MODIFICATION OF SAND II

BY
S. BERG

TRW SYSTEMS GROUP
TRW, INC.
REDONDO BEACH, CALIFORNIA

AUGUST 1968

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Foreword

The work reported in this document was performed between December 1967 and June 1968 under Battelle Memorial Institute, Pacific Northwest Laboratory Purchase Order B8G-S77-38515.*

This document includes material previously reported in an "Interim Progress Report for P. O. B8G-S77-38515 - Modification of SAND II," TRW letter 1330.5-1513, dated 18 March 1968. This partial duplication is for facility of reference, and because the Interim Progress Report is not generally available.

This document has been reviewed by the BMI/PNL Program Manager and is approved.

APPROVED: W.N. McElroy

W. N. McElroy
Research Associate
Irradiation Effects
Battelle Memorial Institute/Pacific Northwest Laboratory

APPROVED: H.H. Yoshikawa

H. H. Yoshikawa
Manager
Irradiation Effects
Battelle Memorial Institute/Pacific Northwest Laboratory

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I. INTRODUCTION

A computer code, SAND II, has been developed to determine neutron flux spectra from multiple foil activation measurements.⁽¹⁾ This report documents subsequent work which resulted in substantial changes to the code, and additional understanding of the behavior of the iterative method previously described.⁽²⁾

The principal objective of the present program was to retard the generation of spurious structure in solution neutron differential spectra, while allowing real structure to be indicated. Additional results accomplished include changing the criterion for solution achievement, improvement of a curve-plotting routine and adaptation to BMI/PNL plotting facilities, modification of extrapolation procedures for increased input versatility, and certain miscellaneous simplifications which result in increased efficiency.

All these modifications are described in detail in the following sections. Several of the changes affect the input data deck; Section VII, "User Instruction Supplement", documents the changes to the input data deck, and is intended to be used as a supplement to Reference 1, Section II.B.2, "Input Data Deck Sequence Outline".

II. RETARDATION OF SPURIOUS STRUCTURE

A. Weighting Functions

Spurious structure in neutron differential solution spectra is propagated by the iterative technique from differential structure in neutron detector reaction cross sections (especially for resonance reactions). This follows from the form of the iterative algorithm, which employs the cross sections as weighting functions, as shown below.

- Let $\phi_j^{[k]}$ = k^{th} iterative differential flux (assumed constant) over the j^{th} energy interval;*
- $C_j^{[k]}$ = k^{th} iterative flux correction term for the j^{th} energy interval;
- A_i = measured activity for the i^{th} detector reaction (extrapolated to saturation and infinite dilution);
- $A_i^{[k]}$ = calculated (saturated, infinitely dilute) activity for the i^{th} detector reaction, based on the k^{th} iterative flux spectrum;
- $A_{i,j}^{[k]}$ = that portion of $A_i^{[k]}$ contributed by neutrons in the j^{th} energy interval;
- $\sigma_{i,j}$ = i^{th} detector reaction cross section (averaged constant) over the j^{th} energy interval;
- E_j = lower energy bound of the j^{th} energy interval;
- m = total number of energy intervals (currently 620);
- n = number of detectors used.

Then the iterative algorithm used in SAND II (see ref. 2, Section III.B) may be written as

$$\phi_j^{[k+1]} = \phi_j^{[k]} \exp \{C_j^{[k]}\}, \quad j=1,2,\dots,m; \quad (1)$$

where

$$C_j^{[k]} = \frac{\sum_{i=1}^n w_{i,j}^{[k]} \ln \left(A_i / A_i^{[k]} \right)}{\sum_{i=1}^n w_{i,j}^{[k]}}, \quad j=1,2,\dots,m; \quad (2)$$

* SAND II represents the energy range between 10^{-10} and 18 Mev in 620 discrete contiguous intervals.

$$w_{i,j}^{[k]} \equiv A_{i,j}^{[k]} / A_i^{[k]}, \quad j=1,2,\dots,m; i=1,2,\dots,n; \quad (3)$$

$$A_{i,j}^{[k]} = \phi_j^{[k]} \sigma_{i,j}^* (E_{j+1} - E_j), \quad j=1,2,\dots,m; i=1,2,\dots,n; \quad (4)$$

and

$$A_i^{[k]} = \sum_{j=1}^m A_{i,j}^{[k]}, \quad i=1,2,\dots,n. \quad (5)$$

If substantial activity measurement errors exist for a particular case (or if library cross section values contain sufficient error), an extended number of iterations might be required to perturb the input trial spectrum to the point at which all the calculated activities may become reasonably consistent with the input measured activities; in such a case, the reflection of cross section structure in the solution spectrum, reinforced with each iteration, may become pronounced.

B. Smoothing

1. Renormalization

The weighting function for each reaction, given by eq. (3) above, is seen to be essentially the sensitivity (activity) function normalized to unity total activity. The first attempt to minimize artificial structure was a renormalization of the weighting function to unity quotient of total activity divided by effective range. That is, eq. 3 was replaced by

$$w_{i,j}^{[k]} \equiv [E_{H,i} - E_{L,i}]^{[k]} A_{i,j}^{[k]} / A_i^{[k]},$$

where $E_{L,i}$ and $E_{H,i}$ are (say) the 5% and 95% "tail" cutoff energies, respectively, for the i^{th} reaction sensitivity. The original normalization effectively gave each reaction measurement equal total effect, in some sense, on the total solution flux; this new normalization was intended to make each reaction affect the total flux only in proportion to the relative size of the energy region over which it is sensitive. (Instead of all the weighting functions being normalized to equal average values over the entire energy range from 10^{-10} to 18 Mev, they

*In practice, an exponential term appears in this product to account for flux attenuation by cover materials; it is omitted here for convenience.

were normalized to equal average values over only their respective regions of influence.) The effect is to reduce the magnitude (relative to those of all other reactions) of those weighting functions which consist mostly of very large resonance peaks over very narrow energy regions [such as, for example, $\text{Au}^{197} (n, \gamma) \text{Au}^{198}$] so as to reduce the reflections of these peaks in the solution spectrum.

Only several computer test runs were needed to show that this new normalization was not effective. Results of four substantially different test cases were not significantly different for the two weighting schemes, either in solution values or in number of iterations required. Apparently, most resonance peaks dominate their individual energy regions (with respect to the other reactions used) to the extent that reducing them by the relative widths of their energy regions left them still very dominant.

2. Analytical Forms

Partly as a result of the previous observation, the next technique investigated consisted of an attempt to find some two-parameter analytical form for use as the weighting function, which would only generally describe the sensitivity distribution of a given reaction by means of first and second moments (mean and "spread"), and completely ignore detailed structure. To evaluate the merits of this scheme, variations of several common distribution forms were examined, with parameters easily described as functions of the first and second moments about the origin (μ and μ_2 , respectively), which are readily computed for the actual sensitivity functions. These forms included:

- (1) Normal distribution - -

$$w(x) = e^{-a(x-\mu)^2} \quad , \text{ where } a = 1/2(\mu_2 - \mu^2)$$

- (2) Chi-squared distribution - -

$$w(x) = x^b e^{-ax} \quad , \text{ where } a = \mu / (\mu_2 - \mu^2)$$

$$b = [\mu^2 / (\mu_2 - \mu^2)] - 1;$$

(3) Beta distribution - -

$$w(x) = X^a(1-X)^b, \quad 0 \leq X \leq 1, \quad \text{where } X \equiv (x-x_L)/(x_H-x_L),$$

$$a = [2M^2 - M_2(M+1)] / (M_2 - M^2),$$

$$b = [M - (2-M)M_2] / (M_2 - M^2),$$

$$M \equiv (\mu - x_L) / (x_H - x_L),$$

$$M_2 \equiv [\mu_2 - x_L(2\mu - x_L)] / (x_H - x_L)^2,$$

and x_L and x_H are suitably chosen lower and upper limits, respectively, for x .

After some examination, it became clear that neither the normal nor the chi-squared distribution is satisfactory for these purposes. The normal form is, of course, always symmetrical about the mean and therefore cannot adequately reflect any skew in the sensitivity distribution. As for the chi-squared form, application of the definition of the mean yields: $\mu = (b+1)/a$; differentiation to find the modal abscissa value yields; $x_{\text{mode}} = b/a$, or $x_{\text{mode}} = \mu - (1/a)$. That is, the mode is always to the left of the mean, so that the chi-squared form is always skewed to the left. Both forms are thus too restrictive.

The beta distribution, on the other hand, is quite versatile. The skew increases with increasing difference between a and b , and the sign of that difference determines the direction of skew. Since the independent variable X must not exceed unity, an appropriate choice of limits must be made for each case. A manual parametric study showed that, if the abscissa (energy) range includes at least several (6 to 10) times $\sqrt{\mu_2 - \mu^2}$ (analogous to the standard deviation of a statistical distribution) on each side of the mean, further extension of limits has very little additional effect on the shape of the derived beta function, which approaches near-symmetry about the mean. As the range is narrowed below several

"standard deviations" in width, the skewness of that portion of the sensitivity function remaining within the range is increasingly reflected in the derived beta function. It seemed reasonable, therefore, for trial purposes, to set the range for each detector reaction (at each iteration) to include the significant portion of the sensitivity function and not much more. Accordingly, the limits for each case were chosen to be the 5% and 95% "tails" of the sensitivity distribution. (This decision was supported by its convenience, since the code already includes a search for these tails for printout purposes, and no additional execution time would be required to calculate the limits.)

Test results showed that this technique is also not suitable. The complete elimination of well-defined structure caused iterative spectral corrections based on a given measured detector activity to be made in regions which did not always affect the calculated activity for that detector to the extent required, and vice versa. The result was that the iterative procedure did not necessarily tend monotonically toward a solution, and "solutions" achieved were likely to contain more pathological structure than in the original method.

This observation indicates that, although the solution spectral structure which is propagated from reaction cross section form is unreal, at least some of it may be required in many experimental cases, to achieve a solution consistent with the estimated experimental limits of error^{*}. Accordingly, it was decided to investigate next only smoothing techniques which retain some structural qualities of the actual sensitivity functions.

3. Moving Linear Averaging

The method of moving k-point n^{th} degree polynomial least-squares fitting was selected as being both appropriate and convenient. In this method, each tabulated value of a function (sensitivity) is replaced by the value of a polynomial of degree n fitted by standard least-squares techniques to a subrange of k (odd) points, centered (if possible) at the point being modified. Thus, each smoothed value is obtained from a distinct least-squares polynomial except near each end of the range of the function being smoothed, where the polynomial fitted to the extreme k points is used to smooth the extreme $(k+1)/2$ points.

*This conclusion supports the observation that some current reaction cross section evaluations are not as accurate as they are commonly assumed to be.

Clearly for any given k , $n=1$ (straight line) provides the most severe smoothing (and also results in the simplest arithmetic), and for any given n , smoothing severity increases with increasing k . Thus, for trial purposes, $n=1$ was chosen for testing various values of k .

For least squares fitting of a straight line to the k points (x_i, y_i) , $i=j - \frac{k-1}{2}, \dots, j + \frac{k-1}{2}$, where k is odd [this indexing centers the k points about (x_j, y_j)], a change of abscissa scale may be used to simplify the arithmetic if the points are equispaced along the abscissa. If, for all i , $x_i - x_{i-1} \equiv \delta$, and if X_i is defined by

$$X_i \equiv \frac{x_i - x_j}{\delta} = \frac{(i-j)\delta}{\delta} = i-j, \quad (6)$$

then (letting $j - \frac{k-1}{2}$ and $j + \frac{k-1}{2}$ be denoted by i_L and i_H respectively)

$$\sum_{i=i_L}^{i_H} X_i = \sum_{i=i_L}^{i_H} i - \sum_{i=i_L}^{i_H} j = \frac{\left(j + \frac{k-1}{2}\right)\left(j + \frac{k-1}{2} + 1\right) - \left(j - \frac{k-1}{2} - 1\right)\left(j - \frac{k-1}{2}\right)}{2} - k_j = 0, \quad (7)$$

and

$$\begin{aligned} \sum_{i=i_L}^{i_H} X_i^2 &= \sum_{i=i_L}^{i_H} i^2 - 2j \sum_{i=i_L}^{i_H} i + \sum_{i=i_L}^{i_H} j^2 \\ &= \frac{1}{6} \left[\left(j + \frac{k-1}{2}\right)\left(j + \frac{k+1}{2}\right)(2j+k) - \left(j - \frac{k-1}{2}\right)\left(j - \frac{k+1}{2}\right)(2j-k) \right] \\ &\quad - j \left[\left(j + \frac{k-1}{2}\right)\left(j + \frac{k+1}{2}\right) - \left(j - \frac{k+1}{2}\right)\left(j - \frac{k-1}{2}\right) \right] + kj^2 \\ &= k(k^2-1)/12. \end{aligned} \quad (8)$$

Thus, if $w_X = aX + b$ is fitted to the k points (X_i, y_i) , the least-squares expressions for a and b ,

$$a = \frac{k \sum X_i y_i - \sum X_i \sum y_i}{k \sum X_i^2 - (\sum X_i)^2} ; \quad b = \frac{\sum X_i^2 \sum y_i - \sum X_i \sum X_i y_i}{k \sum X_i^2 - (\sum X_i)^2} , \quad (9)$$

where all sums are over i from $j - \frac{k-1}{2}$ to $j + \frac{k-1}{2}$, is reduced to

$$a = \frac{12 \sum X_i y_i}{k(k^2 - 1)} , \quad b = \frac{\sum y_i}{k} . \quad (10)$$

Since, except at the ends of the range, each straight line is used to smooth at only one point (x_j, y_j) , at which $X_j = j - j = 0$, the expression for the smoothed value of y_j becomes simply

$$w_{x=x_j} = w_{X=0} = \frac{1}{k} \sum_{i=j-\frac{k-1}{2}}^{j+\frac{k-1}{2}} y_i , \quad j = \frac{k+1}{2}, \dots, m - \frac{k-1}{2} , \quad (11)$$

where m is the total number of points in the range.

To smooth y_j for $j=1, \dots, \frac{k-1}{2}$, and for $j=m - \frac{k+1}{2}, \dots, m$, the straight lines centered about $(X_{(k+1)/2}, y_{(k+1)/2})$ and $(X_{m-(k-1)/2}, y_{m-(k-1)/2})$ are used respectively. The resultant smoothing forms are:

$$w_{x=x_j} = \frac{1}{k} \left[\frac{6(2j-k-1)}{k^2-1} \sum_{i=1}^k \left(i - \frac{k+1}{2} \right) y_i + \sum_{i=1}^k y_i \right] , \quad j=1, \dots, \frac{k-1}{2} ; \quad (12)$$

and

$$w_{x=x_j} = \frac{1}{k} \left[\frac{6(2j-2m+k-1)}{k^2-1} \sum_{i=m-\frac{k-1}{2}}^m \left(i - m + \frac{k-1}{2} \right) y_i + \sum_{i=m-\frac{k-1}{2}}^m y_i \right] , \quad j=m - \frac{k-3}{2}, \dots, m. \quad (13)$$

The smoothing forms of eqs. (11) through (13) are based on equidistant abscissa spacing [see eq. (6)]. Since, in SAND II, the energy grid is approximately logarithmically spaced (but not exactly, because of round-off for convenience) between 10^{-10} and 1 Mev, and linearly spaced between 1 and 18 Mev, this smoothing technique provides quasi-semilogarithmic least-squares (because of the inexact logarithmic spacing) smoothing below 1 Mev and rigorous linear least-squares smoothing above 1 Mev.

During the testing of this smoothing scheme, one difficulty became apparent. For any given k-point smoothing, eqs. (12) and (13) are used to fit a single straight line to the first and last $\frac{k-1}{2}$ points, respectively. This introduces an inordinate degree of arbitrariness into the scheme (especially for large values of k), since it restricts the ends of all weighting functions to be linear. More seriously, it was found that, in some cases, the least squares line could assume negative values in the extreme low and high regions. This caused serious arithmetic problems in the code, which reasonably does not include provisions for negative weighting for any detector. The problem was solved by abandoning the "off-center" fitting represented by eqs. (12) and (13), and using instead eq. (11), reducing k to k' sufficiently so that the point being smoothed is centered between the 1st and k'th points at the low end, or between the (m-k'+1)th and mth points at the high end. Thus, for the 2nd and (m-1)th points, for example, 3-point smoothing is used, regardless of the value of k used over the major portion of the energy range. With this scheme, only the first and last points require off-center smoothing, and the possibility of negative values for those two points can easily be tested for.

To return to the nomenclature of eqs. (1) through (5), the weighting functions obtained with moving linear averaging are given in eqs. (14) through (16), which replace eq. (3). In eqs. (14a) through (14f), N_S is the (odd) number of points, ≥ 3 , used for smoothing (except at the ends).

$$w_{i,j}^{[k]} = \sum_{l=\ell_1}^{\ell_2} A_{i,l}^{[k]} / [(\ell_2 - \ell_1 + 1) A_i^{[k]}], \quad j=2,3,\dots,m-1; \quad i=1,2,\dots,n; \quad (14)$$

$$\text{where } \ell_1 = 1, \quad j=2,\dots,\left(\frac{N_S-1}{2}\right), \quad (14a)$$

$$= j - \left(\frac{N_S-1}{2}\right), \quad j = \left(\frac{N_S+1}{2}\right), \dots, \left(m - \frac{N_S-1}{2}\right), \quad (14b)$$

$$= 2j - m, \quad j = \left(m - \frac{N_S-3}{2}\right), \dots, (m-1), \quad (14c)$$

$$\text{and } \ell_2 = 2j-1, \quad j=2,\dots,\left(\frac{N_S-1}{2}\right), \quad (14d)$$

$$= j + \left(\frac{N_S-1}{2}\right), \quad j = \left(\frac{N_S+1}{2}\right), \dots, \left(m - \frac{N_S-1}{2}\right), \quad (14e)$$

$$= m, \quad j = \left(m - \frac{N_S-3}{2}\right), \dots, (m-1); \quad (14f)$$

$$w_{i,1}^{[k]} = (5A_{i,1}^{[k]} + 2A_{i,2}^{[k]} - A_{i,3}^{[k]}) / 6A_i^{[k]}, \text{ and} \quad (15)$$

$$w_{i,m}^{[k]} = (5A_{i,m}^{[k]} + 2A_{i,m-1}^{[k]} - A_{i,m-2}^{[k]}) / 6A_i^{[k]}. \quad (16)$$

[Eq. (15) and/or (16) is set to zero if the calculated value is negative.]

C. Discussion of Results

An extensive series of tests has confirmed the appropriateness of the smoothing scheme represented by eqs. (14) through (16). The influence of the various degrees of smoothing (afforded by changing values of N_S) on solution spectra is very much as would be expected. Accordingly, this technique has been incorporated into the SAND II code (in subroutine WATE).

The tests performed utilized a large variety of test cases with widely varying conditions. The most important observation to be made from the results is that the degree of smoothing (value of N_S) appropriate to a given case is a fairly sensitive function of the particular conditions which apply. This is true in the obvious sense that the amount of real structure expected in the

solution depends strongly on the environment being measured. It is also true, however, in a less obvious sense, with regard to measured activity and cross section errors. Over a given energy region, the amount of spectral structure introduced is a direct function of the relative inconsistency of measured activities (of all detectors sensitive over that region) with the calculated spectrum before introduction of the structure.* Therefore, solution structure can only be meaningful to the extent that the resultant improvement in consistency of the spectrum with the measured activities is meaningful. In other words, any structure which results in measured-to-calculated activity ratios more nearly constant than can reasonably be expected, considering errors in activity measurements and cross section values used, cannot be credited as being real.

This argument provides a means of helping to evaluate the credibility of differential spectral structure which might be questioned in the solution to a particular case. The user may manually smooth the solution spectrum over the energy region in question, to the degree deemed reasonable (depending on previous knowledge of the measured environment). The resultant spectrum can then be submitted for a SAND II ITERATION run with a specified limit of zero iterations. The results of that run will provide the standard deviation of measured-to-calculated activities for the smoothed spectrum (as well as all the individual ratios). (A zero-iteration limit ITERATION run is suggested, rather than an ACTIVITY run, since the latter would provide only calculated activities, requiring manual calculation of the measured-to-calculated ratios and their standard deviation.) The structure in question can only be credited as real if the smoothed-solution standard deviation is not within acceptable limits of error, and is significantly worse than the original solution results.

Two very different degrees of structure credibility are shown by the examples referred to as Test 1 and Test 2, differential spectra for which are given in Figures 1 and 2, respectively. In both figures, only the portion of the spectrum containing the structure being investigated is shown. (The curves have been redrawn, omitting the fine histogram structure imposed by the code. In each figure, the curves have been separated vertically by one decade, for clarity

*Inconsistency is indicated by the deviation from constancy of the ratios of measured-to-calculated detector activities.

Detector Reaction	Deviation of Measured from Calculated Activity (%)			
	Original Trial	First Solution	Smoothed First	Second Solution
			Solution (2nd Trial)	
Ni ⁵⁸ (n,p)Co ⁵⁸	- 8.46	- 7.53	- 1.20	- 1.57
Fe ⁵⁴ (n,p)Mn ⁵⁴	+16.64	+ 3.41	+ 15.04	+ 0.14
S ³² (n,p)P ³²	- 6.42	- 0.64	- 0.47	- 1.79
Cl ³⁵ (n, α)P ³²	+ 8.60	+ 4.34	+23.86	+ 2.91
I ¹²⁷ (n,2n)I ¹²⁶	-21.11	- 0.03	+ 4.19	+ 0.02
Al ²⁷ (n, α)Na ²⁴	-61.28	- 0.21	-48.77	- 0.10
In ¹¹⁵ (n,n')In ^{115m}	+72.03	+ 0.65	+ 7.34	+ 0.41
Std.Deviation (%)	40.52	3.83	23.26	1.55

Figure 1. Differential Structure Test 1.

Detector Reaction	Deviation of Measured from Calculated Activity (%)	
	Trial	Solution
Na ²³ (n, γ) Na ²⁴	- 3.35	- 0.22
U ²³⁸ (n, γ) U ²³⁹	- 0.96	+ 0.66
Au ¹⁹⁷ (n, γ) Au ¹⁹⁸	- 4.12	- 0.40
In ¹¹⁵ (n, γ) In ¹¹⁶	- 1.88	+ 1.21
Mn ⁵⁵ (n, γ) Mn ⁵⁶	- 5.21	- 0.88
Cu ⁶³ (n, γ) Cu ⁶⁴	- 5.96	- 1.14
Np ²³⁷ (n, f) F.P.	- 1.49	+ 1.28
Th ²³² (n, f) F.P.	- 4.91	- 0.23
Ni ⁵⁸ (n, p) Co ⁵⁸	- 0.05	- 1.18
Zn ⁶⁴ (n, p) Cu ⁶⁴	+ 0.85	- 0.76
Fe ⁵⁴ (n, p) Mn ⁵⁴	+ 4.63	+ 0.72
S ³² (n, p) P ³²	+ 3.05	+ 1.54
Cl ³⁵ (n, α) P ³²	+ 7.91	+ 1.53
I ¹²⁷ (n, 2n) I ¹²⁶	- 4.51	+ 0.11
Cu ⁶³ (n, 2n) Cu ⁶²	+12.20	- 0.04
P ³¹ (n, p) Si ³¹	- 4.28	- 2.39
Fe ⁵⁶ (n, p) Mn ⁵⁶	+ 8.92	+ 0.48
Al ²⁷ (n, p) Mg ²⁷	+ 8.88	+ 0.38
U ²³⁸ (n, f) F.P.	- 5.54	- 0.34
U ²³⁵ (n, f) F.P.	- 2.22	+ 0.82
Al ²⁷ (n, α) Na ²⁴	+ 3.40	- 0.74
In ¹¹⁵ (n, n') In ^{115m}	- 5.36	- 0.41
+		
Std. Deviation (%)	5.51	0.99

Figure 2. Differential Structure Test 2.

of presentation.) For purposes of testing, no weighting function smoothing was used for both tests ($N_S=1$).

For Test 1, a set of measured detector activities was obtained in a beryllium-reflected graphite-moderated assembly, and submitted as input to SAND II with a trial spectrum consisting of a fission form matched to an E^{-1} form at 0.5 Mev. The structure in the resulting solution spectrum was smoothed as shown and the smoothed solution was resubmitted as a second trial, with the same set of measured activities, to obtain a second solution. The table in Figure 1 shows the pertinent numerical results. (The original runs included several n- γ detectors not reported here, since they are not sensitive over the region being examined. The values in the table have been recalculated on the basis of only the threshold reaction detectors listed, since they are the only ones which affect the spectral shape in the region shown.)

The original trial spectrum is obviously not an appropriate solution, as shown by the tabulated standard deviation. (Expected errors are estimated to be approximately 5%.) When the first solution spectrum was smoothed, the resulting standard deviation indicated that the structure eliminated by the smoothing is indeed meaningful, at least to some degree, since the standard deviation for the second trial spectrum is unacceptably large. Comparison of the structure generated in the second solution spectrum with that in the first is very helpful in evaluating the degree to which the structure is credible. (It should be noted that the two solutions are obtained from two significantly different trial spectra.) In this case, it can be seen that the dip at ~ 9.5 Mev is clearly to be credited; the extent and magnitude of the relative minimum and maximum at ~ 3 and 4 Mev must also be credited, although the fine detailed structure over the entire inflection is obviously spurious.

For Test 2, an artificial "true" spectrum was obtained by manually introducing many dips into a pure fission spectrum. "Measured" activities were obtained from a SAND II "ACTIVITY" run with a comprehensive set of detectors. The trial spectrum for the "ITERATION" run was a pure fission spectrum. The table in Figure 2 shows the pertinent numerical results. In this case, the trial spectrum standard deviation is surprisingly small, considering the extensive differences in shape between the trial and "true" spectra. If this test reflected

an actual experiment, the input spectrum could be taken as an appropriate solution. In an effort to produce structure to be compared with the known "true" structure, iteration was allowed to proceed to a standard deviation of less than 1% (see Section III). The resultant solution is seen to reflect essentially none of the "true" structure. This is a good example of the non-uniqueness of a solution spectrum under certain conditions. Had the "true" spectrum shown in Figure 2 been obtained as the SAND II solution to some experimental case, subsequent examination would have shown none of the structure to be credible.

It is emphasized that the manual spectral smoothing discussed here is very different from the weighting function smoothing represented by eqs. (14) through (16). The spectral smoothing will in general change the values of calculated detector activities, and may (depending on the extent of change) result in a spectrum which is not an appropriate solution. The weighting function smoothing simply affects the iterative procedure (retarding structure generation), and in no way affects the accuracy of the activity calculations for the eventual solution spectrum.

The many tests performed to characterize the behavior of the smoothing technique resulted in another observation, not directly related to the intent of this effort, but sufficiently important to warrant discussion. Because of the sensitivity regions of most detectors currently used, there is frequently inadequate detector coverage in the energy region between nominally 0.01 and 0.75 Mev. Therefore, the solution spectrum shape in that region may be largely a reflection of the input trial spectrum shape, and may not be justified by the measurements, although it may significantly affect the value of total integral flux. In a case in which such poor coverage exists, and in which the solution flux in that region appears to affect the total flux value substantially, it is recommended that the solution shape in that region be replaced with an E^{-a} form (straight line on log-log plot) and the spectrum resubmitted for an ITERATION run. (Slowing down theory predicts an E^{-1} form, but since the solution will provide correct relative magnitudes for resonance and fast flux, no a priori recommendation can be made for the exponent, which is the slope of the log-log line.

D. Effect on Input Data Deck

The test cases of Figures 1 and 2 illustrate graphically the previous assertion that the degree of weighting-function smoothing appropriate for a given case should depend on the particular conditions of that case, since the amount of structure generated is a function of the smoothing. Accordingly, the value of N_s to be used in any ITERATION run has been left to the discretion of the user. A card has been added to the input deck to provide this selection; the format for this card is described in Section VII.

III. SOLUTION CRITERION CHANGE

A. Description of Change

As originally reported in reference (1), the criterion for achievement of an appropriate solution spectrum was based on comparison of differential flux values at successive iterations. An iterative spectrum was accepted as a solution if the difference between its flux values and those of the preceding iteration was less than a predetermined fractional amount, specified as input, at all energies. This solution criterion had proved to be not entirely satisfactory. Specifically, if a user has some knowledge of the expected experimental errors in the input data or expected errors in available cross section data for detectors used, this knowledge should be useable in determining what amount of inconsistency among activities calculated for those detectors from the solution spectrum is acceptable. However, the relationship of changes in differential flux as a function of energy to changes in the relative consistency of activities of the various detectors calculated from that flux, is an extremely complex one. Therefore, it is practically impossible to obtain a useful algorithm by which to determine a meaningful input value for the solution criterion from information about experimental precision. These values have in the past been determined by a combination of previous experience with the code, and trial and error.

Another difficulty with the original solution criterion is related to sensitivity. It is possible for fairly severe iterative perturbations over a very narrow energy region to have little or no effect on total calculated

activity of any detector. Spectral structure introduced in this way is thus completely unjustified on the basis of input measured activities, but it will postpone solution achievement as determined by the original criterion.

A much more obvious choice of solution criterion is an examination of the standard deviation of the ratio of measured-to-calculated activities for each iteration. Knowledge of expected experimental precision is directly applicable to this value. A spectrum which yields a standard deviation consistent with expected precision is as good a solution as is justified by the input data. Accordingly, this criterion has been incorporated into the SAND II code. To preclude the possibility of an inordinately large number of iterations caused by over-optimism by the user as to expected precision, a secondary criterion is included, based on the rate of iterative change of standard deviation. The measured activity inputs may actually contain errors (mutual inconsistencies) substantially larger than expected, so that the iteration procedure will not readily achieve as small a standard deviation of measured-to-calculated activity ratios as specified by the user, but will produce higher values that become fairly invariant with successive iterations. Therefore, iteration is currently stopped when any of the following occurs:

- (1) The standard deviation of measured-to-calculated activity ratios is smaller than the value specified as input (solution is achieved);
- (2) The standard deviation becomes stable to within less than 1% (this value can be easily changed) in two successive iterations at a value higher than that specified;
- (3) The maximum allowed number of iterations (specified as input) is reached.

An appropriate message is printed to indicate the reason for cessation of iteration.

Fairly comprehensive tests performed to date, as well as examination of many runs made using the original solution criterion, strongly support adoption of the new solution criterion.

B. Effect on Input Data Deck

The input data card which specified the acceptable fractional flux change at successive iterations began, appropriately, with the word DIFFERENCE,

which is not suggestive of the new solution criterion. In keeping with the desirability of a properly mnemonic term, the word has been changed to DEVIATION (see Section VII).

IV. PLOTTING ROUTINE

After completion of the program reported by references (1) and (2), but before the start of the present program, a subroutine (GRAF) was incorporated into the BMI/PNL version of SAND II, which provided graphical output of the input (trial) differential spectrum and the solution differential and integral spectra for an ITERATION run, or the input differential and integral spectra for an ACTIVITY run. Subroutine GRAF utilized software compatible with the Computer Sciences Corporation Northwest Operations (CSC/NW) modified Model J Benson-Lehner Digital X-Y Plotter.

A. Conversion to CalComp Plotter

Conversion of subroutine GRAF to logic and software compatible with CSC/NW's newly-acquired CalComp Model 565 Digital Incremental Plotter was accomplished on the present program. This results in a substantial saving of off-line plotting time, from nominally 45 minutes per plot on the Benson-Lehner to nominally ten minutes on the CalComp. A major portion of this time is occupied by the drawing of the variable log-log grid, which is done individually for each plot, with scales adjusted so that each spectrum curve is as large as possible within a 9" vertical by 15" horizontal grid. Scale labels are provided at each vertical and horizontal decade grid line.

B. Abscissa Range Determination

As originally written, subroutine GRAF performed a search for possible zero flux values at the low and/or high ends of the energy range for each curve to be plotted; if such zero values existed, the scale would be expanded to omit the corresponding energy region from the plot. Therefore, in the case of zero differential flux below a certain cutoff energy (greater than 10^{-10} Mev), the lower limit of the differential plot would in general be at the nearest whole decade below the cutoff energy, whereas the lower limit of the integral plot

would always be at 10^{-10} Mev (since the integral flux is a constant non-zero value below the cutoff energy). Thus, interesting detail in the integral curve over regions of non-zero differential flux would be unnecessarily "squeezed" for the sake of presenting the constant portion of the curve.

The subroutine has been changed to restrict the integral curve energy range to be the same as that for the differential curve. The search for zero-flux end regions is no longer performed in GRAF for each curve, but in the main routine near the beginning of a case, so that the leftmost and rightmost energies of non-zero flux are determined only once. (This change also precludes unwanted non-zero extrapolation over zero-flux regions, as discussed in Section V.

C. Detector Sensitivity Range Indication

Subroutine GRAF has been modified to provide visual indication of detector sensitivity ranges; this indication appears on the solution differential spectrum for an ITERATION run, and on the input differential spectrum for an ACTIVITY run. A set of horizontal "bars" is plotted, each representing one detector. Each bar extends in length from the 5% to the 95% sensitivity energy limit of the corresponding detector; e.g., its length covers the energy region in which 90% of the detector activity is produced. A "bar" is composed of vertical line segments, 0.1" long and 0.02" apart, connected by diagonal line segments, forming a dense zigzag pattern that approximates a solid rectangular figure 0.1" high, clearly discernible from the grid pattern. The complete name of the corresponding reaction is printed in letters 0.07" high just above each bar. Vertical locations of successive bars are incremented 0.28" to prevent overlap of bars and reaction names.

D. Titles, Headings and Legends

Printing of titles, headings and legends has been added to the plotting routine. The abscissa legend, printed and centered horizontally beneath the grid, is: NEUTRON ENERGY (MEV). The ordinate legend, printed and centered vertically to the left of the grid, is one of the following:

NEUTRON DIFFERENTIAL FLUX
NEUTRON DIFFERENTIAL FLUENCE
NEUTRON INTEGRAL FLUX ABOVE ENERGY
NEUTRON INTEGRAL FLUENCE ABOVE ENERGY

Legend characters are 0.14" high. The heading, printed and centered horizontally above the grid in characters 0.21" high, is one of the following:

INPUT DIFFERENTIAL SPECTRUM
SOLUTION DIFFERENTIAL SPECTRUM OBTAINED AFTER nn ITERATIONS
DIFFERENTIAL SPECTRUM OBTAINED AFTER nn ITERATION LIMIT
INPUT INTEGRAL SPECTRUM
SOLUTION INTEGRAL SPECTRUM OBTAINED AFTER nn ITERATIONS
INTEGRAL SPECTRUM OBTAINED AFTER nn ITERATION LIMIT

The contents of the first two input data deck title cards are duplicated, in 0.14"-high characters, above the heading. Each card is duplicated on one line, the first above the second. The title-identifying character T in column 1 (see ref. 1, Section II.B.2) is not printed. If fewer than two title cards are submitted, one or both printed lines will be blank. Titles are centered about the center of the data card (columns 40-41).

E. Effect on Input Data Deck

Use of the CSC/NW CalComp Model 565 requires that an end-of-file record be written on the off-line plotter input tape, after all plot-executing records have been written. It is therefore necessary that the number of cases submitted in a given run be furnished as input. Accordingly, one card has been added (per run, not per case) at the beginning of the input data deck. A card has also been added to indicate whether or not graphical plots are desired for a given case. (The punchout option described in Section VI.A. is included on the same card.) Section VII gives detailed descriptions of the added cards.

V. RETENTION OF INPUT ENERGY RANGE LIMITS

SAND II provides extrapolation, when required, at the low and high ends of the spectrum according to any of several alternate forms. (See ref. 1,

Section II.A.6.) In the case of an ITERATION run, extrapolation may be performed at any iteration; if there is an energy below (or above) which all detectors being used have zero sensitivity, all spectral values below (or above) that energy are discarded as being meaningless, and are replaced by extrapolation. In the code's original form, this would occur regardless of the form of the input trial spectrum. In the particular case in which the input spectrum included low- and/or high-end regions of zero flux, such regions would in general not be maintained as zero-flux regions, because of subsequent extrapolation from some non-zero flux point.

This feature has been changed, to allow the device of zero-flux end regions to be used for expansion of energy regions of interest on the output plots. No change has been made in this respect to the logic of the code, but only to the regions over which extrapolation is effective. Zero-flux end regions, if any, are identified at the beginning of each case, and extrapolation is not performed over these regions at any time.

VI. MISCELLANEOUS CHANGES

A. Punchout Format and Option

Solution absolute differential flux spectrum punchout is described in reference 1, Section II.C.2. Because of certain specific applications to which the punchout has been put at BMI/PNL, three slight changes have been made, as follows:

- (1) The word FLUX has been deleted from the first four columns of each card. Spectrum cards are currently punched in IP7E10.3 format.
- (2) Only the first title card for a case precedes the spectrum punchout.
- (3) Punchout for each case is preceded by a card which contains the word SPECTRUM in columns 1 through 8.

An input card has been added to indicate whether or not punchout is desired for a given case. (The plotting option described in Section IV.E. is included on the same card.) Section VII gives a detailed description of this card.

B. Simplification of Subroutine NORM

Time and funding did not permit general restructuring of the code to optimize compilation and execution efficiency. However, subroutine NORM

contained logic and flow that was obviously inefficient and unnecessarily cumbersome. Major portions of that subroutine have been substantially simplified.

C. Other Changes

The printed message giving the reason for cessation of iteration was either of two, depending on whether the solution criterion was satisfied or the iteration limit was reached; a third has been added, for attainment of stability at a standard deviation value higher than that specified (see Section III.A).

The spectrum tabulation printout format has been changed to increase the number of entries per page from 30 to 37, to make more efficient use of the page size used at the CSC/NW facility. This results in a reduction from 21 to 17 pages for spectrum tabulation.

Various other printout formats have been changed to correct misalignment or other minor errors and omissions. In several places, sequences of IF tests and other control statements have been rewritten and/or combined for improvement of efficiency.

In specifying attenuating cover materials used with detectors, the word RANDOM has been changed to the word GOLD. Because this word change results in a different number of VIF words (each VIF word is four characters, as explained in reference 1, Section II.B.1) than required for the other two cover names (CADMIUM, BORON), some additional programming was required in subroutine READ to insert a dummy blank word if the word GOLD is encountered.

VII. USER INSTRUCTION SUPPLEMENT

All input data cards which have been changed from or added to the input deck are read by SAND II using subroutine VIF (see ref. 1, Section II.B.1) and are therefore free from location and spacing format. The notation of the sequence outline presented below is consistent with that of reference 1, Section II.B.2; specifically, the following abbreviations and symbols are used:

{ } select one;
 () omit if not needed or desired;
n integer number;
x "real" or "floating point" number;
a alphameric character.

(The distinction between n and x is not necessary, because of VIF, but is maintained for clarity.) For facility of presentation, the outline is divided into sections, according to function. (To avoid confusion between these sections and Sections of this report, the data deck sections are referred to with a lower case "s" and are numbered with Arabic numerals.)

Those sections which are not changed are so noted, and are presented with no accompanying explanation or comment. (Explanation and comments are given in reference 1, Section II.B.2.) Those sections which are new or changed are also so noted and explanatory comments are included.

section 0: Number of Cases. One card.

n CASES

NEW. This card is to be included only once, at the beginning of the entire data deck for a run. It is not to be added at the beginning of each case. (This card will be reproduced as the first line of printout on a separate page.) If this card is missing, or contains an error, an appropriate message will be printed, and one case will be assumed. To save execution time, however, it should be included even in a single-case run.

section 1: Title Cards. As many cards as desired.

Taaa.....aaa.....
 " " "

NO CHANGE.

section 2. Type of Run, and Type of Activity Measurement. One card.

{ ITERATION }
 { ACTIVITY } (TIME INTEGRATED)

NO CHANGE.

section 3: Foils. One card specifying number of foils, plus one card for each foil.

n FOILS

<u>aaaaaa</u>	(CADMIUM <u>x</u>)	(BORON <u>x</u>)	(GOLD <u>x</u>)
"	"	"	"
"	"	"	"

CHANGED. The word GOLD used as a cover name replaces the word RANDOM. No other changes.

section 4: FOR ITERATION RUN ONLY: Measured Activities. As many cards as needed.

ACTS	<u>x</u>	<u>x</u>	<u>x</u>	<u>x</u>	
"	"	"	"	"	

NO CHANGE.

section 5: Spectrum Form. One card.

SPECTRUM	{	LIBRARY (<u>n</u>)	}
		FUNCTION <u>n</u>	
		TABULAR	

NO CHANGE.

section 6: FOR TABULAR SPECTRUM INPUT ONLY: Spectrum Tabulation. As many cards as needed.

n POINTS

ENER	<u>x</u>	<u>x</u>	<u>x</u>	<u>x</u>	
"	"	"	"	"	
FLUX	<u>x</u>	<u>x</u>	<u>x</u>	<u>x</u>	
"	"	"	"	"	

NO CHANGE.

section 7: FOR ITERATION RUN ONLY: Solution Parameters. Three cards.

LIMIT n

DEVIATION x

DISCARD x

CHANGED. The word DEVIATION replaces the word DIFFERENCE.
No other changes.

section 8: Extrapolation Forms and Normalization Energy. Three cards.

LOW END {
E
SQ RTE
THERMAL (x)
}

HIGH END {FISSION}
FUSION }

NORM x

NO CHANGE.

section 9: Auxiliary Output. 1 card.

(NO) (PLOT) (NO) (CARDS)

NEW. The reference to plots and cards may be in either order. The word NO preceding either the word PLOT or the word CARDS will suppress graphical spectrum plotting or punchout, respectively. The omission of either the word PLOT or the word CARDS will result in that auxiliary output being provided. As an extreme example, a blank card will result in punchout and plots both being provided. The card must be in the deck, however, even if blank. (Through a quirk in the logic in subroutine READ, a double negative will be taken to be a positive. For example, if through some mistake the card contained the words NO NO PLOT, plots would be provided; punchout would also be provided, by omission. Also, a diagnostic message would be printed indicating that the first NO is not followed by either of the words PLOT or CARDS.)

section 10: FOR ITERATION RUN ONLY: Structure Retardation. 1 card.

SMOOTH n

NEW. The number n refers to N_S , the number of points used in the weighting function smoothing (see Section II.B.3). Increasing n will cause increased smoothing (more structure retardation). The maximum allowable value for n is 75; a larger value will result in a diagnostic message, and N_S will be set equal to 75. The specified number should be odd; an even number will be internally increased by 1. If n is 1, 0, negative, or blank, N_S will be set equal to 1 (no smoothing).

VIII. RECOMMENDED FUTURE EFFORT

The scope of the present program did not permit all the effort which is known to be required or desirable for optimizing the utility of SAND II. Several areas of effort are recommended below which will either increase the code's utility or correct current weaknesses. No indication of priority is intended in the order of discussion.

Because of the variety of applications in which output plots are eventually used as reference figures in publications and other documents, the option should be added to select either absolute or normalized spectra for plotting. Currently, plots are of absolute spectra.

Available system software should be utilized to monitor an ITERATION run time. Currently, if the time limit specified by the user is exceeded, execution terminates with no further output, essentially wasting the entire run time. The provision should be included to initiate printout of running results (specifically, the interim iterative spectrum) if the time limit is being approached within, say, thirty seconds; this would salvage the run time used, especially if punchout were also initiated in a format to allow its subsequent use as input to a new ITERATION run.

Available system software should be utilized to write an end-of-file record on the off-line plotter tape (if plots are being provided) in the event of a system-detected execution error. Currently, SAND II writes a plotter tape

end-of-file record if an input error is detected within the code in the last case of a run (see ref. 1, Appendix VII), in which case control remains with the code; no end-of-file writing provision exists, however, if control is transferred to the system, which occurs when an execution error is detected.

A study should be initiated to evaluate the feasibility of point-by-point extrapolation toward a solution spectrum based on three successive iterations, using some well-known extrapolation process such as, say, Aiken's δ^2 procedure:

$$\phi_j^{[0]} = \frac{\phi_j^{[k+1]} \phi_j^{[k-1]} - (\phi_j^{[k]})^2}{\phi_j^{[k+1]} + \phi_j^{[k-1]} - 2\phi_j^{[k]}}, \quad j=1, \dots, m, \quad (17)$$

where $\phi_j^{[k]}$ is the k^{th} iterative differential flux value in the j^{th} energy interval. Such a procedure would involve substantial reprogramming of the code, but may result in significant savings in execution time.

The provision should be added, as an input option, for plotting the sensitivity functions for any or all of the various detectors used in a given case. Such plots are often valuable tools for interpretation of results; when desired, they are currently being obtained at BMI/PNL by using a predecessor of the SAND II code, SAND I, which includes this provision. This is the only reason for maintaining SAND I operational; incorporation of this feature into SAND II would allow discontinuance of SAND I, which is otherwise obsolete.

The number of forms in which a trial spectrum may be submitted as input (see ref. 1, Section II.A.3) should be increased to include the options of submitting differential flux as a function of lethargy [$\phi(u)$] vs. lethargy and vs. energy, in tabular form. Reactor physics calculations, often used as trial spectra, are commonly reported as $\phi(u)$ vs. u , or $\phi(u)$ vs. E . Such data must currently be laboriously converted manually prior to use as SAND II input. (It may be more expeditious to write a separate auxiliary code to perform this conversion, rather than to make it an integral part of SAND II.)

An auxiliary code should be written to accept SAND II results [$\phi(E)$ vs. E] as input, and provide as output graphical plots of $\phi(u)$ vs. u , with a linear abscissa, and the option of a linear or logarithmic ordinate. Lethargy plots are often useful in presenting a better visual indication of flux fractions within various energy regions than can be obtained from energy plots.

The current subprogram division is not as efficient as it might be. Because of the history of the code, certain features which were added as temporary measures became permanent; certain provisions not originally included have been subsequently added, etc. Optimum subprogram structure could not always readily be maintained. SAND II should be extensively re-programmed, to increase efficiency of compilation and execution time.

Sand II contains arithmetic to solve activity equations which result from two extremes in the time-behavior of a neutron environment: (1) steady-state, where the spectrum is in dimensions of flux (constant with time), and activities are assumed to be extrapolated to saturation, and (2) pulsed, where the spectrum is in dimensions of fluence (time-integrated flux), and activities are assumed to be time-of-removal, with a negligibly short irradiation time compared to all product half-lives. (See reference 2, Section II.B.) In both these cases, burnup is ignored. However, many occasions arise which require experiments to be conducted in reactor environments which are not steady-state, but vary in magnitude with time. Furthermore, burnup may in general be significant. The requirement exists, therefore, for solution of a set of activity equations based on the general energy- and time-dependent activation equation, represented in reference (2), Section II.B, eqs. (7) and (5). A third-generation code (SAND III) should be developed to provide this requirement.

REFERENCES

1. S. Berg and W.N. McElroy, "A Computer-Automated Iterative Method for Neutron Flux Spectra Determination by Foil Activation", AFWL-TR-67-41, Sept. 1967, Vol. II: "SAND II (Spectrum Analysis by Neutron Detectors II) and Associated Codes"
2. W. N. McElroy, S. Berg, T. Crockett, and R. G. Hawkins, *ibid*, Vol. I: "A Study of the Iterative Method"

Appendix: Listing of SAND II

CSC/NW Univac 1108 Version

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000001      C      SA-D II - SPECTRUM ANALYSIS BY NEUTRON DETECTORS II - MAIN PROGRAM00000010
000002      C      -----00000020
000003      C      00000030
000004      C      SUBPROGRAMS REQUIRED FOR EXECUTION --00000040
000005      C      SUBROUTINE READ00000050
000006      C      SUBROUTINE VIF00000060
000007      C      SUBROUTINE SIGS00000070
000008      C      SUBROUTINE LIBR00000080
000009      C      SUBROUTINE FAPT00000090
000010      C      SUBROUTINE NORM00000100
000011      C      SUBROUTINE CALC00000110
000012      C      SUBROUTINE WATE00000120
000013      C      SUBROUTINE ITER00000130
000014      C      SUBROUTINE GRAF00000140
000015      C      FUNCTIONS DIF1 THRU DIF500000150
000016      C      00000160
000017      C      TAPE FILE NUMBERS USED FOR CSC 110800000170
000018      C      SYMBOLIC                                PHYSICAL00000180
000019      C      UNIT                                UNIT00000190
000020      C      0 TYPEWRITER -00000200
000021      C      5 CARD READER -00000210
000022      C      6 PRINTER -00000220
000023      C      15 RESERVE (CROSS SECTION LIBRARY) D00000230
000024      C      18 RESERVE (REFERENCE SPECTRUM LIBRARY) E00000240
000025      C      11 SCRATCH (PERTINENT CROSS SECTIONS) B00000250
000026      C      14 SCRATCH (WEIGHTING FUNCTIONS) G00000260
000027      C      16 OUTPUT (PLOT TAPE) H00000270
000028      C      00000280
000029      C      DIMENSION A(35),AC(35),APSI(621),ASOL(621),BAD(35),DEV(35),00000290
000030      C      1 TITL(39),E(621),DNAM(4), FOIL(35,2),JHI(35),JLO(35),OVER(35),00000300
000031      C      2 PFIR(621),PSI(621), SOLN(621),UNDR(35),FULN(35,4),00000310
000032      C      3 FC(35),ICOV(35,3),WCOV(4),COVR(3),CNUM(621),EAV(621),EDEL(620)00000320
000033      C      00000330
000034      C      COMMON E,M,NPL1,N00000340
000035      C      COMMON /MRLNCG/KIND,TINT00000350
000036      C      COMMON /MRN/ENOR00000360
000037      C      COMMON /MR/DCR,SDNO,TITL,INIT,KMAX,NFCN,NCAS,NMAX,PLOT,CARDS,SRCH00000370
000038      C      1,NPLOT00000380
000039      C      COMMON /MSL/FOIL,ICOV00000390
000040      C      COMMON /MLCI/BAD,FC,NDIS00000400
000041      C      COMMON /MLF/PFIR00000410
000042      C      COMMON /MNI6/PSI,K,JLZ,JHZ00000420
000043      C      COMMON /MLN/APSI,EAV,CNUM,SOLN,ASOL00000430
000044      C      COMMON /MCL/AC00000440

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000045		COMMON /MSG/FULN	00000450
000046		COMMON /MC/DEV,F,OVER,STEM,TAIL,UNDR	00000460
000047		COMMON /MC6/JHI,JLO	00000470
000048		COMMON /MSLC/A	00000480
000049		COMMON /MSN/EDEL	00000490
000050		COMMON /MG/ACHV,STBL	00000500
000051	C		00000510
000052		LOGICAL STBL,ACHV,BAD,DISC,TINT,SRCH,PLOT,CARDS,OK	00000520
000053	C		00000530
000054		DATA (WCOV(I),I=1,4)/1H,2HCD,1HB,2HAU/	00000540
000055	C		00000550
000056		NPL0T = 0	00000560
000057		NCAS=0	00000570
000058		IPCHCT = 0	00000580
000059	C		00000590
000060	C	READ INPUT AND OBTAIN REQUIRED REACTION CROSS SECTIONS	00000600
000061	C		00000610
000062		1 SRCH=.FALSE.	00000620
000063		CALL READ	00000630
000064		2 NCAS=NCAS+1	00000640
000065		CALL SIGS(OK)	00000650
000066		IF(.NOT.OK) GO TO 245	00000660
000067	C		00000670
000068	C	INITIALIZE NECESSARY FLAGS AND COUNTERS	00000680
000069	C		00000690
000070		DO 5 I=1,N	00000700
000071		5 BAD(I)=.FALSE.	00000710
000072		DISC=.FALSE.	00000720
000073		IF(KIND.EQ.2) IF(INIT-2) 20,25,46	00000730
000074		NDIS=0	00000740
000075		K=0	00000750
000076		ACHV=.FALSE.	00000760
000077		STBL=.FALSE.	00000770
000078		15 IF(INIT-2) 20,25,46	00000780
000079	C		00000790
000080	C	OBTAIN FIRST APPROXIMATION SPECTRUM	00000800
000081	C		00000810
000082		20 CALL LIBR(OK)	00000820
000083		IF(.NOT.OK) GO TO 245	00000830
000084		GO TO 47	00000840
000085		25 GO TO(26,28,30,32,34),NFCN	00000850
000086		26 DO 27 J=1,MPL1	00000860
000087		27 PFIR(J)=DIF1 (E(J))	00000870
000088		GO TO 47	00000880
000089		28 DO 29 J=1,MPL1	00000890
000090		29 PFIR(J)=DIF2 (E(J))	00000900
000091		GO TO 47	00000910
000092		30 DO 31 J=1,MPL1	00000920
000093		31 PFIR(J)=DIF3 (E(J))	00000930

000094	GO TO 47	00000940
000095	32 DO 33 J=1,MPL1	00000950
000096	33 PFIR(J)=DIF4 (E(J))	00000960
000097	GO TO 47	00000970
000098	34 DO 35 J=1,MPL1	00000980
000099	35 PFIR(J)=DIF5 (E(J))	00000990
000100	GO TO 47	00001000
000101	46 CALL FAPT	00001010
000102	C	00001020
000103	C	00001030
000104	C	00001040
000105	47 DO 50 J=1,M	00001050
000106	IF (PFIR(J).EQ.0.0.OR.PFIR(J+1).EQ.0.0.OR.	00001060
000107	1 PFIR(J).LT.1.0E-36.OR.PFIR(J+1).LT.1.0E-36) GO TO 49	00001070
000108	YDEL=ALOG(PFIR(J+1)/PFIR(J))	00001080
000109	XDEL=ALOG(E(J+1)/E(J))	00001090
000110	APL1=1.+YDEL/XDEL	00001100
000111	IF (ABS(APL1).EQ.0.0) GO TO 48	00001110
000112	IF (ABS(APL1).LT.1.0E-5) GO TO 48	00001120
000113	PFIR(J)=(PFIR(J+1)*E(J+1)-PFIR(J)*E(J))/(APL1*EDEL(J))	00001130
000114	GO TO 50	00001140
000115	48 PFIR(J)=E(J)*PFIR(J)*XDEL/EDEL(J)	00001150
000116	GO TO 50	00001160
000117	49 PFIR(J)=0.5*(PFIR(J)+PFIR(J+1))	00001170
000118	50 CONTINUE	00001180
000119	PFIR(MPL1)=0.	00001190
000120	PSI (MPL1)=0.	00001200
000121	APSI(MPL1)=0.	00001210
000122	SOLN(MPL1)=0.	00001220
000123	ASOL(MPL1)=0.	00001230
000124	C	00001240
000125	C	00001250
000126	C	00001260
000127	C	00001270
000128	DO 51 J=1,M	00001280
000129	JLZ=J	00001290
000130	IF (PFIR(J).GT.1.0E-36) GO TO 52	00001300
000131	51 CONTINUE	00001310
000132	52 DO 53 J=1,M	00001320
000133	JHZ=MPL1-J	00001330
000134	IF (PFIR(JHZ).GT.1.0E-36) GO TO 55	00001340
000135	53 CONTINUE	00001350
000136	55 DO 56 J=1,M	00001360
000137	56 PSI(J)=PFIR(J)	00001370
000138	IF (KIND.EQ.2.OR..NOT.PLOT) GO TO 60	00001380
000139	CALL GRAF(1,0)	00001390
000140	NPLOT = NPLOT + 1	00001400
000141	C	00001410
000142	C	00001420

NORMALIZE CURRENT ITERATIVE SPECTRUM AND

000143	C	CALCULATE NEW NORMALIZED ACTIVITIES	00001430
000144	C		00001440
000145		60 CALL NORM	00001450
000146		CALL CALC	00001460
000147		IF(KIND.EQ.2) GO TO 225	00001470
000148	C		00001480
000149	C	PROCEED WITH ITERATION TYPE RUN	00001490
000150	C		00001500
000151		IF(K.EQ.0) GO TO 70	00001510
000152	C		00001520
000153	C	TEST WHETHER SOLUTION IS ACHIEVED	00001530
000154	C		00001540
000155		IF(STEM.GT.DCR) GO TO 65	00001550
000156		ACHV=.TRUE.	00001560
000157		GO TO 70	00001570
000158		65 IF(STEM.GT.STDV) GO TO 70	00001580
000159		IF(STDV-STEM.LE.0.01*STEM) STBL=.TRUE.	00001590
000160		70 STDV=STEM	00001600
000161		IF(ACHV.OR.STBL.OR.K.EQ.KMAX) GO TO 100	00001610
000162		WRITE(6,1000) K,TAI	00001620
000163		1000 FORMAT(1H1/34X,21HINTERIM RESULTS AFTER,13,11H ITERATIONS/34X,35(100001630	
000164		1H-)/48X,7HNOMINAL,24X,9HDEVIATION/39X,F10.2,8H PERCENT,21X,11HOF M00001640	
000165		2EASURED/47X,8HACTIVITY,11X,5HRATIO,10X,4HFROM/45X,12HLIMITS (MEV),00001650	
000166		36X,11HMEASURED TO,4X,10HCALCULATED/41X,20(1H-),3X,10HCALCULATED,5X00001660	
000167		4,8HACTIVITY/16X,13HFOIL REACTION,15X,5HLOWER,5X,5HUPPER,5X,10HACTI00001670	
000168		5VITIES,5X,9H(PERCENT)/15X,16(1H-),10X,9(1H-),2X,9(1H-),2X,12(1H-),00001680	
000169		64X,9(1H-))	00001690
000170		DO 1010 I=1,N	00001700
000171		IF(BAD(I)) GO TO 1010	00001710
000172		JL=JLO(I)	00001720
000173		JH=JHI(I)	00001730
000174		DO 1002 L=1,3	00001740
000175		IND=ICOV(I,L)	00001750
000176		1002 COVR(L)=WCOV(IND)	00001760
000177		WRITE(6,1005) (FULN(I,L),L=1,4),(COVR(L),L=1,3),E(JL),E(JH),FC(I),00001770	
000178		1 DEV(I)	00001780
000179		1005 FORMAT(1H ,14X,4A4,1X,2A3,A2,2(1PE10.3,1X),0PF10.4,2PF14.2)	00001790
000180		1010 CONTINUE	00001800
000181		WRITE(6,1015) STDV,ENOR,F	00001810
000182		1015 FORMAT(1H0,79X,6(1H-))//28X,51HSTANDARD DEVIATION OF MEASURED ACTI00001820	
000183		1VITIES (PERCENT),2PF7.2///40X,25HAVERAGE TOTAL FLUX (ABOVE,1PE9.2,00001830	
000184		25H MEV),E11.3)	00001840
000185	C		00001850
000186	C	ADVANCE ITERATION COUNT AND PERFORM NEXT ITERATION	00001860
000187	C		00001870
000188		K=K+1	00001880
000189		CALL ITER	00001890
000190		GO TO 60	00001900
000191	C		00001910

000192	C	CALCULATE ABSOLUTE SPECTRAL VALUES	00001920
000193	C		00001930
000194		100 DO 105 J=1,4	00001940
000195		ASOL(J)=F*SOLN(J)	00001950
000196		105 APSI(J)=F*PSI(J)	00001960
000197	C		00001970
000198	C	PUNCH TITLE CARD FOR PUNCHOUT	00001980
000199	C		00001990
000200		IF(.NOT.CARDS) GO TO 110	00002000
000201		PUNCH 106	00002010
000202		IPCHCT = IPCHCT + 1	00002020
000203		106 FORMAT(8HSPECTRUM,72X)	00002030
000204		IF(NDIS.EQ.0) GO TO 107	00002040
000205		PUNCH 1065,TITL,NDIS,DNAM	00002050
000206		IPCHCT = IPCHCT + 1	00002060
000207		1065 FORMAT(39A1,1X,I1,18H FOILS DISCARDED, ,4A4,5H LAST)	00002070
000208		GO TO 110	00002080
000209		107 PUNCH 108, TITL	00002090
000210		IPCHCT = IPCHCT + 1	00002100
000211		108 FORMAT(39A1,41X)	00002110
000212	C		00002120
000213	C	TEST FOR, FLAG, AND COUNT DISCARDED FOILS	00002130
000214	C		00002140
000215		110 DRAT=DCR/STDV	00002150
000216		CRIT=AMAX1(DRAT,SDNO)	00002160
000217		FAIL=0.	00002170
000218		DO 114 I=1,N	00002180
000219		OUT=DEV(I)/STDV	00002190
000220		CRIT=AMAX1(CRIT,FAIL)	00002200
000221		IF(BAD(I).OR..NOT.ABS(OUT).GT.CRIT) GO TO 114	00002210
000222		IOUT=I	00002220
000223		FAIL=OUT	00002230
000224		DISC=.TRUE.	00002240
000225		114 CONTINUE	00002250
000226		IF(DISC) GO TO 115	00002260
000227		IOUT = N+1	00002270
000228		GO TO 117	00002280
000229		115 DO 116 L=1,4	00002290
000230		116 DNAM(L)=FULN(IOUT,L)	00002300
000231		BAD(IOUT)=.TRUE.	00002310
000232		NDIS=NDIS+1	00002320
000233	C		00002330
000234	C	WRITE REASON FOR CESSATION OF ITERATION	00002340
000235	C		00002350
000236		117 IF(ACHV)GO TO 125	00002360
000237		IF(STBL) GO TO 122	00002370
000238		WRITE(6,120) DCR,K,K	00002380
000239		120 FORMAT(1H1//27H THE SPECIFIED PRECISION OF,2PF6.2,70H PERCENT FOR 00002390*NEW	
000240		1MEASURED-TO-CALCULATED ACTIVITY RATIOS STANDARD DEVIATION/51H IS NO0002400*NEW	

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000241      20T ACHIEVED AFTER THE MAXIMUM ALLOWED NUMBER (,I3,16H) OF ITERATIO000002410*NEW
000242      3NS, //32X, 22H RESULTS OBTAINED AFTER, I3, 16H ITERATION LIMIT/32X, 41(100002420*NEW
000243      4H-)) 00002430*NEW
000244      GO TO 135 00002440***-5
000245      122 WRITE(6,123) DCR,K 00002450
000246      123 FORMAT(1H1//100H STANDARD DEVIATION OF MEASURED-TO-CALCULATED ACTI00002460*NEW
000247      1VITY RATIOS HAS BECOME STABLE (TO WITHIN LESS THAN/ 71H ONE00002470*NEW
000248      2 PERCENT CHANGE PER ITERATION) AT A HIGHER VALUE THAN THE SPECIFIE00002480***-2
000249      3D, 2PF6.2, 9H PERCENT, //34X, 22H RESULTS OBTAINED AFTER, I3, 11H ITERAT00002490
000250      4I0HS/34X, 36(1H-)) 00002500
000251      GO TO 135 00002510
000252      125 WRITE(6,130) DCR,K 00002520
000253      130 FORMAT(1H1//28H SOLUTION HAS BEEN ACHIEVED, //74H STANDARD DEVIATION00002530*NEW
000254      1 OF MEASURED-TO-CALCULATED ACTIVITY RATIOS IS LESS THAN, 2PF6.2, 9H 00002540*NEW
000255      2PERCENT, //29X, 31HSOLUTION RESULTS OBTAINED AFTER, I3, 11H ITERATIONS00002550*NEW
000256      3/29X, 45(1H-)) 00002560*NEW
000257      C 00002570***-4
000258      C WRITE HEADINGS FOR TABULATED ACTIVITIES 00002580
000259      C AND ASSOCIATED PARAMETERS 00002590
000260      C 00002600
000261      135 WRITE(6,151) TAIL 00002610
000262      151 FORMAT(1H0, 63X, 7HNOMINAL, 25X, 9HDEVIATION/55X, F10.2, 8H PERCENT, 00002620
000263      1 22X, 11HOF MEASURED) 00002630
000264      IF(TINT)GO TO 153 00002640
000265      WRITE(6,152) 00002650
000266      152 FORMAT(1H , 26X, 9HSATURATED, 7X, 9HSATURATED, 11X, 8HACTIVITY, 12X, 5HRAT00002660
000267      1I0, 10X, 4HFROM) 00002670
000268      GO TO 155 00002680
000269      153 WRITE(6,154) 00002690
000270      154 FORMAT(1H , 62X, 8HACTIVITY, 12X, 5HRATIO, 10X, 4HFROM) 00002700
000271      155 WRITE(6,156) 00002710
000272      156 FORMAT(1H , 26X, 8HMEASURED, 7X, 10HCALCULATED, 9X, 12HLIMITS (MEV), 7X, 100002720
000273      11HMEASURED TO, 4X, 10HCALCULATED/25X, 2(2X, 8HACTIVITY, 6X), 20(1H-), 4X, 00002730
000274      210HCALCULATED, 5X, 8HACTIVITY/2X, 13HFOIL REACTION, 7X, 2(3X, 13H(DPS/NU00002740
000275      3CLEUS)), 5X, 5HLOWER, 6X, 5HUPPER, 6X, 10HACTIVITIES, 5X, 9H(PERCENT)/1X, 100002750
000276      46(1H-), 8X, 13(1H-), 3X, 13(1H-), 3X, 9(1H-), 2X, 9(1H-), 3X, 12(1H-), 4X, 9(00002760
000277      51H-)) 00002770
000278      C 00002780
000279      C TABULATE ACTIVITIES AND ASSOCIATED PARAMETERS 00002790
000280      C 00002800
000281      163 DO 170 I=1,N 00002810
000282      IF(BAD(I).AND.I.NE.IOUT) GO TO 170 00002820
000283      164 I1=JLO(I) 00002830
000284      I2=JHI(I) 00002840
000285      DO 165 L=1,3 00002850
000286      IND=ICOV(I,L) 00002860
000287      165 COVR(L)=WCOV(IND) 00002870
000288      WRITE(6,166) (FULN(I,L), L=1,4), (COVR(L), L=1,3), A(I), AC(I), E(I1), 00002880
000289      1 E(I2), FC(I), DEV(I) 00002890

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000290	166	FORMAT(1H ,4A4,1X,2A3,A2, 1PE10.3,E16.3,1X,2E12.3,0PF12.4,2PF14.2)	00002900
000291	170	CONTINUE	00002910
000292		WRITE(6,171)	00002920
000293	171	FORMAT(1H0,96X,6(1H-))	00002930
000294		WRITE(6,176) STDV	00002940
000295	176	FORMAT(1H0,44X,51HSTANDARD DEVIATION OF MEASURED ACTIVITIES (PERCENTAGE)	00002950
000296		1INT),2PF7.2)	00002960
000297		IF(.NOT.DISC)GO TO 195	00002970
000298			00002980
000299	C	IF APPROPRIATE, WRITE DISCARDED FOIL MESSAGE	00002990
000300	C		00003000
000301		WRITE(6,180)	00003010
000302	180	FORMAT(1H0, 84HTHE FOLLOWING FOIL MEASUREMENT SHOULD BE DISCARDED	00003020
000303		1BECAUSE OF EXCESSIVE DEVIATION --/ 98H (AFTER TABULATION OF THE SOLUTION	00003030
000304		2LUTION SPECTRUM, A NEW SOLUTION WILL BE CALCULATED OMITTING THIS FOIL)	00003040
000305		3OIL) //53X,9HNUMBER OF/24X,14HDISCARDED FOIL,10X,19HSTANDARD DEVIATIONS/23X,16(1H-),9X,19(1H-))	00003050
000306		DO 183 L=1,3	00003060
000307		IND=ICOV(IOUT,L)	00003070
000308		183 COVR(L)=WCOV(IND)	00003080
000309		WRITE(6,185) DNAM,(COVR(L),L=1,3),FAIL	00003090
000310		185 FORMAT(1H ,22X,4A4,3X,3A2,F12.3)	00003100
000311			00003110
000312	C	WRITE HEADINGS FOR SOLUTION SPECTRUM	00003120
000313	C		00003130
000314	C		00003140
000315	195	IF(ACHV.OR.STBL) GO TO 197	00003150
000316		WRITE(6,196) K	00003160
000317	196	FORMAT(1H1,38X,23HSPECTRUM OBTAINED AFTER,I3,16H ITERATION LIMIT/	00003170
000318		1 39X,42(1H-))	00003180
000319		GO TO 199	00003190
000320	197	WRITE(6,198) K	00003200
000321	198	FORMAT(1H1,36X,32HSOLUTION SPECTRUM OBTAINED AFTER,I3,11H ITERATION	00003210
000322		1NS/37X,46(1H-))	00003220
000323	199	IF(.NOT.TINT) GO TO 201	00003230
000324		WRITE(6,200)	00003240
000325	200	FORMAT(1H ,38X,41H(TIME-INTEGRATED OVER FOIL EXPOSURE TIME))	00003250
000326	C		00003260
000327	C	CALCULATE AVERAGE ENERGIES	00003270
000328	C		00003280
000329	201	CNUM(MPL1)=0.	00003290
000330		DO 206 MINJ=1,M	00003300
000331		J=MPL1-MINJ	00003310
000332		IF(SOLN(J).LE.1.0E-36.OR.SOLN(J).EQ.0.) GO TO 205	00003320
000333		EBAR=0.5*(E(J)+E(J+1))	00003330
000334		CNUM(J)=PSI(J)*EDEL(J)*EBAR	00003340
000335		CNUM(J)=CNUM(J)+CNUM(J+1)	00003350
000336		EAV(J)=CNUM(J)/SOLN(J)	00003360
000337		GO TO 206	00003370
000338	205	EAV(J)=0.	00003380

000339	CNUM(J)=0.	00003390
000340	206 CONTINUE	00003400
000341	C	00003410
000342	C	00003420
000343	C	00003430
000344	NP=MPL1/37	00003440
000345	IF(MPL1-37*NP,GT,0)NP=NP+1	00003450
000346	DO 211 LP=1, NP	00003460
000347	WRITE(6,207) ENOR	00003470
000348	207 FORMAT(1H0,35X,15HABSOLUTE VALUES,7X,13HNORMALIZED TO,1PE9.2,4H ME	00003480
000349	1V/36X,15(1H-),7X,26(1H-),7X,7HAVERAGE/22X,6HENERGY,4X,2(12HDIFFERE	00003490
000350	2NTIAL,3X,8HINTEGRAL,5X),4X,6HENERGY/22X,5H(MEV),2(9X,4HFLUX,9X,4HF	00003500
000351	3LUX,2X),9X,5H(MEV)/21X,8(1H-),3X,12(1H-),3X,8(1H-),5X,12(1H-),3X,8	00003510
000352	4(1H-),8X,8(1H-))	00003520
000353	IA=1+37*(LP-1)	00003530
000354	IB=IA+36	00003540
000355	IF(LP.EQ.NP) IB=MPL1	00003550
000356	DO 209 J=IA, IB	00003560
000357	WRITE(6,208) E(J), APSI(J), ASOL(J), PSI(J), SOLN(J), EAV(J)	00003570
000358	208 FORMAT(1H ,1PE28.3,2(2E13.3,2X),E14.3)	00003580
000359	209 CONTINUE	00003590
000360	IF(LP.EQ.NP)GO TO 211	00003600
000361	WRITE(6,210)	00003610
000362	210 FORMAT(1H1)	00003620
000363	211 CONTINUE	00003630
000364	IF(.NOT.CARDS) GO TO 214	00003640
000365	NFUL=MPL1/7	00003650
000366	IF(MPL1.GT.7*NFUL) NFUL=NFUL+1	00003660
000367	LA=1	00003670
000368	DO 213 NC=1,NFUL	00003680
000369	LB=LA+6	00003690
000370	IF(NC.EQ.NFUL) LB=MPL1	00003700
000371	PUNCH 212,(APSI(J),J=LA,LB)	00003710
000372	IPCHCT = IPCHCT + 1	00003720
000373	212 FORMAT(1P7E10.3)	00003730
000374	213 LA=LB+1	00003740
000375	214 IF(.NOT.PLOT) GO TO 217	00003750
000376	DO 2145 J=1,MPL1	00003760
000377	2145 PSI(J)=APSI(J)	00003770
000378	CALL GRAF(1,1)	00003780
000379	NPLOT = NPLOT + 1	00003790
000380	DO 215 J=1,MPL1	00003800
000381	215 PSI(J)=ASOL(J)	00003810
000382	CALL GRAF(2,0)	00003820
000383	NPLOT = NPLOT + 1	00003830
000384	217 IF(DISC) GO TO 220	00003840
000385	IF(NMAX-NCAS) 259,259,1	00003850
000386	C	00003880
000387	C	00003890
	DISCARD FLAG AND BEGIN NEW SOLUTION	

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000383      220 DISC=.FALSE.                                00003900
000389      WRITE(6,221)                                  00003910
000390      221 FORMAT(1H1//91H"CALCULATION WILL NOW BEGIN FOR A NEW SOLUTION WITH 00003920
000391      1THE FOLLOWING DISCARDED FOILS OMITTED --)      00003930
000392      DO 224 I=1,N                                    00003940
000393      IF(.NOT.BAD(I)) GO TO 224                      00003950
000394      DO 222 L=1,3                                    00003960
000395      IND=ICOV(I,L)                                  00003970
000396      222 COVR(L)=WCOV(IND)                          00003980
000397      WRITE(6,223) (FULN(I,L),L=1,4),(COVR(L),L=1,3) 00003990
000398      223 FORMAT(1H ,65X,4A4,3X,3A2)                 00004000
000399      224 CONTINUE                                    00004010
000400      K = 0                                             00004020
000401      ACHV = .FALSE.                                  00004030
000402      STBL = .FALSE.                                  00004040
000403      IF(INIT-2) 20,55,55                          00004050
000404      C                                              00004060
000405      C          PROCEED (FROM S.R. CALC) WITH ACTIVITY TYPE RUN 00004070
000406      C                                              00004080
000407      C          TABULATE RESULTS OF ACTIVITY TYPE RUN      00004090
000408      C                                              00004100
000409      225 WRITE(6,228) ENOR                          00004110
000410      228 FORMAT(1H1,39X,28H"ACTIVITY CALCULATION RESULTS/40X,28(1H-)/ 00004120
000411      140X,14H(NORMALIZED TO,1PE9.2,5H MEV)/40X,28(1H-)/64X,7HNOMINAL) 00004130
000412      WRITE(6,229) TAIL                             00004140
000413      229 FORMAT(1H ,54X, F10.2,8H PERCENT,7X,15H"ACTUAL ACTIVITY) 00004150
000414      IF(TINT)GO TO 231                              00004160
000415      WRITE(6,230)                                    00004170
000416      230 FORMAT(1H ,42X,9HSATURATED,11X,8H"ACTIVITY,9X,14H"OUTSIDE LIMITS) 00004180
000417      GO TO 233                                       00004190
000418      231 WRITE(6,232)                                00004200
000419      232 FORMAT(1H ,62X,8H"ACTIVITY,9X,14H"OUTSIDE LIMITS) 00004210
000420      233 WRITE(6,234)                                00004220
000421      234 FORMAT(1H ,41X,10H"CALCULATED,8X,13H"LIMITS (MEV),10X,9H(PERCENT)/4300004230
000422      1X,8H"ACTIVITY,6X,20(1H-),3X,15(1H-)/15X,13H"FOIL REACTION,13X,13H(DP00004240
000423      2S/NUCLEUS),5X,5H"LOWER,6X,5H"UPPER,6X,5H"LOWER,3X,5H"UPPER/14X,16(1H-)00004250
000424      3,10X,15(1H-),2X,9(1H-),2X,9(1H-),3X,7(1H-),1X,7(1H-)) 00004260
000425      DO 240 I=1,N                                    00004270
000426      I1=JLO(I)                                       00004280
000427      I2=JHI(I)                                       00004290
000428      DO 237 L=1,3                                    00004300
000429      IND=ICOV(I,L)                                  00004310
000430      237 COVR(L)=WCOV(IND)                          00004320
000431      WRITE(6,238) (FULN(I,L),L=1,4),(COVR(L),L=1,3),AC(I),E(I1),E(I2), 00004330
000432      1 UNDR(I),OVER(I)                              00004340
000433      238 FORMAT(1H ,13X,4A4,1X,3A3,1PE12.3,E14.3,E11.3,2PF9.3,F8.3) 00004350
000434      240 CONTINUE                                    00004360
000435      C                                              00004370
000436      C          TABULATE INPUT SPECTRUM FOR ACTIVITY TYPE RUN 00004380

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000437	C	WRITE(6,242)	00004390
000438			00004400
000439	242	FORMAT(1H1,47X,25HINPUT SPECTRUM TABULATION/48X,25(1H-))	00004410
000440		IF(.NOT. CARDS) GO TO 199	00004420
000441		PUNCH 106	00004430
000442		PUNCH 108,TITL	00004440
000443		IPCHCT = IPCHCT + 2	00004450
000444		GO TO 199	00004460
000445	C		00004470
000446	C	IF ERROR IN INPUT, SEARCH FOR NEXT CASE IN S.R. READ	00004480
000447	C		00004490
000448	245	IF(NCAS.EQ.NMAX) GO TO 250	00004500
000449		SRCH=.TRUE.	00004510
000450		CALL READ	00004520
000451		GO TO 2	00004530
000452	250	WRITE(6,255)	00004540
000453	255	FORMAT(1H ,18HJOB IS TERMINATED.)	00004550
000454	C		00004560
000455	C	WRITE EOF ON PLOT TAPE	00004570
000456	C		00004580
000457	259	IF(NPLOT.EQ.0) STOP	00004590
000458		CALL CPLLOT(0.,0.,999)	00004600
000459		WRITE(6,270) NPLOT	00004610
000460	270	FORMAT(1H1,I6,40H PLOTS TO BE PLOTTED ON CALCOMP PLOTTER.)	00004620
000461		STOP	00004630
000462		END	00004640

Q ELT READ,1,680706, 53449

000001		SUBROUTINE READ	00004650
000002	C	SUBROUTINE READ - READING OF INPUT DATA DECK	00004660
000003		DIMENSION AIN(35),ALF(80),CNSC(35,3),E(621),ENER(200),FLUX(200),	00004670
000004		1 INCO(35,3),ILF(80),ITEM(41),LFNM(30),REAC(35,2),YTEM(41),TITL(39)	00004680*NEW
000005		2,HDNG(28)	00004690**-1
000006	C		00004700
000007		COMMON E,M,MPL1,N	00004710
000008		COMMON /MRLNCG/KIND,TINT	00004720
000009		COMMON /MRN/ENOR	00004730
000010		COMMON /MR/DCR,SDNO,TITL,INIT,KMAX,NFCN,NCAS,NMAX,PLOT,CARDS,SRCH	00004740
000011		1,NPLOT	00004750
000012		COMMON /RV/ALF,YTEM,LAST	00004760
000013		COMMON /RSFI/EKT,LHIX,LOEX,J11	00004770
000014		COMMON /RS/AIN,CNSC,REAC,INCO	00004780
000015		COMMON /RF/ENER,FLUX,NIN	00004790
000016		COMMON /RL/ NFIR	00004800
000017		COMMON /RG/HDNG	00004810
000018		COMMON /RW/NS	00004820
000019	C		00004830
000020		EQUIVALENCE (ALF,ILF),(YTEM,ITEM)	00004840
000021	C		00004850
000022		LOGICAL TINT,SRCH,PLOT,CARDS,FP,FC,DFLT,OK	00004860
000023	C		00004870
000024		DATA (LFNM(I),I=1,30)/	00004880
000025	1	4HITER,4HACTI,4HFOIL,4HCADM,4HBORO,4HGOLD,4HACTS,4HSPEC,	00004890
000026	2	4HLIBR,4HFUNC,4HTABU,4HPOIN,4HENER,4HFLUX,4HLIMI,4HDEVI,	00004900
000027	3	4HDISC,4HLOW ,4HE ,4HSQRT,4HTHER,4HHIGH,4HFISS,4HFUSI,	00004910
000028	4	4HNORM,4HTIME,4HNO ,4HPLOT,4HCARD,4HSMOO/	00004920
000029		DATA IDEN/1HT/,BLNK/4H /,LCAS/4HCASE/	00004930
000030		IF(SRCH) GO TO 33	00004940
000031		FP=.FALSE.	00004950
000032		FC=.FALSE.	00004960
000033		DFLT=.FALSE.	00004970
000034		PLOT=.TRUE.	00004980
000035		CARDS=.TRUE.	00004990
000036		WRITE(6,1)	00005000*NEW
000037	1	FORMAT(1H1//)	00005010*NEW
000038		IF(NCAS.GT.0) GO TO 5	00005020**-2
000039		READ(5,10) ALF	00005030
000040		IF(ILF(1).EQ.IDEN) GO TO 2	00005035*NEW
000041		CALL VIF(1,OK)	00005040
000042		IF(.NOT.OK) GO TO 30	00005050
000043		IF(ITEM(2).EQ.LCAS) GO TO 4	00005060
000044	2	WRITE(6,3)	00005070*NEW

000045	3	FORMAT(1H0,51HNUMBER OF CASES CARD IS MISSING. 1 CASE IS ASSUMED.)	00005080**-1
000046		WRITE(6,1)	00005090*NEW
000047		NMAX=-1000	00005100**-1
000048		GO TO 5	00005110
000049	4	NMAX=YTEM(1)	00005120
000050		WRITE(6,15) ALF	00005130
000051		WRITE(6,1)	00005140*NEW
000052	C		00005150**-1
000053	C	READ AND WRITE TITLE CARDS	00005160
000054	C		00005170
000055	5	NTC=0	00005180
000056		DO 6 L=1,28	00005190
000057	6	HDNG(L)=BLNK	00005200
000058		DO 7 L=1,39	00005210
000059	7	TITL(L)=BLNK	00005220
000060		IF(NMAX.EQ.-1000) GO TO 18	00005230
000061	8	READ(5,10) ALF	00005240
000062	10	FORMAT(80A1)	00005250
000063	9	IF(ILF(1).NE.IDEN) GO TO 19	00005260
000064		NTC=NTC+1	00005270
000065		IF(NTC-2) 11,13,17	00005280
000066	C		00005290
000067	C	STORE FIRST TITLE CARD FOR PUNCHOUT	00005300
000068	C		00005310
000069	11	DO 12 L=1,39	00005320
000070	12	TITL(L)=ALF(L+1)	00005330
000071	C		00005340
000072	C	REREAD FIRST 2 TITLE CARDS IN A6 TO STORE FOR CALCOMP PLOT TITLING	00005350
000073	C		00005360
000074	13	JH1=1 + (NTC-1)*14	00005370
000075		JH2=JH1+13	00005380
000076		LV=-4	00005390
000077		READ(LV,14)(HDNG(J),J=JH1,JH2)	00005400
000078	14	FORMAT(1X,13A6,A1)	00005410
000079	15	FORMAT(1H,80A1)	00005420
000080	17	WRITE(6,15) ALF	00005430
000081		GO TO 8	00005440
000082	18	NMAX=1	00005450
000083		GO TO 9	00005460
000084	C		00005470
000085	C	EXAMINE TYPE CARD AND ASSIGN KIND AND TINT	00005480
000086	C		00005490
000087	19	WRITE(6,15) ALF	00005500
000088		IF(ITEM(1).EQ.LFNM(1).OR.ITEM(1).EQ.LFNM(2)) GO TO 20	00005505*NEW
000089		CALL VIF(1,OK)	00005510
000090		IF(.NOT.OK) GO TO 30	00005520
000091	20	DO 21 L=1,2	00005530*NEW
000092		KIND=L	00005540**-1
000093	21	IF(ITEM(1).EQ.LFNM(L)) GO TO 45	00005550*NEW

000094	WRITE(6,25)	00005560***-1
000095	25 FORMAT(1H0,78HJOB TYPE CARD DOES NOT CONTAIN EITHER THE WORD ITERA	00005570
000096	TION OR THE WORD ACTIVITY.)	00005580
000097	30 IF(NCAS+1.LT.NMAX) GO TO 33	00005590
000098	WRITE(6,32)	00005600
000099	32 FORMAT(1H ,18HJOB IS TERMINATED.)	00005610
000100	IF(NPLOT.EQ.0) STOP	00005620
000101	CALL CPLLOT(0.,0.,999)	00005630
000102	WRITE(6,1000) NPLOT	00005640
000103	1000 FORMAT(1H1,I6,40H PLOTS TO BE PLOTTED ON CALCOMP PLOTTER.)	00005650
000104	STOP	00005660
000105	33 WRITE(6,35)	00005670
000106	35 FORMAT(1H ,46HCASE TERMINATED. BEGIN SEARCH FOR NEXT CASE.)	00005680
000107	C	00005690
000108	C	00005700
000109	C	00005710
000110	WRITE(6,1)	00005720*NEW
000111	40 READ(5,10) ALF	00005730***-1
000112	IF(ILF(1).NE.IDEN)GO TO 40	00005740
000113	NTC=1	00005750
000114	NCAS=NCAS+1	00005760
000115	DO 42 L=15,28	00005770
000116	42 HDNG(L)=BLNK	00005780
000117	GO TO 11	00005790
000118	45 TINT=,FALSE.	00005800
000119	IF(ITEM(3).EQ.LFNM(26).OR.ITEM(4).EQ.LFNM(26)) TINT=,TRUE.	00005810
000120	C	00005820
000121	C	00005830
000122	C	00005840
000123	READ(5,10) ALF	00005850
000124	WRITE(6,15) ALF	00005860
000125	CALL VIF(1,OK)	00005870
000126	IF(.NOT.OK) GO TO 30	00005880
000127	IF(LAST.GE.2) GO TO 55	00005890
000128	47 WRITE(6,50)	00005900
000129	50 FORMAT(1H0,73HFOIL NUMBER CARD DOES NOT CONTAIN THE NUMBER OF FOIL	00005910
000130	1S AND THE WORD FOILS.)	00005920
000131	GO TO 30	00005930
000132	55 N=YTEM(1)	00005940
000133	IF(ITEM(2).NE.LFNM(3))GO TO 47	00005950
000134	C	00005960
000135	C	00005970
000136	C	00005980
000137	DO 110 I=1,N	00005990
000138	READ(5,10) ALF	00006000
000139	WRITE(6,15) ALF	00006010
000140	DO 60 IK=1,3	00006020
000141	60 INCO(I,IK)=1	00006030
000142	CALL VIF(1,OK)	00006040

000143	IF(.NOT.OK) GO TO 30	00006050
000144	REAC(I,1)=YTEM(1)	00006060
000145	IF(LAST.GT.1)GO TO 65	00006070
000146	REAC(I,2)=BLNK	00006080
000147	GO TO 110	00006090
000148	65 DO 70 L=4,6	00006100
000149	70 IF(ITEM(2).EQ.LFNM(L))GO TO 95	00006110
000150	75 REAC(I,2)=YTEM(2)	00006120
000151	IF(LAST.EQ.2)GO TO 110	00006130
000152	LCO=3	00006140
000153	80 IC=LCO/3	00006150
000154	DO 85 L=4,6	00006160
000155	INCO(I,IC)=L-2	00006170
000156	LL=L	00006180
000157	85 IF(ITEM(LCO).EQ.LFNM(L))GO TO 105	00006190
000158	WRITE(6,90) I,IC	00006200
000159	90 FORMAT(1H0,16HFOIL CARD NUMBER,I3,79H CONTAINS NAME OTHER THAN CAD	00006210
000160	1MIUM, BORON OR GOLD FOR ATTENUATING COVER NUMBER,I2,1H.)	00006220
000161	GO TO 30	00006230
000162	95 LMOV=LAST-1	00006240
000163	DO 100 ML=1,LMOV	00006250
000164	JL=LAST+1-ML	00006260
000165	100 YTEM(JL+1)=YTEM(JL)	00006270
000166	YTEM(2)=BLNK	00006280
000167	LAST=LAST+1	00006290
000168	GO TO 75	00006300
000169	105 IF(LL.EQ.6) GO TO 107	00006310
000170	106 CNCO(I,IC)=YTEM(LCO+2)	00006320
000171	LCO=LCO+3	00006330
000172	IF((LCO.LE.9).AND.(LCO.LE.LAST)) GO TO 80	00006340
000173	GO TO 110	00006350
000174	107 LMOV=LAST-LCO	00006360
000175	DO 108 ML=1,LMOV	00006370
000176	JL=LAST+1-ML	00006380
000177	108 YTEM(JL+1)=YTEM(JL)	00006390
000178	YTEM(LCO+1)=BLNK	00006400
000179	LAST=LAST+1	00006410
000180	GO TO 106	00006420
000181	110 CONTINUE	00006430
000182	IF(KIND.EQ.2)GO TO 150	00006440
000183	C	00006450
000184	C	00006460
000185	C	00006470
000186	NCT=0	00006480
000187	115 READ(5,10) ALF	00006490
000188	WRITE(6,15) ALF	00006500
000189	CALL VIF(1,OK)	00006510
000190	IF(.NOT.OK) GO TO 30	00006520
000191	IF(ITEM(1).EQ.LFNM(7))GO TO 125	00006530

PEAD AND WRITE ACTIVITIES

000192	WRITE(6,120)	00006540
000193	120 FORMAT(1H0,50HACTIVITIES CARD DOES NOT BEGIN WITH THE WORD ACTS.)	00006550
000194	GO TO 30	00006560
000195	125 DO 130 L=2, LAST	00006570
000196	LSUB=NCT+L-1	00006580
000197	130 AIN(LSUB)=YTEM(L)	00006590
000198	IF(N-LSUB) 140,150,135	00006600
000199	135 NCT=LSUB	00006610
000200	GO TO 115	00006620
000201	140 WRITE(6,145)	00006630
000202	145 FORMAT(1H0,52HNUMBER OF ACTIVITIES LISTED EXCEEDS NUMBER OF FOILS.	00006640
000203	1)	00006650
000204	GO TO 30	00006660
000205	C	00006670
000206	C READ AND WRITE SPECTRUM FORM CARD	00006680
000207	C	00006690
000208	150 READ(5,10) ALF	00006700
000209	WRITE(6,15) ALF	00006710
000210	CALL VIF(1,OK)	00006720
000211	IF(.NOT.OK) GO TO 30	00006730
000212	IF(ITEM(1).EQ.LFNM(8))GO TO 160	00006740
000213	WRITE(6,155)	00006750
000214	155 FORMAT(1H0,57HSPECTRUM FORM CARD DOES NOT BEGIN WITH THE WORD SPEC	00006760
000215	1TRUM.)	00006770
000216	GO TO 30	00006780
000217	C	00006790
000218	C ASSIGN INIT AND NFIR OR NFCN	00006800
000219	C	00006810
000220	160 DO 165 L=9,11	00006820
000221	INIT=L-8	00006830
000222	165 IF(ITEM(3).EQ.LFNM(L)) IF(INIT-2) 172,174,176	00006840
000223	WRITE(6,170)	00006850
000224	170 FORMAT(1H0,52HSPECTRUM FORM CARD DOES NOT CONTAIN ANY OF THE WORDS	00006860
000225	1/58H LIBRARY, FUNCTION OR TABULAR FOLLOWING THE WORD SPECTRUM.)	00006870
000226	GO TO 30	00006880
000227	172 NFIR=YTEM(5)	00006890
000228	IF(KIND.EQ.1.OR.NFIR.NE.0) IF(KIND-2) 270,305,305	00006900
000229	WRITE(6,173)	00006910
000230	173 FORMAT(1H0,97HJOB TYPE CARD SPECIFIES ACTIVITY JOB, AND SPECTRUM F	00006920
000231	10RM CARD SPECIFIES REFERENCE SPECTRA LIBRARY,/46H BUT NO SPECIFIC	00006930
000232	2SPECTRUM NUMBER IS SPECIFIED.)	00006940
000233	GO TO 30	00006950
000234	174 NFCN=YTEM(5)	00006960
000235	IF(NFCN.GE.1.AND.NFCN.LE.5) IF(KIND-2) 270,305,305	00006970
000236	WRITE(6,175)	00006980
000237	175 FORMAT(1H0,77HFUNCTION NUMBER SPECIFIED ON SPECTRUM FORM CARD IS N	00006990
000238	10T 1 THROUGH 5 INCLUSIVE.)	00007000
000239	GO TO 30	00007010
000240	C	00007020

	C	READ AND WRITE TABULAR SPECTRUM INPUT	
000241			00007030
000242	C		00007040
000243		176 READ(5,10) ALF	00007050
000244		WRITE(6,15) ALF	00007060
000245		CALL VIF(1,OK)	00007070
000246		IF(.NOT.OK) GO TO 30	00007080
000247		IF (LAST.GE.3) GO TO 190	00007090
000248		180 WRITE(6,185)	00007100
000249		185 FORMAT(1H0,85HTABULAR POINTS NUMBER CARD DOES NOT CONTAIN THE NUMB	00007110
000250		IER OF POINTS AND THE WORD POINTS.)	00007120
000251		GO TO 30	00007130
000252		190 N1=YTEM(1)	00007140
000253		IF (ITEM(2).NE.LFNM(12))GO TO 180	00007150
000254		NCT=0	00007160
000255		195 READ(5,10) ALF	00007170
000256		WRITE(6,15) ALF	00007180
000257		CALL VIF(1,OK)	00007190
000258		IF(.NOT.OK) GO TO 30	00007200
000259		IF (ITEM(1).EQ.LFNM(13))GO TO 205	00007210
000260		WRITE(6,200)	00007220
000261		200 FORMAT(1H0,57HENERGY TABULATION CARD DOES NOT BEGIN WITH THE WORD	00007230
000262		ENER.)	00007240
000263		GO TO 30	00007250
000264		205 DO 210 L=2, LAST	00007260
000265		LSUB=NCT+L-1	00007270
000266		210 ENER(LSUB)=YTEM(L)	00007280
000267		IF (MIN-LSUB) 220,230,215	00007290
000268		215 NCT=LSUB	00007300
000269		GO TO 195	00007310
000270		220 WRITE(6,225)	00007320
000271		225 FORMAT(1H0,59HNUMBER OF TABULATED ENERGY POINTS EXCEEDS SPECIFIED	00007330
000272		NUMBER.)	00007340
000273		GO TO 30	00007350
000274		230 NCT=0	00007360
000275		235 READ(5,10) ALF	00007370
000276		WRITE(6,15) ALF	00007380
000277		CALL VIF(1,OK)	00007390
000278		IF(.NOT.OK) GO TO 30	00007400
000279		IF (ITEM(1).EQ.LFNM(14))GO TO 245	00007410
000280		WRITE(6,240)	00007420
000281		240 FORMAT(1H0,55HFLUX TABULATION CARD DOES NOT BEGIN WITH THE WORD FL	00007430
000282		UX.)	00007440
000283		GO TO 30	00007450
000284		245 DO 250 L=2, LAST	00007460
000285		LSUB=NCT+L-1	00007470
000286		250 FLUX(LSUB)=YTEM(L)	00007480
000287		IF (MIN-LSUB) 260,267,255	00007490
000288		255 NCT=LSUB	00007500
000289		GO TO 235	00007510

000290	260 WRITE(6,265)	00007520
000291	265 FORMAT(1H0,57HNUMBER OF TABULATED FLUX POINTS EXCEEDS SPECIFIED NUMBER.)	00007530
000292	GO TO 30	00007540
000293	267 IF(KIND.EQ.2) GO TO 305	00007550
000294		00007560
000295	C	00007570
000296	C READ AND WRITE ITERATION LIMIT CARD	00007580
000297	C	00007590
000298	270 READ(5,10) ALF	00007600
000299	WRITE(6,15) ALF	00007610
000300	CALL VIF(1,OK)	00007620
000301	IF(.NOT.OK) GO TO 30	00007630
000302	IF(ITEM(1).EQ.LFNM(15))GO TO 280	00007640
000303	WRITE(6,275)	00007650
000304	275 FORMAT(1H0,56HITERATION LIMIT CARD DOES NOT BEGIN WITH THE WORD LIMIT.)	00007660
000305	GO TO 30	00007670
000306	280 KMAX=YTEM(3)	00007680
000307		00007690
000308	C	00007700
000309	C READ AND WRITE DEVIATION CARD	00007710
000310	C	00007720
000311	READ(5,10) ALF	00007730
000312	WRITE(6,15) ALF	00007740
000313	CALL VIF(1,OK)	00007750
000314	IF(.NOT.OK) GO TO 30	00007760
000315	IF(ITEM(1).EQ.LFNM(16))GO TO 290	00007770
000316	WRITE(6,285)	00007780
000317	285 FORMAT(1H0,70HITERATIVE FLUX DIFFERENCE CARD DOES NOT BEGIN WITH THE WORD DEVIATION.)	00007790
000318	GO TO 30	00007800
000319	290 DCQ=YTEM(4)*.01	00007810
000320		00007820
000321	C	00007830
000322	C READ AND WRITE DISCARD CARD	00007840
000323	C	00007850
000324	READ(5,10) ALF	00007860
000325	WRITE(6,15) ALF	00007870
000326	CALL VIF(1,OK)	00007880
000327	IF(.NOT.OK) GO TO 30	00007890
000328	IF(ITEM(1).EQ.LFNM(17))GO TO 300	00007900
000329	WRITE(6,295)	00007910
000330	295 FORMAT(1H0,65HFOIL DISCARD CRITERION CARD DOES NOT BEGIN WITH THE WORD DISCARD.)	00007920
000331	GO TO 30	00007930
000332	300 SDQO=YTEM(3)	00007940
000333		00007950
000334	C	00007960
000335	C READ AND WRITE EXTRAPOLATION CARDS	00007970
000336	C	00007980
000337	305 READ(5,10) ALF	00007990
000338	WRITE(6,15) ALF	00008000

000339	CALL VIF(1,OK)	00008010
000340	IF(.NOT.OK) GO TO 30	00008020
000341	IF(ITEM(1).EQ.LFNM(18))GO TO 315	00008030
000342	WRITE(6,310)	00008040
000343	310 FORMAT(1H0,60HLOW END EXTRAPOLATION CARD DOES NOT BEGIN WITH THE	00008050
000344	10R+ LOW.)	00008060
000345	GO TO 30	00008070
000346	315 DO 320 L=19,21	00008080
000347	LOEX=L-18	00008090
000348	320 IF(ITEM(3).EQ.LFNM(L)) IF(LOEX-2) 330,330,326	00008100
000349	WRITE(6,325)	00008110
000350	325 FORMAT(1H0,81HLOW END EXTRAPOLATION CARD DOES NOT CONTAIN ANY OF T	00008120
000351	HE WORDS E, SORTS OR THERMAL.)	00008130
000352	GO TO 30	00008140
000353	326 EKT=2.526E-8	00008150
000354	IF(YTEM(5).GT.1.0E-36) EKT=8.62E-11*(YTEM(5)+273.)	00008160
000355	330 READ(5,10) ALF	00008170
000356	WRITE(6,15) ALF	00008180
000357	CALL VIF(1,OK)	00008190
000358	IF(.NOT.OK) GO TO 30	00008200
000359	IF(ITEM(1).EQ.LFNM(22))GO TO 340	00008210
000360	WRITE(6,335)	00008220
000361	335 FORMAT(1H0,62HHHIGH END EXTRAPOLATION CARD DOES NOT BEGIN WITH THE	00008230
000362	1WORD HIGH.)	00008240
000363	GO TO 30	00008250
000364	340 DO 345 L=23,24	00008260
000365	LHIX=L-22	00008270
000366	345 IF(ITEM(3).EQ.LFNM(L))GO TO 355	00008280
000367	WRITE(6,350)	00008290
000368	350 FORMAT(1H0,63HHHIGH END EXTRAPOLATION CARD DOES NOT CONTAIN EITHER	00008300
000369	1OF THE WORDS FISSION OR FUSION.)	00008310
000370	GO TO 30	00008320
000371	C	00008330
000372	C READ AND WRITE NORMALIZATION CARD	00008340
000373	C	00008350
000374	355 READ(5,10) ALF	00008360
000375	WRITE(6,15) ALF	00008370
000376	CALL VIF(1,OK)	00008380
000377	IF(.NOT.OK) GO TO 30	00008390
000378	IF(ITEM(1).EQ.LFNM(25))GO TO 365	00008400
000379	WRITE(6,360)	00008410
000380	360 FORMAT(1H0,63HEENERGY OF NORMALIZATION CARD DOES NOT BEGIN WITH THE	00008420
000381	1 WORD NORM.)	00008430
000382	GO TO 30	00008440
000383	365 ENQR=YTEM(2)	00008450
000384	C	00008460
000385	C READ AND WRITE AUXILIARY OUTPUT CARD	00008470
000386	C	00008480
000387	READ(5,10) ALF	00008490

000388	WRITE(6,15) ALF	00008500
000389	CALL VIF(1,OK)	00008510
000390	IF(.NOT.OK) GO TO 30	00008520
000391	L=1	00008530
000392	370 DO 375 J=27,29	00008540
000393	LL=J	00008550
000394	IF(ITEM(L).EQ.LFNM(LL)) IF(LL-28) 390,410,425	00008560
000395	375 CONTINUE	00008570
000396	380 WRITE(6,385) L	00008580
000397	385 FORMAT(1H0,4HWORD,I2,66H ON AUXILIARY OUTPUT CARD IS NONE OF THE W	00008590
000398	1ORDS NO, PLOT, OR CARDS.)	00008600
000399	DFLT=.TRUE.	00008610
000400	GO TO 415	00008620
000401	390 L=L+1	00008630
000402	IF(ITEM(L).EQ.LFNM(28)) GO TO 405	00008640
000403	IF(ITEM(L).EQ.LFNM(29)) GO TO 420	00008650
000404	395 WRITE(6,400)	00008660
000405	400 FORMAT(1H0,90HTHE WORD NO ON AUXILIARY OUTPUT CARD IS NOT FOLLOWED	00008670
000406	1 BY EITHER OF THE WORDS PLOT OR CARDS.)	00008680
000407	DFLT=.TRUE.	00008690
000408	GO TO 415	00008700
000409	405 PLOT=.FALSE.	00008710
000410	410 FP=.TRUE.	00008720
000411	415 IF(L.GE.LAST) GO TO 430	00008730
000412	L=L+1	00008740
000413	GO TO 370	00008750
000414	420 CARDS=.FALSE.	00008760
000415	425 FC=.TRUE.	00008770
000416	L=L+1	00008780
000417	GO TO 415	00008790
000418	430 IF(.NOT.DFLT) IF(KIND-2) 450,470,470	00008800*NEW
000419	J=28	00008810*-1
000420	IF(FP) GO TO 445	00008820
000421	435 WRITE(6,440) LFNM(J)	00008830
000422	440 FORMAT(1H ,7HOUTPUT ,A4,20HS WILL BE FURNISHED.)	00008840
000423	445 IF(FC.OR.J.EQ.29) IF(KIND-2) 450,470,470	00008850*NEW
000424	J=29	00008860*-1
000425	GO TO 435	00008870
000426	C	00008880
000427	C READ AND WRITE SMOOTHING CARD	00008890
000428	C	00008900
000429	450 READ(5,10) ALF	00008910
000430	WRITE(6,15) ALF	00008920
000431	CALL VIF(1,OK)	00008930
000432	IF(.NOT.OK) GO TO 30	00008940
000433	IF(ITEM(1).EQ.LFNM(30)) GO TO 460	00008950
000434	WRITE(6,455)	00008960
000435	455 FORMAT(1H0,79HSMOOTHING CARD DOES NOT BEGIN WITH THE WORD SMOOTH.	00008970
000436	1 NO SMOOTHING WILL BE USED.)	00008980

000437	NS=1	00008990
000438	RETURN	00009000
000439	460 NS=YTEM(3)	00009010
000440	IF(NS.LE.75) RETURN	00009020
000441	NS = 75	00009030
000442	WRITE(6,465)	00009040
000443	465 FORMAT(1H0,106HSPECIFIED NUMBER OF POINTS FOR SMOOTHING EXCEEDS AL	00009050
000444	1LOWABLE MAXIMUM OF 75. 75-POINT SMOOTHING WILL BE USED.)	00009060
000445	470 RETURN	00009070*NEW
000446	END	00009080**-1

Q ELT VIF,1,680706, 53458

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000001      SUBROUTINE VIF(KOMA,OK)                                00009090
000002      C      SUBROUTINE VIF - DATA ITEM CONSTRUCTION FROM VARIABLE INPUT FORMAT 00009100
000003      DIMENSION ALF(80),ILF(80),ITEM(41),YTEM(41),KAR(48),IBD(47,4), 00009110
000004      1      PART(2),SIGN(2),KBLA(4),A(47),B(47),C(47),D(47)      00009120
000005      COMMON/RV/ALF,YTEM,LAST                                     00009130
000006      EQUIVALENCE (ALF,ILF),(YTEM,ITEM)                         00009140
000007      EQUIVALENCE (A,IBD(1,1)),(B,IBD(1,2)),(C,IBD(1,3)),(D,IBD(1,4)) 00009150
000008      LOGICAL DEC,NEW,ENEW,OK                                     00009160
000009      DATA (KAR(I),I=1,48)/                                     00009170
000010      1      1H,1H,,1H0,1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1H,,1H+, 00009180
000011      2      1H-,1HE,1HA,1HB,1HC,1HD,1HE,1HG,1HH,1HI,1HJ,1HK,1HL,1HM, 00009190
000012      3      1HN,1HO,1HP,1HQ,1HR,1HS,1HT,1HU,1HV,1HW,1HX,1HY,1HZ,1H/, 00009200
000013      4      1H(,1H),1H=,1H$,1H*,1H' / 00009210
000014      C                                                         00009220
000015      C**      EXPLANATION OF DATA(A(I),I=1,47)              00009230
000016      C**      ,      0      1      2                        00009240
000017      C**      3      4      5      6                        00009250
000018      C**      7      8      9      .                        00009260
000019      C**      +      -      E      A                        00009270
000020      C**      B      C      D      F                        00009280
000021      C**      G      H      I      J                        00009290
000022      C**      K      L      M      N                        00009300
000023      C**      O      P      Q      R                        00009310
000024      C**      S      T      U      V                        00009320
000025      C**      W      X      Y      Z                        00009330
000026      C**      /      (      )      =                        00009340
000027      C**      $      *      '                                00009350
000028      DATA(A(I),I=1,47)                                       00009360
000029      1/0560000000000,0600000000000,0610000000000,0620000000000, 00009370
000030      2 0630000000000,0640000000000,0650000000000,0660000000000, 00009380
000031      3 0670000000000,0700000000000,0710000000000,0750000000000, 00009390
000032      4 0420000000000,0410000000000,0120000000000,0060000000000, 00009400
000033      5 0070000000000,0100000000000,0110000000000,0130000000000, 00009410
000034      6 0140000000000,0150000000000,0160000000000,0170000000000, 00009420
000035      7 0200000000000,0210000000000,0220000000000,0230000000000, 00009430
000036      8 0240000000000,0250000000000,0260000000000,0270000000000, 00009440
000037      9 0300000000000,0310000000000,0320000000000,0330000000000, 00009450
000038      * 0340000000000,0350000000000,0360000000000,0370000000000, 00009460
000039      1 0740000000000,0510000000000,0400000000000,0440000000000, 00009470
000040      2 0470000000000,0500000000000,0720000000000 / 00009480
000041      DATA (B(I),I=1,47)                                       00009490
000042      1/0005600000000,0006000000000,0006100000000,0006200000000, 00009500
000043      2 0006300000000,0006400000000,0006500000000,0006600000000, 00009510
000044      3 0006700000000,0007000000000,0007100000000,0007500000000, 00009520

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4 000420000000,000410000000,000120000000,000060000000,
5 000070000000,000100000000,000110000000,000130000000,
6 000140000000,000150000000,000160000000,000170000000,
7 000200000000,000210000000,000220000000,000230000000,
8 000240000000,000250000000,000260000000,000270000000,
9 000300000000,000310000000,000320000000,000330000000,
* 000340000000,000350000000,000360000000,000370000000,
1 000740000000,000510000000,000400000000,000440000000,
2 000470000000,000500000000,000720000000
DATA( C(I),I=1,47)
1/000005600000,000006000000,000006100000,000006200000,
2 000006300000,000006400000,000006500000,000006600000,
3 000006700000,000007000000,000007100000,000007500000,
4 000004200000,000004100000,000001200000,000000600000,
5 000007000000,000001000000,000001100000,000001300000,
6 000001400000,000001500000,000001600000,000001700000,
7 000002000000,000002100000,000002200000,000002300000,
8 000002400000,000002500000,000002600000,000002700000,
9 000003000000,000003100000,000003200000,000003300000,
* 000003400000,000003500000,000003600000,000003700000,
1 000007400000,000005100000,000004000000,000004400000,
2 000004700000,000005000000,000007200000
DATA( D(I),I=1,47 )
1/000000560000,0000000600000,0000000610000,0000000620000,
2 0000000630000,0000000640000,0000000650000,0000000660000,
3 0000000670000,0000000700000,0000000710000,0000000750000,
4 0000000420000,0000000410000,0000000120000,0000000060000,
5 0000000070000,0000000100000,0000000110000,0000000130000,
6 0000000140000,0000000150000,0000000160000,0000000170000,
7 0000000200000,0000000210000,0000000220000,0000000230000,
8 0000000240000,0000000250000,0000000260000,0000000270000,
9 0000000300000,0000000310000,0000000320000,0000000330000,
* 0000000340000,0000000350000,0000000360000,0000000370000,
1 0000000740000,0000000510000,0000000400000,0000000440000,
2 0000000470000,0000000500000,0000000720000
DATA (KBLA(I),I=1,4)
1/ 0000505050505,0000005050505,00000005050505,0000000000505
```

INITIALIZE ALL DATA ITEMS

```
DO 1 JIT=1,41
1 YTEM(JIT)=0.
L=1
JIT=0
```

TEST WHETHER ITEM IS NUMERIC (FIRST CHARACTER
IS DIGIT, DECIMAL, OR SIGN), OR ALPHABETIC
(ANY OTHER FIRST CHARACTER) OR BLANK OR COMMA

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00009990
00010000
00010010

000094	5	DO 10 J=1,15	00010020
000095		JCH=J	00010030
000096	10	IF(ILF(L).EQ.KAR(JCH)) IF(JCH-2) 105,105,35	00010040
000097	C		00010050
000098	C	ALPHABETIC ITEM (WORD)	00010060
000099	C		00010070
000100		J1=16	00010080
000101	12	DO 30 KK=1,4	00010090
000102		KB=KK-1	00010100
000103	C		00010110
000104	C	DETERMINE KKTH CHARACTER	00010120
000105	C		00010130
000106		DO 15 J=J1,48	00010140
000107		JCH=J	00010150
000108	15	IF(ILF(L).EQ.KAR(JCH)) IF(JCH-2) 32, 21,25	00010160
000109	C		00010170
000110	C	WRITE ERROR MESSAGE FOR INSCRUTABLE CHARACTER	00010180
000111	C		00010190
000112		WRITE(6,20) L	00010200
000113	20	FORMAT(1H0,53HDATA CARD CONTAINS AN INSCRUTABLE CHARACTER IN COLUMN	00010210
000114		1N,13,1H.)	00010220
000115		OK=.FALSE.	00010230
000116		RETURN	00010240
000117	C		00010250
000118	C	CHECK WHETHER COMMA IS ADMISSIBLE CHARACTER OR SPACER	00010260
000119	C		00010270
000120	21	IF(KOMA-2)32,25,25	00010280
000121	C		00010290
000122	C	ADD CHARACTER TO KKTH POSITION IN WORD	00010300
000123	C		00010310
000124	25	JAD=JCH-1	00010320
000125		IF(KK.EQ.1) J1T=J1T+1	00010330
000126		ITEM(J1T)=ITEM(J1T)+IBD(JAD, KK)	00010340
000127	29	L=L+1	00010350
000128	30	J1=1	00010360
000129		KB=4	00010370
000130	32	ITEM(J1T)=ITEM(J1T) + KBLA(KB)	00010380
000131	34	IF(L.EQ.81) GO TO 110	00010390
000132		IF(ILF(L).EQ.KAR(1).OR.ILF(L).EQ.KAR(2).AND.KOMA.EQ.1) GO TO 105	00010400
000133		GO TO 12	00010410
000134	C		00010420
000135	C	NUMERIC ITEM (DATA VALUE)	00010430
000136	C		00010440
000137	35	J1T=J1T+1	00010450
000138	C		00010460
000139	C	INITIALIZE PARTS OF DATA ITEM, SIGNS, AND DECIMAL MULTIPLIER	00010470
000140	C		00010480
000141		DPL=0.	00010490
000142		DO 40 IP=1,2	00010500

000143		PART(IP)=0.	00010510
000144		40 SIGN(IP)=1.	00010520
000145	C		00010530
000146	C	FIRST PART OF DATA ITEM (SIGNIFICANT VALUE)	00010540
000147	C		00010550
000148		IP=1	00010560
000149	C		00010570
000150	C	INITIALIZE FLAGS FOR DECIMAL, NEW ITEM, AND NEW EXPONENT	00010580
000151	C		00010590
000152		DEC=,FALSE.	00010600
000153		NEW=,TRUE.	00010610
000154		45 ENER=,FALSE.	00010620
000155	C		00010630
000156	C	TEST WHETHER CHARACTER IS DIGIT, DECIMAL, SIGN, OR LETTER E	00010640
000157	C		00010650
000158		IF(JCH-13) 50,55,65	00010660
000159	C		00010670
000160	C	ADVANCE DECIMAL MULTIPLIER, IF DECIMAL IS FLAGGED	00010680
000161	C		00010690
000162		50 IF(DEC)DPL=DPL-1.	00010700
000163	C		00010710
000164	C	IDENTIFY DIGIT VALUE	00010720
000165	C		00010730
000166		VAL=JCH-3	00010740
000167	C		00010750
000168	C	ADD DIGIT TO SIGNIFICANT VALUE OR EXPONENT	00010760
000169	C		00010770
000170		PART(IP)=10.*PART(IP)+VAL	00010780
000171		GO TO 60	00010790
000172	C		00010800
000173	C	FLAG DECIMAL	00010810
000174	C		00010820
000175		55 DEC=,TRUE.	00010830
000176		60 IF(L-80)80,100,100	00010840
000177	C		00010850
000178	C	TEST WHETHER SIGN IS FOR SIGNIFICANT VALUE OR FOR EXPONENT	00010860
000179	C		00010870
000180		65 IF(NEW)GO TO 70	00010880
000181	C		00010890
000182	C	SECOND PART OF DATA ITEM (EXPONENT)	00010900
000183	C		00010910
000184		IP=2	00010920
000185	C		00010930
000186	C	STOP DECIMAL MULTIPLIER ADVANCE	00010940
000187	C		00010950
000188		DEC=,FALSE.	00010960
000189	C		00010970
000190	C	FLAG ENTRY INTO EXPONENT	00010980
000191	C		00010990

000192		ENEW=.TRUE.	00011000
000193	C		00011010
000194	C	TEST FOR NEGATIVE SIGNIFICANT VALUE OR NEGATIVE EXPONENT	00011020
000195	C		00011030
000196		70 IF(JCH.EQ.15) SIGN(IP)=-1	00011040
000197		IF(L.LT.80) GO TO 80	00011050
000198	C		00011060
000199	C	WRITE ERROR MESSAGE FOR ITEM ENDING WITH A SIGN OR THE LETTER E	00011070
000200	C		00011080
000201		WRITE(6,75) KAR(JCH)	00011090
000202		75 FORMAT(1H0,67HLAST DATA ITEM ON CARD ENDS IN LAST CARD COLUMN WITH	00011100
000203		1 THE CHARACTER ,A1,24H WHICH IS NOT PERMITTED.)	00011110
000204		OK=.FALSE.	00011120
000205		RETURN	00011130
000206	C		00011140
000207	C	FLAG ENTRY INTO ITEM	00011150
000208	C		00011160
000209		80 NEW=.FALSE.	00011170
000210	C		00011180
000211	C	ADVANCE TO NEXT CHARACTER	00011190
000212	C		00011200
000213		L=L+1	00011210
000214		DO 85 J=1,16	00011220
000215		JCH=J	00011230
000216	C		00011240
000217	C	DETERMINE WHETHER CHARACTER IS OR IS NOT A BLANK OR COMMA	00011250
000218	C		00011260
000219		85 IF(ILF(L).EQ.KAR(JCH)) IF(JCH-2) 95,100,45	00011270
000220	C		00011280
000221	C	WRITE ERROR MESSAGE FOR NUMERIC ITEM	00011290
000222	C	CONTAINING UNALLOWED CHARACTER	00011300
000223	C		00011310
000224		WRITE(6,90) L	00011320
000225		90 FORMAT(1H0,76HDATA CARD CONTAINS NUMERIC DATA ITEM WHICH INCLUDES	00011330
000226		1A CHARACTER OTHER THAN A/76H NUMERIC DIGIT, DECIMAL, SIGN, OR THE	00011340
000227		2LETTER E. THIS CHARACTER IS IN COLUMN,13,1H.)	00011350
000228		OK=.FALSE.	00011360
000229		RETURN	00011370
000230	C		00011380
000231	C	IF BLANK, TEST WHETHER END OF ITEM OR IMBEDDED	00011390
000232	C	IN EXPONENT IMMEDIATELY FOLLOWING LETTER E	00011400
000233	C		00011410
000234		95 IF(.NOT.ENEW) GO TO 100	00011420
000235	C		00011430
000236	C	CONTINUE, IF BLANK IMMEDIATELY FOLLOWS THE LETTER E	00011440
000237	C		00011450
000238		ENEW=.FALSE.	00011460
000239		GO TO 60	00011470
000240	C		00011480

000241	C	CALCULATE EXPONENT, INCLUDING DECIMAL MULTIPLIER	00011490
000242	C		00011500
000243		100 EXPO=SIGN(2)*PART(2)+DPL	00011510
000244	C		00011520
000245	C	CALCULATE VALUE OF NUMERIC DATA ITEM	00011530
000246	C		00011540
000247		YTEM(JIT)=SIGN(1)*PART(1)*10.**EXPO	00011550
000248	C		00011560
000249	C	TEST FOR END OF CARD	00011570
000250	C		00011580
000251		105 IF(L.EQ.80) GO TO 110	00011590
000252	C		00011600
000253	C	ADVANCE TO NEXT CHARACTER	00011610
000254	C		00011620
000255		L=L+1	00011630
000256		GO TO 5	00011640
000257	110	LAST=JIT	00011650
000258		OK=.TRUE.	00011660
000259		RETURN	00011670
000260		END	00011680

@ ELT SIGS,1,680706, 53466

000001		SUBROUTINE SIGS(OK)	00011690
000002	C	SUBROUTINE SIGS - SELECTION OF PERTINENT CROSS SECTIONS	00011700
000003		DIMENSION A(35),AIN(35),CNSC(35,3),E(621),EDEL(620),FACT(621),	00011710
000004		1 FOIL(35,2),ICOV(35,3),IREA(35,2),ONTP(35),REAC(35,2),SIG(620),	00011720
000005		2 FULN(35,4),WORD(4),CLAM(35),INCO(35,3),ATT(3,620)	00011730
000006	C		00011740
000007		COMMON E,M,MPL1,N	00011750
000008		COMMON /MSL/FOIL,ICOV	00011760
000009		COMMON /RSFI/EKT,LHIX,LOEX,J11	00011770
000010		COMMON /RS/AIN,CNSC,REAC,INCO	00011780
000011		COMMON /SL/ONTP	00011790
000012		COMMON /SC/SIG	00011800
000013		COMMON /MSG/FULN	00011810
000014		COMMON /MSLC/A	00011820
000015		COMMON /MSN/EDEL	00011830
000016		COMMON /SLC/CLAM	00011840
000017	C		00011850
000018		EQUIVALENCE (REAC,IREA),(TNAM,INAM),(UNAM,JNAM)	00011860
000019	C		00011870
000020		LOGICAL ONTP,OK	00011880
000021	C		00011890
000022	C	INITIALIZE FOUND FLAGS	00011900
000023	C		00011910
000024		DO 5 I=1,N	00011920
000025		5 ONTP(I)=.FALSE.	00011930
000026	C		00011940
000027	C	READ NUMBER OF TABULATED ENERGY POINTS FROM TAPE	00011950
000028	C		00011960
000029		READ (15)MPL1	00011970
000030		M=MPL1-1	00011980
000031	C		00011990
000032	C	READ ENERGY POINTS	00012000
000033	C		00012010
000034		READ (15)(E(J),J=1,MPL1)	00012020
000035	C		00012030
000036	C	READ ATTENUATING COVER CROSS SECTIONS	00012040
000037	C	(CD, B, AND RANDOM, IN THAT ORDER)	00012050
000038	C		00012060
000039		READ (15)NCOV	00012070
000040		DO 6 I=1,NCOV	00012080
000041		READ (15)DUMY	00012090
000042		6 READ (15)(ATT(I,J),J=1,M)	00012100
000043	C		00012110
000044	C	INITIALIZE FOUND FOIL COUNTING INDEX	00012120

000045	C		00012130
000046		NFND=0	00012140
000047	C		00012150
000048	C	READ NUMBER OF FOILS ON TAPE	00012160
000049	C		00012170
000050		READ (15)NLIB	00012180
000051	C		00012190
000052	C	EXAMINE FOILS ON TAPE IN ORDER	00012200
000053	C		00012210
000054		DO 70 ILIB=1,NLIB	00012220
000055		READ (15)INAM,UNAM,(WORD(L),L=1,4)	00012230
000056	C		00012240
000057	C	SEARCH INPUT FOILS FOR MATCH TO TAPE FOIL	00012250
000058	C		00012260
000059		IT=1	00012270
000060		7 DO 10 II=IT,N	00012280
000061		I=II	00012290
000062		10 IF (IPEA(I,1).EQ.INAM.AND.IREA(I,2).EQ.UNAM) GO TO 15	00012300
000063	C		00012310
000064	C	IF NO INPUT FOILS MATCH,	00012320
000065	C	READ PAST LAMBDA AND TAPE FOIL CROSS SECTION TABULATION	00012330
000066	C		00012340
000067		READ (15)DUMY	00012350
000068		READ (15)DUMY	00012360
000069		GO TO 70	00012370
000070	C		00012380
000071	C	IF INPUT FOIL MATCHES,	00012390
000072	C	READ LAMBDA AND CROSS SECTION TABULATION	00012400
000073	C		00012410
000074		15 NFND=NFND+1	00012420
000075		READ (15)CLAN(NFND)	00012430
000076		READ (15)(SIG(J),J=1,M)	00012440
000077	C		00012450
000078	C	CALCULATE ATTENUATION FACTORS	00012460
000079	C		00012470
000080		DO 20 J=1,M	00012480
000081	20	FACT(J)=0.	00012490
000082		DO 30 L=1,NCOV	00012500
000083		IF (INCO(I,L).EQ.1) GO TO 60	00012510
000084		IGO=INCO(I,L)-1	00012520
000085		DO 30 J=1,M	00012530
000086	30	FACT(J)=FACT(J)-CNSC(I,L)*ATT(IGO,J)	00012540
000087	C		00012550
000088	C	CORRECT CROSS SECTION VALUES FOR ATTENUATION	00012560
000089	C		00012570
000090		60 DO 65 J=1,M	00012580
000091		65 SIG(J)=SIG(J)*EXP(FACT(J))	00012590
000092	C		00012600
000093	C	STORE CROSS SECTION VALUES ON SCRATCH TAPE	00012610

000094	C		00012620
000095		WRITE (11)(SIG(J),J=1,M)	00012630
000096	C		00012640
000097	C	FLAG FOUND FOIL	00012650
000098	C		00012660
000099	C	ONTP(I)=.TRUE.	00012670
000100	C		00012680
000101	C	REARRANGE INPUT FOIL ORDER TO MATCH TAPE ORDER	00012690
000102	C		00012700
000103		FOIL(NFND,1)=REAC(I,1)	00012710
000104		FOIL(NFND,2)=REAC(I,2)	00012720
000105		A(NFND)=AIN(I)	00012730
000106		DO 66 L=1,4	00012740
000107	66	FULN(NFND,L)=WORD(L)	00012750
000108		DO 67 L=1,3	00012760
000109	67	ICOV(NFND,L)=INCO(I,L)	00012770
000110		IF(NFND.EQ.N) GO TO 90	00012780
000111		IF(I.EQ.N) GO TO 70	00012790
000112	C		00012800
000113	C	RESUME SEARCH FOR DUPLICATE INPUT FOILS TO MATCH SAME TAPE FOIL	00012810
000114	C		00012820
000115		IT=I+1	00012830
000116		BACKSPACE 15	00012840
000117		BACKSPACE 15	00012850
000118		GO TO 7	00012860
000119	70	CONTINUE	00012870
000120	C		00012880
000121	C	WRITE MESSAGE FOR FOILS NOT FOUND ON TAPE	00012890
000122	C		00012900
000123		NO=0	00012910
000124		DO 80 I=1,N	00012920
000125		IF(ONTP(I)) GO TO 80	00012930
000126		WRITE(6,75) REAC(I,1),REAC(I,2)	00012940
000127	75	FORMAT(1H0,10HFOIL NAME ,A4,A2,30H IS NOT ON CROSS SECTION TAPE.)	00012950
000128		NO=NO+1	00012960
000129	80	IF(NO.EQ.N-NFND) GO TO 85	00012970
000130	85	REWIND 15	00012980
000131		REWIND 11	00012990
000132	C		00013000
000133	C	RETURN TO TERMINATE CASE AND BEGIN SEARCH FOR NEXT CASE	00013010
000134	C		00013020
000135		OK=.FALSE.	00013030
000136		RETURN	00013040
000137	90	REWIND 15	00013050
000138		REWIND 11	00013060
000139	C		00013070
000140	C	FIND AND LABEL ENERGY POINT AT OR CLOSEST TO 11 MEV,	00013080
000141	C	FOR SUBSEQUENT USE IN FUSION EXTRAPOLATION	00013090
000142	C		00013100

000143	IF(LHIX.EQ.1) GO TO 110	00013110
000144	DO 95 J=1, PL1	00013120
000145	JJ=J	00013130
000146	IF(E(J)-11.) 95,100,105	00013140
000147	95 CONTINUE	00013150
000148	100 J11=JJ	00013160
000149	GO TO 110	00013170
000150	105 IF(E(JJ)-11..LT.11.-E(JJ-1)) GO TO 100	00013180
000151	J11=JJ-1	00013190
000152	C	00013200
000153	C CALCULATE ENERGY INTERVALS FOR USE IN SUBSEQUENT	00013210
000154	C ACTIVITY AND SPECTRUM INTEGRATIONS	00013220
000155	C	00013230
000156	110 DO 115 J=1,M	00013240
000157	115 EDEL(J)=E(J+1)-E(J)	00013250
000158	OK=,TRUE.	00013260
000159	RETURN	00013270
000160	END	00013280

ELT LIBR,1,680706, 53474

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000001		SUBROUTINE LIBR(OK)	00013290
000002	C	SUBROUTINE LIBR - SPECTRUM LIBRARY SEARCH FOR FIRST APPROXIMATION	00013300
000003		DIMENSION A(35),ACAL(35,75),BAD(35),FC(35),ONTP(35),SNAM(20),	00013310
000004		1 E(621),ATF(75,4),PFIR(621),FOIL(35,2),IFOI(35,2),JFOI(35,2),	00013320
000005		2 RFOI(35,2),ICOV(35,3),CLAM(35),XDUM(160)	00013330
000006	C		00013340
000007		COMMON E,M,NPL1,N	00013350
000008		COMMON /MSL/FOIL,ICOV	00013360
000009		COMMON /MLCI/BAD,FC,NDIS	00013370
000010		COMMON /RL/ NFIR	00013380
000011		COMMON /SL/ONTP	00013390
000012		COMMON /MSLC/A	00013400
000013		COMMON /MRLNCG/KIND,TINT	00013410
000014		COMMON /SLC/CLAM	00013420
000015		COMMON /MLF/PFIR	00013430
000016		COMMON /MLN/ACAL,ATF,SNAM,XDUM	00013440
000017	C		00013450
000018		EQUIVALENCE (FOIL,IFOI),(RFOI,JFOI),(RNM1,INM1),(RNM2,INM2)	00013460
000019	C		00013470
000020		LOGICAL BAD,ONTP,TINT,PIK,OK	00013480
000021	C		00013490
000022	C	READ NUMBER OF REFERENCE SPECTRA AND	00013500
000023	C	NUMBER OF FOILS FROM LIBRARY TAPE	00013510
000024	C		00013520
000025		READ (18)KREF	00013530
000026		IF(NFIR.LE.KREF.AND.NFIR.GE.0) GO TO 4	00013540
000027		WRITE(6,3) NFIR,KREF	00013550
000028		3 FORMAT(1H0,36H SPECIFIED REFERENCE SPECTRUM NUMBER,,I4,51H,IS NOT W	00013560
000029		1ITHIN THE RANGE OF LIBRARY NUMBERS (1 THRU,I4,2H).)	00013570
000030		REWIND 18	00013580
000031		OK=.FALSE.	00013590
000032		RETURN	00013600
000033		4 READ (18)NREF	00013610
000034	C		00013620
000035	C	READ FOIL NAMES FROM LIBRARY TAPE	00013630
000036	C	AND TEST FOR CORRECT FOIL INPUTS	00013640
000037	C		00013650
000038		READ (18)(RFOI(L,1),RFOI(L,2),L=1,NREF)	00013660
000039		IF(NFIR.NE.0) GO TO 96	00013670
000040		DO 15 I=1,N	00013680
000041		DO 5 L=1,NREF	00013690
000042		5 IF(IFOI(I,1).EQ.JFOI(L,1).AND.IFOI(I,2).EQ.JFOI(L,2))GO TO 15	00013700
000043		WRITE(6,10) FOIL(I,1),FOIL(I,2)	00013710
000044		10 FORMAT(1H0,10HFOIL NAME ,A4,A2,42H IS NOT ON REFERENCE SPECTRA LIB	00013720

000045		1RARY TAPE.)	00013730
000046		REWIND 18	00013740
000047		OK=.FALSE.	00013750
000048		RETURN	00013760
000049		15 CONTINUE	00013770
000050	C		00013780
000051	C	INITIALIZE FOUND FOIL FLAGS	00013790
000052	C		00013800
000053		DO 20 I=1,N	00013810
000054		20 ONTP(I)=.FALSE.	00013820
000055	C		00013830
000056	C	SEARCH FOR AND READ PERTINENT FOIL	00013840
000057	C	ACTIVITIES FOR ALL REFERENCE SPECTRA	00013850
000058	C		00013860
000059		25 DO 45 L=1,NREF	00013870
000060		READ (18)RNM1,RNM2	00013880
000061		DO 30 II=1,N	00013890
000062		I=II	00013900
000063		IF(BAD(I).OR.ONTTP(I)) GO TO 30	00013910
000064		IF(IFOI(I,1).EQ.INM1.AND.IFOI(I,2).EQ.INM2) GO TO 33	00013920
000065		30 CONTINUE	00013930
000066		READ (18)DUMY	00013940
000067		GO TO 45	00013950
000068		33 ONTP(I)=.TRUE.	00013960
000069		READ (18)((ATF(KK,JJ),JJ=1,4),KK=1,KREF)	00013970
000070		IF(.NOT.TINT) GO TO 35	00013980
000071		DO 34 KK=1,KREF	00013990
000072		DO 34 JJ=1,4	00014000
000073		34 ATF(KK,JJ)=ATF(KK,JJ)*CLAM(I)	00014010
000074		35 DO 36 KK=1,KREF	00014020
000075		36 ACAL(I,KK)=ATF(KK,1)	00014030
000076		DO 38 J=1,3	00014040
000077		IF(ICOV(I,J).EQ.1) GO TO 39	00014050
000078		JJ=ICOV(I,J)	00014060
000079		DO 38 KK=1,KREF	00014070
000080		38 ACAL(I,KK)=AMIN1(ACAL(I,KK),ATF(KK,JJ))	00014080
000081		39 DO 40 I=1,N	00014090
000082		40 IF(.NOT.BAD(I).AND..NOT.ONTTP(I)) GO TO 45	00014100
000083		REWIND 18	00014110
000084		READ (18)NDUM	00014120
000085		READ (18)NDUM	00014130
000086		READ (18)DUMY	00014140
000087		GO TO 60	00014150
000088		45 CONTINUE	00014160
000089	C		00014170
000090	C	TEST WHETHER ALL FOILS WERE FOUND BY LAST TAPE PASS	00014180
000091	C		00014190
000092		REWIND 18	00014200
000093		READ (18)NDUM	00014210

000143	82 IF (ACAL(I,KK).LT.1.0E-36.OR.ACAL(I,KK).EQ.0.0) GO TO 85	00014710
000144	KPIK=KK	00014720
000145	STOV=SREF	00014730
000146	PIK=.TRUE.	00014740
000147	85 CONTINUE	00014750
000148		00014760
000149	C WRITE NUMBER AND IDENTIFYING TITLE OF SELECTED SPECTRUM,	00014770
000150	C AND READ SPECTRUM FLUX VALUES FROM LIBRARY TAPE	00014780
000151	C	00014790
000152	WRITE(6,95) KPIK	00014800
000153	95 FORMAT(1H0,10X,72HTHE SPECTRUM SELECTED AS THE BEST FIRST APPROXIM	00014810
000154	ATION IS LIBRARY NUMBER ,I3,2H -)	00014820
000155	GO TO 98	00014830
000156	96 KPIK=NFIR	00014840
000157	WRITE(6,97) KPIK	00014850
000158	97 FORMAT(1H0,44HSPECIFIED REFERENCE SPECTRUM, LIBRARY NUMBER,I4,1H-)	00014860
000159	98 DO 99 L=1,NREF	00014870
000160	READ (18)DUMY	00014880
000161	99 READ (18)DUMY	00014890
000162	IF(KPIK.EQ.1) GO TO 105	00014900
000163	KPM1=KPIK-1	00014910
000164	DO 100 L=1,KPM1	00014920
000165	READ (18)DUMY	00014930
000166	100 READ (18)NDUM	00014940
000167	105 READ (18)(SNAM(L),L=1,20)	00014950
000168	WRITE(6,110) (SNAM(L),L=1,20)	00014960
000169	110 FORMAT(1H ,20X,20(A4))	00014970
000170	READ (18)(PFIR(J),J=1,MPL1)	00014980
000171	REWIND 18	00014990
000172	OK=.TRUE.	00015000
000173	RETURN	00015010
000174	END	00015020

W ELT FAPT,1,680706, 53481

000001		SUBROUTINE FAPT	00015030
000002	C	SUBROUTINE FAPT - FIRST APPROXIMATION SPECTRUM FROM TABULAR INPUT	00015040
000003		DIMENSION E(621),ENER(200),FLUX(200),PFIR(621)	00015050
000004	C		00015060
000005		COMMON E,M,NPL1,N	00015070
000006		COMMON /MLF/PFIR	00015080
000007		COMMON /RSFI/EKT,LHIX,LOEX,J11	00015090
000008		COMMON /RF/ENER,FLUX,NIN	00015100
000009	C		00015110
000010	C	TEST WHETHER LOW END EXTRAPOLATION IS REQUIRED	00015120
000011	C		00015130
000012		IF(E(1)-ENER(1)) 5,50,55	00015140
000013	C	LOW END EXTRAPOLATION	00015150
000014		5 IF(LOEX-2) 10,20,30	00015160
000015	C	E EXTRAPOLATION	00015170
000016		10 FRAC=FLUX(1)/ENER(1)	00015180
000017		DO 15 J=1,M	00015190
000018		JJ=J	00015200
000019		IF(E(J)-ENER(1)) 15,37,40	00015210
000020		15 PFIR(J)=FRAC*E(J)	00015220
000021		RETURN	00015230
000022	C	SQRTE EXTRAPOLATION	00015240
000023		20 FRAC=FLUX(1)/SQRT(ENER(1))	00015250
000024		DO 25 J=1,M	00015260
000025		JJ=J	00015270
000026		IF(E(J)-ENER(1)) 25,37,40	00015280
000027		25 PFIR(J)=FRAC*SQRT(E(J))	00015290
000028		RETURN	00015300
000029	C	THERMAL EXTRAPOLATION	00015310
000030		30 EMAT=2.*EKT	00015320
000031		IF(.NOT.ENER(1).GT.EMAT) GO TO 35	00015330
000032		PROD=FLUX(1)*ENER(1)	00015340
000033		CMAX=1.8473*PROD/EKT**2	00015350
000034		DO 32 J=1,M	00015360
000035		L1=J	00015370
000036		IF(E(J)-ENER(1)) 31,37,40	00015380
000037		31 IF(.NOT.E(J).LT.EMAT) GO TO 33	00015390
000038		32 PFIR(J)=CMAX*E(J)*EXP(-E(J)/EKT)	00015400
000039		RETURN	00015410
000040		33 DO 34 J=L1,M	00015420
000041		JJ=J	00015430
000042		IF(E(J)-ENER(1)) 34,37,40	00015440
000043		34 PFIR(J)=PROD/E(J)	00015450
000044		RETURN	00015460

000045	35	C	C	MAX=FLUX(1)*EXP(ENER(1)/EKT)/ENER(1)	00015470
000046				DO 36 J=1,M	00015480
000047				JJ=J	00015490
000048				IF(E(J)-ENER(1)) 36,37,40	00015500
000049	36			PFIR(J)=C*E(J)*EXP(-E(J)/EKT)	00015510
000050				RETURN	00015520
000051	37			PFIR(JJ)=FLUX(1)	00015530
000052				IF(JJ.EQ.M) RETURN	00015540
000053				LIM1=JJ+1	00015550
000054				GO TO 45	00015560
000055	40			LIM1=JJ	00015570
000056	45			IF(NIN.EQ.1) GO TO 89	00015580
000057				GO TO 60	00015590
000058		C			00015600
000059		C		LOGLOG INTERPOLATION	00015610
000060		C			00015620
000061	50			PFIR(1)=FLUX(1)	00015630
000062				LIM1=2	00015640
000063				GO TO 60	00015650
000064	55			LIM1=1	00015660
000065	60			DO 85 L=2,NIN	00015670
000066				IF(FLUX(L-1).LT.1.0E-36.OR.FLUX(L).LT.1.0E-36.OR.	00015680
000067	1			FLUX(L-1).EQ.0.0 .OR.FLUX(L).EQ.0.0) GO TO 71	00015690
000068				X1=ALOG(ENER(L-1))	00015700
000069				Y1=ALOG(FLUX(L-1))	00015710
000070				SLOP=(ALOG(FLUX(L))-Y1)/(ALOG(ENER(L))-X1)	00015720
000071				DO 70 J=LIM1,M	00015730
000072				JJ=J	00015740
000073				IF(E(J)-ENER(L)) 65,75,80	00015750
000074	65			X=ALOG(E(J))	00015760
000075				Y=Y1+SLOP*(X-X1)	00015770
000076	70			PFIR(J)=EXP(Y)	00015780
000077				RETURN	00015790
000078	71			SLOP=(FLUX(L)-FLUX(L-1))/(ENER(L)-ENER(L-1))	00015800
000079				DO 73 J=LIM1,M	00015810
000080				JJ=J	00015820
000081				IF(E(J)-ENER(L)) 73,75,80	00015830
000082	73			PFIR(J)=FLUX(L-1)+(E(J)-ENER(L-1))*SLOP	00015840
000083				RETURN	00015850
000084	75			PFIR(JJ)=FLUX(L)	00015860
000085				IF(JJ.EQ.M) RETURN	00015870
000086				LIM1=JJ+1	00015880
000087				GO TO 85	00015890
000088	80			LIM1=JJ	00015900
000089	85			CONTINUE	00015910
000090		C			00015920
000091		C		HIGH END EXTRAPOLATION	00015930
000092		C			00015940
000093	89			E1=ENER(NIN)	00015950

000094	F1=FLUX(NIN)	00015960
000095	IF(LHIX.EQ.2) GO TO 105	00015970
000096	C	00015980
000097	C	00015990
000098	C	00016000
000099	LIM2=M	00016010
000100	95 DEN=SQRT(E1)*EXP(-.776*E1)	00016020
000101	F1=F1/DEN	00016030
000102	DO 100 J=LIM1,LIM2	00016040
000103	100 PFIR(J)=F1*SQRT(E(J))*EXP(-.776*E(J))	00016050
000104	IF(LIM2.EQ.M) RETURN	00016060
000105	LIM1=J11+1	00016070
000106	E1=E(J11)	00016080
000107	F1=PFIR(J11)	00016090
000108	GO TO 115	00016100
000109	C	00016110
000110	C	00016120
000111	C	00016130
000112	105 IF(.NOT.E1.LT.E(J11)) GO TO 110	00016140
000113	C	00016150
000114	C	00016160
000115	C	00016170
000116	LIM2=J11	00016180
000117	GO TO 95	00016190
000118	C	00016200
000119	C	00016210
000120	C	00016220
000121	110 IF(E1-14.)115,120,125	00016230
000122	115 FEX=(14.-E1)**2	00016240
000123	FJ1=(2.+4.*FEX)/(2.+FEX)	00016250
000124	GO TO 130	00016260
000125	120 FJ1=1.	00016270
000126	GO TO 130	00016280
000127	125 FEX=2.+4.*(E1-14.)	00016290
000128	FJ1=1.+(E1-14.)*FEX	00016300
000129	130 F1=F1*FJ1	00016310
000130	DO 150 J=LIM1,M	00016320
000131	IF(E(J)-14.)135,140,145	00016330
000132	135 FEX=(14.-E(J))**2	00016340
000133	PFIR(J)=F1*(2.+FEX)/(2.+4.*FEX)	00016350
000134	GO TO 150	00016360
000135	140 PFIR(J)=F1	00016370
000136	GO TO 150	00016380
000137	145 FEX=2.+4.*(E(J)-14.)	00016390
000138	PFIR(J)=F1/(1.+(E(J)-14.)*FEX)	00016400
000139	150 CONTINUE	00016410
000140	RETURN	00016420
000141	END	00016430

3 ELT NORM,1,660706, 53487

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000001		SUBROUTINE NORM	00016440
000002	C	SUBROUTINE NORM - SPECTRUM INTEGRATION AND NORMALIZATION	00016450
000003		DIMENSION E(621),EDEL(620),PSI(621), SOLN(621),ASOL(621),	00016460
000004		1 SADD(620),APSI(621),YDUM(1242)	00016470
000005	C		00016480
000006		COMMON E,M,MPL1,N	00016490
000007		COMMON /MRLNCG/KIND,TINT	00016500
000008		COMMON /MRN/ENOR	00016510
000009		COMMON /MNIG/PSI,K,JLZ,JHZ	00016520
000010		COMMON /MLN/APSI,YDUM,SOLN,ASOL	00016530
000011		COMMON /NC/SADD	00016540
000012		COMMON /MSN/EDEL	00016550
000013	C		00016560
000014	C	CALCULATE INTEGRAL SPECTRUM	00016570
000015	C		00016580
000016		DO 10 MINJ=1,M	00016590
000017		J=MPL1-MINJ	00016600
000018		SADD(J)=PSI(J)*EDEL(J)	00016610
000019	10	SOLN(J)=SOLN(J+1)+SADD(J)	00016620
000020		IF(KIND.EQ.2.OR.K.EQ.0) GO TO 25	00016630
000021		IF(JNOR-1) 50,50,95	00016640
000022	C		00016650
000023	C	FIND INDEX OF NORMALIZING ENERGY	00016660
000024	C		00016670
000025	25	IF(1.00001*ENOR-E(1)) 35,45,30	00016680
000026	30	IF(E(MPL1)-ENOR)35,55,65	00016690
000027	35	WRITE(6,40)	00016700
000028	40	FORMAT(1H0,98HSPECIFIED ENERGY TO WHICH SPECTRUM IS TO BE NORMALIZED	00016710
000029	1E	IS NOT WITHIN RANGE OF PROGRAMMED ENERGIES./57H SPECTRUM WILL BE	00016720
000030	2E	NORMALIZED TO LOWEST PROGRAMMED ENERGY.)	00016730
000031	45	ENOR=E(1)	00016740
000032		JNOR=1	00016750
000033	50	SNOR=SOLN(1)	00016760
000034		IF(KIND-1) 115,115,105	00016770
000035	55	WRITE(6,60)	00016780
000036	60	FORMAT(1H0,100HSPECTRUM CANNOT BE NORMALIZED TO FLUX ABOVE HIGHEST	00016790
000037	1	ENERGY (ARBITRARILY TAKEN TO BE 0) AS SPECIFIED./57H SPECTRUM WILL	00016800
000038	2L	BE NORMALIZED TO LOWEST PROGRAMMED ENERGY.)	00016810
000039		GO TO 45	00016820
000040	65	DO 70 J=2,MPL1	00016830
000041		JNOR=J	00016840
000042		IF(E(J).GT.ENOR) GO TO 95	00016850
000043	70	CONTINUE	00016860
000044	C		00016870

000045	C	INTERPOLATION FORMULA	00016880
000046	C		00016890
000047		95 ADD=PSI(JNOR-1)*(E(JNOR)-ENOR)	00016900
000048		SNOR=SOLN(JNOR)+ADD	00016910
000049		IF(KIND.EQ.1) GO TO 115	00016920
000050	C		00016930
000051	C	IF ACTIVITY RUN, STORE ABSOLUTE INPUT SPECTRUM	00016940
000052	C		00016950
000053		105 DO 110 J=1,M	00016960
000054		APSI(J)=PSI(J)	00016970
000055		110 ASOL(J)=SOLN(J)	00016980
000056	C		00016990
000057	C	NORMALIZE SPECTRUM	00017000
000058	C		00017010
000059		115 DO 120 J=1,M	00017020
000060		SADD(J)=SADD(J)/SNOR	00017030
000061		PSI(J)=PSI(J)/SNOR	00017040
000062		120 SOLN(J)=SOLN(J)/SNOR	00017050
000063		RETURN	00017060
000064		END	00017070

0 ELT CALC,1,680706, 53496

000001		SUBROUTINE CALC	00017080
000002	C	SUBROUTINE CALC - CALCULATION OF ACTIVITIES AND RELATED PARAMETERS	00017090
000003		DIMENSION A(35),AC(35),BAD(35),DEV(35),E(621),FC(35),JHI(35),	00017100
000004		1 JLO(35),OVER(35),SENS(620),SIG(620),UNDR(35),WSUM(620),CLAM(35),	00017110
000005		2 SADD(620)	00017120
000006	C		00017130
000007		COMMON E,M,NPL1,N	00017140
000008		COMMON /MRLNCG/KIND,TINT	00017150
000009		COMMON /MLCI/BAD,FC,NOIS	00017160
000010		COMMON /MCW/AC	00017170
000011		COMMON /MC/DEV,F,OVER,STEM,TAIL,UNDR	00017180
000012		COMMON /MCG/JHI,JLO	00017190
000013		COMMON /SC/SIG	00017200
000014		COMMON /CWI/SENS,WSUM,IR	00017210
000015		COMMON /NC/SADD	00017220
000016		COMMON /MSLC/A	00017230
000017		COMMON /SLC/CLAM	00017240
000018	C		00017250
000019		LOGICAL BAD,TINT	00017260
000020	C		00017270
000021	C	ASSIGN DESIRED VALUE, IN UNITS OF PERCENT,	00017280
000022	C	TO SENSITIVITY CURVE CUTOFF LIMITS	00017290
000023	C		00017300
000024		TAIL=5.	00017310
000025	C		00017320
000026		IF(KIND.EQ.2) GO TO 7	00017330
000027		F=C.	00017340
000028		DO 5 J=1,M	00017350
000029		5 WSUM(J)=0.	00017360
000030	C		00017370
000031	C	CALCULATE ACTIVITY FOR EACH FOIL	00017380
000032	C		00017390
000033		7 DO 85 IR=1,N	00017400
000034	C		00017410
000035	C	READ CROSS SECTIONS FOR ITH FOIL FROM SCRATCH TAPE	00017420
000036	C		00017430
000037		READ (11)(SIG(J),J=1,M)	00017440
000038	C		00017450
000039	C	TEST WHETHER FOIL HAS BEEN DISCARDED IN PREVIOUS SOLUTION	00017460
000040	C		00017470
000041		IF(BAD(IR))GO TO 85	00017480
000042		AC(IR)=0.	00017490
000043		DO 35 J=1,M	00017500
000044		SENS(J)=SADD(J)*SIG(J)	00017510

000045	35	AC(IR)=AC(IR)+SENS(J)	00017520
000046	C		00017530
000047	C	FIND SENSITIVITY CURVE CUTOFF LIMITS	00017540
000048	C		00017550
000049		OSUM=0.	00017560
000050		CHOP=TAIL*AC(IR)*.01	00017570
000051		DO 40 J=1,M	00017580
000052		JJ=J	00017590
000053		O=OSUM+SENS(J)	00017600
000054		IF(O-CHOP)40,45,50	00017610
000055	40	OSUM=O	00017620
000056	45	UNDR(IR)=O/AC(IR)	00017630
000057		JLO(IR)=JJ+1	00017640
000058		GO TO 55	00017650
000059	50	IF(O-CHOP.LT.CHOP-OSUM) GO TO 45	00017660
000060		UNDR(IR)=OSUM/AC(IR)	00017670
000061		JLO(IR)=JJ	00017680
000062	55	OSUM=0.	00017690
000063		DO 60 MINJ=1,M	00017700
000064		JJ=MPL1-MINJ	00017710
000065		O=OSUM+SENS(JJ)	00017720
000066		IF(O-CHOP)60,65,70	00017730
000067	60	OSUM=O	00017740
000068	65	OVER(IR)=O/AC(IR)	00017750
000069		JHI(IR)=JJ	00017760
000070		IF(KIND-2) 80,82,82	00017770
000071	70	IF(O-CHOP.LT.CHOP-OSUM) GO TO 65	00017780
000072		OVER(IR)=OSUM/AC(IR)	00017790
000073		JHI(IR)=JJ+1	00017800
000074		IF(KIND.EQ.2) GO TO 82	00017810
000075	80	CALL WATE	00017820
000076	82	IF(TINT) AC(IR)= AC(IR)*CLAM(IR)	00017830
000077		AC(IR)=AC(IR)*1.0E-24	00017840
000078	85	CONTINUE	00017850
000079	C		00017860
000080	C	REWIND CROSS SECTION AND CORRECTION WEIGHTING SCRATCH TAPES	00017870
000081	C		00017880
000082		REWIND 11	00017890
000083		IF(KIND.EQ.2) RETURN	00017900
000084		REWIND 14	00017910
000085	C		00017920
000086	C	CALCULATE INDIVIDUAL RATIOS AND TOTAL FLUX	00017930
000087	C		00017940
000088		STEM=0.	00017950
000089		DO 90 I=1,N	00017960
000090		IF(BAD(I)) GO TO 90	00017970
000091		FC(I)=A(I)/AC(I)	00017980
000092		F=F+FC(I)	00017990
000093	90	CONTINUE	00018000

000094		F=F/FLOAT(N-NDIS)	00018010
000095	C		00018020
000096	C	CALCULATE ABSOLUTE ACTIVITIES,	00018030
000097	C	INDIVIDUAL FOIL DEVIATIONS, AND STANDARD DEVIATION	00018040
000098	C		00018050
000099		DO 95 I=1,N	00018060
000100		IF(BAD(I)) GO TO 95	00018070
000101		AC(I)=AC(I)*F	00018080
000102		FC(I)=FC(I)/F	00018090
000103		DEV(I)=FC(I)-1.	00018100
000104		STEM=STEM+DEV(I)*DEV(I)	00018110
000105	95	CONTINUE	00018120
000106		DEGF=N-NDIS-1	00018130
000107		STEM=SQRT(STEM/DEGF)	00018140
000108		RETURN	00018150
000109		END	00018160

Q ELT WATE,1,680706, 53503

000001		SUBROUTINE WATE	00018170
000002	C	SUBROUTINE WATE - ITERATIVE CORRECTION FOIL WEIGHTING FUNCTIONS	00018180
000003	C		00018190
000004		DIMENSION E(621),SENS(620),AC(35),WSUM(620)	00018200
000005		DIMENSION TEMP(39)	00018210
000006	C		00018220
000007		COMMON E,M,MPL1,N	00018230
000008		COMMON /MCW/AC	00018240
000009		COMMON /CWI/SENS,WSUM,IR	00018250
000010		COMMON/RW/NS	00018260
000011	C		00018270
000012	C	NORMALIZE WEIGHTING FUNCTION TO TOTAL ACTIVITY	00018280
000013	C		00018290
000014		DO 10 J=1,M	00018300
000015		10 SENS(J)=SENS(J)/AC(IR)	00018310
000016	C		00018320
000017	C	SMOOTH BY LINEAR NS-POINT LEAST SQUARES MOVING AVERAGES	00018330
000018	C		00018340
000019	C	(SMOOTH FIRST AND LAST (NS-1)/2 POINTS)	00018350
000020	C		00018360
000021		IF(NS.LE.1) GO TO 25	00018370
000022		NSIDE=NS/2	00018380
000023		NMID=NSIDE+1	00018390
000024		TEMP(1) = (5.*SENS(1)+2.*SENS(2)-SENS(3))/6.	00018400
000025		IF(TEMP(1).LT.0.) TEMP(1) = 0.	00018410
000026		SUM = SENS(1)	00018420
000027		DEN = 1.	00018430
000028		DO 12 J=2,NMID	00018440
000029		IS = J+J-2	00018450
000030		SUM = SUM + SENS(IS) + SENS(IS+1)	00018460
000031		DEN = DEN +2.	00018470
000032		12 TEMP(J) = SUM/DEN	00018480
000033	C		00018490
000034	C	(SMOOTH CENTRAL RANGE, LAGGING STORAGE BY (NS-1/2))	00018500
000035	C		00018510
000036		L1 = NMID+1	00018520
000037		L2 = M-NSIDE	00018530
000038		DO 15 J=L1,L2	00018540
000039		SUM = SUM - SENS(J-NMID) + SENS(J+NSIDE)	00018550
000040		TEMP(L1) = SUM/DEN	00018560
000041		SENS(J-NMID) = TEMP(1)	00018570
000042		DO 15 JT=1,NMID	00018580
000043		15 TEMP(JT) = TEMP(JT +1)	00018590
000044	C		00018600

000045	C	(STORE LAST (NS-1/2) SMOOTHED VALUES)	00018610
000046	C		00018620
000047		L2 = L2 + 1	00018630
000048		L3 = M-1	00018640
000049		DO 20 J=L2,L3	00018650
000050		IS = J+J-M-2	00018660
000051		SUM = SUM - SENS(IS) - SENS(IS+1)	00018670
000052		DEN = DEN - 2.	00018680
000053		TEMP(L1) = SUM/DEN	00018690
000054		L1 = L1 - 1	00018700
000055		SENS(IS) = TEMP(1)	00018710
000056		SENS(IS+1) = TEMP(2)	00018720
000057		NMID = NMID-1	00018730
000058		DO 20 JT=1,NMID	00018740
000059	20	TEMP(JT) = TEMP(JT+2)	00018750
000060		SENS(M) = (5.*SENS(M)+2.*SENS(M-1)-SENS(M-2))/6.	00018760
000061		IF(SENS(M),LT,0.) SENS(M) = 0.	00018770
000062		SENS(M-2) = TEMP(1)	00018780
000063		SENS(M-1) = TEMP(2)	00018790
000064	C		00018800
000065	C	WRITE WEIGHTING FUNCTION VALUES ON SCRATCH TAPE	00018810
000066	C		00018820
000067	25	WRITE (14)(SENS(J),J=1,M)	00018830
000068	C		00018840
000069	C	KEEP RUNNING SUM OF WEIGHTING VALUES AT EACH ENERGY	00018850
000070	C		00018860
000071		DO 30 J=1,M	00018870
000072	30	WSUM(J)=WSUM(J)+SENS(J)	00018880
000073		RETURN	00018890
000074		END	00018900

ELT ITER,1,680706, 53513

000001		SUBROUTINE ITER	00018910
000002	C	SUBROUTINE ITER - APPLICATION OF ITERATIVE PROCEDURE	00018920
000003		DIMENSION BAD(35),CORL(621),E(621),PSI(621),FC(35),	00018930
000004		1 SENS(620),WSUM(620)	00018940
000005	C		00018950
000006		COMMON E,M,MPL1,N	00018960
000007		COMMON /MLCI/BAD,FC,NDIS	00018970
000008		COMMON /MNIG/PSI,K,JLZ,JHZ	00018980
000009		COMMON /RSFI/EKT,LHIX,LOEX,J11	00018990
000010		COMMON /CWI/SENS,WSUM,IR	00019000
000011	C		00019010
000012		LOGICAL BAD	00019020
000013	C		00019030
000014	C	INITIALIZE ALL CORRECTION FACTORS	00019040
000015	C		00019050
000016		DO 5 J=JLZ,JHZ	00019060
000017		5 CORL(J)=0.	00019070
000018	C		00019080
000019	C	CALCULATE CORRECTION FACTOR AT EACH ENERGY AND SUM OVER FOILS	00019090
000020	C		00019100
000021		DO 15 I=1,N	00019110
000022		IF(BAD(I)) GO TO 15	00019120
000023		READ (14)(SENS(J),J=1,M)	00019130
000024		RLOG=ALOG(FC(I))	00019140
000025		DO 10 J=JLZ,JHZ	00019150
000026	10	CORL(J)=CORL(J)+SENS(J)*RLOG	00019160
000027	15	CONTINUE	00019170
000028		REWIND 14	00019180
000029	C	NORMALIZE CORRECTION FACTORS TO TOTAL WEIGHT OF UNITY	00019190
000030	C	AND CORRECT FLUX VALUES COVERED BY AT LEAST ONE FOIL	00019200
000031	C		00019210
000032		DO 20 J=JLZ,JHZ	00019220
000033		IF(WSUM(J).LT.1.0E-36.OR.WSUM(J).EQ.0.) GO TO 20	00019230
000034		CORL(J)=CORL(J)/WSUM(J)	00019240
000035		PSI(J)=PSI(J)*EXP(CORL(J))	00019250
000036	20	CONTINUE	00019260
000037	C		00019270
000038		JJ=JLZ+1	00019280
000039		IF(WSUM(1).LT.1.0E-36.OR.WSUM(1).EQ.0.) GO TO 40	00019290
000040		NGAP=0	00019300
000041	C		00019310
000042	C	SEARCH FOR LOW LIMIT OF FOIL COVERAGE GAP	00019320
000043	C		00019330
000044		25 DO 30 J=JJ,JHZ	00019340

000045		JK=J	00019350
000046		IF (WSUM(J).LT.1.0E-36.OR.WSUM(J).EQ.0.) GO TO 35	00019360
000047	30	CONTINUE	00019365*NEW
000048		RETURN	00019370**-1
000049	C		00019380
000050	C		00019390
000051	C	LOW LIMIT OF GAP FOUND	00019400
000052	35	NGAP=NGAP+1	00019410
000053		J1=JK-1	00019420
000054		LIM1=JK	00019430
000055		JJ=JK+1	00019440
000056		GO TO 45	00019450
000057	40	NGAP=1	00019460
000058	C		00019470
000059	C	SEARCH FOR HIGH LIMIT OF FOIL COVERAGE GAP	00019480
000060	C		00019490
000061	45	DO 50 J=JJ,JHZ	00019500
000062		JK=J	00019510
000063	50	IF (WSUM(J).GT.0.) GO TO 55	00019520
000064		IF (LHIX-2) 105,120,120	00019530
000065	C		00019540
000066	C	HIGH LIMIT OF GAP FOUND	00019550
000067	C		00019560
000068	55	J2=JK	00019570
000069		LIM2=JK-1	00019580
000070		JJ=JK+1	00019590
000071	C		00019600
000072	C	TEST WHETHER FIRST GAP IS INTERPOLATION	00019610
000073	C	OR LOW END EXTRAPOLATION	00019620
000074		IF (NGAP.GT.1.OR.WSUM(1).GT.0.) GO TO 90	00019630
000075	C		00019640
000076	C	LOW END EXTRAPOLATION	00019650
000077	C		00019660
000078		IF (J2.LE.JLZ) GO TO 25	00019670
000079		IF (LOEX-2) 60,70,80	00019680
000080	C		00019690
000081	C	E EXTRAPOLATION	00019700
000082	C		00019710
000083	60	FRAC=PSI(J2)/E(J2)	00019720
000084		DO 65 J=JLZ,LIM2	00019730
000085	65	PSI(J)=FRAC*E(J)	00019740
000086		IF (J2.LT.JHZ) GO TO 25	00019750
000087		RETURN	00019760
000088	C		00019770
000089	C	SQRTE EXTRAPOLATION	00019780
000090	C		00019790
000091	70	FRAC=PSI(J2)/SQRT(E(J2))	00019800
000092		DO 75 J=JLZ,LIM2	00019810
000093	75	PSI(J)=FRAC*SQRT(E(J))	00019820

000094	IF(J2.LT.JHZ) GO TO 25	00019830
000095	RETURN	00019840
000096	C	00019850
000097	C	00019860
000098	C	00019870
000099	80 EMAT=2.*EKT	00019880
000100	IF(.NOT.E(J2).GT.EMAT) GO TO 82	00019890
000101	PROD=PSI(J2)*E(J2)	00019900
000102	CMAX=1.8473*PROD/EKT**2	00019910
000103	DO 82 J=JLZ,LIM2	00019920
000104	LI=1=J	00019930
000105	IF(.NOT.E(J).LT.EMAT) GO TO 84	00019940
000106	82 PSI(J)=CMAX*E(J)*EXP(-E(J)/EKT)	00019950
000107	IF(J2.LT.JHZ) GO TO 25	00019960
000108	RETURN	00019970
000109	84 DO 86 J=LIM1,LIM2	00019980
000110	86 PSI(J)=PROD/E(J)	00019990
000111	IF(J2.LT.JHZ) GO TO 25	00020000
000112	RETURN	00020010
000113	88 CMAX=PSI(J2)*EXP(E(J2)/EKT)/E(J2)	00020020
000114	DO 89 J=JLZ,LIM2	00020030
000115	89 PSI(J)=CMAX*E(J)*EXP(-E(J)/EKT)	00020040
000116	IF(J2.LT.JHZ) GO TO 25	00020050
000117	RETURN	00020060
000118	C	00020070
000119	C	00020080
000120	C	00020090
000121	90 IF(PSI(J1).LT.1.0E-36.OR.PSI(J2).LT.1.0E-36.OR.	00020100
000122	1 PSI(J1).EQ.0.0.OR.PSI(J2).EQ.0.0) GO TO 102	00020110
000123	X1=ALOG(E(J1))	00020120
000124	Y1=ALOG(PSI(J1))	00020130
000125	SLOP=(ALOG(PSI(J2))-Y1)/(ALOG(E(J2))-X1)	00020140
000126	DO 95 J=LIM1,LIM2	00020150
000127	X=ALOG(E(J))	00020160
000128	95 PSI(J)=EXP(Y1+SLOP*(X-X1))	00020170
000129	IF(J2.LT.JHZ) GO TO 25	00020180
000130	RETURN	00020190
000131	102 SLOP=(PSI(J2)-PSI(J1))/(E(J2)-E(J1))	00020200
000132	DO 103 J=LIM1,LIM2	00020210
000133	103 PSI(J)=PSI(J1)+SLOP*(E(J)-E(J1))	00020220
000134	IF(J2.LT.JHZ) GO TO 25	00020230
000135	RETURN	00020240
000136	C	00020250
000137	C	00020260
000138	C	00020270
000139	C	00020280
000140	C	00020290
000141	105 LI=2 = JHZ	00020300
000142	110 DEH=SQRT(E(J1))*EXP(-.776*E(J1))	00020310

000143	PT1=PSI(J1)/DEN	00020320
000144	DO 115 J=LIM1,LIM2	00020330
000145	115 PSI(J)=PT1*SQRT(E(J))*EXP(-.776*E(J))	00020340
000146	IF(LIM2.EQ.JHZ) RETURN	00020350
000147	GO TO 130	00020360
000148	C	00020370
000149	C FUSION EXTRAPOLATION	00020380
000150	C	00020390
000151	120 IF(LIM1.GT.J11) GO TO 135	00020400
000152	C	00020410
000153	C RETURN FOR FISSION EXTRAPOLATION UP TO 11 MEV	00020420
000154	C	00020430
000155	LIM2=J11	00020440
000156	GO TO 110	00020450
000157	C	00020460
000158	C FUSION EXTRAPOLATION FROM 11 MEV, IF FIRST ITERATION	00020470
000159	C	00020480
000160	130 J1=J11	00020490
000161	LIM1=J1+1	00020500
000162	C	00020510
000163	C FUSION EXTRAPOLATION FROM LAST FOIL	00020520
000164	C	00020530
000165	135 IF(E(J1)-14.)140,145,150	00020540
000166	140 FEX=(14.-E(J1))**2	00020550
000167	FJ1=(2.+4.*FEX)/(2.+FEX)	00020560
000168	GO TO 155	00020570
000169	145 FJ1=1.	00020580
000170	GO TO 155	00020590
000171	150 FEX=2.+4.*(E(J1)-14.)	00020600
000172	FJ1=1.+(E(J1)-14.)*FEX	00020610
000173	155 PT1=PSI(J1)*FJ1	00020620
000174	DO 175 J=LIM1,JHZ	00020630
000175	IF(E(J)-14.)160,165,170	00020640
000176	160 FEX=(14.-E(J))**2	00020650
000177	PSI(J)=PT1*(2.+FEX)/(2.+4.*FEX)	00020660
000178	GO TO 175	00020670
000179	165 PSI(J)=PT1	00020680
000180	GO TO 175	00020690
000181	170 FEX=2.+4.*(E(J)-14.)	00020700
000182	PSI(J)=PT1/(1.+(E(J)-14.)*FEX)	00020710
000183	175 CONTINUE	00020720
000184	RETURN	00020730
000185	END	00020740

Q ELT GRAF,1,680706, 53526

000001		SUBROUTINE GRAF(ID,IBAR)	00020750
000002		DIMENSION E(621),PSI(621),GABS(101),GORD(199),VAL(9),HDNG(28),	00020760
000003		1 WLAB(22),X(1243),Y(1243),XDRAW(400),YDRAW(400),IDATA(2500)	00020770
000004		2, FULN(35,4),JHI(35),JLO(35)	00020780
000005		DATA IST/1/	00020790
000006		COMMON E,M,MPL1,N	00020800
000007		COMMON /MNIG/PSI,K,JLZ,JHZ	00020810
000008		COMMON /MRLNCG/KIND,TINT	00020820
000009		COMMON /MG/ACHV,STBL	00020830
000010		COMMON /RG/HDNG	00020840
000011		COMMON /MSG/FULN	00020850
000012		COMMON /MCG/JHI,JLO	00020860
000013		LOGICAL TINT,ACHV,STBL	00020870
000014	C		00020880
000015		IF(IST.GT.1) GO TO 3	00020890
000016	C		00020900
000017	C	ALLOCATE WORK AREA FOR CALCOMP TO COMPUTE---TAPE H IS UNIT 8	00020910
000018	C		00020920
000019		CALL CPLOTS(IDATA,2500,8)	00020930
000020		IST = 2	00020940
000021	C		00020950
000022	C	ORIGIN IS 2 INCHES OVER, 0.75 INCHES UP, AND PLOT IS 9X15 INCHES	00020960
000023	C		00020970
000024		CALL CPLOT(2.,.6,-3)	00020980
000025		GO TO 4	00020990
000026	C		00021000
000027	C	ADVANCE PAPER FOR NEXT PLOT	00021010
000028	C		00021020
000029		3 CALL CPLOT(18.,0.,-3)	00021030
000030	C		00021040
000031	C	RANGE OF ABSCISSAS	00021050
000032	C		00021060
000033		4 XB=E(JLZ)	00021070
000034		XT=E(JHZ)	00021080
000035	C		00021090
000036	C	RANGE OF ORDINATES	00021100
000037	C		00021110
000038		YB=PSI(JLZ)	00021120
000039		YT=YB	00021130
000040		JL1=JLZ+1	00021140
000041		DO 25 J=JL1,JHZ	00021150
000042		IF(PSI(J).LT.1.0E-36.OR.PSI(J).EQ.0.0) GO TO 25	00021160
000043		YB=AMIN1(YB,PSI(J))	00021170
000044		YT=AMAX1(YT,PSI(J))	00021180

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25 CONTINUE

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C
C      EXTEND TO WHOLE DECADE RANGES - CALCULATE EXTREME LOGS
C
      A=ALOG10(XB)
      LXB=A
      ALXB=LXB
      IF (XB.LT.1.,AND,ABS(ALXB-A).GT,0.001)    LXB=LXB-1
      ALXB=LXB
      A=ALOG10(XT)
      LXT=A
      ALXT=LXT
      IF (XT.GT.1.,AND,ABS(ALXT-A).GT,0.001)    LXT=LXT+1
      ALXT=LXT
      A=ALOG10(YB)
      LYB=A
      ALYB=LYB
      IF (YB.LT.1.,AND,ABS(ALYB-A).GT,0.001)    LYB=LYB-1
      ALYB=LYB
      A=ALOG10(YT)
      LYT=A
      ALYT=LYT
      IF (YT.GT.1.,AND,ABS(ALYT-A).GT,0.001)    LYT=LYT+1
      ALYT=LYT

C
C      ASSIGN LOGS OF 2-9 FOR GRID LINES WITHIN EACH DECADE
C
      ANUM=1.
      DO 30 J=1,9
      ANUM=ANUM+1.
30 VAL(J)=ALOG10(ANUM)

C
C      IF HIGHEST ENERGY EXCEEDS 10 MEV, CUTOFF AT 20 MEV.
C
      JTOP=10
      IF (LXT.EQ.2) JTOP=2
      IF (LXT.EQ.2) ALXT=1.+VAL(1)
      NXD=LXT-LXB
      NYD=LYT-LYB

C
C      LOG VALUES OF ABSCISSA GRID LINES
C
      GABS(1)=LXB
      JA=2
      DO 40 IDEC=1,NXD
      JB=JA+8
      IF (IDEC.EQ.NXD) JB=JTOP+JA-2
      IND=0
      POWER=LXB-1+IDEC
```

00021190
00021200
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00021670

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000094      DO 35 J=JA,JB      00021680
000095      IND=IND+1      00021690
000096      35 GABS(J)=POWR+VAL(IND)      00021700
000097      40 JA = JA + 9      00021710
000098      C      00021720
000099      C      LOG VALUES OF ORDINATE GRID LINES      00021730
000100      C      00021740
000101      GORD(1)=LYB      00021750
000102      JA=2      00021760
000103      DO 50 IDEC=1,NYD      00021770
000104      JB=JA+8      00021780
000105      INC=0      00021790
000106      POWR=LYB-1+IDEC      00021800
000107      DO 45 J=JA,JB      00021810
000108      IND=IND+1      00021820
000109      45 GORD(J)=POWR+VAL(IND)      00021830
000110      50 JA=JA+9      00021840
000111      NXGL=9*(NXD-1)+JTOP      00021850
000112      NYGL=9*NYD +1      00021860
000113      C      00021870
000114      C      CONVERTS GRID LINE LOCATION COORDINATES TO INCHES      00021880
000115      C      00021890
000116      CX = 15./(ALXT-ALXB)      00021900
000117      DO 55 J=1,NXGL      00021910
000118      55 GABS(J)=CX*(GABS(J)-ALXB)      00021920
000119      CY = 9./(ALYT-ALYB)      00021930
000120      DO 60 J=1,NYGL      00021940
000121      60 GORD(J)=CY*(GORD(J)-ALYB)      00021950
000122      C      00021960
000123      C      ASSIGNS VERTICAL(ABSCISSA) GRID LINE COORDINATES FOR ZIGZAG PLOT      00021970
000124      C      00021980
000125      DO 62 I=1,NXGL      00021990
000126      IH = 2*I-1      00022000
000127      XDRAW(IH) = GABS(I)      00022010
000128      62 XDRAW(IH+1) = GABS(I)      00022020
000129      DO 64 I=1,NXGL,2      00022030
000130      IH = 2*I-1      00022040
000131      YDRAW(IH) = GORD(1)      00022050
000132      64 YDRAW(IH+1) = GORD(NYGL)      00022060
000133      DO 66 I=2,NXGL,2      00022070
000134      IH = 2*I-1      00022080
000135      YDRAW(IH) = GORD(NYGL)      00022090
000136      66 YDRAW(IH+1) = GORD(1)      00022100
000137      C      00022110
000138      C      DRAW VERTICAL GRID LINES      00022120
000139      C      00022130
000140      NEC = 2*NXGL      00022140
000141      XDRAW(NEC+1) = XDRAW(1)      00022150
000142      XDRAW(NEC+2) = 1.      00022160

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000143      YDRAW(NEC+1) = YDRAW(1)                                00022170
000144      YDRAW(NEC+2) = 1.                                      00022180
000145      CALL LINE(XDRAW,YDRAW,NEC,1,0,29)                       00022190
000146      C                                                        00022200
000147      C      ASSIGNS HORIZONTAL (ORDINATE) GRID LINE COORDINATES FOR ZIGZAG PLO 00022210
000148      C                                                        00022220
000149      DO 68 I=1,NYGL                                           00022230
000150      IH = 2*I-1                                               00022240
000151      YDRAW(IH) = GORD(I)                                     00022250
000152      68 YDRAW(IH+1) = GORD(I)                                00022260
000153      DO 70 I=1,NYGL,2                                         00022270
000154      IH = 2*I-1                                               00022280
000155      XDRAW(IH) = GABS(1)                                       00022290
000156      70 XDRAW(IH+1) = GABS(NXGL)                             00022300
000157      DO 72 I=2,NYGL,2                                         00022310
000158      IH = 2*I-1                                               00022320
000159      XDRAW(IH) = GABS(NXGL)                                   00022330
000160      72 XDRAW(IH+1) = GABS(1)                                 00022340
000161      C                                                        00022350
000162      C      DRAW HORIZONTAL GRID LINES                       00022360
000163      C                                                        00022370
000164      NEC = 2*NYGL                                             00022380
000165      XDRAW(NEC+1) = XDRAW(1)                                  00022390
000166      XDRAW(NEC+2) = 1.                                       00022400
000167      YDRAW(NEC+1) = YDRAW(1)                                  00022410
000168      YDRAW(NEC+2) = 1.                                       00022420
000169      CALL LINE(XDRAW,YDRAW,NEC,1,0,29)                       00022430
000170      C                                                        00022440
000171      C      WRITE ABSCISSA LABELS                            00022450
000172      C                                                        00022460
000173      DO 75 J=1,NXGL,9                                          00022470
000174      NLABX = (J+8)/9                                           00022480
000175      WLAB(NLABX) = GABS(J) - 0.28                             00022490
000176      75 CALL NUMBER(WLAB(NLABX),-0.27,0.14,10.,0.,-1)       00022500
000177      FPN=LXB                                                    00022510
000178      DO 85 J=1,NLABX                                           00022520
000179      WLAB(J)=WLAB(J)+0.28                                       00022530
000180      CALL NUMBER(WLAB(J),-0.17,0.14,FPN,0.0,-1)             00022540
000181      85 FPN=FPN+1.0                                           00022550
000182      C                                                        00022560
000183      C      WRITE ABSCISSA LEGEND                             00022570
000184      C                                                        00022580
000185      CALL SYMBOL(6.1,-0.5,0.14,20HNEUTRON ENERGY (MEV),0.0,20) 00022590
000186      C                                                        00022600
000187      C      WRITE ORDINATE LABELS                             00022610
000188      C                                                        00022620
000189      DO 110 J=1,NYGL,9                                          00022630
000190      NLABY=(J+8)/9                                             00022640
000191      WLAB(NLABY)=GORD(J)-0.1                                  00022650

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000192	110	CALL NUMBER(-0.70,WLAB(NLABY),0.14,10.0,0.0,-1)	00022660
000193		FPN=LYB	00022670
000194		DO 115 J=1,NLABY	00022680
000195		WLAB(J)=WLAB(J)+0.1	00022690
000196		CALL NUMBER(-.42,WLAB(J),.14,FPN,0.,-1)	00022700
000197	115	FPN=FPN+1.0	00022710
000198		IF(ID.EQ.2) GO TO 165	00022720
000199		IF(TINT) GO TO 120	00022730
000200	C		00022740
000201	C	WRITE ORDINATE LEGEND AND HEADING FOR DIFFERENTIAL CURVE	00022750
000202	C		00022760
000203		CALL SYMBOL(-.8,2.75,.14,25HNEUTRON DIFFERENTIAL FLUX,90.,25)	00022770
000204		GO TO 125	00022780
000205	120	CALL SYMBOL(-.8,2.54,.14,28HNEUTRON DIFFERENTIAL FLUENCE,90.,28)	00022790
000206	125	IF(KIND.EQ.1.AND.K.GT.0) GO TO 130	00022800
000207		CALL SYMBOL(4.66,9.1,.21,27HINPUT DIFFERENTIAL SPECTRUM,0.,27)	00022810
000208		GO TO 150	00022820
000209	130	IF(ACHV.OR.STBL) GO TO 135	00022830
000210		XLOC=1.72	00022840
000211		GO TO 140	00022850
000212	135	CALL SYMBOL(1.3,9.1,.21,8HSOLUTION,0.,8)	00022860
000213		XLOC=3.19	00022870
000214	140	CALL SYMBOL(XLOC,9.1,.21,36HDIFFERENTIAL SPECTRUM OBTAINED AFTER,	00022880
000215	1	0.,36)	00022890
000216		XLOC=XLOC+7.77	00022900
000217		FPN=K	00022910
000218		CALL NUMBER(XLOC,9.1,.21,FPN,0.,-1)	00022920
000219		XLOC=XLOC+.42	00022930
000220		IF(K.GE.10) XLOC=XLOC+.21	00022940
000221		IF(ACHV.OR.STBL) GO TO 145	00022950
000222		CALL SYMBOL(XLOC,9.1,.21,15HITERATION LIMIT,0.,15)	00022960
000223		GO TO 150	00022970
000224	145	CALL SYMBOL(XLOC,9.1,.21,10HITERATIONS,0.,10)	00022980
000225	C		00022990
000226	C	SETUP DIFFERENTIAL CURVE (HISTOGRAM)	00023000
000227	C		00023010
000228	150	NP=2*(JHZ-JLZ)+1	00023020
000229		Y(1)=ALOG10(PSI(JLZ))	00023030
000230		Y(2)=Y(1)	00023040
000231		X(1)=ALOG10(E(JLZ))	00023050
000232		LIM=NP-2	00023060
000233		DO 160 J=3,LIM,2	00023070
000234		J2=JLZ+J/2	00023080
000235		X(J-1)=ALOG10(E(J2))	00023090
000236		X(J)=X(J-1)	00023100
000237		IF(PSI(J2).LT.1.0E-36) GO TO 155	00023110
000238		Y(J)=ALOG10(PSI(J2))	00023120
000239		GO TO 160	00023130
000240	155	Y(J)=LYB	00023140

000241	160	Y(J+1)=Y(J)	00023150
000242		X(JP-1)=ALOG10(E(JHZ))	00023160
000243		X(NP)=X(NP-1)	00023170
000244		Y(JP)=ALOG10(PHI(JHZ))	00023180
000245		GO TO 224	00023190
000246	C		00023200
000247	C	WRITE ORDINATE LEGEND AND HEADING FOR INTEGRAL CURVE	00023210
000248	C		00023220
000249	165	YLOC=2.12	00023230
000250		IF(TINT) YLOC=1.8	00023240
000251		CALL SYMBOL(-.8,YLOC,.14,16HNEUTRON INTEGRAL,90.,16)	00023250
000252		IF(TINT) GO TO 170	00023260
000253		CALL SYMBOL(-.8,4.5,.14,4HFLUX,90.,4)	00023270
000254		YLOC=5.2	00023280
000255		GO TO 175	00023290
000256	170	CALL SYMBOL(-.8,4.18,.14,7HFLUENCE,90.,7)	00023300
000257		YLOC=5.3	00023310
000258	175	CALL SYMBOL(-.8,YLOC,.14,12HABOVE ENERGY,90.,12)	00023320
000259		IF(KIND.EQ.1) GO TO 180	00023330
000260		CALL SYMBOL(5.08,9.1,.21,23HINPUT INTEGRAL SPECTRUM,0.,23)	00023340
000261		GO TO 200	00023350
000262	180	IF(ACHV.OR.STBL) GO TO 185	00023360
000263		XLOC=2.14	00023370
000264		GO TO 190	00023380
000265	185	CALL SYMBOL(1.72,9.1,.21,8HSOLUTION,0.,8)	00023390
000266		XLOC=3.61	00023400
000267	190	CALL SYMBOL(XLOC,9.1,.21,32HINTEGRAL SPECTRUM OBTAINED AFTER,0.,	00023410
000268	1	32)	00023420
000269		XLOC=XLOC+6.93	00023430
000270		FPN=K	00023440
000271		CALL NUMBER(XLOC,9.1,.21,FPN,0.,-1)	00023450
000272		XLOC=XLOC+.42	00023460
000273		IF(K.GE.10) XLOC=XLOC+.21	00023470
000274		IF(ACHV.OR.STBL) GO TO 195	00023480
000275		CALL SYMBOL(XLOC,9.1,.21,15HITERATION LIMIT,0.,15)	00023490
000276		GO TO 200	00023500
000277	195	CALL SYMBOL(XLOC,9.1,.21,10HITERATIONS,0.,10)	00023510
000278	C		00023520
000279	C	SETUP INTEGRAL CURVE	00023530
000280	C		00023540
000281	200	NP=JHZ-JLZ+1	00023550
000282		JP =JLZ-1	00023560
000283		DO 223 J=1,NP	00023570
000284		JP =JP+1	00023580
000285		IF(PHI(JP).LT.1.0E-36.OR.PHI(JP).EQ.0.0) GO TO 222	00023590
000286		Y(J)=ALOG10(PHI(JP))	00023600
000287		GO TO 223	00023610
000288	222	Y(J) = LYB	00023620
000289	223	X(J) = ALOG10(E(JP))	00023630

000290	C		00023640
000291	C	CONVERT CURVE COORDINATES TO INCHES AND PLOT CURVE	00023650
000292	C		00023660
000293		224 DO 225 J=1,NP	00023670
000294		X(J)=CX*(X(J)-ALXB)	00023680
000295		225 Y(J)=CY*(Y(J)-ALYB)	00023690
000296		X(NP+1)=0.	00023700
000297		Y(NP+1)=0.	00023710
000298		Y(NP+2)=1.0	00023720
000299		X(NP+2)=1.0	00023730
000300		CALL LINE(X,Y,NP,1,0,29)	00023740
000301	C		00023750
000302	C	WRITE FIRST TWO TITLE CARDS	00023760
000303	C		00023770
000304		CALL SYMBOL (1.57,9.7,.14,HDNG,0.,79)	00023780
000305		CALL SYMBOL (1.57,9.5,.14,HDNG(15),0.,79)	00023790
000306	C		00023800
000307	C	PLOT FOIL SENSITIVITY RANGE BARS	00023810
000308	C		00023820
000309		IF (IBAR.EQ.0) RETURN	00023830
000310		Y(1)=-0.19	00023840
000311		DO 240 I=1,N	00023850
000312		JL=JLO(I)	00023860
000313		JH=JHI(I)	00023870
000314		X(1)=CX*(ALOG10(E(JL))-ALXB)	00023880
000315		X(2)=X(1)	00023890
000316		XMAX=CX*(ALOG10(E(JH))-ALXB)	00023900
000317		Y(1)=Y(1)+0.28	00023910
000318		Y(2)=Y(1)+0.1	00023920
000319		XLONG=XMAX-X(1)	00023930
000320		NVSEG=50.*XLONG +1.	00023940
000321		TEST=(NVSEG-1)/50	00023950
000322		IF (TEST.LT.XLONG) NVSEG=NVSEG+1	00023960
000323		NPTS=2*NVSEG	00023970
000324		DO 230 J=3,NPTS,2	00023980
000325		X(J)=X(J-1)+.02	00023990
000326		X(J+1)=X(J)	00024000
000327		Y(J)=Y(1)	00024010
000328	230	Y(J+1)=Y(2)	00024020
000329		X(NPTS-1)=XMAX	00024030
000330		X(NPTS)=XMAX	00024040
000331		X(NPTS+1)=0.	00024050
000332		Y(NPTS+1)=0.	00024060
000333		X(NPTS+2)=1.	00024070
000334		Y(NPTS+2)=1.	00024080
000335		CALL LINE(X,Y,NPTS,1,0,29)	00024090
000336		FXLOC=XMAX-.555-.5*XLONG	00024100
000337		FYLOC=Y(2)+.02	00024110
000338		DO 240 J=1,4	00024120

000339	CALL SYMBOL(FXLOC,FYLOC,.07,FULN(I,J),0.,4)	00024130
000340	240 FXLOC=FXLOC+.28	00024140
000341	RETURN	00024150
000342	END	00024160

Q ELT DIF1,1,680706, 53532

000001		FUNCTION DIF1 (X)	00024170
000002	C		00024180
000003	C	1.. FISSION FORM 1, WATT. 0.484*SINH(SQRT(2E))*EXP(-E)	00024190
000004	C		00024200
000005		TERM=EXP(SQRT(2.*X))	00024210
000006		DIF1=.484*.5*(TERM-1./TERM)*EXP(-X)	00024220
000007		RETURN	00024230
000008		END	00024240

Q ELT DIF2,1,680706, 53539

000001		FUNCTION DIF2 (X)	00024250
000002	C		00024260
000003	C	8. THERMAL MAXWELLIAN FORM, 20 DEGREES C. 1.5918E15*E*EXP(-3.987*E	00024270
000004	C		00024280
000005		XPON=-3.987E7*X	00024290
000006		DIF2=1.5918E15*X*EXP(XPON)	00024300
000007		RETURN	00024310
000008		END	00024320

@ ELT DIF3,1,680706, 53546

000001		FUNCTION DIF3 (X)	00024330
000002	C		00024340
000003	C	6, RECIPROCAL ENERGY (1/E)	00024350
000004	C		00024360
000005		DIF3=1.0/X	00024370
000006		RETURN	00024380
000007		END	00024390

@ ELT DIF4,1,680706, 53555

000001		FUNCTION DIF4 (X)	00024400
000002	C	FUNCTION DIF4 - DUMMY FIRST APPROXIMATION FUNCTION 4	00024410
000003		DIF4 =1.	00024420
000004		RETURN	00024430
000005		END	00024440

87

000001		FUNCTION DIF5 (X)	00024450
000002	C	FUNCTION DIF5 - DUMMY FIRST APPROXIMATION FUNCTION 5	00024460
000003		DIF5 =1.	00024470
000004		RETURN	00024480
000005		END	00024490

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