FUNK
      NF=NF+1
      SECOND(K,L)=CHISQ
      X(J)=XSAVE(J)
 1100 DX(J)=-DX(J)
      X(I)=XSAVE(I)
 1110 DX(I)=-DX(I)
      ERR(I,J)=0.25*(SECOND(1,1)-SECOND(1,2)-SECOND(2,1)+SECOND(2,2))
     1 /ABS(DX(I)*DX(J))
      ESUM=ESUM+ABS(ERR(I,J))
 1120 ERR(J,I)=ERR(I,J)
      BRAAAK=ABS(ESUM)/FLOAT(NV)**2
      NGRAPE=0
      DO 1140 I=1,NV
      DO 1140 J=1,NV
      IF (ERR(I,J)) 1140,1130,1140
 1130 NGRAPE=1
 1140 ERR(I,J)=ERR(I,J)/BRAAAK
      DET=1.0
      DO 1150 J=1,NV
 1150 SALVO(J)=1.0
      DO 1300 I=1,NV
      BIGAJJ=0.0
```

```
      DO 1180 J=1,NV
      IF (SALVO(J)) 1160,1180,1160
 1160 IF (ABS(ERR(J,J))-BIGAJJ) 1180,1180,1170
 1170 BIGAJJ=ABS(ERR(J,J))
      K=J
 1180 CONTINUE
      IF (BIGAJJ) 1200,1190,1200
 1190 DET=0.0
      GO TO 1310
 1200 SALVO(K)=0.0
      DET=DET*ERR(K,K)
      TRIAL(K)=1.0/ERR(K,K)
      ERR(K,K)=0.0
      XSAVE(K)=1.0
      M=K-1
      IF (M) 1240,1240,1210
 1210 DO 1230 J=1,M
      XSAVE(J)=ERR(K,J)
      TRIAL(J)=ERR(K,J)*TRIAL(K)
      IF (SALVO(J)) 1190,1230,1220
 1220 TRIAL(J)=-TRIAL(J)
 1230 ERR(K,J)=0.0
 1240 M=K+1
      IF (M-NV) 1250,1250,1290
 1250 DO 1280 J=M,NV
      XSAVE(J)=ERR(J,K)
      IF (SALVO(J)) 1190,1260,1270
 1260 XSAVE(J)=-XSAVE(J)
 1270 TRIAL(J)=-ERR(J,K)*TRIAL(K)
 1280 ERR(J,K)=0.0
 1290 DO 1300 J=1,NV
      DO 1300 K=J,NV
 1300 ERR(K,J)=ERR(K,J)+XSAVE(J)*TRIAL(K)
 1310 CALL FUNK
      WRITE (NOUT,1320)
      WRITE (NOUT,1330) (X(I),I=1,NV)
      IF (CHISQ.GT.1.E-20) WRITE (NOUT,1340) CHISQ
      IF (CHISQ.LE.1.E-20) WRITE (NOUT,1350) DIFLIM
      RETURN
C
 1320 FORMAT (//1X,22H  FINAL VALUES OF X(I))
 1330 FORMAT (1X,10H X        = ,10E12.4/(10X,10E12.4))
 1340 FORMAT (///1X,23HFINAL VALUE OF CHISQ = ,E15.8///)
 1350 FORMAT (1H0,1X,10H DIFLIM = E15.8)
      END


      SUBROUTINE FINECHK (KL)
C
C     ROUTINE CALCULATES INTERMEDIATE POINTS AND CHECKS FOR
C     REASONABLENESS.
C
      COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPRUB,
     1 NIN, NOUT
      COMMON /PULSDAT/ NDT, EB(25), GX(25,400), NERG, ALF(25,50), ALAM(2
     1 5,50)
      COMMON /PULSCAL/ A(50,50), B(50,1)
      COMMON /MANI/ TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM
      COMMON /FINRAD/ IRAD, NCORS, RADT(200), DELT(200)
      DIMENSION FXP(700), TP(700), TI(10), XL(10), YL(10), TPF(700)
      K=KL
      ENCODE (27,170,TI(1)) K
      ENCODE (20,190,XL)
      ENCODE (10,200,YL)
      XL(2)=10H SECONDS,
      FXMIN=FX(1)
      DO 10 I=1,ITSP
      IF (FX(I).LT.FXMIN) FXMIN=FX(I)
```

```
   10 CONTINUE
      DELF=0.
      L=0
      TP(1)=T(1)
      DEC=T(1)
   20 CONTINUE
      L=L+1
      DELF=DELF+1.0
      TP(L)=DELF*DEC
      IF (TP(L).GE.T(ITSP)) GO TO 30
      IF ((TP(L)/DEC).GE.10.0) DELF=1.0
      IF ((TP(L)/DEC).GE.10.0) DEC=DEC*10.0
      GO TO 20
   30 CONTINUE
      NK=L
C
C     THIS LOOP IS TO INCREASE TIME MESH BY FACTOR OF FIVE.
C
      NPF=1
      TPF(NPF)=TP(1)
      DO 50 N=2,NK
      IF (NPF.GT.700) GO TO 50
      DELF=(TP(N)-TP(N-1))/5.0
      DO 40 NJ=1,5
      NPF=NPF+1
      TPF(NPF)=TPF(NPF-1)+DELF
   40 CONTINUE
   50 CONTINUE
      IF (NPF.GT.700) WRITE (NOUT,140) TPF(NPF)
      NK=NPF
      DO 60 N=1,NK
      TP(N)=TPF(N)
   60 CONTINUE
      WRITE (NOUT,180) K
      DO 90 N=1,NK
      FXP(N)=0.
      KTRM=KTR(K)
      DO 80 J=1,KTRM
      IF (IRAD.LE.0) GO TO 70
      XP0=ALF(K,J)*EXP(-ALAM(K,J)*TP(N))
      COFF=ALF(K,J)/DELT(N)/ALAM(K,J)**2
      XP01=1.-EXP(-ALAM(K,J)*RAUT(N))
      XP02=1.-EXP(-ALAM(K,J)*DELT(N))
      XP03=EXP(-ALAM(K,J)*(T(N)-DELT(N)/2.))
      FXP(N)=FXP(N)+COFF*XP01*XP02*XP03
      GO TO 80
   70 TEMP=ALAM(K,J)*TP(N)
      IF (ABS(TEMP).GT.600) GO TO 80
      FXP(N)=FXP(N)+ALF(K,J)*EXP(-TEMP)
   80 CONTINUE
   90 CONTINUE
      WRITE (NOUT,210) (N,TP(N),FXP(N),N=1,NK)
C
C     TEST FOR POINT DEVIATION AND SLOPE REVERSAL.
C
      NFLG=0
      LFLG=0
      NK1=NK-1
      WRITE (NOUT,150) K
      DO 110 N=2,NK1
      IF (FXP(N).GT.0.) GO TO 100
      NFLG=NFLG+1
      GO TO 110
  100 CONTINUE
      IF (FXP(N-1).LE.0.0.OR.FXP(N+1).LE.0.0) GO TO 110
      AVLG=(ALOG(FXP(N-1))+ALOG(FXP(N+1)))/2.0
      FAVG=EXP(AVLG)
      FDIF=ABS((FXP(N)-FAVG)/FXP(N))
```

```
      IF (FDIF.GE.1.0) LFLG=LFLG+1
      IF (FDIF.GE.1.0) WRITE (NOUT,230) N
      IF (FDIF.GE.0.1) WRITE (NOUT,220) N,FDIF
      IF (FXP(N).GT.FXP(N-1)) WRITE (NOUT,160) N
  110 CONTINUE
      IF (FXP(1).LE.0.) NFLG=NFLG+1
      IF (FXP(NK).LE.0.) NFLG=NFLG+1
      IF (NFLG.EQ.0) GO TO 120
      WRITE (NOUT,240) NFLG
      RETURN
  120 CONTINUE
      IF (LFLG.EQ.0) GO TO 130
      WRITE (NOUT,250) LFLG
  130 CONTINUE
      NK=1-NK
C     CALL PLOTM (TP,FXP,NK,-1,0,0,0.0,1.0,1.0,TI,30,XL,20,YL,10)
CC    CALL PLOTM (T,FX,-ITSP,-1,-1,-47,0.,1.0,1.0,TI,30,XL,20,YL,10)
      RETURN
C
  140 FORMAT (1H0,18H PLOTS CUT AT TP =1PE12.5,28H SEC AS POINT LIMIT RE
     1ACHED.)
  150 FORMAT (33H0 POINT DEVIATION CHECK FOR GROUP,I3//51H NOTE - ONLY V
     1ALUES GREATER THAN TEN PERCENT FOLLOW)
  160 FORMAT (30H0 FUNCTION RISING AT POINT NO.,I3)
  170 FORMAT (25HFINE CHECK FOR GROUP NO. ,I2)
  180 FORMAT (26H FINE CHECK FOR GROUP NO. ,I2)
  190 FORMAT (20H    TIME IN SECONDS  )
  200 FORMAT (10H   FX(I)  )
  210 FORMAT (4(2X,I4,2X,F10.3,2X,E10.3))
  220 FORMAT (19H0   AT POINT NUMBER ,I3,8H FDIF = ,F6.3)
  230 FORMAT (22H0   CHECK POINT NUMBER ,I3)
  240 FORMAT (12H0 THERE ARE ,I3,30H NEG FXP VALUES.  FIT NO GOOD.)
  250 FORMAT (21H0 FIT RATHER POOR AT ,I3,21H POINTS.  CHECK PLOT.)
      END


      SUBROUTINE PULSFIT (KKF)
C
C     THIS ROUTINE PROVIDES A SINGLE PARAMETER FIT FOR A COMBINATION
C     OF LINEAR FUNCTIONS OF THE FORM --
C
C         FX(T)=SISUM+ALPHA(K)*EXP(-ALAMDA(K)*T(I)),SUM OVER K=1,KTRM,
C                 THE NUMBER OF TERMS USED TO REPRESENT FX.
C
C     GIVEN A SET OF ALAMDAS,(SEE COMMENTS BELOW),THIS ROUTINE SOLVES
C     FOR ALPHAS.
C     IT IS ADVISABLE TO MAKE A SINGLE PARAMETER FIT WITH PULSFIT BEFORE
C     MAKING A TWO PARAMETER FIT WITH SIEFIT.
C
      COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,
     1 NIN, NOUT
      COMMON /PULSCAL/ A(50,50), B(50,1)
      COMMON /PULSOUT/ ALPHA(50), FXC(100), PCT(100)
      COMMON /MANI/ W(100), ITITL(8), KTR(50), NS(10), KKN(25), DIFLIM
      COMMON /FINRAD/ IRAD, NCORS, RADT(200), DELT(200)
      DIMENSION KCAL(71)
      ITS=1
      IPRO=KKF
      READ (NIN,230) LWT,NOK,KTRM,IPRT
C
C     LWT=WT FCN DESIRED,=0,W=1,=1,W=1/FX,=2,W=1/FX**2,=3,W=1/FX**1.5.
C     NOK=FLAG FOR ALAMDA PARAMETER SELECTION
C     KTRM=NO. OF ALAMDAS USED IN FIT.
C         NOK=0,KTRM=KTRM,READ (ALAMDA(K),K=1,KTRM), THIS OPTION
C         USED FOR INITIAL INPUT ,FOR EXAMPLE,TWO ALAMDAS PER TIME
C         DECADE -- 1.0,0.5,0.1,0.05,0.01,0.005,ETC.
C         NOK=1,KTRM=1,ALAMDAS CALCULATED FROM SLOPES AT EVERY PAIR
C         OF POINTS.
```

```
C          NOK=1,KTRM=KTRM,READ IN (KCAL(L),L=2,KTRM)(12I6),WHICH SELECTS
C          THOSE POINTS TO BE USED IN THE CALCULATION OF THE ALAMDAS.
C          NOTE -- KCAL ALSO USED TO ELIMINATE UNWANTED PARAMETERS IN
C          SUBSEQUENT RUNS.  SEE BELOW.
C          NOK=2,KTRM=1,READ KTRM(55X,I11) AND B(K,1),ALAMDA(K),K=1,KTRM
C          (B(K,1)=ALPHA(K))(6E11.4) FROM PREVIOUS PROBLEM.  THIS OPTION
C          IS USED WHEN FIT FOR THIS GROUP IS NOW BEING DONE IN STEPIT.
C      IPRT=1,PRINT A-MATRIX,=0,NO PRINT.
C           NOTE --- BYPASS IWANT READ BELOW IF NOK=2.
C
      IF (NOK.NE.2) GO TO 10
      READ (NIN,250) KTRM
      READ (NIN,260) (B(K,1),ALAMDA(K),K=1,KTRM)
      RETURN
   10 CONTINUE
      IF (NOK.LE.0) GO TO 60
C     KTRM IS NO OF INPUT ALAMDAS,ITSP IS NO OF TIME STEPS USED IN FIT.
C
C     LOOP TO CALCULATE ALAMDA FOR SELECTED STEPS.
C
      NOK=ITSP
      DO 20 L=1,NOK
      KCAL(L)=L
   20 CONTINUE
      IF (KTRM.EQ.1) GO TO 30
      KCAL(1)=1
      READ (NIN,230) (KCAL(L),L=2,KTRM)
   30 CONTINUE
      IF (L.LE.50) GO TO 40
      WRITE (NOUT,220) L
      STOP
   40 CONTINUE
      IF (KTRM.GT.2) KTRM=KTRM-1
      IF (KTRM.EQ.1) KTRM=NOK-1
      ALAMDA(1)=1/T(1)*1.5
      DO 50 K=1,KTRM
      K1=KCAL(K)
      K2=KCAL(K+1)
      TST=(T(K2)-T(K1))
      IF (TST.EQ.0.0) GO TO 50
      ALAMDA(K+1)=ALOG(FX(K1)/FX(K2))/(T(K2)-T(K1))
      IF (ALAMDA(K+1).LE.0.) ALAMDA(K+1)=ALAMDA(K)/2.
   50 CONTINUE
      KTRM=KTRM+1
      IF (ALAMDA(1).LE.ALAMDA(2)) ALAMDA(1)=ALAMDA(2)*2.
      IF (ALAMDA(1).GT.(ALAMDA(2)*2.)) ALAMDA(1)=ALAMDA(2)*2.
      IF (ALAMDA(KTRM).GT.(1./T(ITSP))) ALAMDA(KTRM)=1./T(ITSP)
      GO TO 70
   60 CONTINUE
      READ (NIN,240) (ALAMDA(K),K=1,KTRM)
   70 CONTINUE
C
C     SELECT ALAMDAS WANTED,E.G. LEAVE OUT ONE OF A DUPLICATED PAIR.
C     IWANT=NO. OF ALAMDAS KEPT. SET=0 IF ALL ARE KEPT.
C     KCAL(L)=ALAMDAS WANTED.  NOTE - IWANT USUALLY SET TO ZERO ON
C              INITIAL RUNS,AND KCAL(L) NOT READ.
C     ALSO NOTE -- THIS INPUT NEEDED FOR EACH SEGMENT.
C
      READ (NIN,230) IWANT,(KCAL(L),L=1,IWANT)
      IF (IWANT.LE.0) GO TO 100
      DO 80 L=1,IWANT
      LL=KCAL(L)
      ALPHA(L)=ALAMDA(LL)
   80 CONTINUE
      KTRM=IWANT
      DO 90 K=1,KTRM
      ALAMDA(K)=ALPHA(K)
   90 CONTINUE
  100 CONTINUE
```

```
C
C      WRITE OUT INPUT FOR DEBUG
       WRITE (NOUT,270) (K,ALAMDA(K),KCAL(K),KCAL(K+1),K=1,KTRM)
       WRITE (NOUT,280) (I,T(I),FX(I),I=1,ITSP)
       DO 110 I=1,ITSP
       W(I)=1./FX(I)**2
       IF (LWT.EQ.3) W(I)=1./FX(I)**1.5
       IF (LWT.EQ.1) W(I)=1./FX(I)
       IF (LWT.LE.0) W(I)=1.
  110  CONTINUE
       WRITE (NOUT,290) LWT
C
C      CALCULATE B MATRIX
C
       DO 140 K=1,KTRM
       B(K,1)=0.
       DO 130 I=1,ITSP
       IF (IRAD.LE.0) GO TO 120
       XP1=EXP(-ALAMDA(K)*RADT(I))
       XP2=EXP(-ALAMDA(K)*DELT(I))
       XP3=EXP(-ALAMDA(K)*(T(I)-DELT(I)/2.))
       B(K,1)=B(K,1)+FX(I)*1./DELT(I)/ALAMDA(K)**2*(1.-XP1)*(1.-XP2)*XP3
      1 *W(I)
       GO TO 130
  120  CONTINUE
       B(K,1)=B(K,1)+FX(I)*EXP(-ALAMDA(K)*T(I))*W(I)
  130  CONTINUE
  140  CONTINUE
C
C      CALCULATE A MATRIX
C
       DO 150 I=1,KTRM
       DO 150 J=1,KTRM
       A(I,J)=0.
  150  CONTINUE
       DO 190 K=1,KTRM
       ALAM=ALAMDA(K)
       DO 180 L=1,KTRM
       DO 170 I=1,ITSP
       IF (IRAD.LE.0) GO TO 160
       XP01=1.-EXP(-ALAMDA(K)*RADT(I))
       XP02=1.-EXP(-ALAMDA(L)*RADT(I))
       XP03=1.-EXP(-ALAMDA(K)*DELT(I))
       XP04=1.-EXP(-ALAMDA(L)*DELT(I))
       XP05=EXP(-ALAMDA(K)*(T(I)-DELT(I)/2.))
       XP06=EXP(-ALAMDA(L)*(T(I)-DELT(I)/2.))
       COFF=1./DELT(I)/ALAMDA(K)**2
       COFT=1./DELT(I)/ALAMDA(L)**2
       A(K,L)=A(K,L)+COFF*COFT*XP01*XP02*XP03*XP04*XP05*XP06*W(I)
       GO TO 170
  160  CONTINUE
       A(K,L)=EXP(-(ALAM+ALAMDA(L))*T(I))*W(I)+A(K,L)
  170  CONTINUE
  180  CONTINUE
  190  CONTINUE
C
C      PRINT A MATRIX
C
       IF (IPRT.LT.1) GO TO 210
       WRITE (NOUT,300) IPROB
       DO 200 K=1,KTRM
       WRITE (NOUT,310) (A(K,L),L=1,KTRM)
  200  CONTINUE
  210  CONTINUE
       WRITE (NOUT,320) IPROB
       WRITE (NOUT,310) (B(K,1),K=1,KTRM)
C      SUBROUTINE LSS SOLVES THE SET OF LINEAR EQUATIONS  AX=B
       CALL LSS (KTRM,1,50,A,B,D,DET)
       WRITE (NOUT,320) IPROB
```

```
      WRITE (NOUT,310) (B(K,1),K=1,KTRM)
      L=0
      CALL SEEFIT (IPRO,L)
      RETURN
C
  220 FORMAT (1H1,45H  ONLY FIFTY TERMS ALLOWED IN FIT.  YOU WANT I3)
  230 FORMAT (12I6)
  240 FORMAT (3(11X,E11.4))
  250 FORMAT (55X,I11)
  260 FORMAT (1P6E11.4)
  270 FORMAT (3H K=,I3,11H ALAMDA(K)=,1PE12.5,9H KCAL(K)=,I3,11H KCAL(K+
     11)=,I3)
  280 FORMAT (4H  I=,I3,6H T(I)=,1PE12.5,7H FX(I)=,1PE12.5)
  290 FORMAT (1H0,6H  LWT=,I3)
  300 FORMAT (16H0  A-MATRIX FOR ,I6)
  310 FORMAT (2X,10E12.3)
  320 FORMAT (15H0  B-MATRIX FOR,I6)
      END


      SUBROUTINE SEEFIT (IP,LP)
C
C     ROUTINE COMPARES FIT WITH ORIGINAL VALUES.
C
      COMMON /PULSIN/ ALAMDA(50), FX(200), T(401), KTRM, ITSP, IPROB,
     1 NIN, NOUT
      COMMON /PULSCAL/ A(50,50), B(50,1)
      COMMON /PULSOUT/ ALPHA(50), FXC(100), PCTDIF(100)
      COMMON /FINRAD/ IRAD, NCORS, RADT(200), DELT(200)
      DIMENSION TI(10), XL(10), YL(10)
      DO 30 I=1,ITSP
      PCTDIF(I)=0.
      FXC(I)=0.
      DO 20 K=1,KTRM
      IF ((-ALAMDA(K)*T(I)).GT.300.) ALAMDA(K)=-300.0/T(I)
      IF (IRAD.LE.0) GO TO 10
      COFF=B(K)/DELT(I)/ALAMDA(K)**2
      XP01=1.-EXP(-ALAMDA(K)*RADT(I))
      XP02=1.-EXP(-ALAMDA(K)*DELT(I))
      XP03=EXP(-ALAMDA(K)*(T(I)-DELT(I)/2.))
      FXC(I)=FXC(I)+COFF*XP01*XP02*XP03
      GO TO 20
   10 CONTINUE
      FXC(I)=FXC(I)+B(K)*EXP(-ALAMDA(K)*T(I))
      ALPHA(K)=B(K)*EXP(-ALAMDA(K)*T(I))
   20 CONTINUE
      PCTDIF(I)=(FX(I)-FXC(I))/FX(I)*100.
      IF (LP.LE.0) GO TO 30
      WRITE (NOUT,90) I,T(I)
      WRITE (NOUT,100) (K,ALPHA(K),K=1,KTRM)
   30 CONTINUE
      IPRO=IP
      WRITE (NOUT,110) IPRO
      WRITE (NOUT,120) (I,T(I),FX(I),FXC(I),PCTDIF(I),I=1,ITSP)
      RMS=0.
      DO 40 I=1,ITSP
      RMS=RMS+PCTDIF(I)**2
   40 CONTINUE
      RMS=RMS**0.5
      WRITE (NOUT,130) RMS
      AR1=0.
      AR2=0.
      DO 50 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))
   50 CONTINUE
      ARDIF=(AR1-AR2)/AR1*100.
      WRITE (NOUT,140) AR1,AR2,ARDIF
```

```
      FXMIN=FX(1)
      DO 60 I=1,ITSP
      IF (FX(I).LE.0.0) FX(I)=FX(I-1)/10.
      IF (FX(I).LT.FXMIN) FXMIN=FX(I)
   60 CONTINUE
      DO 70 I=1,ITSP
      IF (FXC(I).LT.FXMIN) FXC(I)=FXMIN
   70 CONTINUE
      ENCODE (40,150,TI(1))
      ENCODE (10,160,XL(1))
      ENCODE (10,170,YL(1))
      ITS=ITSP
      IS=1
      IF ((FX(1)/FX(ITSP-1)).LT.100.) GO TO 80
      ITS=-ITSP
      IS=-1
   80 CONTINUE
C     CALL PLOTM (T,FX,ITS,IS,0,0,0.,1.,1.,TI,40,XL,10,YL,10)
C     CALL PLOTM (T,FXC,ITS,IS,-1,-47,0.,1.,1.,TI,40,XL,10,YL,10)
      RETURN
C
   90 FORMAT (18H   TERMS FOR STEP ,I3,8H T(I) = ,1PE12.5)
  100 FORMAT (6(2X,I3,2X,1PE10.3))
  110 FORMAT (107H1 STEP NO.      TIME            ORIGINAL VALUE    COMPUT
     1ED VALUE    PERCENT DIFFERENCE                 IPROB=,I3)
  120 FORMAT (I6,1P4E18.5)
  130 FORMAT (21H0    ROOT-MEAN-SQUARE=1PE12.5)
  140 FORMAT (13H0  ORIG INT =,1PE12.5,14H  FITTED INT= ,1PE12.5,15H PER
     1CENT DIFF =,1PE12.5)
  150 FORMAT (40HCOMPARISON OF ORIGINAL WITH FITTED DATA.)
  160 FORMAT (10HTIME(SEC) )
  170 FORMAT (10H  FX(I)    )
      END

      SUBROUTINE PCHOUT (LXX)
C
C     ROUTINE PUNCHES OUT PARAMETERS IN ENDF-LIKE FORMAT.
C
      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(2
     1 5,50)
      COMMON /MANI/ TC(100), TITL(8), KTR(50), NS(10), KKN(25), DIFLIM
      COMMON /ENDF/ MAT, MF, MT, RUNTIM, NPUN
      DIMENSION F(10), P(10), L(10), LXX(20)
      NPUN=7
      C1=0.
      NUL=0
      NSEQ=1
      WRITE (NOUT,30) (TITL(I),I=1,7),MAT,MF,MT,NSEQ
      WRITE (NPUN,30) (TITL(I),I=1,7),MAT,MF,MT,NSEQ
      NSEQ=NSEQ+1
      WRITE (NOUT,40) C1,C1,NUL,NUL,NUL,NERG,MAT,MF,MT,NSEQ
      WRITE (NPUN,40) C1,C1,NUL,NUL,NUL,NERG,MAT,MF,MT,NSEQ
      DO 20 K=1,NERG
      NPX=NTR(K)
      LPX=LXX(K)
      EB1=EB(K)
      EB2=EB(K+1)
      CALL CXFP (EB1,F(1),P(1),L(1))
      CALL CXFP (EB2,F(2),P(2),L(2))
      NSEQ=NSEQ+1
      WRITE (NOUT,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,K,MAT,MF,MT
     1 ,NSEQ)
      WRITE (NPUN,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,K,MAT,MF,MT
     1 ,NSEQ)
      EB1=T(1)
      EB2=T(LPX)
```

```
      CALL CXFP (EB1,F(1),P(1),L(1))
      CALL CXFP (EB2,F(2),P(2),L(2))
      NSEQ=NSEQ+1
      WRITE (NOUT,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,NPX,MAT,MF,MI
     1 ,NSEQ)
      WRITE (NPUN,50) ((F(I),P(I),L(I),I=1,2),NUL,NUL,NUL,NPX,MAT,MF,MI
     1 ,NSEQ)
      ALF(K,NPX+1)=0.
      ALF(K,NPX+2)=0.
      ALAM(K,NPX+1)=0.
      ALAM(K,NPX+2)=0.
      J1=1
   10 CONTINUE
      E1=ALF(K,J1)
      E2=ALF(K,J1+1)
      E3=ALF(K,J1+2)
      FX1=ALAM(K,J1)
      FX2=ALAM(K,J1+1)
      FX3=ALAM(K,J1+2)
      NSEQ=NSEQ+1
      CALL CXFP (E1,F(1),P(1),L(1))
      CALL CXFP (FX1,F(2),P(2),L(2))
      CALL CXFP (E2,F(3),P(3),L(3))
      CALL CXFP (FX2,F(4),P(4),L(4))
      CALL CXFP (E3,F(5),P(5),L(5))
      CALL CXFP (FX3,F(6),P(6),L(6))
      WRITE (NOUT,60) (F(I),P(I),L(I),I=1,6),MAT,MF,MI,NSEQ
      WRITE (NPUN,60) (F(I),P(I),L(I),I=1,6),MAT,MF,MI,NSEQ
      IF ((J1+2).GE.NPX) GO TO 20
      J1=J1+3
      GO TO 10
   20 CONTINUE
      MAT1=0
      MF1=0
      MT1=0
      MEND=-1
      NSEQ=NSEQ+1
      WRITE (NOUT,70) MAT,MF,MT1,NSEQ
      WRITE (NPUN,70) MAT,MF,MT1,NSEQ
      NSEQ=NSEQ+1
      WRITE (NOUT,70) MAT,MF1,MT1,NSEQ
      WRITE (NPUN,70) MAT,MF1,MT1,NSEQ
      NSEQ=NSEQ+1
      WRITE (NOUT,70) MAT1,MF1,MT1,NSEQ
      WRITE (NPUN,70) MAT1,MF1,MT1,NSEQ
      WRITE (NOUT,70) MEND
      WRITE (NPUN,70) MEND
      STOP
C
   30 FORMAT (6A10,A6,I4,I2,I3,I5)
   40 FORMAT (1P2E11.5,4I11,I4,I2,I3,I5)
   50 FORMAT (2(F8.5,A1,I2),4I11,I4,I2,I3,I5)
   60 FORMAT (6(F8.5,A1,I2),I4,I2,I3,I5)
   70 FORMAT (66X,I4,I2,I3,I5)
      END


      SUBROUTINE CXFP (X,F,S,N)
C     ******************************************************************
C     CONVERT X FOR PUNCHING
C     X - FLOATING POINT NUMBER = F*10.0**N
C     F - 0.999995 LE F LT 9.999995
C     S - SIGN (HOLLERITH + OR -) OF EXPONENT
C     N - EXPONENT
C     ******************************************************************
      DATA SP /1H+/, SM /1H-/
      IF (X.NE.0.0) GO TO 10
```

```
      F=0.0
      S=SP
      N=0
      RETURN
   10 N=ALOG10(ABS(X))
      IF (ABS(X)-1.0) 40,20,20
   20 F=X/10.0**N
      S=SP
      IF (ABS(F)-9.999995) 70,30,30
   30 F=F/10.0
      N=N+1
      GO TO 70
   40 N=1-N
      F=X*10.0**N
      S=SM
      IF (ABS(F)-9.999995) 70,50,50
   50 F=F/10.0
      N=N-1
      IF (N) 60,60,70
   60 S=SP
   70 CONTINUE
      RETURN
      END
      SUBROUTINE LSS (N,M,I,A,B,D,DET)
      DIMENSION A(I,N), B(I,M), COM2(5), COM3(5), D(N)
      DOUBLE S1, S2, DOTPRO
      DATA (COM2(J),J=1,5) /50HLSS SINGULAR SYSTEM, INPUT DESTROYED.  N
     1=        /
      DATA (COM3(J),J=1,5) /50HLSS CALLED WITH N.LE.0 OR N.GT.I,      N
     1 =       /
C
C     LIBMSG IS ONLY FOR LASL STATISTICS
C     CALL LIBMSG (10H  8 LSS    )
C     TO PUT MESSAGE IN SYSTEM DAYFILE
C
      NN=N
      IF (NN.LE.0.OR.NN.GT.I) GO TO 140
      MM=M
      SN=1.
      DO 90 J=1,NN
      L=J-1
      IF (J.EQ.NN) GO TO 70
      T=ABS(A(J,J))
      M1=J
      M2=J+1
      DO 10 K=M2,NN
      X=ABS(A(K,J))
      IF (X.LE.T) GO TO 10
      T=X
      M1=K
   10 CONTINUE
      IF (M1.EQ.J) GO TO 40
      DO 20 K=1,NN
      T=A(J,K)
      A(J,K)=A(M1,K)
   20 A(M1,K)=T
      SN=-SN
      IF (MM.LE.0) GO TO 40
      DO 30 K=1,MM
      T=B(J,K)
      B(J,K)=B(M1,K)
   30 B(M1,K)=T
   40 IF (A(J,J).EQ.0.) GO TO 130
      DO 60 K=M2,NN
      S1=0.
      S2=0.
      IF (L.EQ.0) GO TO 50
      S1=DOTPRO(L,A(J,1),I,A(1,K),1)
```

```
   50 A(J,K)=(A(J,K)-S1)/A(J,J)
      S2=DOTPRO(J,A(K,1),I,A(1,M2),1)
   60 A(K,M2)=A(K,M2)-S2
   70 IF (MM.LE.0) GO TO 90
      IF (A(J,J).EQ.0.) GO TO 130
      DO 80 K=1,MM
      S1=0.
      IF (L.EQ.0) GO TO 80
      S1=DOTPRO(L,A(J,1),I,B(1,K),1)
   80 B(J,K)=(B(J,K)-S1)/A(J,J)
   90 CONTINUE
      DET=A(1,1)*SN
      IF (DET.EQ.0.) GO TO 130
      IF (N.EQ.1) GO TO 150
      DO 100 J=2,NN
  100 DET=DET*A(J,J)
      IF (DET.EQ.0.) GO TO 130
      IF (MM.EQ.0) GO TO 150
      M3=NN-1
      DO 120 J=1,MM
      DO 110 L=1,M3
      M1=NN-L
      S1=0.
      M2=M1+1
      K=NN-M2+1
      S1=DOTPRO(K,A(M1,M2),I,B(M2,J),1)
  110 B(M1,J)=B(M1,J)-S1
  120 CONTINUE
      GO TO 150
  130 CALL LABRT (1,COM2,N)
      DET=0.
      GO TO 150
  140 CALL LABRT (1,COM3,N)
      DET=0.
  150 RETURN
      END
```

```
          IDENT  DOTPRO
          ENTRY  DOTPRO
          VFD    42/0HDOTPRO,18/5
*****************************************************************
*                                                               *
*   *DOTPRO* IS A FORTRAN COMPATIBLE FUNCTION-TYPE SUBPROGRAM   *
*                                                               *
*   CALLING SEQUENCE      Z = DOTPRO(N, X, IX, Y, IY)           *
*                                                               *
*           WHERE  -X-  AND  -Y-  ARE REAL VECTORS EACH CONTAING *
*                            -N-  ELEMENTS,
*                 -IX-  AND  -IY- ARE THE SPACING BETWEEN SUCCESSIVE *
*                                 ELEMENTS OF -X- AND -Y- RESPECTIVELY *
*                                                               *
*   THE RESULT RETURNED BY *DOTPRO* IS THE INNER PRODUCT (X,Y) OF THE *
*           VECTORS -X- AND -Y-. I.E. THE SUM OF X(I)*Y(I) FOR I=1 TO N*
*                                                               *
*           THE RESULT IS DOUBLE PRECISION BUT WILL BE USED AS SINGLE *
*           PRECISION UNLESS *DOTPRO* IS DECLARED TO BE DOUBLE  *
*           PRECISION IN THE CALLING PROGRAM.                   *
*                                                               *
*           THE RESULT IS ZERO IF N = 0, INFINITE IF N .LT. 0   *
*                                                               *
*****************************************************************
*                                                               *
* MODIFIED  9/15/72  BY J SOPKA, C-4  TO ELIMINATE ACCESS OUT OF RANGE *
*                              AND IMPROVE IN-CODE DOCUMENTATION*
*                                                               *
*****************************************************************
```

```
DOTPRO   DATA  0                                                        DOT  291
         SA2   B1               FETCH -N- → X2                          DOT  301
         MX0   0                ZERO  X0                                DOT  311
         SA4   B3               FETCH -IX- → X4                         DOT  321
         SA5   B5               FETCH -IY- → X5                         DOT  331
         SA1   B2               FETCH 1ST ELEMENT OF -X- → X1           DOT  341
         SA3   B4               FETCH 1ST ELEMENT OF -Y- → X3           DOT  351
         SB7   2                   2  →  B7                             DOT  361
         SB1   X2                 -N-  →  B1                            DOT  371
         LX2   59               SHIFT LO-ORDER BIT OF -N- INTO SIGN BIT X2 DOT  381
         SB5   X5                 -IY- →  B5                            DOT  391
         MX5   0                ZERO X5                                 DOT  401
         SB3   X4                 -IX- →  B3                            DOT  411
         SB6   X5                 -IY- →  B6                            DOT  421
         LE    B1,B7,TWO        BRANCH IF  -N-  .LE.  2                 DOT  431
         SB2   B3                 -IX- →  B2                            DOT  441
         NG    X2,NOD           BRANCH IF  -N-  IS ODD, LO-ORDER BIT ON. DOT  451
*******************************************************************DOT  461
*                                                                 *DOT  471
*   HI-ORDER PART OF THE INNER PRODUCT IS ACCUMULATED IN  X0,     *DOT  481
*                                   LO-ORDER PART IN  X5.         *DOT  491
*                                                                 *DOT  501
*******************************************************************DOT  511
 LOOP    FX2   X1*X3                     UPPER PROD X,Y             DOT  521
         FX6   X0+X5                                                DOT  531
         DX4   X1*X3                     LOWER PROD X,Y             DOT  541
         SA1   A1+B3            FETCH NEXT ELEMENT OF -X-           DOT  551
         DX7   X0+X5                                                DOT  561
         SA3   A3+B5            FETCH NEXT ELEMENT OF -Y-           DOT  571
         DX5   X2+X6                                                DOT  581
         FX0   X2+X6                                                DOT  591
         NO                                                         DOT  601
         FX5   X4+X5                                                DOT  611
         NX0   X0                                                   DOT  621
         FX5   X5+X7                                                DOT  631
 NOD     FX2   X1*X3                     UPPER PROD X,Y             DOT  641
         FX6   X0+X5                                                DOT  651
         DX4   X1*X3                     LOWER PROD X,Y             DOT  661
         SA1   A1+B2            FETCH NEXT ELEMENT OF -X-           DOT  671
         DX7   X0+X5                                                DOT  681
         SA3   A3+B6            FETCH NEXT ELEMENT OF -Y-           DOT  691
         DX5   X2+X6                                                DOT  701
         FX0   X2+X6                                                DOT  711
         SB1   B1-B7            DECREMENT ELEMENT COUNTER  B1       DOT  721
         FX5   X4+X5                                                DOT  731
         NX0   X0                                                   DOT  741
         FX5   X5+X7                                                DOT  751
         GT    B1,B7,LOOP       LOOP BACK IF MORE THAN 2 ELEMENTS STILL  DOT  761
*                                   REMAIN TO BE PROCESSED          DOT  771
         LE    B1,B0,FINISH     BRANCH IF LAST 2 ELEMENTS ALREADY PROCESSEDDOT  781
         SB2   B0               ZERO OUT -IX- AND -IY- FOR 2ND SET OF   DOT  791
         SB6   B0                 FETCHES TO ELIMINATE ACCESS OUT OF RANGE DOT  801
         EQ    B0,B0,LOOP       LOOP BACK TO PROCESS LAST 2 ELEMENTS    DOT  811
*******************************************************************DOT  821
*                                                                 *DOT  831
* HI-ORDER PART OF THE RESULT IS RETURNED IN  X6, LO-ORDER PART IN  X7 *DOT  841
*                                                                 *DOT  851
*******************************************************************DOT  861
 FINISH  FX1    X0*X5                                               DOT  871
         DX2   X0+X5                                                DOT  881
         NX3   X1                                                   DOT  891
         NX4   X2                                                   DOT  901
         DX7   X3+X4                                                DOT  911
         FX6   X3+X4                                                DOT  921
         EQ    B0,B0,DOTPRO          RETURN TO CALLING PROGRAM      DOT  931
 TWO     LE    B1,B0,ZERO       BRANCH IF  -N- .LE. 0               DOT  941
         SB2   B0               ZERO OUT -IX- AND -IY- FOR 2ND SET OF   DOT  951
         SB6   B0                 FETCHES TO ELIMINATE ACCESS OUT OF RANGE DOT  961
```

```
         NE     B1,B7,NOD       BRANCH IF  -N- .EQ. 1
         EQ     B0,B0,LOOP      BRANCH TO PROCESS 2 ELEMENTS
ZERO     LT     B1,B0,IND       BRANCH IF  -N- .LT. 0
         SA7    B0               IF N = 0
         MX6    0                  RESULT = ZERO
         EQ     B0,B0,DOTPRO          RETURN TO CALLING PROGRAM
IND      MX7    1               IF N .LT. 0
         MX6    1                  RESULT = INFINITE
         EQ     B0,B0,DOTPRO          RETURN TO CALLING PROGRAM
         END
      SUBROUTINE LABRT (ISW,LHOL,INX)
      DIMENSION LHOL(5)
      LOGICAL PS, TS
      IF ((ISW.EQ.0).OR.(ISW.GT.5)) RETURN
      GO TO (10,20,30,40,50), ISW
      DATA NP /10/, PS /.TRUE./, TS /.FALSE./
   10 IF (PS.AND.(NP.GT.0)) PRINT 60, LHOL,INX
      NP=NP-1
      IF (TS) STOP
      RETURN
   20 PS=.FALSE.
      RETURN
   30 PS=.TRUE.
      NP=INX
      RETURN
   40 TS=.TRUE.
      RETURN
   50 TS=.FALSE.
      RETURN
C
   60 FORMAT (1H0,9X,5A10,3X,O6)
      END
      END
```

APPENDIX C

SOME USEFUL FITS OF THE PULSE DATA

This appendix contains a listing (Table IC) of the parameters for 11 energy group pulse fits for 5 ENDF/B-IV fission-yield sets. The parameters for the fits, given in Table IC, are in an ENDF/B-like format and are for ^{233}U thermal, ^{235}U thermal, ^{238}U fast, ^{239}Pu thermal, and ^{232}Th fast neutron incident energy for both beta- and gamma-decay energy spectra.

In the ENDF-like format, columns 66-70 contain the "MAT-No." that is used to identify the target nucleus. The MAT-Nos. used in Table IC are the same as those used in ENDF/B-IV and are as follows.

MAT No.	Target Nucleus	MAT No.	Target Nucleus
1260	^{233}U	1264	^{239}Pu
1261	^{235}U	1296	^{232}Th
1262	^{238}U		

A zero in column 70 signifies the end of the data for that MAT. The next two columns, 71 and 72, are used for the MF-No., which identifies the energy of the incident neutron. Here only two numbers are used; MF=80 denotes "thermal" neutrons, and MF=81 denotes "fast" neutrons. A zero in column 72 signifies the end of the data for that MF.

Columns 73-75 contain the MT-Nos. that are used here to identify whether the parameters are for a fit for the beta decay energy spectrum (MT=802) or a fit for the gamma decay energy spectrum (MT=803). A zero in column 75 signifies the end of the data for that MT.

The data for a particular MAT, MF, MT combination are given in field widths of 11 and are organized as follows.

1. The sixth field on the first data card (number 11 in this case) gives the number of broad-energy groups for which the pulse fits are given.

2. On the next card, the first two fields give the energy bounds for the group in MeV; 0.1 to 0.9 MeV for group 1, for example. The sixth field gives the group number; 1, 2, 3, 4, etc.

3. The first two fields on the third data card give the cooling-time range in s over which the fit was made; 0.1 to 1 x 10^9 s for group 1, for example. The sixth field gives the number of pairs of parameters used in the fit; 16 for group 1, for example.

4. Next follows a number of cards containing the α_i and λ_i used for the pulse fit.

   For example, for group 1, $fc(t) = \sum_{i=1}^{16} \alpha_i e^{-\lambda_i t}$, so six cards are needed to contain the sixteen parameters needed for the fit.

TABLE IC

USEFUL FITS IN 11 GROUPS

11 GROUP FITS FROM 2PT/TIME DECADE PEFPYD DATA,JUN78,RJL/DCG,LASL					-0-0 -0	0
0.	0.	0	0	0	11126080802	1
1.00000- 1	4.00000- 1	0	0	0	1126080802	2
1.00000- 1	1.00000+ 9	0	0	0	161126080802	3
1.17847- 3	1.31789+ 0	7.30423- 4	1.23996- 1	3.33156- 4	1.67269- 2126080802	4
4.18899- 5	3.14840- 3	2.95328- 5	1.00728- 3	8.50174- 6	4.16289- 4126080802	5
3.00218- 6	1.43197- 4	7.87240- 7	4.15921- 5	4.88582- 7	1.53794- 5126080802	6
6.29912- 8	4.52958- 6	3.25016- 8	1.27831- 6	7.57565- 9	4.98598- 7126080802	7
4.22701- 9	2.20467- 7	6.79934-10	7.57640- 8	3.61435-11	1.61480- 8126080802	8
1.32696-11	8.87199-10	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+ 0126080802	9
4.00000- 1	9.00000- 1	0	0	0	2126080802	10
1.00000- 1	1.00000+ 9	0	0	0	17126080802	11
7.99016- 3	1.48645+ 0	1.69559- 3	2.99261- 1	3.95672- 3	1.22866- 1126080802	12

1.79823- 3	1.85960- 2	2.42225- 4	3.97993- 3	1.03123- 4	1.30779-	3126080802	13
3.45295- 5	4.54034- 4	1.23831- 5	1.67415- 4	2.10957- 6	4.42210-	5126080802	14
1.47045- 6	1.70484- 5	2.02086- 7	5.76043- 6	5.05948- 8	1.44126-	6126080802	15
9.84458- 9	4.62132- 7	6.85799- 9	2.03147- 7	1.23372- 9	8.09713-	8126080802	16
1.30093-10	2.11370- 8	1.52754-11	8.62735-10	0.00000+ 0	0.00000+	0126080802	17
9.00000- 1	1.35000+ 0	0	0	0		3126080802	18
1.00000- 1	1.00000+ 9	0	0	0		17126080802	19
1.57186- 2	1.60646+ 0	4.61113- 3	3.54381- 1	7.61468- 3	1.27400-	1126080802	20
2.98653- 3	2.01209- 2	3.61986- 4	4.49169- 3	1.22266- 4	1.40394-	3126080802	21
3.73673- 5	4.73914- 4	1.34546- 5	1.78053- 4	2.61936- 6	5.48139-	5126080802	22
1.43189- 6	2.31377- 5	1.27872- 7	7.06160- 6	1.19771- 8	1.33661-	6126080802	23
3.33251- 9	2.98222- 7	2.12419- 9	1.44930- 7	6.43493-13	5.93584-	8126080802	24
1.85603-10	2.19179- 8	1.89017-11	8.54770-10	0.00000+ 0	0.00000+	0126080802	25
1.35000+ 0	1.80000+ 0	0	0	0		4126080802	26
1.00000- 1	1.00000+ 9	0	0	0		17126080802	27
2.51541- 2	1.69336+ 0	8.17767- 3	3.24759- 1	1.05374- 2	1.36190-	1126080802	28
3.92872- 3	2.17691- 2	3.68696- 4	4.51814- 3	1.40071- 4	1.44406-	3126080802	29
3.60831- 5	4.75951- 4	1.03436- 5	1.71545- 4	1.73613- 6	5.04944-	5126080802	30
1.61758- 6	2.78985- 5	8.53165- 8	9.24376- 6	4.06210- 9	1.45389-	6126080802	31
4.34269-10	2.94410- 7	4.04202-11	5.85841- 8	4.19332-10	2.83529-	8126080802	32
4.22893-11	2.24316- 8	1.48324-11	7.82500-10	0.00000+ 0	0.00000+	0126080802	33
1.80000+ 0	2.20000+ 0	0	0	0		5126080802	34
1.00000- 1	1.00000+ 9	0	0	0		16126080802	35
2.67997- 2	1.75825+ 0	9.79129- 3	3.97575- 1	1.20350- 2	1.41739-	1126080802	36
3.68242- 3	2.38143- 2	3.81235- 4	5.11213- 3	1.15250- 4	1.53819-	3126080802	37
3.26646- 5	5.24298- 4	4.77670- 6	1.74888- 4	1.29386- 6	4.76461-	5126080802	38
1.18018- 6	3.13581- 5	6.46069- 8	1.13694- 5	5.21521-10	1.00596-	6126080802	39
2.33654-12	1.82662- 7	3.66427-10	2.77694- 8	2.63892-14	7.73443-	9126080802	40
4.10293-12	7.83700-10	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126080802	41
2.20000+ 0	2.60000+ 0	0	0	0		6126080802	42
1.00000- 1	1.00000+ 9	0	0	0		16126080802	43
2.63443- 2	1.85815+ 0	1.20439- 2	5.25591- 1	1.37984- 2	1.41964-	1126080802	44
3.12440- 3	2.42660- 2	4.22520- 4	5.91974- 3	1.04156- 4	1.59895-	3126080802	45
[illegible] 5	[illegible] 4	3.24567- 6	1.84159- 4	5.24379- 7	4.99604-	5126080802	46
1.24880- 6	3.63546- 5	2.71175- 8	1.40884- 5	2.08737-11	6.97300-	8126080802	47
1.34354-10	2.68711- 8	3.70320-11	2.85321- 8	2.93500-11	2.45991-	8126080802	48
2.72400-14	7.90394-10	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126080802	49
2.60000+ 0	3.00000+ 0	0	0	0		7126080802	50
1.00000- 1	1.00000+ 9	0	0	0		15126080802	51
2.47528- 2	2.49495+ 0	1.31971- 2	5.67221- 1	1.31090- 2	1.52802-	1126080802	52
2.87281- 3	2.60491- 2	3.68876- 4	5.95494- 3	8.54516- 5	1.67914-	3126080802	53
2.11128- 5	5.89142- 4	1.30756- 6	1.66618- 4	2.12659- 7	6.67863-	5126080802	54
1.43713- 6	4.76290- 5	3.82280- 9	1.41515- 5	1.23430-11	9.33799-	7126080802	55
2.51502-11	3.01380- 8	2.16852-11	2.36158- 8	6.07421-17	1.00000-	9126080802	56
3.00000+ 0	4.00000+ 0	0	0	0		8126080802	57
1.00000- 1	1.00000+ 9	0	0	0		15126080802	58
3.03203- 2	2.63620+ 0	3.32298- 2	6.19487- 1	2.11625- 2	1.35191-	1126080802	59
3.44896- 3	2.38179- 2	6.22859- 4	6.83902- 3	1.31045- 4	1.77137-	3126080802	60
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1.51295- 6	5.94260- 5	3.57963- 9	1.69857- 5	1.91793-11	1.24070-	6126080802	62
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4.30002+ 0	5.00000+ 0	0	0	0		9126080802	64
1.00000- 1	1.00000+ 9	0	0	0		14126080802	65
1.76532- 2	2.49308+ 0	9.36264- 3	5.21734- 1	1.25463- 2	1.44344-	1126080802	66
1.16599- 3	2.83475- 2	2.94050- 4	8.48785- 3	2.77222- 5	2.66519-	3126080802	67
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5.00000+ 0	6.00000+ 0	0	0	0		10126080802	71
1.00000- 1	1.00000+ 9	0	0	0		13126080802	72
8.21597- 3	2.59379+ 0	4.51384- 3	3.86088- 1	6.33458- 3	1.31950-	1126080802	73
3.10320- 4	3.55307- 2	9.50091- 5	1.09562- 2	1.22664- 5	4.31053-	3126080802	74
9.43819- 6	1.14566- 3	1.93264- 8	6.85689- 5	1.01233-14	3.19931-	6126080802	75
2.92196-13	1.43353- 6	3.00223-19	1.29786- 7	2.11902-20	2.70455-	11126080802	76
5.87326-20	2.42474-12	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126080802	77
6.00000+ 0	7.50000+ 0	0	0	0		11126080802	78
1.00000- 1	1.00000+ 7	0	0	0		11126080802	79
3.57554- 3	2.46348+ 0	1.40706- 3	4.70754- 1	2.80901- 3	1.47840-	1126080802	80

1.92368- 4	6.53921- 2	1.78010- 5	1.57095- 2	4.87805- 7	4.97659-	3126080802	81
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						126080 0	84
0.	0.	0	0	0		11126080803	85
1.00000- 1	4.00000- 1	0	0	0		1126080803	86
1.00002- 1	1.00000+ 9	0	0	0		17126080803	87
1.89325- 2	1.44703+ 0	7.05340- 3	1.52217- 1	1.30050- 3	2.43368-	2126080803	88
1.62580- 4	5.76486- 3	4.37230- 5	1.04581- 3	1.87770- 5	5.10305-	4126080803	89
6.98573- 6	2.47235- 4	3.56388- 7	3.74253- 5	2.33710- 7	1.05674-	5126080803	90
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4.00000- 1	9.00000- 1	0	0	0		2126080803	94
1.00000- 1	1.00000+ 9	0	0	0		16126080803	95
8.22835- 2	2.23834+ 0	4.77789- 2	8.12574- 1	3.63471- 2	1.87581-	1126080803	96
3.72441- 3	2.31596- 2	5.83374- 4	4.43976- 3	1.81455- 4	1.39806-	3126080803	97
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1.89664- 6	1.26902- 5	1.41442- 7	4.88981- 6	2.02228- 7	1.91329-	6126080803	99
1.45733- 8	1.22653- 7	1.10403-10	3.31610- 8	-1.38468-15	8.74440-	9126080803	100
3.11532-11	7.47294-13	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126080803	101
9.72330- 1	1.35400+ 0	0	0	0		3126080803	102
1.00000- 1	1.00000+ 9	0	0	0		16126080803	103
1.94238- 2	1.68138+ 0	7.17798- 3	3.04452- 1	8.73607- 3	1.11615-	1126080803	104
3.62909- 3	1.70921- 2	2.83618- 4	4.46986- 3	1.89610- 4	1.04538-	3126080803	105
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1.61227-16	4.53280-13	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126080803	109
1.35700+ 0	1.80000+ 0	0	0	0		4126080803	110
1.00000- 1	1.40000+ 9	0	0	0		14126080803	111
9.73488- 3	1.32524+ 0	7.83183- 3	1.32085- 1	3.91782- 3	1.85826-	2126080803	112
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6.17038-12	2.70810- 8	2.33063-16	3.57423-10	0.00000+ 0	0.00000+	0126080803	116
1.00000+ 0	2.20000+ 0	0	0	0		5126080803	117
1.00000- 1	1.00000+ 9	0	0	0		15126080803	118
2.47866- 3	1.35692+ 0	1.91617- 3	1.27042- 1	1.25692- 3	1.73512-	2126080803	119
9.41932- 5	4.63827- 3	6.67399- 5	7.53098- 4	8.93792- 6	4.45432-	4126080803	120
4.23775- 6	1.54208- 4	3.34213- 6	7.92945- 5	6.94403- 7	3.80097-	5126080803	121
5.24338- 9	5.08527- 6	9.06809- 9	2.58819- 6	3.35679-10	9.51548-	7126080803	122
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2.20000+ 0	2.60000+ 0	0	0	0		6126080803	124
1.00000- 1	1.00000+ 9	0	0	0		13126080803	125
4.23325- 3	1.38942+ 0	3.29307- 3	1.31796- 1	1.82627- 3	1.77436-	2126080803	126
2.23452- 4	5.95908- 3	2.43730- 5	6.02426- 4	1.17665- 5	2.81664-	4126080803	127
8.71145- 6	8.68231- 5	5.29131- 7	5.95306- 5	3.25421-10	1.25122-	6126080803	128
4.76826- 9	6.51576- 7	1.22792-13	8.14057- 8	7.09240-14	2.01521-	8126080803	129
5.79528-17	7.87235-12	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126080803	130
2.60000+ 0	3.00000+ 0	0	0	0		7126080803	131
1.00000- 1	1.00000+ 9	0	0	0		14126080803	132
3.59237- 3	1.37718+ 0	2.86956- 3	1.31731- 1	1.05739- 3	2.07429-	2126080803	133
1.84551- 4	5.09092- 3	2.94412- 5	1.00819- 3	4.87394- 6	3.96467-	4126080803	134
3.96425- 6	1.95825- 4	4.80228- 7	1.11253- 4	4.81360- 7	7.20150-	5126080803	135
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8.37690-15	1.95012- 8	1.72686-17	2.96936-12	0.00000+ 0	0.00000+	0126080803	137
3.02000+ 0	4.00000+ 0	0	0	0		8126080803	138
1.00000- 1	1.00000+ 9	0	0	0		15126080803	139
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2.92548- 4	5.37660- 3	1.35423- 4	2.52772- 3	5.62011- 6	5.41770-	4126080803	141
3.79498- 6	1.87000- 4	6.76027- 7	1.14637- 4	2.89359- 7	7.69293-	5126080803	142
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2.54322-19	4.91284- 9	7.82941-19	5.15433-11	1.02158-17	1.39532-1	3126080803	144
4.00000+ 0	5.00000+ 0	0	0	0		9126080803	145
1.00000- 1	1.00000+ 9	0	0	0		13126080803	146
1.60747- 3	1.80160+ 0	1.52883- 3	2.25890- 1	9.83004- 4	3.77720-	2126080803	147
4.09906- 4	6.56220- 3	1.25744- 4	4.22700- 3	6.99651- 6	1.16000-	3126080803	148
3.08706- 8	2.36360- 4	2.67969- 8	8.24140- 5	9.73688- 9	6.18350-	5126080803	149

1.19193-11	1.16122- 6	5.46651-12	7.69220- 7	1.52415-13	4.30750-	7126480803	150
2.33121-19	3.78[illegible]-11	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126030803	151
5.[illegible]0+ 0	6.[illegible]+ 0	0	0	0		1012604[illegible]803	152
1.00000- 1	1.00000+ 7	0	0	0		1212600080803	153
1.27450- 3	2.91445+ 0	8.78971- 4	8.21442- 1	1.44623- 3	1.78353-	1126080803	154
1.92[illegible]3- 4	5.69186- 2	6.41882- 5	1.10420- 2	1.74079- 5	5.97661-	3126080803	155
2.31868- 5	4.12612- 3	5.69813- 7	1.58143- 3	4.10434- 6	7.85728-	4126080803	156
1.23518-13	1.36270- 7	4.11718-12	7.50078-	7-5.08962-14	5.73601-	8126080803	157
6.[illegible]+ 0	7.5[illegible]+ 0	0	0	0		1112600080803	158
1.00000- 1	1.00000+ 7	0	0	0		1112600080803	159
2.65368- 4	2.23454+ 0	1.11320- 4	5.36125- 1	2.37870- 4	1.53795-	1126080803	160
9.54509- 6	1.88410- 2	6.16453- 6	1.18887- 2	1.18051- 6	1.01567-	2126080803	161
5.03227-10	1.55458- 3	7.03980-14	8.19018-	5-2.17311-13	8.43794-	7126080803	162
6.41982-13	6.00326- 7	1.14132-15	1.80848- 7	0.00000+ 0	0.00000+	0126080803	163
						120480 0	164
						1200 7 0	165
						0 0 0	166
0.	0.	0	0	0		11126180802	1
1.00000- 1	4.00000- 1	0	0	0		1126180802	2
1.00000- 1	1.00000+ 9	0	0	0		16126180802	3
2.76879- 3	1.45381+ 0	1.28097- 3	1.38592- 1	4.76613- 4	1.70696-	2126180802	4
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3.80721- 6	1.47429- 4	6.97162- 7	4.22706- 5	5.25675- 7	1.47919-	5126180802	6
6.02172- 8	4.56836- 6	3.27577- 8	1.29054- 6	7.27157- 9	5.08353-	7126180802	7
4.09634- 9	2.30415- 7	7.20339-10	7.66225- 8	4.66955-11	1.58689-	8126180802	8
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4.00000- 1	9.00000- 1	0	0	0		2126180802	10
1.00000- 1	1.00000+ 9	0	0	0		17126180802	11
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1.07649- 8	5.22256- 7	6.05622- 9	2.20085- 7	1.32156- 9	8.12784-	8126180802	16
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9.00000- 1	1.35000+ 0	0	0	0		3126180802	18
1.00000- 1	1.00000+ 9	0	0	0		17126180802	19
3.83659- 2	1.64979+ 0	1.20318- 2	3.21283- 1	9.60829- 3	1.05840-	1126180802	20
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3.65779-11	2.22882- 8	1.30160-11	7.92748-10	0.00000+ 0	0.00000+	0126180802	33
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2.20000+ 0	2.60000+ 0	0	0	0		6126180802	42
1.00000- 1	1.00000+ 9	0	0	0		16126180802	43
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3.00000+ 0	4.00000+ 0	0	0	0		8126180802	57
1.00000- 1	1.00000+ 9	0	0	0		15126180802	58
1.23767- 1	1.81367+ 0	4.34200- 2	4.59880- 1	2.94350- 2	1.24126-	1126180802	59
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1.00000- 1	1.00000+ 9	0	0	0		14126180802	65
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5.00000+ 0	6.00000+ 0	0	0	0		10126180802	71
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6.00000+ 0	7.50302+ 0	0	0	0		11126180802	78
1.00000- 1	1.20000+ 7	0	0	0		11126180802	79
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						126180 0	84
0.	0.	0	0	0		11126180803	85
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4,00000+ 0	5.00000+ 0	0	0	0		9126180803	151
1,00002- 1	1.00000+ 9	0	0	0		16126180805	152
3,18297- 3	2.5585[illegible] 0	2,87557- 3	4.95990- 1	1.71152- 3	1,35710-	1126180803	153
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5,00000+ 0	6.00000+ 0	0	0	0		10126180803	159
1,00030- 1	1.00000+ 7	0	0	0		12126180803	160
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						1261 0 0	172
						0 0 0	173
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2,75226-11	7.35103-10	0,00000+ 0	0.00000+ 0	0,00000+ 0	0,00000+	0126281803	103
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1,00000- 1	1.00000+ 9	0	0	0		19126281803	105
1,05106- 1	1.70053+ 0	5,98281- 2	5.97672- 1	2,29980- 2	1,11699-	1126281803	106
5,86919- 3	3.37099- 2	3,02614- 3	1.25887- 2	7,37095- 4	4,54185-	3126281803	107
1,38651- 4	1.13567- 3	9,31884- 5	6.15801- 4	1,91336- 5	2,08397-	4126281803	108
2,34910- 6	3.92186- 5	7,05070- 7	1.79362- 5	4,78540- 8	2,60335-	6126281803	109
3,77342- 9	7.32215- 7	1,02785- 9	5.49878- 7	2,28855-11	1,71546-	7126281803	110
1,44932-11	2.16636- 8	4,33608-14	2.23759- 8	2,82405-17	5,36277-1	1126281803	111
5,04485-18	2.77730-11	0,00000+ 0	0.00000+ 0	0,00000+ 0	0,00000+	0126281803	112
1,35000+ 0	1.80000+ 0	0	0	0		4126281803	113
1,00000- 1	1.00000+ 9	0	0	0		14126281803	114
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1,17996- 4	2.46018- 3	6,79717- 5	3.96956- 4	1,16056- 5	1,53525-	4126281803	117
2,98589- 6	4.07339- 5	6,87086- 8	6.35132- 7	8,32146-12	2,51760-	8126281803	118
2,41599-15	9.05109- 9	5,27716-17	4.43663-11	0,00000+ 0	0,00000+	0126281803	119
1,80000+ 0	2.20000+ 0	0	0	0		5126281803	120
1,00000- 1	1.00000+ 9	0	0	0		18126281803	121
1,37801- 2	1.43343+ 0	5,35251- 3	2.96103- 1	3,40309- 3	1,27204-	1126281803	122
1,73103- 3	2.83300- 2	9,44486- 4	1.39569- 2	1,36912- 4	5,01941-	3126281803	123
6,57600- 5	9.49852- 4	1,47096- 5	5.52576- 4	4,92491- 6	1,98121-	4126281803	124
3,72281- 6	9.04812- 5	3,32471- 7	4.14675- 5	1,90021- 8	9,90620-	6126281803	125
1,05127- 8	2.35522- 6	2,11403-10	6.27219- 7	-9,22881-12	3,25351-	8126281803	126
3,11842-11	2.80343- 8	4,01780-15	1.18259- 8	1,81828-17	2,94831-1	0126281803	127
2,20000+ 0	2.60000+ 0	0	0	0		6126281803	128
1,00000- 1	1.00000+ 9	0	0	0		16126281803	129
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2,44169- 3	2.52449- 2	1,23109- 3	9.31485- 3	5,71229- 5	2,94643-	3126281803	131
2,12642- 5	4.13479- 4	7,36009- 6	1.46158- 4	1,90885- 6	6,88077-	5126281803	132
-3,43876- 9	9.04265- 6	4,18627-10	1.19616- 6	2,86544- 9	6,66865-	7126281803	133
1,50572- 9	5.96339- 7	8,52373-13	2.16747- 8	4,77990-19	4,69100-1	1126281803	134
1,76868-17	5.36608-12	0,00000+ 0	0.00000+ 0	0,00000+ 0	0,00000+	0126281803	135
2,60000+ 0	3.00000+ 0	0	0	0		7126281803	136
1,00000- 1	1.00000+ 9	0	0	0		15126281803	137
1,96407- 2	1.39816+ 0	8,79956- 3	3.24869- 1	5,08760- 3	1,29099-	1126281803	138
1,86324- 3	3.83664- 2	8,11545- 4	1.47115- 2	2,64222- 4	7,66709-	3126281803	139
7,93700- 5	3.27213- 3	2,59054- 6	1.68207- 4	7,68430- 6	3,08298-	4126281803	140
3,24549- 7	7.54109- 5	1,29370-10	1.19587- 6	1,01696-10	6,62591-	7126281803	141
1,06436-13	2.16685- 8	3,48545-22	9.83700-11	5,38863-18	3,73610-1	2126281803	142
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1,00000- 1	1.00000+ 9	0	0	0		16126281803	144
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2,56201- 3	3.30429- 2	1,39542- 3	1.31015- 2	2,23585- 4	4,45143-	3126281803	146
2,91953- 5	1.50874- 3	6,11476- 6	5.14067- 4	1,40932- 6	1,40604-	4126281803	147
6,27413- 7	1.31276- 4	1,38711- 7	7.66330- 5	3,10267-10	1,02300-	6126281803	148
1,93393-11	5.98662- 7	1,29404-16	1.01114- 7	1,93062-18	1,79063-1	1126281803	149
1,46024-18	2.21301-12	0,00000+ 0	0.00000+ 0	0,00000+ 0	0,00000+	0126281803	150
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1,00000- 1	1.00000+ 9	0	0	0		16126281803	152
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1,31773- 3	2.62327- 2	4,32764- 4	1.30568- 2	7,58001- 5	8,75530-	3126281803	154
1,70549- 4	4.05170- 3	1,57962- 6	1.01725- 3	7,89368- 8	3,47493-	4126281803	155

1.50389- 8	9.75343- 5	6.23427- 9	6.24248- 5	1.87093-10	1.04411-	6126281803	156
2.03340-13	6.77242- 7	2.25972-16	1.72020- 7	1.31290-22	2.00000-	8126281803	157
6.87217-20	2.39375-13	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00002+	0126281803	158
5.00200+ 2	6.00200+ 0	0	0	0		10126281803	159
1.00000- 1	1.00000+ 7	0	0	0		12126281803	160
1.28529- 2	1.70929+ 0	6.54462- 3	3.45830- 1	1.52776- 3	8.70199-	2126281803	161
1.52357- 4	1.57706- 2	2.04631- 5	5.11245- 3	6.42499- 6	3.28140-	3126281803	162
7.61545- 8	8.69636- 4	2.47239- 9	1.17448- 3	4.44115-13	2.03870-	4126281803	163
2.15732-11	1.40218- 6	1.89161-14	5.90263- 7	9.99597-23	2.45830-	8126281803	164
6.22200+ 0	7.54200+ 0	0	0	0		11126281803	165
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1.75170- 3	1.78076+ 0	1.15388- 3	3.53983- 1	2.52907- 4	8.45266-	2126281803	167
1.38943- 5	1.36583- 2	6.48457- 7	8.49691- 3	1.91878- 9	1.53165-	3126281803	168
8.60487-12	9.64726- 4	8.92896-14	1.03916- 6	2.65164-15	6.05244-	7126281803	169
6.52441-21	1.55895- 9	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126281803	170
						126281 0	171
						1262 0 0	172
						0 0 0	173
0.	0.	0	0	0		11126480802	1
1.00000- 1	4.00000- 1	0	0	0		1126480802	2
1.00000- 1	1.00000+ 9	0	0	0		16126480802	3
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4.82923- 5	2.31047- 3	2.72643- 5	7.68549- 4	7.01046- 6	3.96417-	4126480802	5
3.34766- 6	1.62355- 4	6.66177- 7	4.43033- 5	5.33139- 7	1.45949-	5126480802	6
1.03116- 7	4.26015- 6	2.86511- 8	1.33135- 6	4.67937- 9	4.63108-	7126480802	7
3.08912- 9	2.48649- 7	5.82984-10	7.86038- 8	4.75823-11	1.70574-	8126480802	8
1.05176-11	8.52187-10	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126480802	9
4.00000- 1	9.00000- 1	0	0	0		2126480802	10
1.00000- 1	1.00000+ 9	0	0	0		17126480802	11
1.04129- 2	1.42215+ 0	2.24530- 3	2.51811- 1	4.11135- 3	1.20100-	1126480802	12
1.94538- 3	1.81233- 2	2.55576- 4	4.22000- 3	1.13091- 4	1.19516-	3126480802	13
4.13869- 5	4.56191- 4	1.29300- 5	1.80159- 4	1.87301- 6	5.28654-	5126480802	14
1.45663- 6	1.83792- 5	3.66317- 7	6.06126- 6	3.51889- 8	8.99489-	7126480802	15
7.40431- 9	4.08754- 7	6.78442-10	3.23467- 7	1.06348- 9	8.00628-	8126480802	16
1.69868-10	1.98178- 8	5.19700-12	7.63802-10	0.00000+ 0	0.00000+	0126480802	17
9.80200- 1	1.35100+ 0	0	0	0		3126480802	18
1.00000- 1	1.00000+ 9	0	0	0		17126480802	19
2.16755- 2	1.44884+ 0	5.12548- 3	2.79765- 1	7.88359- 3	1.22001-	1126480802	20
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3.52762- 5	4.08969- 4	1.22334- 5	1.87526- 4	1.27662- 6	7.31064-	5126480802	22
1.49573- 6	2.49300- 5	1.00012- 7	6.11045- 6	1.01400- 8	1.10327-	6126480802	23
1.76530- 9	3.32517- 7	8.53121-10	2.60217- 7	5.98391-10	4.95692-	8126480802	24
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1.35000+ 0	1.80000+ 0	0	0	0		4126480802	26
1.00000- 1	1.00000+ 9	0	0	0		17126480802	27
3.03321- 2	1.47516+ 0	8.88618- 3	2.60270- 1	1.07152- 2	1.27154-	1126480802	28
4.19525- 3	2.09463- 2	4.42563- 4	4.46701- 3	1.39718- 4	1.02428-	3126480802	29
1.86643- 5	2.86359- 4	4.01573- 6	1.84640- 4	9.51260- 7	6.03701-	5126480802	30
1.11990- 6	3.08247- 5	1.00000- 7	9.58474- 6	5.08164- 9	1.50877-	6126480802	31
2.71882-10	3.16885- 7	1.63938-10	3.08140- 8	5.13671-10	2.42641-	8126480802	32
1.51497-11	1.24954- 8	4.51176-12	7.54044-10	0.00000+ 0	0.00000+	0126480802	33
1.82000+ 0	2.20000+ 0	0	0	0		5126480802	34
1.00000- 1	1.00000+ 9	0	0	0		16126480802	35
3.74744- 2	1.53732+ 0	9.60065- 3	3.19116- 1	1.29227- 2	1.33231-	1126480802	36
3.95548- 3	2.20473- 2	4.42255- 4	5.00738- 3	1.26387- 4	1.24015-	3126480802	37
1.35999- 5	2.79734- 4	6.72376- 6	5.45202- 4	4.84560- 7	3.58105-	5126480802	38
5.32917- 7	3.54974- 5	5.05537- 8	1.12566- 5	7.75392-10	1.27626-	6126480802	39
1.09627-10	6.07899- 7	5.67226-10	2.48918- 8	2.55320-12	9.55175-	9126480802	40
1.23624-12	7.48560-10	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126480802	41
2.20000+ 0	2.60000+ 0	0	0	0		6126480802	42
1.00000- 1	1.00000+ 9	0	0	0		16126480802	43
2.77469- 2	2.57636+ 0	2.51679- 2	5.95191- 1	1.44242- 2	1.26202-	1126480802	44
3.30486- 3	2.24170- 2	5.17911- 4	5.49068- 3	9.70473- 5	1.16297-	3126480802	45
9.86007- 6	4.58324- 4	4.51617- 6	3.06246- 4	2.00155- 7	3.05789-	5126480802	46
5.67330- 7	4.26260- 5	1.65890- 8	1.11047- 5	8.52570-11	2.55424-	7126480802	47
3.29834-10	2.36794- 8	7.55774-12	1.63724- 8	3.39814-11	2.36443-	8126480802	48
7.61553-15	6.73652-10	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126480802	49
2.60000+ 0	3.00000+ 0	0	0	0		7126480802	50
1.00000- 1	1.00000+ 9	0	0	0		15126480802	51

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2.78822- 3	2.22776- 2	4.32489- 4	5.61691- 3	7.00665- 5	1.23784-	3126480802	53
1.37692- 5	5.72721- 4	1.38028- 6	3.43703- 4	5.77862- 8	3.94645-	5126480802	54
6.38635- 7	5.11039- 5	6.27083- 9	1.17524- 5	1.15546-10	1.07719-	6126480802	55
1.64264-12	2.32279- 8	4.31920-12	1.65311- 8	5.14126-17	1.00000-	9126480802	56
3.00000+ 0	4.00000+ 0	0	0	0		8126480802	57
1.00000- 1	1.00000+ 9	0	0	0		15126480802	58
4.78771- 2	2.58547+ 0	4.34899- 2	6.49900- 1	2.08763- 2	1.30640-	1126480802	59
3.67583- 3	2.13151- 2	6.39773- 4	6.40119- 3	1.09437- 4	1.60053-	3126480802	60
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4.00000+ 0	5.00000+ 0	0	0	0		9126480802	64
1.00000- 1	1.00000+ 9	0	0	0		14126480802	65
2.04801- 2	1.87709+ 0	8.56555- 3	6.32676- 1	1.20413- 2	1.30006-	1126480802	66
1.05668- 3	2.42650- 2	2.56984- 4	9.45211- 3	2.12940- 5	2.77694-	3126480802	67
9.37519- 7	5.60072- 4	1.94668- 8	1.53248- 4	2.66584- 7	6.90789-	5126480802	68
5.33455-11	7.53547- 5	1.90580-11	1.03762- 6	2.87114-16	1.79544-	7126480802	69
1.97753-16	7.19592-12	2.46078-18	7.18320-13	0.00000+ 0	0.00000+	0126480802	70
5.22040+ 0	6.00000+ 0	0	0	0		10126480802	71
1.02030- 1	1.00000+ 9	0	0	0		13126480802	72
1.19566- 2	1.87641+ 0	3.30170- 3	5.03159- 1	6.10431- 3	1.55015-	1126480802	73
2.69424- 4	3.24962- 2	1.00246- 4	1.20093- 2	7.04297- 6	4.47406-	3126480802	74
1.62689- 7	1.34414- 3	4.95008- 9	6.85689- 5	8.75369-14	1.22980-	6126480802	75
2.63581-12	1.03353- 6	1.53810-18	1.55652- 7	6.20351-21	7.46290-12	126480802	76
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6.00000+ 0	7.50000+ 0	0	0	0		11126480802	78
1.00000- 1	1.00000+ 7	0	0	0		11126480802	79
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2.67929- 4	6.85444- 2	1.52465- 5	1.41366- 2	3.71382- 7	5.14886-	3126480802	81
5.26719- 9	1.49507- 3	2.82328-10	8.31972- 4	2.05401-14	9.17090-	4126480802	82
5.99126-14	1.03766- 6	2.85070-20	5.86991- 8	0.00000+ 0	0.00000+	0126480802	83
						126480 0	84
0.	0.	0	0	0		11126480803	85
1.00000- 1	4.00000- 1	0	0	0		1126480803	86
1.00000- 1	1.00000+ 9	0	0	0		19126480803	87
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5.95517- 3	1.34321- 1	1.81682- 3	5.52554- 2	9.76668- 4	1.71601-	2126480803	89
1.19397- 4	3.95301- 3	5.28369- 5	6.70283- 4	1.92828- 5	5.31679-	4126480803	90
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8.91766- 8	2.88749- 6	1.43142- 8	8.52413- 7	1.27377- 9	2.65480-	7126480803	92
1.44556-11	2.80274- 8	1.21362-12	2.25502- 8	2.68642-13	8.09492-	9126480803	93
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4.00000- 1	9.00000- 1	0	0	0		2126480803	95
1.00000- 1	1.00000+ 9	0	0	0		19126480803	96
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2.87630- 7	3.11840- 6	5.64685- 8	4.80504- 6	5.14641- 8	7.88215-	7126480803	101
1.26341- 8	1.07459- 7	6.33332-11	1.09296- 8	4.68522-15	6.22488-	8126480803	102
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9.34000- 1	1.55000+ 0	0	0	0		5126480803	104
1.00000- 1	1.00000+ 9	0	0	0		19126480803	105
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2.14042- 6	3.97404- 5	6.68804- 7	1.78639- 5	5.09027- 8	2.79144-	6126480803	109
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3.39170-18	1.42050-11	0.00000+ 0	0.00000+ 0	0.00000+ 0	0.00000+	0126480803	112
1.55000+ 0	1.80000+ 0	0	0	0		4126480803	113
1.00000- 1	1.00000+ 9	0	0	0		14126480803	114
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4.30469- 3	6.32810- 2	2.68516- 3	1.79253- 2	7.15780- 4	8.07336-	3126480803	116
9.21953- 5	2.15623- 3	6.02749- 5	4.03454- 4	9.89939- 6	1.57134-	4126480803	117
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1,00000- 1	1.00000+ 9	0	0	0		16126480803	143
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1,00000- 1	1,00000+ 7	0	0	0		12126480803	159
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						1264 0 0	171
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						129681 0	84

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2,94421- 5	3.12173- 4	7,53301- 6	9,46752- 5	3,15826- 6	6,55706-	5129681803	132
3,44424- 9	5.46552- 6	9,24803-10	6.01924- 7	3.12416- 9	6,67984-	7129681803	133
1,59186- 9	5.97900- 7	1,49186-14	2.23878- 8	3.11665-20	9,53230-	11129681803	134
1,36267-17	1.88319-11	0,00000+ 0	0.00000+ 0	0,00000+ 0	0,00000+	0129681803	135
2,60000+ 0	3.00000+ 0	0	0	0		7129681803	136
1,00000- 1	1.00000+ 9	0	0	0		15129681803	137
1,31144- 2	2.70585+ 0	1,43796- 2	4,52984- 1	5,27646- 3	1.17594-	1129681803	138
1,91182- 3	4.03913- 2	1,11924- 3	1.37541- 2	1,72261- 4	7.43558-	3129681803	139
9,14350- 5	2.98837- 3	4,03110- 5	1.82696- 4	8,71789- 6	3.70106-	4129681803	140
6,20691- 7	7.07612- 5	5,19358-11	6.27173- 7	4,63066-11	6,25146-	7129681803	141
1,75777-15	2.17128- 8	1,78360-24	2.45928-11	4,00728-18	2.33789-	12129681803	142
3,00000+ 0	4.00000+ 0	0	0	0		8129681803	143
1,00000- 1	1.00000+ 9	0	0	0		16129681803	144
6,71745- 3	2.75492+ 0	9,48800- 3	4.72103- 1	4,16736- 3	1,22448-	1129681803	145
3,22394- 3	3.12021- 2	1,13289- 3	9.75701- 3	3,71700- 4	4,00920-	3129681803	146
3,09868- 5	1.36580- 3	9,40002- 6	3.71220- 4	2,73865- 6	1,62437-	4129681803	147
2,39705- 7	8.68151- 5	2,40287- 7	7.42730- 5	2,66404-11	7,09598-	7129681803	148
1,46425-11	5.76721- 7	4,13482-17	6.49378- 8	1,03789-18	1,43143-	11129681803	149
1,53248-18	1.28915-12	0,00000+ 0	0.00000+ 0	0,00000+ 0	0,00000+	0129681803	150
4,00000+ 0	5.00000+ 0	0	0	0		9129681803	151
1,00000- 1	1.00000+ 9	0	0	0		16129681803	152
8.36770- 3	1.39342+ 0	3,59519- 3	2.73349- 1	2,57283- 3	1,36271-	1129681803	153

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1.64435- 3 3.26432- 2 6.32586- 4 8.67498- 3 1.71964- 4 4.40785- 3129681803  154
1.65977- 4 3.95929- 3 3.83334- 6 1.07777- 3 1.98496- 7 3.35828- 4129681803  155
3.69245- 8 7.88871- 5 8.84167- 9 5.94478- 5 5.45819-12 1.05237- 6129681803  156
1.82547-14 5.75328- 7 4.97833-16 1.71894- 7 8.11248-20 4.00009- 8129681803  157
5.15442-20 1.21066-13 0.00000+ 0 0.00000+ 0 0.00000+ 0 0.00000+ 0129681803  158
5.00000+ 0 6.00000+ 0           0          0          0         10129681803  159
1.00000- 1 1.00000+ 7           0          0          0         12129681803  160
9.06730- 3 1.54310+ 0 4.69205- 3 2.66182- 1 1.49543- 3 1.03914- 1129681803  161
2.43663- 4 1.38061- 2 5.03207- 5 4.77039- 3 6.40819- 6 3.11276- 3129681803  162
7.13734- 8 8.66134- 4 6.42245- 9 7.03013- 4 7.15931-13 9.74764- 5129681803  163
6.19302-13 1.26165- 6 1.91366-14 7.53108- 7 1.08254-25 1.95064- 7129681803  164
6.00000+ 0 7.50000+ 0           0          0          0         11129681803  165
1.20000- 1 1.20000+ 7           0          0          0         11129681803  166
1.40319- 3 1.77094+ 0 5.58437- 4 3.94210- 1 5.25535- 4 1.79184- 1129681803  167
9.32001- 5 6.68275- 2 3.56183- 5 1.27709- 2 6.76887-10 1.76786- 3129681803  168
3.09687-13 3.98051- 4 2.54909-14 3.42285- 5 4.28676-16 2.11576- 6129681803  169
2.71249-15 8.64508- 7 1.79266-18 1.00334- 7 0.00000+ 0 0.00000+ 0129681803  170
                                                             129681  0  171
                                                             1296 0  0  172
                                                                0 0  0  173
                                                              -1-0 -0    1
*COMPLETE*
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APPENDIX D

BASIC DECAY ENERGY FUNCTIONS, TERMINOLOGY, AND UNITS

This appendix summarizes the conceptual basis and equations of this report for those readers who feel a need for additional detail.

I. BASIC EQUATIONS IN ABSENCE OF NEUTRON ABSORPTION EFFECTS

During the fission process, the fission products are generated directly by fission and by decay or neutron absorption from precursors; absorption and decay also transmutes each product. Summation codes account for all simultaneous processes for each product, including the continuing decay following the end of the fission interval.

The buildup and decay processes are continuous, and summation codes necessarily provide information at specified time intervals. The basic libraries described in this report provide the aggregate summation spectra following a fission pulse in a multigroup format at two or more points per time decade out to 10^9 s ($\approx 2.778 \times 10^5$ h $\approx$ 31.7 yr). Collapsing the fine-energy multigroups to a reduced, but still multigroup, set and fitting each group to a single functional form results in a practical but still accurate description of the group decay energies at any decay or "cooling" time. These can be used as Green's functions to provide the decay energies subsequent to specified power (fission) histories.

Because the fits are to pulse decay data, the functions do not account for changes in the ensemble of products due to neutron absorption. Absorption alters the decay energies, particularly at long ($\gtrsim 10^4$ s) cooling times. The effect depends on the magnitude and spectra of the neutron flux, and on the length of the fission history. As described in Sec. V of this report, neutron absorption effects can be accounted for to good approximation in a relatively simple way. In general, absorption decreases the density, hence also the decay energy of some products, and increases the density of others. The net effect, the one of interest here, tends to be an increase in decay energy, depending on the decay group. At some long cooling times, the net effect is very significant but is due to only a very few nuclides -- primarily the shielded nuclides, which are generated only by absorption, and certain nuclides associated with ^{135}Xe and ^{148}Pm.

The following equations apply only in the absence of neutron absorption; for long irradiation times and large neutron fluxes, these must be corrected at long cooling times as described in this appendix and in Sec. V. For simplicity of exposition, subscripts for the decay group and fissioning nuclide are ignored; group results must be summed over each fissioning nuclide. In addition, decay energies can be presented in four related ways: (1) gamma (beta) energy/s, (2) gammas (betas)/s, (3) gamma (beta) energy/fission, or (4) gammas (betas)/fission. Presentation on a per fission basis is preferable in that it eliminates the actual fission rate and is, for example, independent of the reactor power level. However, this is only possible for a constant fission rate prior to cooling. For broad multigrouping, it is also preferable to use the actual energy release per second or per fission rather than multiplicities, because the latter requires a specification of the average energy per group, which is not necessarily well approximated by, for example, the midpoint of the group energy.

We have specified energies in MeV units. The relation between MeV/fiss and MeV/s is

$$\text{MeV/fiss} \equiv \frac{\text{MeV/s}}{\text{fiss/s}} \quad , \tag{D1}$$

where the numerator is the energy release rate during the cooling time, and the denominator is the fission rate prior to cooling. Let

fiss ≡ total number of fissions prior to the beginning of the cooling time,

$S(t') \equiv$ fission rate (per second) during the fission interval,

$f(t) \equiv$ MeV/fiss/s at t seconds following a fission pulse (that is, the release rate in MeV/s normalized to the number of fissions during the pulse),

$F(t,T) \equiv$ MeV/fiss at t seconds following a constant fission rate of T seconds,

$H(t,T) \equiv$ MeV/s at t seconds following a fission interval of T seconds.

Then

$$\text{fiss} = \int_0^T S(t')dt' \quad . \tag{D2}$$

If S(t') is a constant = S, then

$$F(t,T) = \frac{H(t,T)}{S} \left[\frac{\text{MeV/s}}{\text{Fiss/s}} = \frac{\text{MeV}}{\text{Fiss}}\right] . \tag{D3}$$

All quantities are computed on some arbitrary unit volume.

Here we are using f(t), F(t,T), etc., to represent quantities calculated by summation codes or approximations obtained from fitted functions. The actual quantities can be accurately fitted to several functional forms. In this report we have used a linear sum of exponentials

$$f(t) = \sum_{i=1}^{N} \alpha_i e^{-\lambda_i t} \qquad \text{(MeV/fiss/s)} \quad . \tag{D4}$$

The number of exponentials N required for a specified accuracy of fit depends on the total time over which f(t) is to be used and on the energy group. However, the number is minimized by use of a nonlinear least-squares fit to the α_i, λ_i parameters. For example, an extreme case is the fit achieved to the total beta plus gamma energy release rate over a very long cooling time -- 23 exponentials have been used to achieve fits well within 1% out to > 300 000 yr.*

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*The pulse fits are based on 6 points per time decade from 0.1-10^{13} s and form the bases of the 1978 ANS 5 decay-heat standard.

The multigroup spectra, which do not require such accuracy, use fewer exponentials. In addition, when the pulse fits are folded into an extended fission interval, the resulting accuracy is further improved.

In practice, the pulse values were obtained from the summation code using 10^{-4} s as the irradiation time. The code normally provides F(t,T) and H(t,T). Therefore, the pulse data f(T) is obtained from $f(t) = \frac{F(t,T)}{T} = F(t,T) \times 10^4$. The use of 10^{-4} s for the pulse is arbitrary; for times $< 10^{-2}$ s, the value of f(t) does not change. This is to be expected because the fission product half-lives are long compared to such short irradiation times.

The value of the fitted pulse function is that, once obtained, it can be used to produce F(t,T), the energy release rate at t seconds following any finite fission period T.

$$F(t,T) = \int_0^T f(t+T-t')dt' \qquad \text{(MeV/fiss)} \quad , \tag{D5}$$

or changing variables,

$$F(t,T) = \int_t^{t+T} f(t')dt' \qquad \text{(MeV/fiss)} \quad . \tag{D6}$$

Using the fitted form [Eq. (D4)], this results in

$$F(t,T) = \sum_{i-1}^{N} \frac{\alpha_i}{\lambda_i} e^{-\lambda_i t} (1-e^{-\lambda_i T}) \qquad \text{(MeV/fiss)} \quad . \tag{D7}$$

Alternately, we can fit Eq. (D7) to the result of, for example, an experiment following a finite fission time to generate the parameters α_i, λ_i for an equivalent pulse function. This is useful, for example, when it is necessary to combine the results of several experiments, all having different fission intervals.

In the ANS 5.1 decay-heat standard, the concept of heating (or energy release rate) function following an infinite, constant fission rate ($T \to \infty$) is used and is derived from the pulse function. That is,

$$F(t,\infty) = \int_0^{\infty} f(t')dt' \quad . \tag{D8}$$

This is only possible in the absence of neutron absorption. Otherwise the magnitude of F(t,T) would increase continuously with increases in T. However, the concept is useful in that the $F(t,\infty)$ function could, like the pulse function, be used to generate the finite irradiation values. Thus,

$$F(t,T) = \int_t^{t+T} f(t')dt' = \int_t^{\infty} f(t')dt' - \int_{t+T}^{\infty} f(t')dt'$$

$$= F(t,\infty) - F(t+T,\infty) \quad \text{(MeV/fiss)} \quad . \tag{D9}$$

The pulse function f(t) and the infinite irradiation function $F(t,\infty)$ therefore contain equivalent information. In this report, we have concentrated on generating the pulse function because users will likely find it easier to apply to a variable fission history (although either function can be used). It should be noted the the α_i, λ_i parameters apply for either function, provided that the fit extends over a sufficiently long cooling time. Thus,

$$F(t,\infty) = \sum_{i=1}^{N} \frac{\alpha_i}{\lambda_i} e^{-\lambda_i t} \quad \text{(MeV/fiss)} \quad . \tag{D10}$$

However, for practical reasons, the ANS 5.1 decay-heat standard defines 10^{13} s as infinity so that the factor $(1-e^{-\lambda_i T})$ with $T = 10^{13}$ s multiplies the terms in this expression; that is, Eq. (D7) is used for $F(t,\infty)$ in the standard where $T = 10^{13}$ s.

In the case of a variable fission rate S(t), it is necessary to use MeV/s rather than MeV/fiss [i.e., H(t,T) rather than F(t,T)].

$$H(t,T) = \int_0^{T} S(t')\, f(t+T-t')dt' \quad \text{(MeV/s)} \quad . \tag{D11}$$

Alternatively, one can use the power level

$$H(t,T) = \int_0^T \frac{P(t')}{K} f(t+T-t')dt' \quad \text{(MeV/s)} \quad , \tag{D12}$$

where

$P(t)$ = power in watts at time t ,

and

K = watt-s/fiss (for 200 MeV/fiss, $K = 0.32042 \times 10^{-10}$) .

II. APPLICATION OF THE FUNCTIONAL FITS

The Variable $f(t)$ is only a symbolic representation of pulse library data -- of the summation code output. Most of the expressions in this appendix and in the main text are useful only when the pulse values are approximated by a simple functional form such as Eq. (D4). With Eq. (D4), the user can readily construct expressions to be used in practice. For example, if $P(t)$ can be described by J histograms of constant power P_j over time intervals T_j, then

$$H(t,T) = \sum_{j=1}^{J} \frac{P_j}{K} \sum_{k=1}^{N} \frac{\alpha_k}{\lambda_k} \left[e^{-\lambda_k(T+t-T_j)} - e^{-\lambda_k(T+t-T_{j-1})} \right] \quad \text{(MeV/s)} \quad , \tag{D13}$$

where $T_0 = 0$.

If the power is constant over the entire period, then this reverts back to Eq. (D7) multiplied by P/K.

The reader is reminded that there is a set of coefficients (α_i,λ_i) *for each energy group and for each fissioning nuclide.* Thus, the expression [Eq. (D13)] should, strictly, have a group subscript. In addition, if there is more than one fissioning nuclide, the P_j/K should be replaced by the fission rate for each nuclide $S_{j\ell}$ and summed over ℓ. In general, for each group g, Eq. (D13) becomes

$$H_g(t,T) = \sum_{j=1}^{J} \sum_{\ell=1}^{L} S_{j\ell} \sum_{k=1}^{N} \left[\frac{\alpha_{k\ell g}}{\lambda_{k\ell g}} \quad e^{-\lambda_{k\ell g}(T+t-T_j)} - e^{-\lambda_{k\ell g}(T+t-T_{j-1})} \right] . \tag{D14}$$

III. ABSORPTION EFFECTS

Absorption couples mass chains and changes the fission-product distribution. The effect is dependent on the type of reactor (neutron spectrum) and the power history (magnitude of the neutron flux). Therefore, precise calculations of F(t,T) or H(t,T) must resort to summation calculations; there is no single tabulation of F(t,T) appropriate to all reactors and, of course, the pulse function does not incorporate the absorption effects.

Most of the absorption effect occurs in those nuclides near the line of nuclide stability where half-lives are long and where most of the radioactive nuclides that are shielded from precursor decay by stable nuclides are located. Because these nuclides are not only generally long lived but also have relatively small decay energies, their effect is primarily evident following a long fission interval and long cooling times.

On a nuclide-by-nuclide basis, the neutron absorption can increase or decrease nuclide concentrations, hence decay energy. Except for a few nuclides, the net effect is small and positive. At some cooling times there is a very large effect that can be identified as due to only a few specific nuclides. Because these are few in number and do not require explicit calculation of their short-lived precursors, it is possible and practical to supplement the F(t,T) and H(t,T) values with values from correction equations that account for the modified spectra at long cooling times for any power history. This has been done in the main text, and parameters appropriate to light water reactors are included there. The equations apply to any type of reactor with appropriate cross sections. For completeness, this appendix summarizes the basis of the corrections.

The most significant absorption effects do not require explicit calculations for short-lived precursors nor do the significant corrections require computation of multiple captures in fission products. However, the corrections are dependent on fluence, flux level, and neutron spectrum. While the net correction could be approximated with an empirical expression at short cooling times, the long cooling times, where corrections are particularly important, require accurate knowledge of the behavior of specific nuclides. For this we have found that two nuclides per chain for those few nuclides presented in the main text are sufficient. In addition, a general solution of the differential equations for two coupled nuclides can be programmed and used for all nuclide pairs.

Let N_1, N_2 = the density of the first and second nuclide, where 1 and 2 denote parameters of the respective nuclides (N is normally given in units of 1/b-cm).

$A = \int_0^\infty \sigma\phi dE$ = absorption rate per unit density. If ϕ is given on a group basis (two groups are adequate for thermal reactors), the value of A is $\Sigma_g \sigma_g \phi_g$ (s^{-1}).

λ = decay constant (s^{-1}).

S_i = fission rate from fuel i (fiss/s-b-cm).

y_i = nuclide yield per fission from fuel i.

E_j = energy per decay, where j denotes the β or γ decay group (MeV).

α = branching fraction for the type of coupling between nuclide 1 and 2.

[The nuclide subscript (1,2) has been omitted for simplicity of expression from λ, y_i, E_j and α.]

For simplicity in writing the general solution, let

$$\beta \equiv A + \lambda \quad . \tag{D15}$$

$$Y \equiv \Sigma_j y_j S_j \quad \text{(j denotes fissionable nuclide)} \quad . \tag{D16}$$

$$\gamma \equiv \alpha A \text{ or } \alpha\lambda \quad \text{depending on the coupling, where the yields } y_j \text{ will be cumulative, direct, or zero, depending on the nuclide.} \tag{D17}$$

With or without neutron absorption (i.e., $\beta \equiv \lambda$ in absence of absorption), the general solution for N_1 and N_2 during a constant fission rate for a time interval t are

$$N_1(t) = Y_1 \frac{(1-e^{-\beta_1 t})}{\beta_1} + N_1(0)e^{-\beta_1 t} \quad , \tag{D18}$$

$$N_2(t) = \gamma_1 Y_1 \left[\frac{1}{\beta_1\beta_2} - \frac{e^{-\beta_1 t}}{\beta_1(\beta_2-\beta_1)} + \frac{e^{-\beta_2 t}}{\beta_2(\beta_2-\beta_1)} \right]$$

$$+ \gamma_1 N_1(0) \left[\frac{e^{-\beta_1 t} - e^{-\beta_2 t}}{\beta_2-\beta_1} \right] + Y_2 \left[\frac{1 - e^{-\beta_2 t}}{\beta_2} \right] + N_2(0)e^{-\beta_2 t} \qquad \text{(D19)}$$

For a constant fission rate over the entire fission interval, $N_1(0) = N_2(0) = 0$ for fission products. If the power or fission history is variable, as would be the flux and $\beta_{1,2}$ values, these equations can still be applied by using Δt_j in place of t for each histogram interval j and using $N_1(\Delta t_{j-1})$ and $N_2(\Delta t_{j-1})$ in place of $N_1(0)$ and $N_2(0)$. In this case, $N_{1,2}(t)$ is the density at $t_j = \Delta t_1 + \Delta t_2 + \ldots + \Delta t_j$. The associated group decay energies are thus $\lambda NE_{\gamma,\beta}$.

It is necessary to evaluate these equations during and following the fission interval. In addition, it is necessary to subtract the densities or energy emission rates that occur in the absence of neutron absorption because this energy is included in the F(t,T) and H(t,T) functions. From a computer code viewpoint, this is easiest to do by coding the general equations and computing the results with and without a neutron flux — or, rather, a flux too small to result in any significant absorption effects.

We assume that the fission history can be described by histogram intervals during which Y and A are constant. In this case, N(0) = 0 for the first interval and Eqs. (D18) and (D19) provide the basis for recursion equations for subsequent intervals j of duration Δt_j. For example, Eq. (D18) becomes

$$N_1(t_j) = N_{1j} = Y_{1j} \frac{(1-e^{-\beta_{1j}\Delta t_j})}{\beta_{1j}} + N_{1j-1}e^{-\beta_j \Delta t_j} \quad , \qquad \text{(D20)}$$

$j = 1,2,3, \ldots, J,$

and similarly for $N_2(t_j)$.

If J = the final fission interval, then at any shutdown time t

$$N_1(t) = N_{1J}\, e^{-\lambda_1 t} \quad , \tag{D21}$$

$$N_2(t) = \alpha_1 \lambda_1 N_{1J} \left(\frac{e^{-\lambda_1 t} - e^{-\lambda_2 t}}{\lambda_2 - \lambda_1} \right) + N_{2J}\, e^{-\lambda_2 t} \quad . \tag{D22}$$

Note that if the coupling is by (n,γ), then the first term for $N_2(t)$ in Eq. (D22) is zero, that is,

$$N_2(t) = N_{2J}\, e^{-\lambda_2 t} \quad . \tag{D23}$$

(In programming these equations, any potential problem with roundoff can be avoided by replacing each beta or lambda with, for example, $\beta(1-10^{-9}/t)$, where t is the shutdown time or Δt_j appearing in the exponentials. This permits Eqs. (D20)-(D23) to be evaluated without resorting to a special set of equations, yet the effects of the change in beta are too small to alter calculated densities.)

The energies are given by

$$\text{MeV/s} = ([N(t)-N(t)'] \lambda E \quad , \tag{D24}$$

where N(t)' is the density without neutron absorption.

If the fission rate S is constant and applies to a single fissioning nuclide, the MeV/fiss from any nuclide is

$$\text{MeV/fiss} = \frac{\text{MeV/s}}{\text{fiss/s}} = \frac{[N(t)-N(t)']\lambda E}{S} \quad . \tag{D25}$$

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