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GNASH:

A Preequilibrium, Statistical Nuclear-Model Code for Calculation of Cross Sections and Emission Spectra

P. G. Young
E. D. Arthur

los alamos
scientific laboratory
of the University of California
LOS ALAMOS, NEW MEXICO 87545

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GNASH: A PREEQUILIBRIUM, STATISTICAL NUCLEAR-MODEL CODE FOR CALCULATION OF CROSS SECTIONS AND EMISSION SPECTRA

by

P. G. Young and E. D. Arthur

ABSTRACT

A new multistep Hauser-Feshbach code that includes corrections for preequilibrium effects is described. The code can calculate up to 60 decay reactions (cross sections and energy spectra) in one computation, thereby providing considerable flexibility for handling processes with complicated reaction chains. Input parameter setup, problem output, and subroutine descriptions are given along with a sample problem calculation. A brief theoretical description is also included.

I. INTRODUCTION

The preequilibrium, statistical nuclear-model code GNASH provides a flexible method by which reaction and level cross sections, isomer ratios, and spectra (neutron, gamma-ray, and charged-particle) resulting from particle-induced reactions can be calculated. The code uses Hauser-Feshbach[1] theory to calculate complicated sequences of reactions and includes a preequilibrium correction for binary channels. Gamma-ray competition is considered in detail for every decaying compound nucleus. Each calculation can handle decay sequences involving up to 10 compound nuclei, and each decaying compound nucleus can emit a maximum of 6 types of radiation (neutrons, gamma rays, protons, alphas, etc.). Angular-momentum effects and conservation of parity are included explictly. Each residual nucleus in a calculation can contain up to 50 discrete levels, whereas its continuum region can be represented by up to 200 energy bins. The incident-particle types that are permitted are neutrons, protons, deuterons, tritons, ^{3}He, and ^{4}He. These particles and gamma rays can also be emitted from decaying compound nuclei. Angular distributions are not calculated; that is, isotropy is assumed in the center-of-mass (c.m.) system.

Figure 1 illustrates input data used in GNASH calculations and provides a summary of the major output features. The input includes cards that specify the reaction chains to be followed, the incident energies to be included, and the model and parameter options to be used in the calculation. Optical-model transmission coefficients are input for all particle types included, and the energy levels, spins, parities, and branching ratios are provided for all residual nuclei in the calculation.

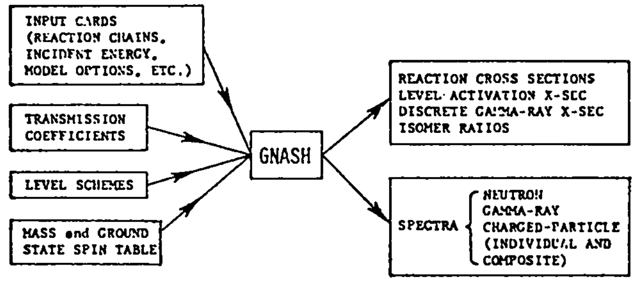

Fig. 1.
Input and output features of the GNASH code.

A complex decay sequence involving multiparticle and gamma-ray emission, typical of the ones that can be handled in a single calculation, is shown in Fig. 2. The sequence is for neutrons incident on ^{59}Co with sufficient energy to cause (n,5n) reactions to occur, and has been used to calculate proton- and alpha-production cross sections for neutrons up to 40 MeV in energy.[2] The heavy arrows in Fig. 2 indicate the main reaction chains that were followed. A part of this calculation is included in this report as a sample problem. Other examples of calculations with GNASH appear in Refs. 3-8.

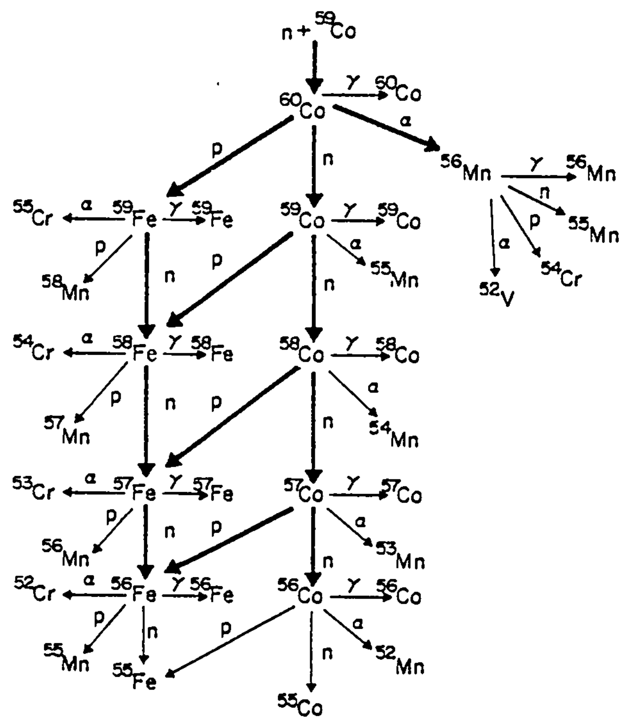

Fig. 2.
Sample decay chain for n + ^{59}Co calculations.

The GNASH code, developed for a Control Data Corp. (CDC) 7600 computer, uses 49 000 words of storage and up to 290 000 words of extended-core memory (depending on the problem) for storage of parameters used in a calculation. As an option, the code can use auxiliary files of transmission coefficient and energy-level data or obtain these data directly from cards.

Included in this report are descriptions of the theoretical expressions used in the calculations (Sec. II), mechanics of the calculation and important subroutines (Sec. III), input parameters and options for streamlined setup (Sec. IV), supplemental data or files needed (Sec. V), and output produced by the code (Sec. VI). Section VII contains a summary discussion, and the code listing and a sample problem are given in Appendixes A-E.

II. THEORETICAL BACKGROUND

A. Calculational Expressions

The statistical portion of the code includes angular-momentum and parity effects explicitly and generally follows the formalism of Uhl.[9] In this section, we give a brief description of the expressions used in the calculation. Reference 9 should be consulted for more detail.

For the calculations of complex reactions involving several particles and compound nuclei, we assume that the reaction proceeds in stages with only one particle emitted at each step. Each newly formed intermediate nucleus, produced by particle decay of the previous compound nucleus, then disintegrates (if energetically possible) with probabilities determined from Hauser-Feshbach theory for binary reactions.[1]

The composition of nuclei involved in a calculation is as follows. At low excitation energies, discrete levels of energy E, total angular momentum J, and parity π are included. Generally, experimentally determined values of E, J^{π}, and branching ratios are used for these levels. For higher excitation energies where discrete-level information may be lacking, a continuum level-density expression is used. For this purpose, the continuum region is divided into energy bins of width ΔE.

The population of continuum bins $P^{(n+1)}(UJ\pi)$ in the (n+1)th compound nucleus, formed by particle disintegration of the nth compound nucleus, is given by

$$P^{(n+1)}(UJ\pi) = \int dU' \sum_{J'\pi'} \hat{P}^{(n)}(U'J'\pi') \frac{\Gamma_a^{(n)}(U'J'\pi',UJ\pi)}{\Gamma(U'J'\pi')} \rho^{(n+1)}(UJ\pi) \quad , (1)$$

where $\hat{P}^{(n)}(U'J'\pi')$ is the population of continuum energy bins in the nth compound nucleus after gamma-ray cascades have been considered, U is the excitation energy, ρ is the level density, and a defines the type of radiation emitted by the nth compound nucleus to form the (n+1)th nucleus. The population of the first compound nucleus is determined from its formation cross section, which can be found from the appropriate sum over transmission coefficients taken at the c.m. energy ε of the incident particles,

$$P^{(1)}(UJ\pi) = \frac{\pi}{k^2}\frac{(2J+1)}{(2I+1)(2i+1)}\sum_s\sum_\ell T_\ell(\varepsilon)f_\ell\delta(U-B) \quad . \tag{2}$$

Here k is the relative-motion wave number, $I(\pi_T)$ and $i(\pi_p)$ are the spins (parity) of the target nucleus and projectile, and $J(\pi)$ is the total angular momentum (parity) of the compound system. The quantity f_ℓ is a parity operator given by $f_\ell = 1/2\ |\pi + (-1)^\ell\pi_T\pi_p|$, $T_\ell(\varepsilon)$ is the transmission coefficient having orbital angular momentum ℓ, s is the channel spin, and B is the binding energy of the incident particle in the compound nucleus. The partial decay widths used in Eq. (1) for reaction channel a have the general form

$$\Gamma_a^{(n)}(U'J'\pi',UJ\pi) = \frac{1}{2\pi\rho(U'J'\pi')}\sum_s\sum_\ell T_\ell(U'-U-B_a)f_\ell \tag{3}$$

for widths involving transitions from continuum bins in the compound nucleus to continuum bins in the residual nucleus. Here the parity operator f_ℓ has the form $f_\ell = 1/2|\pi\pi' + (-1)^\ell\pi_a|$, where π_a is the parity of the emitted particle, and B_a is the binding energy of the emitted particle.

Similar expressions hold for the population of discrete levels:

$$P^{(n+1)}(E_\lambda J_\lambda\pi_\lambda) = \int dU' \sum_{J'\pi'} \hat{P}^{(n)}(U'J'\pi')\ \frac{\Gamma_a^{(n)}(U'J'\pi',E_\lambda J_\lambda\pi_\lambda)}{\Gamma(U'J'\pi')} \quad , \tag{4}$$

where the partial width for continuum to discrete level transitions has the form

$$\Gamma_a(U'J'\pi',E_\lambda J_\lambda\pi_\lambda) = \sum_s\sum_\ell T_\ell(U'-E_\lambda-B_a)f_\ell \quad . \tag{5}$$

Here the sums are taken over channel spin s and orbital angular momentum ℓ. The total width appearing in the denominators of Eqs. (1) and (4) is then the sum over continuum bins $(UJ\pi)$ or discrete levels $(E_\lambda J_\lambda\pi_\lambda)$ of the appropriate partial width $\Gamma_a(U'J'\pi',UJ\pi)$ or $\Gamma_a(U'J'\pi',E_\lambda J_\lambda\pi_\lambda)$ for each reaction channel a.

For many calculations of interest, nonstatistical or preequilibrium effects become important; therefore, a simplified preequilibrium expression formulated by Braga-Marcazzan[10] and based upon the exciton model of Griffin[11] and Blann[12] has been used to correct reaction and level-excitation cross sections as well as spectra for preequilibrium effects:

$$\left(\frac{d\sigma}{d\varepsilon}\right)_{preq} \propto \frac{\sigma_{inv}(\varepsilon) m\varepsilon\sigma_R}{|M|^2 g^4 E^3} \sum_{n=3}^{\bar{n}} (U/E)^{n-2}(n+1)^2(n-1) \quad . \qquad (6)$$

In this expression E and U are the excitation energies of the compound and residual nuclei, respectively; σ_R is the incident-particle reaction cross section; m, ε, and $\sigma_{inv}(\varepsilon)$ are the mass, kinetic energy, and inverse cross section for the outgoing particle; g is the average single-particle level spacing from the Fermi-gas model; and n is the number of particles and holes (n = p + h) in the compound nucleus. The sum extends from the initial exciton number 3 to $\bar{n}$, the limiting value attained when equilibrium is reached.

We assumed that the absolute square of the average matrix element of residual two-body interactions had the form $|M|^2 = KA^{-3}E^{-1}$ (A is the mass of the nucleus involved), determined by Kalbach-Cline.[13] The normalization constant K was obtained from fits to various sets of data, including both spectra and integrated cross sections (for example, see Refs. 14 and 15). The code evaluates the normalization factor using the expression

$$\alpha = \frac{|M|^2 g^4}{A} \quad . \qquad (7)$$

We determined the value of α for neutron- and proton-induced reactions to be 0.0005 ± 0.0001, in agreement with the Braga-Marcazzan value of 0.00045.[10] Our result corresponds to K = 150 ± 30 MeV^3, which can be compared to the value of 100 ± 35 MeV^3 obtained by Kalbach-Cline.[13] To provide flexibility in the code for calculation of preequilibrium emission, we made the normalization factor dependent on the type of particle emitted. Thus, effects such as the possible existence of preformed particles can be included. When the outgoing particles are neutrons and protons, the α values are known fairly reliably, but those for outgoing alphas are less accurately known. Because of the lack of experimental data on d, t, and ^3He emission, even more uncertainty in α exists for these.

The total preequilibrium component, obtained by summing over each outgoing particle channel involved in the decay of the first compound nucleus, then determines a fraction by which the total compound-nucleus reaction cross section is reduced. Because the preequilibrium model used in the code does not include effects of spin and parity, we assumed that the preequilibrium component had the same spin and parity distribution as the statistical population component.

B. Supplemental Quantities: Transmission Coefficients and Level Densities

To provide particle transmission coefficients, external optical model routines or codes must be used. GNASH accepts transmission coefficients in the COMNUC[16] form (see Sec. V) as a function of total angular momentum J and converts them to T_ℓ using the expression

$$T_\ell(\varepsilon) = \frac{1}{(2\ell + 1)} \left[(\ell + 1) T_{\ell,\ell+s} + \ell T_{\ell,\ell-s} \right] . \tag{8}$$

To provide gamma-ray transmission coefficients, either the Weisskopf approximation[17] or the Brink-Axel[18,19] giant dipole resonance form can be used. Specifically, the Weisskopf approximation for E1 transitions yields

$$T^{E1}(U,U') = C_W^{E1} E_\gamma^3 , \tag{9}$$

whereas the Brink-Axel form gives

$$T^{E1}(U,U') = C_{BA}^{E1} \frac{2}{\pi} \frac{1}{\hbar^2 c^2} E_\gamma^2 \frac{0.013A}{\Gamma} \frac{E_\gamma^2 \Gamma^2}{(E_R^2 - E_\gamma^2)^2 + E_\gamma^2 \Gamma^2} , \tag{10}$$

Here $E_\gamma = U - U'$, Γ is the giant dipole resonance width (Γ = 5 MeV), and E_R, the resonance energy in millions of electron volts, is given by $E_R = 80A^{-1/3}$. The normalization constants C_W^{E1} and C_{BA}^{E1} are obtained from the ratio of the average experimental gamma-ray width $\langle\Gamma_\gamma\rangle$ to the observed resonance spacing $\langle D\rangle$ for s-wave neutrons through evaluation of the expression (at the neutron binding energy E_B)

$$\left(\frac{\langle\Gamma_\gamma\rangle}{\langle D\rangle} \right)_{E_B} = \frac{1}{2\pi} \int_0^{E_B} \sum_{\ell,J'} T^{E1}(B_n,U') \rho(U'J'\pi') dU' , \tag{11}$$

where T^{E1} is computed using either the Weisskopf or Brink-Axel forms.

In the code, gamma-ray cascades through E2, E3, M1, M2, and M3 transitions are permitted also. Transmission coefficients for these are computed using the Weisskopf form ($\propto \varepsilon_\gamma^{2\ell+1}$), and the ratios C^{E2}/C^{E1}, C^{E3}/C^{E1}, ..., C^{M3}/C^{E1} are determined from the Weisskopf estimate[17] or are input directly during setup of the calculation.

The level-density expressions are those of Gilbert and Cameron[20] with the pairing and shell parameters of Cook.[21] A Fermi-gas level-density form is used at higher excitation energies,

$$\rho(E,J\pi) = \frac{\sqrt{\pi}}{24} \frac{\exp\,(2\sqrt{aU})}{a^{1/4}U^{5/4}} \frac{(2J + 1)\exp\,[-(J + 1/2)^2/2\sigma^2]}{2\sqrt{2\pi}\,\sigma^3} \quad , \tag{12}$$

and is matched to a constant temperature expression used for lower excitation energies

$$\rho(E,J\pi) = \frac{1}{2T} \exp\,[(E - E_0)/T] \frac{(2J + 1)\exp\,[-J + 1/2)^2/2\sigma^2]}{2\sqrt{2\pi}\,\sigma^3} \quad . \tag{13}$$

The definitions for the quantities in Eqs. (12) and (13) are given in Ref. 20 and will not be repeated here. The experimentally determined number of levels up to a particular excitation energy are used (where possible) to determine parameters for the constant-temperature expression so that a good match is made. The level-density parameter a is either input directly into calculations or determined using the Gilbert-Cameron prescription

$$a/A = 0.00917\,[S(Z) + S(N)] + C \quad , \tag{14}$$

where S(Z) and S(N) are shell effect terms[21] and C, a correction term, depends on whether the nucleus is deformed (C = 0.120) or spherical (C = 0.142).[20]

III. CODE SUBROUTINES

To explain the workings of the GNASH code and to aid in its use, a short description of its subroutines is given here. The code listing is in Appendix A.

MAIN - The main control routine of the program. It reads in data describing incident-particle and target types, problem and decay chains involved, etc. (see Sec. IV), and calls subroutines LEVPREP, TCPREP, and SETUP for initial problem setup. At each energy for which a calculation occurs, SETUP2 and SPECTRA are called. After the calculation, DATAOUT is called to provide a summary of the results.

LCSPACE - Sets up extended-core-storage (ECS) locations, zeroes extended-core locations, determines parent reactions, and creates population-storage buffers.

CHAINS - Called if automatic setup of chains is desired.

ENERGY - Determines masses, separation energies, and ground-state spins and parities from the GROUND2 data file (Appendix B).

XMAGIC - Determines whether a nucleus is "odd" or "even," according to the Gilbert-Cameron[20] level-density prescription.

LEVPREP - Prepares a binary level-data file ordered properly for the calculation from an input binary-coded decimal (BCD) level file or cards. Stores Jπ data in extended-core arrays.

TCPREP - Reads in transmission-coefficient data, eliminates J-dependence of spin 1/2 arrays, reorders spin 0 and spin 1 arrays, determines the number of nonzero coefficients, and stores transmission-coefficient data in ECS.

SETUP - Provides general setup information by determining accumulated separation energies for the decaying nuclei, identifies incident particle as well as secondary particles and photons, determines whether a residudal nucleus is even or odd, sets up Jπ arrays, and initializes level densitities and Gilbert-Cameron level-density parameters.

SETUP2 - Provides setup information for each incident energy in a calculation. Sets up energies, determines integration end points, and generates incident-channel transmission coefficients.

SPECTRA - The main subroutine of the program in which the widths (total and partial) and population increments used to compute the spectra are calculated for all compound nuclei and decay reactions occurring in a specified decay chain. Figure 3 illustrates the treatment of the decay sequence in which gamma rays and particles may be emitted from one or several compound nuclei. Through several nested DO loops, the entire reaction sequence is handled. The outermost loop sums over decaying compound nuclei involved in the reaction sequence. The second loop sums over energy bins in the decaying compound nucleus. The third loop provides flags that indicate whether total decay widths should be calculated (first execution) or whether populations of continuum-continuum or continuum-level transitions should be calculated (second execution). A fourth loop sums over reaction types occuring in the decay of a continuum bin in the compound nucleus. Thus, all decays (either gamma-ray or particle) are handled in the same manner. The decays to contintinnum bins or discrete levels in a particular residual nucleus are then obtained from sums over the fifth loop. If preequilibrium effects are to be included, PRECMP is called to modify the continuum and level populations computed above. The GRLINES subroutine is then called to compute discrete gamma-ray cross sections and to add these cross sections to the computed gamma-ray spectra.

LEVDSET - Provides pairing and shell corrections from the tables of Cook et al.[21] to be used in the computation of level densities using the Gilbert-Cameron Fermi-gas level-density expression. Calls GILCAM to provide information for the Gilbert-Cameron constant-temperature level-density expression.

GILCAM - Where possible, computes energy matching parameters for the Gilbert-Cameron constant-temperature expression using input data that describe the number of levels present up to a given excitation energy.

A. Loop over all decaying nuclei

B. Loop over energy bins $\psi(UJ\pi)$ compound nucleus I

C. Width-summing loop $\begin{cases} M = 1 \rightarrow \Gamma_{tot} \\ M = 2 \rightarrow P \end{cases}$

D. Loop over decay reaction types

E1. Loop over continuun bins $\psi'(U'J'\pi')$ of residual nucleus I'

M = 1 compute

$$\Gamma_{tot}(I,\psi) = \Gamma_{tot}(I,\psi) + \Gamma(I,\psi:I'\psi')\rho(I'\psi')\Delta E$$

M = 2 compute

$$DP = \Gamma(I\psi:I'\psi')\rho(I'\psi')P(I\psi)\Delta E/\Gamma_{tot}(I\psi)$$

$$P(I'\psi') = P(I'\psi') + DP$$

E2. Loop over residual-nucleus discrete levels $\psi'(E'I'\pi')$

M = 1 compute

$$\Gamma_{tot}(I,\psi) = \Gamma_{tot}(I,\psi) + \Gamma(I\psi:I'\psi')$$

M = 2 compute

$$PL(I'\psi') = PL(I'\psi') + \Gamma(I\psi:I'\psi')P(I\psi)/\Gamma_{tot}(I\psi)$$

Close D loop

Close B and C loops

Close A loop

Fig. 3.
Schematic flow diagram for the SPECTRA subroutine.

LCMLOAD - Computes transmission coefficients, level-density values, and Yrast values on an integration energy mesh for each nucleus involved in a particular segment of the decay chain.

GAMSET - Sets up the gamma-ray cascade calculation, determines Weisskopf or Brink-Axel parameters, and computes gamma-ray transmission coefficients.

WEISSKF - Normalizes Weisskopf or Brink-Axel gamma-ray strength expressions to the input values of $(2\pi\langle\Gamma\rangle)/\langle D\rangle$ determined from s-wave neutron resonance data.

INCHSUM - Performs sums over s and ℓ of the incident channel for a given compound nucleus spin and parity.

SUMER - Adds computed population increase into spectra and level-population arrays.

GRLINES - Computes discrete gamma-ray cross sections; sums spectra to obtain integrated cross sections.

DATAOUT - Main output subroutine. Depending on which print options are selected, widths, individual and composite spectra, cross sections, discrete levels, gamma-ray data, and level-density parameters can be printed.

ISERCH - Determines the parameters necessary for the interpolation routine.

PRECMP - Determines preequilibrium contribution, renormalizes compound-nucleus cross sections, adds preequilibrium contribution into calculated particle spectra, and modifies continuum and level populations to account for preequilibrium effects.

INTERP - Main interpolation routine.

IV. MAIN CODE INPUT PARAMETERS

We attempted to keep the GNASH input as simple as possible. Thus all masses, separation energies, and ground-state spins and parities are taken from a data file (GROUND2, listed in Appendix B), which accompanies the program. The masses in the file are either the 1971 adjusted experimental values of Wapstra,[22] or interpolated or extrapolated values from fits to the measured masses using the semi-empirical relations of Garvey et al.[23] The ground-state spins and parities are based on experimental measurements.[24] If J or π is unknown, a value of 99. appears in the file. Unknown spins and parities are flagged during execution, and $J^{\pi} = 0^{+}$ (even A) or $J^{\pi} = 1/2^{+}$ (odd A) is used in the actual calculation.

The input parameters required for the main GNASH code are described in Table I, and a sample input is given in Appendix C. The following sequence of input data cards is used:

(A) (2 cards) FORMAT (8A10): TITLE(N), N = 1, 16

(B) (1 card) FORMAT (5I4): IPRTLEV, IPRTTC, IPRTWID, IPRTSP, IPRTGC

(C) (1 card) FORMAT (5I4): INPOPT, KLIN, KTIN, NIBD, LMAXOPT

(D) (1 card) FORMAT (6I4): NI, NMP, LGROPT, LPEQ, NJMAX, ICAPT

(E) (1 card) FORMAT (4E10.3): ZAP, ZAT, DE, FSIGCN

(F) (1 card) FORMAT (1I4): NELAB

(G) (1-3 cards) FORMAT (8E10.3): ELABS(N), N = 1, NELAB

(H) (0-70 cards) Reaction-chain data. The form and complexity of this segment depends on the particular input option chosen, as follows:

(1) <u>INPOPT = 1, 2, or 3</u> (0 cards)

Reaction chains are set up automatically.

(2) <u>INPOPT = -1</u> (1-10 cards) (DO loop I = 1, NI)

FORMAT (8E10.3): ZACN(I), XNIP(I), SWS(I), [ZZA1(IP), IP = 2, NIP]

(3) <u>INPOPT = 0</u> (2-70 cards)

(a) Outer DO loop I = 1, NI

(1 card per I) FORMAT (5E10.3): ZACN(I), XNIP(I), CNPI(I), CNPIP(I), SWS(I)

(b) Inner DO loop IP = 1, NIP

(1-6 cards per I) FORMAT (5E10.3): ZA1(IR), XNL(IR), A(IR), XNLGC(IR), ECGC(IR), where IR is a running reaction index that defines a unique I, IP for each reaction sequence.

(I) (1-6 cards) (DO loop MP = 1, NMP)

FORMAT (8X, A1, I1, E10.3): LMGHOL(MP), LG, RE1(MP)

(J) (0-1 cards) Input depends on LPEQ parameter, as follows:

(1) LPEQ = 0 (0 cards)

(2) LPEQ = 1 (1 card)

FORMAT (6E10.3): [ALPHA1(IDX), IDX = 1, 6]

TABLE I

MAIN INPUT PARAMETERS FOR GNASH

Parameter	Description
TITLE	Two cards of Hollerith information to describe the problem being calculated.
IPRTLEV	Print control for discrete-level data. Set IPRTLEV = 0(1) to omit (include) print of discrete-level information.

TABLE I (cont)

Parameter	Description
IPRTTC	Print control for transmission coefficients. Set IPRTTC = 0(1) to omit (include) print of input transmission coefficients. Set IPRTTC > 1 to print input values and interpolated transmission coefficients at every (IPRTTC-1)th energy on the basic integration energy mesh.
IPRTWID	Print control for reaction decay widths. Set IPRTWID = 0(1) to omit (include) print of decay widths for each reaction channel on the basic integration energy mesh.
IPRTSP	Print control for calculated energy spectra, as follows: IPRTSP = 0 to omit print of all calculated energy spectra. = 1 to only print composite spectra for each radiation type in the calculation, that is, composite spectra for emitted gamma rays, neutrons, protons, etc. = 2 to print individual spectra from each decay process included in the calculation, omitting the composite spectra. = 3 to print both individual reaction and composite spectra.
IPRTGC	Print control for level-density information. Set IPRTGC = 0(1) to omit (include) print of level-density parameters for each residual nucleus in the calculation. Set IPRTGC > 1 to print parameters and computed level densities at every (IPRTGC-1)th energy on the basic integration energy mesh for each residual nucleus.
INPOPT	Input control for designating the input option chosen to specify the reaction chains followed in the calculation. The following options are available: INPOPT = 0 is the most general input option available for specifying the reaction chains and the various parameters associated with each chain. For example, it permits (but does not require) input of level-density parameters for each residual nucleus in a calculation. See description of card input for details of reaction-chain input. = -1 also permits general specification of reaction chains but uses automatic features to simplify input. With this option, the code uses a built-in level-density parameterization and automatically determines parentage of each decaying compound nucleus by assuming that all previous, unassigned reactions leading to a given compound nucleus contribute to its initial population of states.

TABLE I (cont)

Parameter	Description
	= 1 to automatically follow the neutron chain from the initial compound nucleus. A total of NI (see card no. 5, Sec. IV-D) compound nuclei are included, and each is permitted to decay by emission of gamma rays and neutrons.
	= 2 same as INPOPT = 1 except each compound nucleus is permitted to decay by emission of gamma rays, neutrons, protons, and alpha particles.
	= 3 same as INPOPT = 2 except that the product nuclei that result from proton and alpha emission are themselves allowed to gamma decay.
KLIN	Input fileset for discrete energy-level data (= 5 for card input, = blank or 8 for input on disk or tape file 8).
KTIN	Input fileset for transmission-coefficient data (= 5 for card input, = blank or 10 for input on disk or tape file 10).
NIBD	Number of large-core buffers set up for storing state populations in reaction products that will further decay. The default value for NIBD is 10, which is also the maximum dimension.
LMAXOPT	Control for limiting the number of transmission coefficients (T_ℓ) included in a calculation by requiring that $(2\ell + 1)T > T_0 * 10^{-\|LMAXOPT\|}$. The default value is LMAXOPT = 5.
NI	Number of compound nuclei that are permitted to decay in the reaction chain (maximum of 10).
NMP	Number of gamma-ray multipolarities permitted in radiative decays (maximum of 6).
LGROPT	Control for indicating the model desired for calculating gamma-ray transition probabilities, as follows: LGROPT = 1 for the Weisskopf approximation. = 2 for the Brink-Axel approximation.
LPEQ	Preequilibrium control. Set LPEQ = 0(1) to omit (include) preequilibrium processes in the calculation.
NJMAX	Maximum number of values of total angular momentum permitted in the calculation (dimensioned for 40, which is also the default value). For even-A cases, J_{max} = NJMAX - 1; for odd-A cases, $J_{max} = (2 * NJMAX - 1)/2$.

TABLE I (cont)

Parameter	Description
ICAPT	Gamma-ray cascade control for initial compound nucleus: ICAPT = 0 to omit full gamma-ray cascade calculation in the initial compound nucleus (all subsequent compound nuclei do include the full cascade). = 1 to include the full gamma-ray cascade in calculation in all compound nuclei.
ZAP	1000 * Z + A for the incident particle or projectile, where Z is atomic number and A is the (integer) mass number.
ZAT	1000 * Z + A for the target nucleus.
DE	Energy increment for the basic integration energy mesh (in millions of electron volts). A maximum of 200 energy steps is permitted. If the chosen value of DE is too small, the code automatically increases it to satisfy the 200-step limit.
FGSIGCN	Constant multiplier applied to all calculated quantities (default value is 1.0).
NELAB	Number of incident neutron energies included in the calculation (maximum of 20).
ELABS(N)	Incident particle energies in millions of electron volts for the calculation.
ZACN(I)	1000 * Z + A for each compound nucleus that is permitted to decay (I is the index that specifies the decaying compound nucleus.)
XNIP(I)	Number of decay channels included for compound nucleus ZACN(I). The minimum value is 1., and the maximum is 6. The fixed-point value of XNIP(I) is NIP in the code, and the decay index IP runs from IP = 1 to NIP for each compound nucleus.
SWS(I)	Value of the gamma-ray strength function for s-wave neutrons, $2\pi\langle\Gamma_\gamma\rangle/\langle D\rangle$, that is used to normalize the gamma-ray transition probabilities. A negative value of SWS can be used to directly input a normalization factor of $\lvert$SWS(I)$\rvert$. In the case of the Brink-Axel approximation, SWS(I) can be set equal to 0. to indicate use of a built-in, constant normalization factor.
ZZA1(IP)	1000 * Z + A for the radiation emitted from ZACN(I) by decay into channel IP. Note that ZZA1(1) = 0. (gamma ray) is assumed in all cases. Other possible values are 1., 1001., 1002., 1003., 2003., and 2004. (maximum of IP = 6).
CNPI(I)	Parentage designator that indicates the previous compound nucleus index I_p whose decay leads to the formation of ZACN(I).

TABLE I (cont)

Parameter	Description
CNPIP(I)	Parentage designator that indicates the previous decay index IP_p that leads to the formation of ZACN(I).
ZA1(IR)	Same as ZZA1(IP) described above. Note that the running reaction index IR defines a unique I, IP for each reaction sequence.
XNL(IR)	Number of discrete levels to be included in the calculation for the residual nucleus formed in reaction IR. If XNL(IR) = 0., then the total number of levels input in the Level-Data File (described in Sec. V) is used.
A(IR)	Level-density parameter, a, for use in the Gilbert-Cameron[20] formula for the residual nucleus formed by reaction IR. Set A(IR) = 0. to use built-in values [see Eq. (14)].
XNLGC(IR) and ECGC(IR)	Number of discrete levels, XNLGC(IR), at excitation energy ECGC(IR) that are matched in the code to the Gilbert-Cameron formula for the continuum level density. If both these parameters are set equal to 0., then the total number of levels input in the Level-Data File is used.
LMGHOL(MP)	Hollerith E or M to designate the MPth radiative transition as electric or magnetic.
LG	Multipole order of the MPth transition.
RE1(MP)	Ratio of the strength of the MPth transition to the strength of the E1 transition. Set RE1(MP) = 0. to use a built-in value.
ALPHA1(IDX)	Preequilibrium normalization constants [see Eq. (7)] for reactions involving emitted neutrons, protons, deuterons, tritons, ^{3}He, and ^{4}He for IDX = 1 through 6, respectively. Set ALPHA1(IDX) = 0. to use the built-in values.

V. ADDITIONAL INPUT PARAMETERS

A. Discrete-Level Data

Following the main input, a separate subroutine (LEVPREP) is called to input discrete-level data. These data can either be selected from a general data file on disk or magnetic tape (KLIN = 8) or they can be input directly on cards for the cases required (KLIN = 5). In either case, the overall ordering of the information must be for increasing ZA (1000Z + A). The discrete-level input parameters are described in Table II, and input for the sample problem of Appendix C is given in the first part of Appendix D (pp. D-1 through D-5). The following sequence of cards (or card images) is required for each residual nucleus requiring level data:

(A) (1 card) FORMAT (I8, I5, F12.6): ID, NL, F

(B) Outer loop on levels (DO loop N = 1, NL)

FORMAT (I6, F12.6, 2F6.1, E12.5, I6): NX, EL(N), AJ(N), AT(N), TAU, NT

(C) Inner loop for each level (DO loop K = 1, NT)

FORMAT (12X, I6, 2F12.6): NF, P, CP

TABLE II

DISCRETE-LEVEL INPUT PARAMETERS

Parameter	Description
ID	1000 * Z + A of the nucleus whose levels are being input.
NL	Number of levels being input.
F	For card input, set F = -1. for the last nucleus (highest ID) for which level data is input. Otherwise, set F = 0.
NX	Level number (= N), that is, N = 1 for the ground state, N = 2 for the first excited state, etc.
EL(N)	Energy in million electron volts of the Nth level; that is, EL(1) = 0.
AJ(N)	Spin and parity of the Nth level. The sign of AJ(N) indicates the parity. For example, -0. is interpreted as a $J^{\pi} = 0^{-}$ state.
AT(N)	Isospin of the Nth level (if unknown, it is set equal to 99.0). AT(N) is not used in the calculation at present.
TAU	Half-life of the state in seconds (if unknown, it is set equal to 99.0 or 0.0). TAU is not used in the calculation.
NT	Number of gamma-ray branches from the Nth level to lower levels.
NF	Level number indicator for a level to which a gamma-ray transition is occurring.
P	Gamma-ray branching ratio for the transition defined by N → NF. For bound states, $\sum_{NF} P(N \rightarrow NF) = 1$. For unbound states, $\sum_{NF} P(N \rightarrow NF)$ = the total probability for decays other than particle emission.
CP	Probability that the transitions characterized by P(N → NF) are gamma-ray transitions. If, for example, there is a 20% probability that electron conversion is the decay mechanism, then CP = 0.80.

TABLE III

TRANSMISSION-COEFFICIENT INPUT PARAMETERS

Parameter	Description
NPART	Number of particles for which transmission coefficients are input.
BCDTC(8)	Seventy-five columns of Hollerith descriptive information.
XBCD	Alphanumeric particle identifiers, as follows: _NEUTRON, _PROTON, _DEUTERON, _TRITON, _HE-3, _ALPHA; that is, a blank column precedes each identifier.
NE	Number of energies included in energy grid for transmission coefficients.
NN	Number of coefficients input at each energy in the COMNUC format.
K	Optional card counter. Can be used to check ordering of cards.
ETC(J,ID)	Energy grid for transmission coefficients. The index J specifies the energy and ID is an internal identifier that specifies the particle.
TDUM(L)	Transmission-coefficient array. The index L runs from 1 to NN for each energy on the grid. The coefficients are collapsed to remove J-dependence and are stored as functions of energy for each particle.

B. Transmission Coefficients

Transmission coefficients for the projectile and outgoing particles are input in the subroutine TCPREP, following the discrete-level data input. Again, these data can be provided on a disk or magnetic tape file (KTIN = 10), or directly from cards (KTIN = 5). We have adopted the format used by COMNUC[16] for transmission coefficients, and data for the various particles can be input in any order. The input parameters are described in Table III, and transmission coefficients for the sample problem follows the level data in Appendix D (pp. D-6 through D-14). The following sequences of cards (or card images) is required:

(A) (1 card) FORMAT (I4, 1X, 7A10, A5): NPART, [BCDTC(I), I = 1, 8]

(B) Outer loop on particles (DO loop N = 1, NPART)

(1 card per N loop) FORMAT (42X, A10, 12X, 2I4, A8): XBCD, NE, NN, K

(C) Input energy grid for particle N (internal identifier = ID). (DO loop I = 2, NE, 6)

(1-5 cards per N loop) FORMAT (6E12.2, A6): [ETC(J,ID), J = I, I + 5], K

(D) Input transmission coefficients for particle N. Outer loop on energy (DO loop I = 2, NE), inner loop on NN (DO loop J = 1, NN, 6)

(1-7 cards per energy, depending on NN) FORMAT (6E12.2, A6): [TDUM(L), L = J, J + 5], K

VI. CODE OUTPUT

The code output from the sample problem described in Appendixes C and D is given in Appendix E. The amount of detail included in the output depends upon the values of the parameters IPRTLEV, IPRTTC, IPRTWID, IPRTSP, and IPRTGC, described in Table I. The problem output, the result of a typical setup used at the Los Alamos Scientific Laboratory, consists essentially of six parts:

(1) Input data (pp. E-1 and E-2), including the parentage indicators, masses (XMR), separation energies (S), and buffering information automatically determined by the code. Note that the number of discrete levels (NLEV) and the level-density parameters (A, NLGC, and ECGC) have not been determined yet unless they were input directly into the calculation. Also note in the column at the far right that the number of population-storage buffers is the minimum possible (4) for this particular calculation. Buffer No. 1 is reused in the decay of the ZA = 27059 nucleus for storage of the ZA = 27058 level populations. The buffer numbers set to zero indicate residual nuclei that are not allowed to further decay in the calculation.

(2) Timing information (p. E-3), printed as the code progresses through the main computer loops in subroutine SPECTRA, and normalization constants for the gamma-ray transition strengths (input directly in the example).

(3) Binary reaction cross sections (p. E-4).

(4) Calculated cross sections, average energies, and secondary spectra of emitted radiation from individual reactions (pp. E-5 and E-6) and composite spectra for the various species of emitted radiation (p. E-7). Cross sections for reactions to discrete states, and gamma rays from de-excitation of excited states are included in the spectral listings. Above each spectral column appear the integrated level decay, level excitation, and total production cross sections and average emitted energy for the particular reaction. Multiparticle cross sections such as $\sigma_{n,2n}$ and $\sigma_{n,np}$ can be deduced from the integrated cross sections. The energies associated with the emission spectra are midpoint values from the integration energy bins. Both the spectral energies and cross sections are given in the c.m. system of the recoiling nucleus plus particle or gamma ray. For medium or heavy mass nuclei, the c.m.-to-laboratory transformation factors are essentially unity.

(5) Discrete-level excitation and gamma-ray de-excitation cross sections (pp. E-8 through E-15). The gamma-ray de-excitation cross sections only appear

for the decaying compound nuclei and in those cases the level and gamma-ray production cross sections include cascade effects.

(6) Summary of the parameters used in the Gilbert-Cameron level-density formulas (p. E-12). The quantities E0 [E_0 in Eq. (13)] and EMATCH [energy where Eqs. (12) and (13) are matched] are determined from the number of discrete levels at excitation energy ECUT and the level-density parameter a. The neutron and proton pairing corrections (PN and PZ) and shell corrections (SN and SZ) are listed, together with the neutron-separation energies (S) for each residual nucleus. The quantity SAC is the "accumulated separation energy," that is, the energy of each decaying compound nucleus relative to the first compound nucleus.

VII. DISCUSSION

The transmission coefficients given in Appendix D, which were used for the sample problem, were calculated from the Wilmore-Hodgson[25] global optical parameters for neutrons, the Bechetti-Greenlees[26] parameters for protons, and the Igo[27] parameters for alphas. The gamma-ray strength normalizations, which were input directly for the sample problem, were originally determined by normalizing the calculations for each compound nucleus to values of $2\pi\langle\Gamma_\gamma\rangle/\langle D\rangle$ of approximately 25×10^{-4} for the Co isotopes and 2×10^{-3} and 3×10^{-4} for ^{56}Mn and ^{59}Fe. Note that the sample problem results are for illustrative purposes only. A tighter integration mesh and more careful selection of model parameters would be advisable for a serious calculation. Additional examples of n + ^{59}Co reaction cross-section calculations are compared to experimental data in Figs. 4-7. These results were obtained with the global optical parameters described above, but with a tighter integration mesh in GNASH than the one in our sample problem.

Thus far the validation of the GNASH code[2-8] has been for incident neutrons or protons with energies mainly below 25 MeV. At energies above 25-30 MeV, the binary reactions are dominated by the preequilibrium component, and calculations become increasingly sensitive to the accuracy of that approximation. At incident energies below ~100 keV, use of GNASH becomes inefficient because of restrictions on the integration step size. Caution should also be exercised in using global parameter sets for generating transmission coefficients; we think the discrepancy between calculated and measured values of the ^{59}Co(n,α) cross section in Fig. 6 resulted in part from inadequate optical parameters for alpha particles.

For complicated reaction sequences or higher energy calculations, computational times can be excessive. Because computational times are very problem dependent, the following parameters, which are most important in determining the

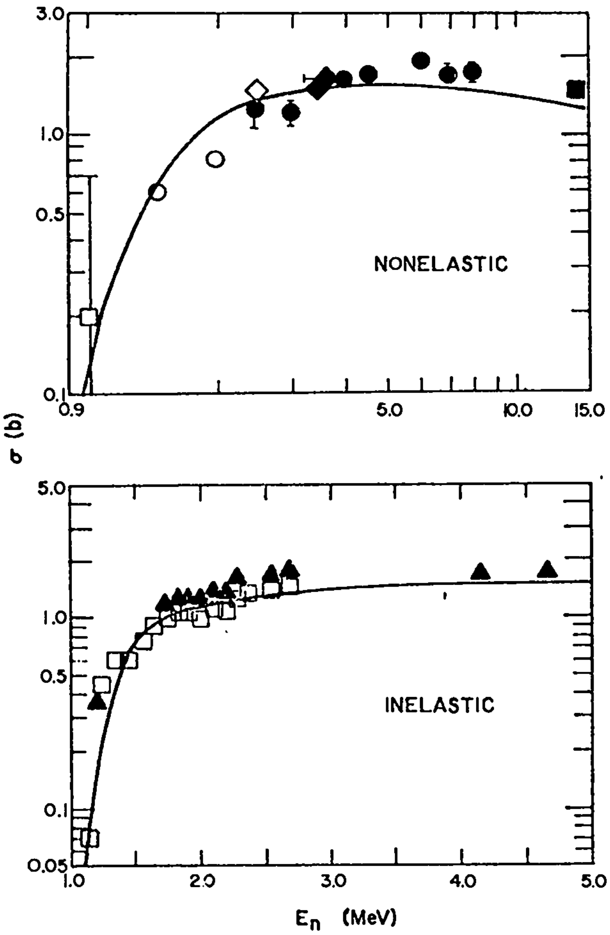

Fig. 4.
Comparison of calculated nonelastic and inelastic neutron cross sections for ^{59}Co with various experimental data. The solid curves represent the GNASH calculations.

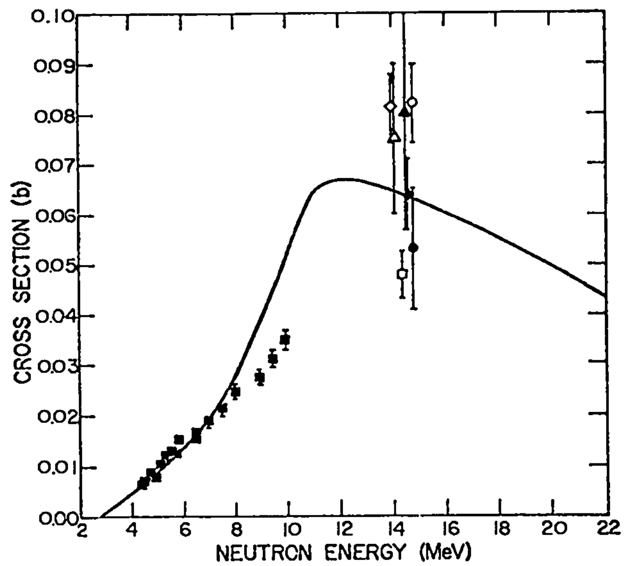

Fig. 5.
Calculated and measured values of the ^{59}Co(n,p) cross section. The solid curve represents the GNASH calculations.

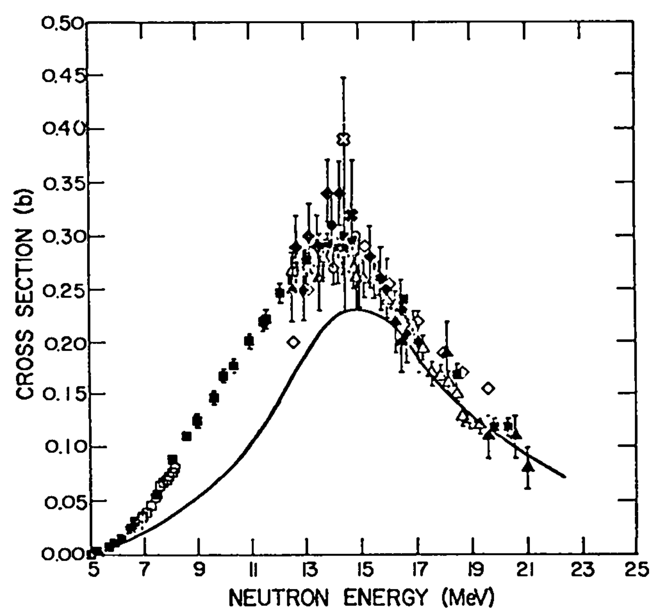

Fig. 6.
Calculated and measured values of the ^{59}Co(n,α) cross section. The solid curve represents the GNASH calculations.

times, should be chosen carefully: energy-bin width (DE), the maximum number of total angular momentum states in the compound nucleus (NJMAX), the criteria for limiting the number of transmission coefficients (LMAXOPT), and the number of decaying nuclei (NI) in the calculation. In addition, the gamma-ray cascade calculation for the initial compound nucleus should always be turned off (ICAPT = 0) unless the spectrum of capture gamma rays is specifically required. A summary of running times for n + ^{59}Co calculations to 40 MeV using the reaction chain of Fig. 2 is shown in Fig. 8. For these calculations, the following parameters were used: DE = 1 MeV, NJMAX = 40, NI = 5, and ICAPT = 0. When they were performed, the option for limiting the number of transmission coefficients had not yet been implemented, so in effect the results were obtained with LMAXOPT ≃ 15. The times given in Fig. 8 can therefore be significantly reduced (~35%) without accuracy loss by using the LMAXOPT parameter.

ACKNOWLEDGMENT

The authors wish to thank D. G. Foster, Jr., for providing the data file that contains ground-state masses, separation energies, spins, and parities.

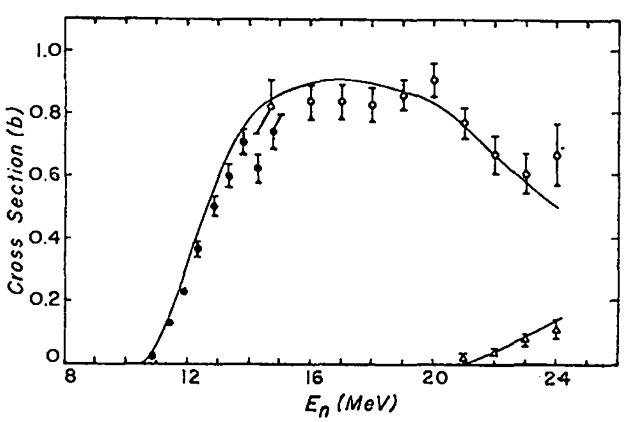

Fig. 7.
Calculated and measured (n,2n) and (n,3n) cross sections for ^{59}Co. The solid curves represent the GNASH calculations; the triangles indicate the (n,3n) measurements.

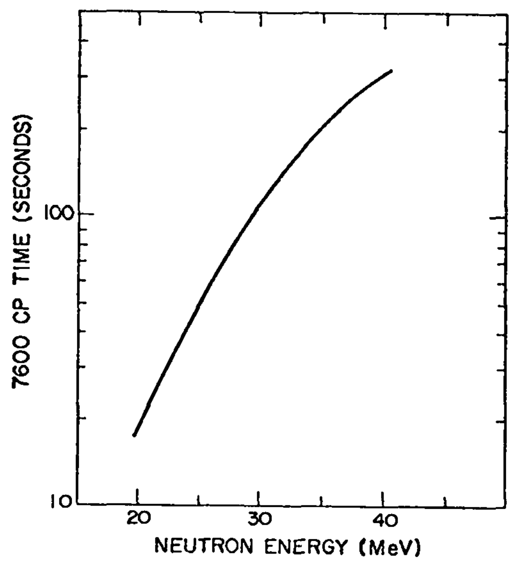

Fig. 8.
CDC 7600 central-processor time for GNASH calculations of n + ^{59}Co reactions out to 40 MeV. These times can be further reduced by careful limitation of the maximum order of transmission coefficients used in the calculation. See text for details.

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APPENDIX A

PROGRAM LISTING

COPYSF   4 FILES FROM FSET1   LASL Identification No. LP-0778

```
      PROGRAM GNASH(INP,FSET5=INP ,OUT,FSET6=OUT,FSET8,FSET9,           MAIN   2
     1 FSET10,FSET11,FSET12,FSET13)                                     APR07771
C                                                                       MAIN   4
C     GAMMA-RAY, NEUTRON, AND ASSORTED SPECTRA FROM HEAVY NUCLEI        MAIN   5
C                                                                       MAIN   6
C     FSET8 = INPUT LEVEL DATA IF CARDS NOT USED                        MAIN   8
C     FSET9 = INTERNAL BINARY LEVEL DATA FILE (KL)                      MAIN   9
C     FSET10= INPUT TRANSMISSION COEFFICIENTS IF CARDS NOT USED         MAIN  10
C     FSET11= LEVEL SCRATCH FILE - AVAILABLE FOR PUNCH OR DISC O/P      APR07772
C     FSET13= INPUT GROUND-STATE MASS EXCESS, SPIN, AND PARITY          MAIN  11
C                                                                       MAIN  12
C     IPRTLEV=0 TO OMIT PRINT OF DISCRETE LEVEL INFORMATION             MAIN  13
C     IPRTTC =0 TO OMIT PRINT OF ANY TRANSMISSION COEFFICIENTS          MAIN  14
C     IPRTTC =1 TO PRINT I/P TRANSMISSION COEFFICIENTS                  MAIN  15
C     IPRTTC.GE.2 TO PRINT TRANSMISSION COEFFICIENTS AT EVERY (IPRTTC-1)MAIN  16
C                 TH ENERGY ON THE BASIC INTEGRATION ENERGY MESH        MAIN  17
C     IPRTWID=0 TO OMIT WIDTH PRINT                                     MAIN  18
C     IPRTSP =0 TO OMIT SPECTRA PRINT                                   MAIN  19
C     IPRTSP =1 TO PRINT COMPOSITE SPECTRA ONLY                         MAIN  20
C     IPRTSP =2 TO PRINT INDIVIDUAL SPECTRA ONLY                        MAIN  21
C     IPRTSP =3 TO PRINT COMPOSITE AND INDIVIDUAL SPECTRA               MAIN  22
C     IPRTGC =0 TO OMIT PRINT OF LEVEL DENSITY PARAMETERS               MAIN  23
C     IPRTGC =1 TO PRINT GILBERT-CAMERON LEVEL DENSITY PARAMETERS       MAIN  24
C     IPRTGC.GE.2 TO PRINT LEVEL DENSITIES AT EVERY (IPRTGC-1) TH ENERGYMAIN  25
C                 ON THE BASIC INTEGRATION ENERGY MESH                  MAIN  26
C     INPOPT=-1 MANUALLY READ IN REACTION CHAINS BUT CODE AUTOMATICALLY MAIN  27
C               ASSIGNS PARENTAGE, CNPI(I) AND CNPIP(I) ARE ASSUMED TO  MAIN  28
C               BE ALL UNASSIGNED HIGHER REACTIONS THAT PRODUCE ZACN(I) MAIN  29
C     INPOPT=0 MANUALLY I/P REACTION CHAINS AND PARENTAGE INDICATORS    MAIN  30
C     INPOPT=1 AUTOMATICALLY FOLLOW NEUTRON CHAIN WITH G,N DECAYS       MAIN  31
C     INPOPT=2 AUTOMATICALLY FOLLOW NEUTRON CHAIN WITH G,N,P,A DECAYS   MAIN  32
C     INPOPT=3 AUTOMATICALLY FOLLOW NEUTRON CHAIN WITH G,N,P,A DECAYS,  MAIN  33
C              AND PICK UP GAMMAS FROM P AND A DECAYS                   MAIN  34
C     SWS(I) = + TO NORMALIZE S-WAVE STRENGTH TO SWS(I)                 MAIN  35
C     SWS(I) = 0. TO USE UNNORMALIZED GAMMA RAY TRANSITION PROBABILITIESMAIN  36
C              AS ADJUSTED BY RE1(1)                                    MAIN  37
C     SWS(I) = - TO MULTIPLY GAMMA TRANSITION PROBABILITIES BY          MAIN  38
C                ABS(SWS(I))                                            MAIN  39
C                                                                       MAIN  40
1     FORMAT(20I4)                                                      MAIN  41
2     FORMAT(1P,8E10.3)                                                 MAIN  42
3     FORMAT(8A10)                                                      MAIN  43
4     FORMAT(1H1,8A10,/1H ,8A10)                                        MAIN  44
5     FORMAT(8X,A1,I1,1P,7E10.3)                                        MAIN  45
    6 FORMAT(1P,E10.3,10X,6E10.3)                                       MAIN  46
7     FORMAT(/ 9H IPRTLEV=I2,3X,7HIPRTTC=I2,3X,             8HIPRTWIDMAIN  47
     1=I2,3X,7HIPRTSP=I2,3X,7HIPRTGC=I2)                                MAIN  48
8     FORMAT( 8H INPOPT=I2,3X,5HKLIN=I2,3X,5HKTIN=I2,3X,5HNIBD=I2,3X,   JUL26771
     1 8HLMAXOPT=I2,/)                                                  JUL26772
    9 FORMAT(/4H NI=,I3,3X,4HNMP=,I2,3X,7HLGROPT=,I2,3X,                MAIN  50
     1 5HLPEQ=I2,3X,6HNJMAX=I3,3X,*ICAPT=*I2)                           MAIN  51
10    FORMAT(/ 5H ZAP=F5.0,3X,4HZAT=F6.0,3X,3HDE=F6.3,4H MEV,           MAIN  52
     1               3X,4HXMT=F10.5,4H AMU,3X,3HSP=F6.3,4H MEV,3X,      MAIN  53
     2 8HECUTOFF=F5.2,4H MEV)                                           MAIN  54
11    FORMAT(  5H ACN=F7.3,5H /MEV,3X,                      7HFSIGCNMAIN  55
     1=F7.3,3X,6HDEFCN=F2.0,3X,7HSPINT =F5.1,3X,4HPIT=F3.0)             MAIN  56
   12 FORMAT(/*  I    ZACN  NIP      PARENT*,9X,*S-WAVE*,8X,*IP*,4X,*ZA1*,MAIN  57
     1  4X*ZA2*,5X,*XMR*,8X,*S*,4X,*NLEV  DEF   A     NLGC     ECGC  BUFMAIN  58
     2FER*/* --  -----  ---         I     IP*,                          MAIN  59
     3                        *   STRENGTH, ENERGY   --   ----  *,      MAIN  60
```

```
      4 * ----- (AMU)     (MEV)   --   --- (/MEV)  ----    (MEV)  NUMBMAIN  61
      5ER*)                                                            MAIN  62
 13   FORMAT(I3,F7.0,F4.0,F7.0,F6.0,2X,1PE10.3,0P,F7.3)                MAIN  63
   14 FORMAT(46X.I5,F7.0.F8.0,F8.3,F10.3,2F5.0,F8.3,F5.0,F10.3,I7)     MAIN  64
 15   FORMAT(/ 46H INDEX   L  PARITY  MULTIPOLARITY  RATIO TO E1)      MAIN  65
 16   FORMAT(I4,2F6.0.9X,A1,I1,8X,G11.4)                               MAIN  66
 17   FORMAT(//* WEISSKOPF APPROXIMATION USED FOR GAMMA-RAY TRANSMISSIONMAIN  67
      1 COEFFICIENTS*)                                                 MAIN  68
 18   FORMAT(//      * AXEL APPROXIMATION USED FOR GAMMA-RAY TRANSMISSIONMAIN  69
      1 COEFFICIENTS*)                                                 MAIN  70
 19   FORMAT(/ 26H INCIDENT ENERGIES (MEV) =,1P,10E10.3,/26X,10E10.3)  MAIN  71
25    FORMAT(//5X*COLLI-MILAZZO CLOSED FORM USED FOR ABSOLUTE CAL OF PREMAIN  72
      1-EQUILIBRIUM CROSS SECTION *//,* PRE-EQUILIBRIUM NORMALIZATION CONMAIN  73
      2STANTS ARE / *,6A10,/39X,*(INPUT) *,1P,6E10.3,/39X,* (USED) *,  MAIN  74
      3 6E10.3)                                                        MAIN  75
C                                                                      MAIN  76
30    FORMAT(//25X*  THE LAB ENERGY IS   *G11.4* MEV *//)              MAIN  77
 33   FORMAT(20A4)                                                     MAIN  78
 34   FORMAT(1X,20A4)                                                  MAIN  79
      COMMON RHO(40,200),T(30,200).P(80),SP(200,6),PP(80),SPP(200,7)   RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                         RHO    3
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC, LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                   LCNDEX 4
      COMMON/TCOEF/ETC(25,6),TC(25,30),BCD(7),XSPIN(7),NLDIM,          TCOEF  2
     1NPART,NEE(6),NO(6),NTC(6),IZAID(7),XMASS(7),NEEDIM,NLEIN(6,25),  TCOEF  3
     2NLE(6,200).JRAST(200,6)                                          TCOEF  4
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM     LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                      LEVEL1 3
      COMMON/BASIC1/NI.XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),  BASIC1 2
     1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60)  BASIC1 3
      COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,   NKKM(10),CNPI(10), BASIC2 2
     1 CNPIP(10).S(60),SAC(10),ID1(60),IDP,IOF2(60),IBUF(6,10),        BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60), BASIC2 4
     3 NRHO(6),XJT,    NPOPMAX,NTC2(6),NJDIM,  IOECN(10).NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2),XMP.XJP,PIT,NLP,XNLP,KL.IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                 BASIC2 7
      COMMON/GAMMA/NMP,LGROPT,SWS(10),GML(6),GMP(6),RE1(6),LMGHOL(6),  GAMMA  2
     1 TGR(200,6),WKCON,CAXEL,GAXEL,ERAXEL,EXSWS(10),WKNORM            GAMMA  3
      COMMON/PREEQ/LPEQ,SIGR,PREQI(6),CSIGI(6),NITT(6),ALPHA(6)        PREEQ  2
      COMMON/PREQ1/EPSIG(200,6),NLEV,NPIT,NIT                          PREQ1  2
      COMMON/FITTING/ACN,FSIGCN,SIGPEQ                                 FITTING2
      COMMON/PRNTOUT/IPRTLEV,IPRTTC,IPRTMLD,IPRTWID,IPRTSP,IPRTGC      PRNTOUT2
      COMMON/LEVDEN/DEF(60),XNLGC(60),ECGC(60),UCUTOFF,DEFCN,TGC(60),  LEVDEN 2
     1 E0GC(60),EMATGC(60),PAIR(60),XMR3(60),XNLLN(60),SZ(100),SN(150), LEVDEN 3
     2 PZ(100),PN(150)                                                 LEVDEN 4
      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                 LEVDEN 5
C                                                                      MAIN  92
      DIMENSION ALPHA1(6)                                              MAIN  93
      DIMENSION ZZA1(6),ELABS(20)                                      MAIN  94
      DIMENSION ZINPU(20)                                              MAIN  95
      DATA BCD/10H NEUTRON  ,10H PROTON   ,10H DEUTERON ,10H TRITON   , MAIN  96
     1         10H HE-3     ,10H ALPHA    ,10H GAMMA-RAY/              MAIN  97
      DATA IZAID/1,1001,1002,1003,2003,2004,0/                         MAIN  98
      DATA KI,KL.K7,KGRD,IHOLE,IHOLM /5,9,7,13,1HE,1HM/                MAIN  99
      DATA XMASS/1.008665,1,007825,2.014102,3.016050,3,016030,4,002603, MAIN 100
     1 0,/                                                             MAIN 101
      DATA XSPIN/0.5.0.5,1.0,0.5,0.5,0.0,0.0/                          MAIN 102
      DATA NKOIM,NJDIM.NEEDIM,NLDIM,NLEVDIM/200,40,25,30,50/           MAIN 103
      DATA NIDIM.NIPDIM,NIBDIM,NGRDIM,NIDDIM/                          MAIN 104
     1      10,    6,     8,    240,     7  /                          MAIN 105
      DATA ALPHA/5.0E-04,5.0E-04,3*1.0E-02,5E-03/                      MAY77  1
      DATA NITT/3,3,3,3,3,3/                                           MAIN 107
```

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C                                                                         MAIN 108
      EXACTM(ZA,EXMASS) = ZA-1000.*FLOAT(IFIX(ZA/1000.))+EXMASS/931.502   MAIN 109
C                                                                         MAIN 110
C                                                                         MAIN 111
C     TAPE 12 = BUFFER INPUT                                              MAIN 112
C                                                                         MAIN 113
      WRITE(6,32)                                                         MAIN 114
 32   FORMAT(1H1)                                                         MAIN 115
 35   READ(KI,33) ZINPU                                                   MAIN 116
      IF(EOF,KI) 300.301                                                  MAIN 117
 301  WRITE(6,34) ZINPU                                                   MAIN 118
      WRITE(12,33) ZINPU                                                  MAIN 119
      GO TO 35                                                            MAIN 120
 300  CONTINUE                                                            MAIN 121
C                                                                         MAIN 122
C     NOW TAPE 12 = INPUT                                                 MAIN 123
C                                                                         MAIN 124
      KI=12                                                               MAIN 125
      ENDFILE KI                                                          MAIN 126
      REWIND KI                                                           MAIN 127
C                                                                         MAIN 128
C     MAIN INPUT SECTION                                                  MAIN 129
      EXMN = ENERGY(1.0)                                                  MAIN 130
 100  READ(KI,3) TITLE                                                    MAIN 131
      IF(EOF,KI)1000.101                                                  MAIN 132
 101  WRITE(6,4) TITLE                                                    MAIN 133
      READ(KI,1) IPRTLEV,IPRTTC,IPRTWID,IPRTSP,IPRTGC                     MAIN 134
      READ(KI,1) INPOPT,KLIN,KTIN,NIBD,LMAXOPT                            JUL26773
      IF(NIBD.GT.0) NIBDIM=NIBD                                           MAIN 136
      IF(KLIN.LT.1) KLIN=8                                                MAIN 137
      IF(KTIN.LT.1) KTIN=10                                               MAIN 138
      IF(KLIN.NE.8) KLIN=12                                               APR07773
      IF(KTIN.NE.10)KTIN=12                                               APR07774
      WRITE(6,7) IPRTLEV,IPRTTC,IPRTWID,IPRTSP,IPRTGC                     MAIN 139
      WRITE(6,8) INPOPT,KLIN,KTIN,NIBD,LMAXOPT                            JUL26774
      EPSILON=1.0E-3                                                      JUL26775
      IF(LMAXOPT.GT.0)  LMAXOPT=-LMAXOPT                                  JUL26776
      IF(LMAXOPT.NE.0) EPSILON=10.**LMAXOPT                               JUL26777
      READ(KI,1) NI,NMP,LGROPT,LPEQ,NJMAX,ICAPT                           MAIN 141
      IF(NJMAX.EQ.0) NJMAX=NJDIM                                          MAIN 142
      READ(KI,2) ZAP.ZAT,DE,FSIGCN                                        MAIN 143
      UCUTOFF = 0.1                                                       MAIN 144
      READ(KI,1) NELAB                                                    MAIN 145
      READ(KI,2) (ELABS(I),I=1,NELAB)                                     MAIN 146
      EXMT = ENERGY(ZAT)                                                  MAIN 147
      XJT  = SPIN                                                         MAIN 148
      PIT  = PARITY                                                       MAIN 149
      XMT  = EXACTM(ZAT,EXMT)                                             MAIN 150
      SIC  = EXMT + ENERGY(ZAP) - ENERGY(ZAT+ZAP)                         MAIN 151
      IF(FSIGCN.EQ.0.) FSIGCN=1.0                                         MAIN 152
      IR=0                                                                MAIN 153
      DO 104 I=1,NI                                                       MAIN 154
      IF(INPOPT.EQ.0) READ(KI,2)ZACN(I),XNIP(I),CNPI(I),CNPIP(I),SWS(I)   MAIN 155
      ZZA1(1)=0.                                                          MAIN 156
      IF(INPOPT.LE.-1)READ(KI,2)ZACN(I),XNIP(I),SWS(I),(ZZA1(IP),IP=2,6)MAIN 157
      IF(INPOPT.GE.1) CALL CHAINS(I,IR)                                   MAIN 158
          ZAC      = ZACN(I)                                              MAIN 159
          EXMC     = ENERGY(ZAC)                                          MAIN 160
          EXSWS(I) = ENERGY(ZAC-1.0) + EXMN - EXMC                        MAIN 161
      NIP=XNIP(I)                                                         MAIN 162
      DO 104 IP=1,NIP                                                     MAIN 163
      IR=IR+1                                                             MAIN 164
      LR(IP,I)=IR                                                         MAIN 165
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```
      XNL(IR)=0.
      A(IR)=0.
      XNLGC(IR)=0.
      ECGC(IR)=0.
      IF(INPOPT.EQ.0)READ(KI,2)ZA1(IR),XNL(IR),A(IR),XNLGC(IR),ECGC(IR)
      IF(INPOPT.LE.-1) ZA1(IR)=ZZA1(IP)
      ZA2(IR) = ZACN(I)-ZA1(IR)
      DEF(IR) = XMAGIC(ZA2(IR))
                ZAR     = ZA2(IR)
                EXMR    = ENERGY(ZAR)
                XM2(IR) = EXACTM(ZAR,EXMR)
                S(IR)   = EXMR + ENERGY(ZAI(IR)) - EXMC
  104 CONTINUE
      NIR=IR
      CALL LCSPACE
      ACN=A(1)
      DEFCN=DEF(1)
      WRITE(6,9) NI,NMP,LGROPT,LPEQ,NJMAX,ICAPT
      WRITE(6,10) ZAP,ZAT,DE,XMT,SIC,UCUTOFF
      WRITE(6,11) ACN,FSIGCN,DEFCN,XJT,PIT
      WRITE(6,19)(ELABS(I),I=1,NELAB)
      WRITE(6,12)
      DO 106 I=1,NI
      WRITE(6,13)I,ZACN(I),XNIP(I),CNPI(I),CNPIP(I),SWS(I),EXSWS(I)
      NIP=XNIP(I)
      DO 106 IP=1,NIP
      IR=LR(IP,I)
      IB=IBUF(IP,I)
      IF(IB.GT.NIBDIM) IB=IB-NIBDIM
  106 WRITE(6,14) IP,ZA1(IR)   ,ZA2(IR)   ,XM2(IR)   ,S(IR)   ,XNL(IR),
     1 DEF(IR)   ,           A(IR)   ,XNLGC(IR)   ,ECGC(IR),IB
      IF(LGROPT.EQ.1) WRITE(6,17)
      IF(LGROPT.EQ.2) WRITE(6,18)
      WRITE(6,15)
      DO 110 MP=1,NMP
      READ(KI,5) LMGHOL(MP),LG,RE1(MP)
      IF(LMGHOL(MP).EQ.IHOLE) GMP(MP)=+1.0
      IF(LMGHOL(MP).EQ.IHOLM) GMP(MP)=-1.0
      IF((LMGHOL(MP).EQ.IHOLE).AND.(LG.EQ.1).AND.(RE1(MP).EQ.0.))
     1                      RE1(MP)=1.0
      GML(MP)=LG
  110 WRITE(6,16) MP,GML(MP),GMP(MP),LMGHOL(MP),LG,RE1(MP)
      IF(LPEQ.EQ.1)READ(KI,2)ALPHA1
      DO 201 IDX=1,6
      IF(ALPHA1(IDX).NE.0.)202,201
 202  ALPHA(IDX)=ALPHA1(IDX)
 201  CONTINUE
      IF(LPEQ.EQ.1) WRITE(6,25) (BCD(IDX),IDX=1,6),ALPHA1,ALPHA
C
C     READ LEVEL INFORMATION
      CALL LEVPREP(KLIN,KL)
C
C     READ TRANSMISSION COEFFICIENT DATA
      CALL TCPREP(KTIN,EPSILON)
C
C     SET UP FOR CALCULATION
      CALL SETUP
C
C     INCIDENT ENERGY LOOP
      DO 200 IELAB=1,NELAB
      CALL SECOND(TKEEP)
      ELAB=ELABS(IELAB)
      CALL SETUP2
```

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C                                                                      MAIN 229
C     CALCULATE SPECTRA                                                MAIN 230
      CALL SPECTRA(ACN,FSIGCN)                                         MAIN 231
C                                                                      MAIN 232
C     PRINT AND WRITE OUTPUT RESULTS                                   MAIN 233
      CALL DATAOUT                                                     MAIN 234
198   CONTINUE                                                         MAIN 235
199   CONTINUE                                                         MAIN 236
C                                                                      MAIN 237
200   CONTINUE                                                         MAIN 238
      GO TO 100                                                        MAIN 239
 1000 STOP                                                             MAIN 240
      END                                                              MAIN 241
      SUBROUTINE LCSPACE                                               LCSPACE2
C                                                                      LCSPACE3
C     SET UP LCM STORAGE, ZERO ARRAY, AND VARIABLE STORAGE BUFFERS     LCSPACE4
C                                                                      LCSPACE5
      COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)   RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                         RHO    3
      COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),  BASIC1 2
     1 ZACN(10),CSGR(60),CSTOT(60).CSLEV(60),CSID(8),EAVID(8),EAV(60)  BASIC1 3
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC, LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIOIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                   LCNDEX 4
      COMMON/TCOEF/ETC(25,6),TC(25,30),BCD(7),XSPIN(7),NLDIM,          TCOEF  2
     1NPART,NEE(6),NO(6),NTC(6),IZAIO(7),XMASS(7),NEEDIM,NLEIN(6,25),  TCOEF  3
     2NLE(6,200),JRAST(200,6)                                          TCOEF  4
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM     LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                      LEVEL1 3
      COMMON/BASIC2/TITLE(16).ELAB.DE,ZAP,ZAT,XMT,   NKKM(10),CNPI(10), BASIC2 2
     1 CNPIP(10),S(60),SAC(10),ID1(60),IDP,IOE2(60),IBUF(6,10),        BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60), BASIC2 4
     3 NRHO(6),XJT,    NPOPMAX,NTC2(6),NJDIM,  IOECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                 BASIC2 7
      DIMENSION SCBUF(4000),IJJ(10),IPJJ(10)                           LCSPAC12
      EQUIVALENCE (SCBUF.RHO)                                          LCSPAC13
C                                                                      LCSPAC14
C     SET LCM STORAGE INDEXES                                          LCSPAC15
      NIRDIM=NIDIM*NIPDIM                                              LCSPAC16
      IPBLC=0                                                          LCSPAC17
      IGLC=IPBLC+NJDIM*NKDIM*NIBDIM*2                                  LCSPAC18
      IZEROLC=IGLC+NKDIM*NIRDIM                                        LCSPAC19
      ISPLC=IZEROLC+8000                                               LCSPAC20
      IPLLC=ISPLC+NKDIM*NIRDIM                                         LCSPAC21
      IEGLC=IPLLC+NLEVDIM*NIROIM                                       LCSPAC22
      ISGLC=IEGLC+NGRDIM*NIRDIM                                        LCSPAC23
      ITCLC=ISGLC+NGRDIM*NIRDIM                                        LCSPAC24
      IRHOLC=ITCLC+NEEDIM*NLOIM*(NIDDIM-1)                             LCSPAC25
      ITLC=IRHOLC+NKDIM*NJDIM*NIPDIM                                   LCSPAC26
      IELLC=ITLC+NKDIM*NLDIM*NIPDIM                                    LCSPAC27
      IAJLC=IELLC+NLEVDIM*NIRDIM                                       LCSPAC28
      IATLC=IAJLC+NLEVOIM*NIRDIM                                       LCSPAC29
      LCMDIM=IATLC+NLEVOIM*NIROIM                                      LCSPAC30
      WRITE(6,1) LCMOIM                                                LCSPAC31
    1 FORMAT(* LCM SPACE REQUIRED (EXCLUDING DISC BUFFERS) IS *,I7)    LCSPAC32
      WRITE(6,2) NIBDIM,NKDIM                                          LCSPAC33
 2    FORMAT( * NUMBER OF LCM BUFFERS IS *,I2/ * MAXIMUM NUMBER OF ENERGLCSPAC34
     1Y BINS IS *,I4)                                                  LCSPAC35
C                                                                      LCSPAC36
C     SET UP LCM ZERO ARRAY                                            LCSPAC37
      DO 10 K=1,1000                                                   LCSPAC38
 10   SCBUF(K)=0.                                                      LCSPAC39
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      INDEX=IZEROLC
      NPTS=1000
      CALL ECWR(SCBUF,INDEX,NPTS,IERR)
      INDEX=INDEX+NPTS
      CALL ECWR(SCBUF,INDEX,NPTS,IERR)
      INDEX=INDEX+NPTS
      CALL ECWR(SCBUF,INDEX,NPTS,IERR)
      INDEX=INDEX+NPTS
      CALL ECWR(SCBUF,INDEX,NPTS,IERR)
      CALL ECRD(SCBUF,IZEROLC,4000,IERR)
      INDEX=INDEX+NPTS
      CALL ECWR(SCBUF,INDEX,4000,IERR)
      IF(INPOPT.GE.0) GO TO 420
C
C     DETERMINE PARENT REACTIONS
      LBUFOPT=1
      CNPI(1)=1.
      CNPIP(1)=1.
      IF(NI.LT.2) GO TO 420
      DO 410 I=2,NI
      CNPI(I)=0.
      CNPIP(I)=0.
      I1=I-1
      DO 409 IM=1,I1
      II=I1-IM+1
      IF(ZACN(I).EQ.ZACN(II)) GO TO 410
      NIP = XNIP(II)
      IF(NIP.LT.2) GO TO 409
      DO 408 IIP=2,NIP
      IR=LR(IIP,II)
      IF(ZA2(IR).NE.ZACN(I)) GO TO 408
      CNPI(I) = II + 100.*CNPI(I)
      CNPIP(I)= IIP+100.*CNPIP(I)
      IF(LBUFOPT.EQ.2) GO TO 410
  408 CONTINUE
  409 CONTINUE
  410 CONTINUE
  420 CONTINUE
C
C      SET UP POPULATION STORAGE BUFFERS FOR LCM
      CALL ECRD(IBUF,IZEROLC,60,IERR)
      CNPI(1)=1.
      CNPIP(1)=1.
      IB=0
      DO 70 J=1,NI
      IB=IB+1
      II=CNPI(J)
      IIP=CNPIP(J)
      DO 62 JJ=1,10
      JJX=10**(JJ*2)
      JJX2=JJX/100
      IJJ(JJ)=MOD(II,JJX)/JJX2
      IPJJ(JJ)=MOD(IIP,JJX)/JJX2
      IF(II/JJX.LT.1) GO TO 64
   62 CONTINUE
   64 NJJ=JJ
      DO 68 I=1,J
      NIP=XNIP(I)
      DO 68 IP=1,NIP
      DO 66 JJ=1,NJJ
      IF((I.NE.IJJ(JJ)).OR.(IP.NE.IPJJ(JJ))) GO TO 66
      IBUF(IP,I) =IB
   66 CONTINUE
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 68    CONTINUE                                                          LCSPA103
 70    CONTINUE                                                          LCSPA104
C                                                                        LCSPA105
C      EQUATE (N,G) REACTION BUFFERS TO PARENT NUCLEUS BUFFER            LCSPA106
       DO 72 I=1,NI                                                      LCSPA107
       II=CNPI(I)                                                        LCSPA108
       IIP=CNPIP(I)                                                      LCSPA109
       II=MOD(II,100)                                                    LCSPA110
       IIP=MOD(IIP,100)                                                  LCSPA111
       IBUF(1,I)=IBUF(IIP,II)                                            LCSPA112
 72    CONTINUE                                                          LCSPA113
       RETURN                                                            LCSPA114
       END                                                               LCSPA115
       SUBROUTINE CHAINS(I,IRX)                                          CHAINS 2
C                                                                        CHAINS 3
C      CONSTRUCT OPTIONAL AUTOMATIC REACTION CHAIN SEQUENCES             CHAINS 4
C                                                                        CHAINS 5
       COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),   BASIC1 2
      1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60)   BASIC1 3
       COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,   NKKM(10),CNPI(10), BASIC2 2
      1 CNPIP(10),S(60),SAC(10),IDI(60),IDP,IOE2(60),IBUF(6,10),         BASIC2 3
      2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60),  BASIC2 4
      3 NRHO(6),XJT,    NPOPMAX,NTC2(6),NJDIM,   IOECN(10),NKKCN(10),ECON,BASIC2 5
      4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
      5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                  BASIC2 7
       COMMON/LEVDEN/DEF(60),XNLGC(60),ECGC(60),UCUTOFF,DEPCN,TGC(60),   LEVDEN 2
      1 E0GC(60),EMATGC(60),PAIR(60),XMR3(60),XNLLN(60),SZ(100),SN(150), LEVDEN 3
      2 PZ(100),PN(150)                                                  LEVDEN 4
       COMMON /SPNPAR/ SPIN,PARITY,KGRD                                  LEVDEN 5
       COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM      LEVEL1 2
      1,EG(240),SG(240),NGRAYS(60)                                       LEVEL1 3
       COMMON/GAMMA/NMP,LGROPT,SWS(10),GML(6),GMP(6),RE1(6),LMGHOL(6),   GAMMA  2
      1 TGR(200,6),WKCON,CAXEL,GAXEL,ERAXEL,EXSWS(10),WKNORM             GAMMA  3
       DIMENSION ZAX(4)                                                  CHAINS11
       DATA ZAX/0.,1.,1001.,2004./                                       CHAINS12
       XI=I                                                              CHAINS13
       ZATOT=ZAP+ZAT                                                     CHAINS14
       SWS(I)=0.                                                         CHAINS15
       IR=IRX                                                            CHAINS16
       GO TO (11,12,13),INPOPT                                           CHAINS17
 11    ZACN(I)=ZATOT-XI+1.0001                                           CHAINS18
       XNIP(I)=2.                                                        CHAINS19
       CNPI(I)=XI-0.99999                                                CHAINS20
       CNPIP(I)=2.                                                       CHAINS21
       GO TO 50                                                          CHAINS22
 12    ZACN(I)=ZATOT-XI+1.0001                                           CHAINS23
       XNIP(I)=4.                                                        CHAINS24
       CNPI(I)=XI-0.99999                                                CHAINS25
       CNPIP(I)=2.                                                       CHAINS26
       GO TO 50                                                          CHAINS27
 13    GO TO (21,22,23,21,22,23,21,22,23,21),I                           CHAINS28
 21    XII=(I-1)/3                                                       CHAINS29
       ZACN(I)=ZATOT-XII                                                 CHAINS30
       XNIP(I)=4.                                                        CHAINS31
       CNPI(I)=I-3                                                       CHAINS32
       CNPIP(I)=2.                                                       CHAINS33
       GO TO 50                                                          CHAINS34
 22    ZACN(I)=ZACN(I-1)-ZAX(3)                                          CHAINS35
       CNPI(I)=I-1                                                       CHAINS36
       CNPIP(I)=3.                                                       CHAINS37
       XNIP(I)=1.                                                        CHAINS38
       GO TO 50                                                          CHAINS39
 23    ZACN(I)=ZACN(I-2)-ZAX(4)                                          CHAINS40
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      CNPI(I)=I+2                                                       CHAINS41
      CNPIP(I)=4.                                                       CHAINS42
      XNIP(I)=1.                                                        CHAINS43
   50 NIP=XNIP(I)                                                       CHAINS44
      IZA=ZACN(I)                                                       CHAINS45
      ZACN(I)=IZA                                                       CHAINS46
      DO 54 IP=1,NIP                                                    CHAINS47
      IR=IR+1                                                           CHAINS48
      ZA1(IR)=ZAX(IP)                                                   CHAINS49
   54 CONTINUE                                                          CHAINS50
      RETURN                                                            CHAINS51
      END                                                               CHAINS52
          FUNCTION ENERGY(ZA)                                           ENERGY 2
C                                                                       ENERGY 3
C     ***** ENERGY LOOKS UP VALUES OF GROUND-STATE MASS EXCESS (MEV), **ENERGY 4
C     ***** SPIN, AND PARITY, MISSING DATA PRODUCE A FATAL ERROR.     **ENERGY 5
C                                                                       ENERGY 6
      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                  ENERGY 7
      DIMENSION I0(11),I1(11),I2(11),J0(11),J1(12),K0(12),ENER(2055)    ENERGY 8
      DIMENSION PAR(3)                                                  ENERGY 9
      DIMENSION SPINPAR(2055)                                           BCDGRD 1
      DATA PAR /1H-,1H ,1H+/                                            ENERGY10
      DATA INPGRD/1/                                                    BCDGRD 2
    1 FORMAT(28H0***** GROUND-STATE DATA FOR I6,19H NOT IN TABLE *****) ENERGY12
    2 FORMAT(I2,2H/2 A1)                                                ENERGY13
    3 FORMAT(I2,      A1)                                               ENERGY14
    4 FORMAT(2X       A1)                                               ENERGY15
5     FORMAT(5X*+++++ GROUND STATE OF  *F6.0* IS INCOMPLETELY DESCRIBEDBCDGRD 3
     X,    SPIN,PARITY  =  *F6.2,2X,F6.2,2X*++++++*)                    BCDGRD 4
    6 FORMAT(5X,*++++++*,28X,* ASSIGNMENTS CHANGED TO,   SPIN,PARITY  *  BCDGRD 5
     1*F6.2,2X,F6.2,2X,*++++++*/)                                       BCDGRD 6
C                                                                       ENERGY18
C         FIRST CALL CAUSES DATA TO BE READ IN                          ENERGY19
      IF(INPGRD.EQ.12345) GO TO 10                                      ENERGY20
      READ (KGRD,100) I0,I1,I2,J0,J1,K0                                 BCDGRD 7
100   FORMAT(8I10)                                                      BCDGRD 8
      READ(KGRD,101)ENER                                                BCDGRD 9
101   FORMAT(6E13.6)                                                    BCDGRD10
      READ(KGRD,102)SPINPAR                                             BCDGRD11
102    FORMAT(8F10.3)                                                   BCDGRD12
      REWIND KGRD                                                       BCDGRD13
      INPGRD = 12345                                                    ENERGY22
   10 IF(ZA) 40,15,20                                                   ENERGY23
C                                                                       ENERGY24
C         Z=0, A=0 IS CONSIDERED A PHOTON                               ENERGY25
   15 ENERGY = SPIN = 0.        $ PARITY = -1.           $ RETURN       ENERGY26
C                                                                       ENERGY27
C         FIND REQUESTED NUCLEUS IN APPROPRIATE TABLE                   ENERGY28
   20 IZA = IFIX(ZA)            $ JZ = IZA/1000                         ENERGY29
      IA  = IZA - 1000*JZ       $ N  = IA - JZ                          ENERGY30
      NZ = N  - JZ              $ N2 = NZ - JZ                          ENERGY31
      DO 30 K=1,11              $ IF(JZ.GE.J1(K+1)) GO TO 30            ENERGY32
          ND = I1(K) - 1        $ I = NZ - ND                           ENERGY33
          IF(I2(K).LT.0)          I = N2 - ND                           ENERGY34
          IK = I0(K)            $ J = JZ - J1(K) + 1                    ENERGY35
          IN = K0(K) + I + (J-1)*IK                                     ENERGY36
          IF(I.GT.0.AND.I.LE.IK) GO TO 50               $ GO TO 40      ENERGY37
   30     CONTINUE                                                      ENERGY38
C                                                                       ENERGY39
C         REQUESTED ISOTOPE IS NOT IN TABLES                            ENERGY40
   40 PRINT 1, IZA              $ STOP 7776                             ENERGY41
C                                                                       ENERGY42
50    CONTINUE                                                          BCDGRD14
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      ENERGY=ENEP(IN)                                                   BCDGRD15
      IF(SPINPAR(IN).GE.9900.)SPIN=SPINPAR(IN)-9900.                    BCDGRD16
      IF(SPINPAR(IN).GE.9900.)PARITY=99.                                BCDGRD17
      IF(SPINPAR(IN).GE.9900.)GO TO 200                                 BCDGRD18
       IF(SPINPAR(IN).GE.100.)PARITY=1.                                 BCDGRD19
       IF(SPINPAR(IN).GE.100.)SPIN=SPINPAR(IN)-100.                     BCDGRD20
      IF(SPINPAR(IN).LT.0.)PARITY=-1.                                   BCDGRD21
      IF(SPINPAR(IN).LT.0.)SPIN=SPINPAR(IN)+100.                        BCDGRD22
200   CONTINUE                                                          BCDGRD23
      IF((PARITY.NE.99.).AND.(SPIN.NE.99.)) RETURN                      BCDGRD24
      PRINT 5, ZA,SPIN,PARITY                                           BCDGRD25
      IF(PARITY.EQ.99.) PARITY=+1.                                      BCDGRD26
      IF(SPIN.EQ.99.) SPIN=0.25*(1.-(-1.)**IA)                          BCDGRD27
      PRINT 6,SPIN,PARITY                                               BCDGRD28
       RETURN                                                           BCDGRD29
      END                                                               ENERGY58
      FUNCTION XMAGIC(ZA)                                               XMAGIC 2
      DIMENSION XMAG(10)                                                XMAGIC 3
      DATA NMAG/8/, XMAG/2.,8.,20.,28.,50.,82.,126.,186./               JUL29771
      IZ=ZA/1000.    $  Z=IZ                                            XMAGIC 5
      A=ZA-Z*1000.                                                      XMAGIC 6
      AN=A-Z                                                            XMAGIC 7
      IF(Z.LT.54.)GO TO 15                                              JUL29772
      IF(AN.LT.86.)GO TO 15                                             JUL29773
      XMAGIC=1.                                                         XMAGIC 8
      DO 10 N=5,8                                                       JUL29774
      C1=ABS(XMAG(N)-Z)                                                 XMAGIC10
      C2=ABS(XMAG(N)-AN)                                                XMAGIC11
      IF((C1.LT.3.5).OR.(C2.LT.3.5)) GO TO 15                           XMAGIC12
 10   CONTINUE                                                          XMAGIC13
      RETURN                                                            XMAGIC14
 15   XMAGIC=0.                                                         XMAGIC15
      RETURN                                                            XMAGIC16
      END                                                               XMAGIC17
      SUBROUTINE LEVPREP(K1,K2)                                         LEVPREP2
C                                                                       LEVPREP3
C     PREPARES BINARY LEVEL DATA FILE ON K2 FROM I/P BCD FILE K1. ALSO  LEVPREP4
C     STORES ENERGY AND J-PI DATA IN LCM ARRAYS ELLC(N,IP,I) AND        LEVPREP5
C     AJLC(N,IP,I)                                                      LEVPREP6
C                                                                       LEVPREP7
 1    FORMAT(I8,I5,3F12.6,I8)                                           LEVPREP8
 2    FORMAT(I6,F12.6,2F6.1,E12.5,I6,24X,I8)                            LEVPREP9
 3    FORMAT(6X,2I6,2F12.6,E12.5,2I3,12X,I8)                            LEVPRE10
 4    FORMAT(// * LEVEL DATA FOR IZA=*I5,* NOT FOUND, USE GROUND STATE  LEVPRE11
     1ONLY.*)                                                           LEVPRE12
C                                                                       LEVPRE13
      COMMON/SPNPAR/SPIN,PARITY,KGRD                                    LEVPRE14
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIOIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDOIM,NIROIM                                                    LCNDEX 4
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM      LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                       LEVEL1 3
      COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),   BASIC1 2
     1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60)   BASIC1 3
      COMMON/PREQ1/EPSIG(200,6),NLEV,NPIT,NIT                           PREQ1  2
      DIMENSION ZATAB(60),DUMMY(120)                                    APR07775
C                                                                       APR07776
C     DETERMINE REQUIRED ZA TABLE                                       APR07777
      K3=11                                                             APR07778
      DO 17 N=1,NIR                                                     APR07779
 17   ZATAB(N)=ZA2(N)                                                   APR07710
      CALL SORT1(NIR,0,ZATAB,DUMMY)                                     APR07711
      NTAB = 1                                                          APR07712
```

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      CSTOT(1) = ZATAB(1)                                               APR07713
      IF(NIR.EQ.1) GO TO 16                                             APR07714
      DO 18 N=2,NIR                                                     APR07715
      IF(ZATAB(N).EQ.ZATAB(N-1)) GO TO 18                               APR07716
      NTAB = NTAB + 1                                                   APR07717
      CSTOT(NTAB) = ZATAB(N)                                            APR07718
   18 CONTINUE                                                          APR07719
   16 DO 19 N=1,NTAB                                                    APR07720
   19 ZATAB(N) = CSTOT(N)                                               APR07721
C                                                                       APR07722
C     SELECT LEVEL DATA FOR REQUIRED ZAS                                APR07723
      IF(K1.EQ.8) REWIND K1                                             APR07724
   20 READ(K1,1) ID,NL,F,A,AE,LDATE                                     APR07725
      KIEOF = IOCHECK(K1,1)                                             APR07726
      IF(KIEOF.GT.4) GO TO 29                                           APR07727
      ISET = 2                                                          APR07728
      DO 21 N=1,NTAB                                                    APR07729
      IZA2 = ZATAB(N)                                                   APR07730
      IF(IO.EQ.IZA2) ISET = 1                                           APR07731
   21 CONTINUE                                                          APR07732
      GO TO (22,23), ISET                                               APR07733
   22 WRITE(K3,1) ID,NL,F,A,AE,LDATE                                    APR07734
   23 DO 28 N=1,NL                                                      APR07735
      READ(K1,2) NX,EL(N),AJ(N),AT(N),TAU,NT,IS                         APR07736
      GO TO (24,25), ISET                                               APR07737
   24 WRITE(K3,2) NX,EL(N),AJ(N),AT(N),TAU,NT,IS                        APR07738
   25 IF(NT.LT.1) GO TO 28                                              APR07739
      DO 27 K=1,NT                                                      APR07740
      READ(K1,3) LL,NF,P,CP,AMR,L1,L2,IS                                APR07741
      GO TO (26,27), ISET                                               APR07742
   26 WRITE(K3,3) LL,NF,P,CP,AMR,L1,L2,IS                               APR07743
   27 CONTINUE                                                          APR07744
   28 CONTINUE                                                          APR07745
      IF(F.GE.0.) GO TO 20                                              APR07746
   29 K1 = K3                                                           APR07747
      REWIND K2                                                         APR07748
C                                                                       APR07749
C     DETERMINE BINARY FILE IN ORDER OF REACTION CHAIN                  APR07750
      REWIND K2                                                         LEVPRE20
      DO 100 IR=1,NIR                                                   LEVPRE21
      IZA2= ZA2(IR)                                                     LEVPRE22
      REWIND K1                                                         LEVPRE24
   30 READ(K1,1) ID,NL,F,A,AE,LDATE                                     LEVPRE25
      K1EOF=IOCHECK(K1,1)                                               LEVPRE26
      IF(K1EOF.LE.4) GO TO 50                                           LEVPRE27
      WRITE(6,4) IZA2                                                   LEVPRE28
      XNL(IR) = 1.0                                                     LEVPRE29
      NLL = 1                                                           LEVPRE30
      EL(1) = 0.                                                        LEVPRE31
      AT(1) = 99.                                                       LEVPRE32
      TAU = 99.                                                         LEVPRE33
      NT = 0                                                            LEVPRE34
      LDATE = 0                                                         LEVPRE35
      EDUM = ENERGY(ZA2(IR))                                            LEVPRE36
      AJ(1) = PARITY*SPIN                                               LEVPRE37
      IF(ZA1(IR).NE.0.) GO TO 45                                        LEVPRE38
      WRITE(K2)IZA2,NLL,LDATE                                           LEVPRE39
      WRITE(K2) EL(1),AJ(1),AT(1),TAU,NT                                LEVPRE40
      GO TO 45                                                          LEVPRE41
   50 ISET=2                                                            LEVPRE42
      IF(ID.EQ.IZA2) ISET=1                                             LEVPRE43
      GO TO (31,32),ISET                                                LEVPRE44
   31 IF(XNL(IR).LT.0.5) XNL(IR)=NL                                     LEVPRE45
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      NLMAX=XNL(IR)                                                     LEVPRE46
      NLL=MIN0(NL,NLMAX)                                                LEVPRE47
      XNL(IR) = NLL                                                     LEVPRE48
      IF(ZA1(IR).NE.0.) GO TO 32                                        LEVPRE49
      WRITE(K2) ID,NLL,LDATE                                            LEVPRE50
   32 DO 40 N=1,NL                                                      LEVPRE51
      READ(K1,2) NX,EL(N),AJ(N),AT(N),TAU,NT,IS                         LEVPRE52
      GO TO (35,36),ISET                                                LEVPRE53
   35 IF((ZA1(IR).NE.0.).OR.(N.GT.NLL)) GO TO 36                        LEVPRE54
      WRITE(K2) EL(N),AJ(N),AT(N),TAU,NT                                LEVPRE55
   36 IF(NT.LT.1) GO TO 40                                              LEVPRE56
      DO 38 K=1,NT                                                      LEVPRE57
      READ(K1,3) LL,NF,P,CP,AMR,L1,L2,IS                                LEVPRE58
      GO TO (37,38),ISET                                                LEVPRE59
   37 IF(N.GT.NLL) GO TO 38                                             LEVPRE60
      IF(ZA1(IR).EQ.0.) WRITE(K2) NF,P,CP,AMR,L1,L2                     LEVPRE61
   38 CONTINUE                                                          LEVPRE62
   40 CONTINUE                                                          LEVPRE63
      GO TO (45,30),ISET                                                LEVPRE64
   45 INDEX=IELLC+(IR-1)*NLEVDIM                                        LEVPRE65
      CALL ECWR(EL,INDEX,NLL,IERR)                                      LEVPRE66
      INDEX=IAJLC+(IR-1)*NLEVDIM                                        LEVPRE67
      CALL ECWR(AJ,INDEX,NLL,IERR)                                      LEVPRE68
      INDEX=IATLC+(IR-1)*NLEVDIM                                        LEVPRE69
      CALL ECWR(AT,INDEX,NLL,IERR)                                      LEVPRE70
      ELMAX(IR)=EL(NLL)                                                 LEVPRE71
  100 CONTINUE                                                          LEVPRE72
      END FILE K2                                                       LEVPRE73
      REWIND K2                                                         LEVPRE74
      RETURN                                                            LEVPRE75
 1000 WRITE(6,4) IZA2                                                   LEVPRE76
      STOP                                                              LEVPRE77
      END                                                               LEVPRE78
      SUBROUTINE TCPREP(K1,EPSILON)                                     JUL26779
C                                                                       TCPREP 3
 1    FORMAT(42X,A10,12X,2I4,A8)                                        TCPREP 4
 2    FORMAT(1P,6E12.5,I8)                                              MAY77  2
 3    FORMAT(I4,1X,7A10,A5)                                             TCPREP 6
 4    FORMAT(// 1X,A10,*TRANSMISSION COEFFICIENT DATA OUT OF ORDER, CARDTCPREP 7
     1 NO* I6,* -- ABORT JOB*)                                          TCPREP 8
 5    FORMAT(//1X,*PARTICLE IDENTIFIER *A10,* NOT RECOGNIZED IN TRANSMISTCPREP 9
     1SION COEFFICIENT DATA -- ABORT JOB*)                              TCPREP10
 6    FORMAT(// * TRANSMISSION COEFFICIENT DATA * / I4,1X,7A10,A5)      TCPREP11
 7    FORMAT(  * ID=*I2,3X,*NE=*I3,3X,*NL=*I3,3X,*PARTICLE =*A10)       TCPREP12
 8    FORMAT(/ * ENERGY =* F7.3,* MEV*)                                 TCPREP13
 9    FORMAT( * TRANS.COEFS. *,1P,10E12.5)                              TCPREP14
 10   FORMAT( * SPLINE DATA  *,1P,10E12.5)                              TCPREP15
C                                                                       TCPREP16
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NI8DIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                    LCNDEX 4
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM      LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                       LEVEL1 3
      COMMON/TCOEF/ETC(25,6),TC(25,30),BCD(7),XSPIN(7),NLDIM,           TCOEF  2
     1NPART,NEE(6),NO(6),NTC(6),IZAID(7),XMASS(7),NEEDIM,NLEIN(6,25),   TCOEF  3
     2NLE(6,200).JRAST(200,6)                                           TCOEF  4
      COMMON/PRNTOUT/IPRTLEV,IPRTTC,IPRTHLO,IPRTWID,IPRTSP,IPRTGC       PRNTOUT2
       DIMENSION TDUM(62),BCDTC(8)                                      TCPREP21
C                                                                       TCPREP22
C     MAIN PARTICLE LOOP                                                TCPREP23
       IF(K1.EQ.10)REWIND K1                                            TCPREP24
      READ(K1,3)NPART,BCDTC                                             TCPREP25
      WRITE(6,6) NPART.BCDTC                                            TCPREP26
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```
      DO 100 N=1,NPART
      KP=2
      READ(K1,1) XBCD,NE,NN,K
C
C     IDENTIFY I/P PARTICLE
      DO 20 ID=1,6
      IF(XBCD.EQ.BCD(ID))   GO TO 22
 20   CONTINUE
      WRITE(6,5) XBCO
      STOP
 22   NEE(ID)= NE
C
C
C     READ ENERGY ARRAY
      DO 30 I=2,NE,6
      KP=KP+1
      IU=I+5
      READ(K1,2)(ETC(J,ID),J=I,IU),K
201   FORMAT(20X,6E12.5,A8)
 30   CONTINUE
C
C     MAIN ENERGY LOOP
      DO 80 I=2,NE
C
C     READ TRANSMISSION COEFFICIENT DATA
      DO 35 J=1,NN,6
      KP=KP+1
      JU=J+5
      READ(K1,2) (TDUM(L),L=J,JU),K
      DO 336 L=J,JU
      IF(TDUM(L).LE.2.0E-14) TDUM(L)=0.
336    CONTINUE
 35   CONTINUE
      IF((ID.EQ.3).OR.(ID.EQ.6)) GO TO 60
C
C     ELIMINATE J-DEPENDENCE OF SPIN 1/2 ARRAYS
      TC(I,1) =  TDUM(1)
      DO 50 J=2,NN,4
      XL = (J-1)/2 + MOD(J/2,2) - 1
      JJ=J-1
      DO 48 JL=1,2
      JJ=JJ+1
      IF(JJ.GT.NN) GO TO 70
      XL=XL+1.0
      LP=XL+1.001
      IF(LP.LE.NLDIM) GO TO 40
      LP=LP-1
      GO TO 70
 40   IF((JJ+2).LE.NN) GO TO 42
      TC(I,LP)  =   TDUM(JJ)
      GO TO 48
 42   TC(I,LP)  =    ((XL+1.)*TDUM(JJ+2) + XL*TDUM(JJ))/(2.*XL+1.)
 48   CONTINUE
 50   CONTINUE
      GO TO 70
C
C     RE-ORDER SPIN 0 AND SPIN 1 ARRAYS
 60   DO 66 L=1,NN
      J = 2*L-MOD(L,2)
      IF(J.GT.NN) GO TO 70
      LP=L
 66   TC(I,LP) =    TDUM(J)
 70   CONTINUE
```

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 80     CONTINUE                                                        TCPREP90
        NO(ID)=LP                                                       TCPREP91
C       SET TC ARRAY TO ZERO FOR ZERO INCIDENT ENERGY                   TCPREP92
        ETC(1,ID)=0.                                                    TCPREP93
        DO 25 L=1,LP                                                    TCPREP94
25      TC(1,L)=0.                                                      TCPREP95
C                                                                       TCPREP96
C       FIND NUMBER OF NON-ZERO COEFFICIENTS                            TCPREP97
        DO 84 II=2,NE                                                   TCPREP98
        I = NE-II+2                                                     TCPREP99
        DO 82 LX=1,LP                                                   TCPRE100
        L = LP-LX+1                                                     TCPRE101
        IF(TC(I,1)) 82,82,83                                            JUL26710
 83     XL=L                                                            JUL26711
        RATIO= (2.*XL+1.)*TC(I,L)/TC(I,1)                               JUL26712
        IF(RATIO.GT.EPSILON) GO TO 84                                   JUL26713
  82    CONTINUE                                                        TCPRE103
  84    NLEIN(ID,I-1) = L                                               TCPRE104
        NLEIN(ID,NE) = NLEIN(ID,NE-1)                                   TCPRE105
C                                                                       TCPRE106
C       STORE TRANSMISSION COEFFICIENT DATA IN LCM                      TCPRE107
        NPTS=LP*NEEDIM                                                  TCPRE108
        NTC(ID)= NPTS                                                   TCPRE109
        INDEX=ITCLC+(ID-1)*NEEDIM*NLDIM                                 TCPRE110
        CALL ECWR(TC,INDEX,NPTS,IERR)                                   TCPRE111
C                                                                       TCPRE112
C       PRINT OPTION                                                    TCPRE113
        IF(IPRTTC.LT.1) GO TO 100                                       TCPRE114
        DO 90 I=1,NE                                                    TCPRE116
        WRITE(6,8) ETC(I,ID)                                            TCPRE117
        LP = NLEIN(ID,I)                                                TCPRE118
        WRITE(6,9)  (TC(I,L),L=1,LP)                                    TCPRE119
 90     CONTINUE                                                        TCPRE120
 100    CONTINUE                                                        TCPRE121
        RETURN                                                          TCPRE122
 1000   WRITE(6,4) XBCD,KP                                              TCPRE123
        STOP                                                            TCPRE124
        END                                                             TCPRE125
        SUBROUTINE SETUP                                                SETUP  2
C                                                                       SETUP  3
 1      FORMAT(// * PARTICLE WITH IZA=*I5,* NOT FOUND. ABORT JOB.*)     SETUP  4
C                                                                       SETUP  5
        COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
       1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
       2 NIDDIM,NIROIM                                                  LCNDEX 4
        COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)  RHO    2
       1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                        RHO    3
        COMMON/TCOEF/ETC(25,6),TC(25,30),BCO(7),XSPIN(7),NLDIM,         TCOEF  2
       1NPART,NEE(6),NO(6),NTC(6),IZAIO(7),XMASS(7),NEEOIM,NLEIN(6,25), TCOEF  3
       2NLE(6,200),JRAST(200,6)                                         TCOEF  4
        COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM    LEVEL1 2
       1,EG(240),SG(240),NGRAYS(60)                                     LEVEL1 3
        COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60), BASIC1 2
       1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60) BASIC1 3
        COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,   NKKM(10),CNPI(10), BASIC2 2
       1 CNPIP(10),S(60),SAC(10),ID1(60),IDP,IOE2(60),IBUF(6,10),       BASIC2 3
       2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60), BASIC2 4
       3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM,   IOECN(10),NKKCN(10),ECON,BASIC2 5
       4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
       5,ICAPT,PLBUF(50,10),INPDPT,TKEEP                                BASIC2 7
        COMMON/LEVDEN/DEF(60),XNLGC(60),ECGC(60),UCUTOFF,DEFCN,TGC(60), LEVDEN 2
       1 E0GC(60),EMATGC(60),PAIR(60),XMR3(60),XNLLN(60),SZ(100),SN(150), LEVDEN 3
       2 PZ(100),PN(150)                                                LEVDEN 4
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      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                  LEVDEN 5
C                                                                       SETUP 13
C     FIND ACCUMULATED SEPARATION ENERGIES FOR THE DECAYING NUCLEI      SETUP 14
      DO 15 I=1,NI                                                      SETUP 15
   15 SAC(I)=0.                                                         SETUP 16
      DO 20 I=1,NI                                                      SETUP 17
      II=I                                                              SETUP 18
      DO 18 J=1,NI                                                      SETUP 19
      IX=II                                                             SETUP 20
      II=CNPI(IX)                                                       SETUP 21
      IF(II.LT.1) GO TO 20                                              SETUP 22
      IIP=CNPIP(IX)                                                     SETUP 23
   16 IF(II.LT.100) GO TO 17                                            SETUP 24
      II=II/100                                                         SETUP 25
      IIP=IIP/100                                                       SETUP 26
      GO TO 16                                                          SETUP 27
   17 CONTINUE                                                          SETUP 28
      IR=LR(IIP,II)                                                     SETUP 29
   18 SAC(I) = SAC(I) + S(IR)                                           SETUP 30
   20 CONTINUE                                                          SETUP 31
C                                                                       SETUP 32
C     IDENTIFY INCIDENT PARTICLE                                        SETUP 33
      DO 30 ID=1,7                                                      SETUP 34
      IZA =  ZAP                                                        SETUP 35
      IF(IZA.EQ.IZAID(ID)) GO TO 32                                     SETUP 36
   30 CONTINUE                                                          SETUP 37
      GO TO 1000                                                        SETUP 38
   32 IDP=ID                                                            SETUP 39
      XJP=XSPIN(IDP)                                                    SETUP 40
      XMP=XMASS(IDP)                                                    SETUP 41
      CSL = ABS(XJT-XJP)-1.0                                            SETUP 42
      CSH = XJT+XJP+0.001                                               SETUP 43
C                                                                       SETUP 44
C     IDENTIFY SECONDARY REACTION PARTICLES AND PHOTONS                 SETUP 45
      DO 36 ID=1,7                                                      SETUP 46
   36 IOSTAT(ID)=0                                                      SETUP 47
      DO 40 IR=1,NIR                                                    SETUP 48
      IZA= ZA1(IR)                                                      SETUP 49
      DO 38 ID=1,7                                                      SETUP 50
      IF(IZA.EQ.IZAID(ID)) GO TO 39                                     SETUP 51
   38 CONTINUE                                                          SETUP 52
      GO TO 1000                                                        SETUP 53
   39 IOSTAT(IO)=1                                                      SETUP 54
   40 ID1(IR)=ID                                                        SETUP 55
C                                                                       SETUP 56
C     IDENTIFY RESIDUAL NUCLEI AS TO ODD OR EVEN A                      SETUP 57
C     IOE2=1 FOR ODD, IOE2=2 FOR EVEN-A RESIDUAL NUCLEUS                SETUP 58
C                                                                       SETUP 59
      DO 50 IR=1,NIR                                                    SETUP 60
      IZA= ZA2(IR)                                                      SETUP 61
      IA= MOD(IZA,1000)                                                 SETUP 62
   50 IOE2(IR)= (3+(-1)**IA)/2                                          SETUP 63
C                                                                       SETUP 64
C     IDENTIFY DECAYING COMPOUND NUCLEI AS TO ODD OR EVEN               SETUP 65
      DO 60 I=1,NI                                                      SETUP 66
      IZA= ZACN(I)                                                      SETUP 67
      IA= MOD(IZA,1000)                                                 SETUP 68
   60 IOECN(I)= (3+(-1)**IA)/2                                          SETUP 69
C                                                                       SETUP 70
C     SET UP J-PI ARRAYS                                                SETUP 71
      JJ=0                                                              SETUP 72
      DO 82 J=1,NJMAX                                                   SETUP 73
      DO 82 IPI=1,2                                                     SETUP 74
```

```
      JJ=JJ+1                                                           SETUP 75
 82   JPI(J,IPI)=JJ                                                     SETUP 76
      DO 84 L=1,NLDIM                                                   SETUP 77
      LL=L-1                                                            SETUP 78
 84   PILLL(L)=(-1)**LL                                                 SETUP 79
C                                                                       SETUP 80
C     INITIALIZE LEVEL DENSITIES AND GIL-CAM PARAMETERS                 SETUP 81
      DO 90 IR=1,NIR                                                    SETUP 82
      A2(IR)= A(IR)                                                     SETUP 83
      IF(XNLGC(IR).LE.0.) XNLGC(IR)=XNL(IR)                             SETUP 84
      IF(ECGC(IR).LE.0.) ECGC(IR)= ELMAX(IR)                            SETUP 85
      XNLLN(IR)=ALOG(XNLGC(IR))                                         SETUP 86
 90   XMR3(IR)= XM2(IR)**0.33333333                                     SETUP 87
C                                                                       SETUP 88
      RETURN                                                            SETUP 89
 1000 WRITE(6,1) IZA                                                    SETUP 90
      STOP                                                              SETUP 91
      END                                                               SETUP 92
      SUBROUTINE SETUP2                                                 SETUP2 2
C                                                                       SETUP2 3
C     SET UP INCIDENT ENERGY DEPENDENT QUANTITIES                       SETUP2 4
C                                                                       SETUP2 5
      COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),   BASIC1 2
     1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60)   BASIC1 3
      COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,    NKKM(10),CNPI(10), BASIC2 2
     1 CNPIP(10),S(60),SAC(10),ID1(60),IDP,IDE2(60),IBUF(6,10),         BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60),  BASIC2 4
     3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM,  IOECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,IKEEP                                  BASIC2 7
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                    LCNDEX 4
      COMMON/TCOEF/ETC(25,6),TC(25,30),BCD(7),XSPIN(7),NLDIM,           TCOEF  2
     1NPART,NEE(6),NO(6),NTC(6),IZAID(7),XMASS(7),NEEDIM,NLEIN(6,25),   TCOEF  3
     2NLE(6,200),JRAST(200,6)                                           TCOEF  4
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM      LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                       LEVEL1 3
C                                                                       SETUP211
C     SET UP ENERGIES AND DETERMINE INTEGRATION END POINTS              SETUP212
      ECM= (XMT/(XMT+XMP))*ELAB                                         SETUP213
      UP = ECM+SIC                                                      SETUP214
      XMU =  XMT*XMP /(XMT+XMP)                                         SETUP215
      ECON = 0.650999/(XMU*ECM*(2.*XJP+1.)*(2.*XJT+1.0))                SETUP216
 75   EKMAX=0.                                                          SETUP217
      DO 77 I=1,NI                                                      SETUP218
      NKKM(I)=0                                                         SETUP219
      NIP = XNIP(I)                                                     SETUP220
      DO 77 IP=1,NIP                                                    SETUP221
      IR=LR(IP,I)                                                       SETUP222
      NL= XNL(IR)                                                       SETUP223
      INDEX=IELLC+(IR-1)*NLEVDIM                                        SETUP224
      CALL ECRD(EL,INDEX,NL,IERR)                                       SETUP225
      EK = UP-SAC(I)-S(IR)                                              SETUP226
      EKMAX = AMAX1(EK,EKMAX)                                           SETUP227
      NKK(IR)= (EK-EL(NL))/DE + 0.5                                     SETUP228
      NKKM(I)=MAX0(NKK(IR),NKKM(I))                                     SETUP229
      IF(IP.EQ.1) NKKCN(I)=NKK(IR)                                      SETUP230
 77   CONTINUE                                                          SETUP231
      NKMAX=EKMAX/DE + 0.5                                              SETUP232
      IF(NKMAX.LT.NKDIM) GO TO 79                                       SETUP233
      XDU=NKDIM-1                                                       SETUP234
      DE =  EKMAX/XDU                                                   SETUP235
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      GO TO 75                                                          SETUP236
 79   NPOPMAX=NKMAX*NJDIM*2                                             SETUP237
C                                                                       SETUP238
C     GENERATE TRANSMISSION COEFFICIENTS FOR INCIDENT CHANNEL           SETUP239
      NE=NEE(IDP)                                                       SETUP240
      NPTS=NTC(IDP)                                                     SETUP241
      INDEX=ITCLC+(IOP-1)*NEEDIM*NLDIM                                  SETUP242
      CALL ECRD(TC,INDEX,NPTS,IERR)                                     SETUP243
      K = ISERCH(ECM,ETC(1,IDP),NE,AA,A5,A6)                            SETUP244
      NLP=NLEIN(IDP,K+1)                                                SETUP245
      XNLP=NLP-1                                                        SETUP246
      DO 85 J=1,NLP                                                     SETUP247
      CALL INTERP(ETC(1,IDP),TC(1,J),NE,2,ECM,YOUT)                     SETUP248
      IF (YOUT.LT.0.) YOUT=0.                                           SETUP249
   85 TCP(J)=YOUT                                                       SETUP250
      RETURN                                                            SETUP251
      END                                                               SETUP252
      SUBROUTINE SPECTRA(ACN,FSIGON)                                    SPECTRA2
C                                                                       SPECTRA3
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                    LCNDEX 4
      COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)    RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                          RHO    3
      COMMON/TCOEF/ETC(25,6),TC(25,30),BCD(7),XSPIN(7),NLDIM,           TCOEF  2
     1NPART,NEE(6),NO(6),NTC(6),IZAID(7),XMASS(7),NEEDIM,NLEIN(6,25),   TCOEF  3
     2NLE(6,200),JRAST(200,6)                                           TCOEF  4
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM      LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                       LEVEL1 3
      COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),   BASIC1 2
     1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60)   BASIC1 3
      COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,    NKKM(10),CNPI(10), BASIC2 2
     1 CNPIP(10),S(60),SAC(10),ID1(60),IDP,IOE2(60),IBUF(6,10),         BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60),  BASIC2 4
     3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM,  IOECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                  BASIC2 7
      COMMON/GAMMA/NMP,LGROPT,SWS(10),GML(6),GMP(6),RE1(6),LMGHOL(6),   GAMMA  2
     1 TGR(200,6),WKCON,CAXEL,GAXEL,ERAXEL,EXSWS(10),WKNORM             GAMMA  3
      COMMON/PREEQ/LPEQ,SIGR,PREQI(6),CSIGI(6),NITT(6),ALPHA(6)         PREEQ  2
      COMMON/SUMBLK1/KP,KD,IP,ID,KMGN,JPI2,N,DP,IK                      SUMBLK12
      COMMON/SUMBLK2/XJCN,PICN,JPICN,ECONJ,MP,J2,L2,TGRL,TLEV,XJ2,      SUMBLK22
     1 TTOT(30)                                                         SUMBLK23
      DIMENSION SCBUF(8000), OECON(2),XJINI(2),PI(3),SCBUF2(80)         SPECTR14
      EQUIVALENCE (SCBUF,RHO)                                           SPECTR15
      DIMENSION IBTAG(10),IBTAG2(10)                                    SPECTR16
      COMMON/TOTALS/SIGTOT(10)                                          SPECTR17
C                                                                       SPECTR18
      DATA PIP,PI1/1.,1./,XJINI/-0.5,-1.0/,PI/+1.0,-1,0,+1.0/           SPECTR19
      DATA OECON/1.0,3.0/                                               SPECTR20
C                                                                       SPECTR21
      SPLIN (B,C,D,E) = B*A5 + C*A6 - AA*(D*A5+E*A6+D+E)                SPECTR22
      CALL SECOND(TIME)                                                 SPECTR23
      DTIME=TIME-TKEEP                                                  SPECTR24
      WRITE(6,3)   DTIME,TIME                                           SPECTR25
  3   FORMAT(1H1. *START OF SPECTRA SUBROUTINE.*,                       JUL19771
     1* TIME FROM START OF THIS ENERGY =*F9,3,* SECONDS, TOTAL ELAPSED TSPECTR27
     2IME =*F9.3,* SECONDS.*)                                           SPECTR28
C                                                                       SPECTR29
C     SET UP LEVEL DENSITY PARMETERS                                    SPECTR30
      CALL LEVDSET(ACN,A,A2)                                            SPECTR31
C                                                                       SPECTR32
C     ZERO LARGE- AND SMALL-CORE ARRAYS                                 SPECTR33
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      CALL ECRD(SCBUF,IZEROLC,8000,IERR)
      CALL ECWR(SCBUF,IPLLC,3000,IERR)
      CALL ECRD(SPP,IZEROLC,1400,IERR)
      CALL ECRD(SPNGN,IZEROLC,NKMAX,IERR)
      N8000=NPOPMAX-8000
      DO 51 N=1,NIDIM
      NPTS=NKDIM*NIPDIM
      INDEX=ISPLC+(N-1)*NPTS
      CALL ECWR(SCBUF,INDEX,NPTS,IERR)
      INDEX=IGLC+(N-1)*NPTS
      CALL ECWR(SCBUF,INDEX,NPTS,IERR)
   51 CONTINUE
      DO 45 IB=1,10
      IBTAG(IB)=0
   45 IBTAG2(IB)=0
C
C     MAIN LOOP TO SET UP DECAYING NUCLEI
C
       SIGR=0.
      CALL ECRD(SIGTOT,IZEROLC,10,IERR)
      DO 500 I=1,NI
      CALL SECOND(TIME)
      DTIME=TIME-TKEEP
      WRITE(6,2) I,DTIME,TIME
    2 FORMAT(/* START OF I=*I2,* LOOP.*,
     1* TIME FROM START OF THIS ENERGY =*F9.3,* SECONDS, TOTAL ELAPSED T
     2IME =*F9.3,* SECONDS.*)
      JOECN= IOECN(I)
      NKCN= NKKCN(I)
      IF(NKCN.LT.1) GO TO 60
      IF((ICAPT.EQ.0).AND.(I.EQ.1)) NKCN=1
   60 IBCN=IBUF(1,I)
      IF (IBCN.GT.NIBDIM) IBCN=IBCN-NIBDIM
      NIP= XNIP(I)
      NJDIM2=2*NJDIM
      NJMAX2=2*NJMAX
C
C     ZERO ARRAYS AND CHECK BUFFERING
      NPTS=NKDIM*NIP
      INDEX=IZEROLC
      CALL ECRD(SP,INDEX,NPTS,IERR)
      CALL ECRD(G,INDEX,NPTS,IERR)
      NPTS=NLEVDIM*NIPDIM
      CALL ECRD(PL,INDEX,NPTS,IERR)
      CALL ECRD(SCBUF,INDEX,8000,IERR)
      DO 64 IP=1,NIP
      IB=IBUF(IP,I)
      IF (IB.LT.1) GO TO 64
      IF(IBTAG(IB).GT.0) GO TO 64
      IBTAG(IB)=1
      IF(IB.LE.NIBDIM) GO TO 62
      IB=IB-NIBDIM
      IF(IBTAG2(IB).GT.0) GO TO 62
      WRITE(6,1) I,IP,IB
    1 FORMAT(//* ----THE REACTION I=*I2,*, IP=*I2,* IS ATTEMPTING TO REU
     1SE BUFFER NUMBER IB=*I2,* BEFORE THAT BUFFER HAS BEEN EMPTIED.*//
     2* ----ABORT JOB.*)
      STOP
   62 CONTINUE
      INDEX=IPBLC+(IB-1)*NJDIM*2*NKDIM
      CALL ECWR(SCBUF,INDEX,8000,IERR)
      IF (N8000.LT.1) GO TO 64
      INDEX=INDEX+8000
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      CALL ECWR(SCBUF,INDEX,N8000,IERR)                                 SPECTR97
   64 CONTINUE                                                          SPECTR98
      IBTAG2(IBCN)=1                                                    SPECTR99
   66 IF (NKCN.LT.1) GO TO 500                                          SPECT100
C                                                                       SPECT101
C     COMPUTE TRANSMISSION COEFFICIENTS AND LEVEL DENSITIES ON          SPECT102
C     INTEGRATION ENERGY MESH AND LOAD INTO LCM                         SPECT103
      CALL LCMLOAD(I)                                                   SPECT104
C                                                                       SPECT105
C     SET UP GAMMA-RAY CASCADE CALCULATION. DETERMINE WEISSKOPF OR AXEL SPECT106
C     PARAMETERS AND COMPUTE GAMMA RAY TRANSMISSION COEFFICIENTS        SPECT107
      CALL GAMSET(I)                                                    SPECT108
C                                                                       SPECT109
C     MAIN LOOP OVER INITIAL ENERGY OF DECAYING COMPOUND NUCLEUS        SPECT110
C                                                                       SPECT111
      UCN= UP-SAC(I)+DE                                                 SPECT112
      DO 400 K=1,NKCN                                                   SPECT113
      UCN=UCN-DE                                                        SPECT114
      JMAXCN=JRAST(K,1)                                                 SPECT115
      CALL ECRD(TTOT,IZEROLC,NJMAX2,IERR)                               SPECT116
      IK=I+K                                                            SPECT117
C                                                                       SPECT118
C     SET UP TRANSMISSION COEFFICIENT TO WIDTH CONVERSION FACTORS       SPECT119
      INDEX=IRHOLC+(K-1)*NJDIM                                          SPECT120
      CALL ECRD(RHOFTR,INDEX,NJMAX,IERR)                                SPECT121
      DO 101 JCN=1,JMAXCN                                               SPECT122
  101 RHOFTR(JCN)= 1./(RHOFTR(JCN)*6.2831853l)                          SPECT123
C                                                                       SPECT124
C     INITIALIZE POPULATION OF ALL STATES                               SPECT125
      INDEX=IP8LC+(K-1)*NJDIM*2+(IBCN-1)*NJDIM*2*NKDIM                  SPECT126
      CALL ECRD(PP,INDEX,NJDIM2,IERR)                                   SPECT127
C                                                                       SPECT128
C     WIDTH SUMMING LOOP                                                SPECT129
      DO 300 M=1,2                                                      SPECT130
C                                                                       SPECT131
C     LOOP OVER REACTION TYPES FOR THE DECAYS                           SPECT132
      DO 300 IP=1,NIP                                                   SPECT133
C                                                                       SPECT134
      IR=LR(IP,I)                                                       SPECT135
      ID=ID1(IR)                                                        SPECT136
      KNGN=2                                                            SPECT137
      IF((K.NE.1).AND.(ID.EQ.1).AND.(I.EQ.1).AND.(ID1(1).EQ,7)) KNGN=1  SPECT138
      JOE2= IOE2(IR)                                                    SPECT139
      XJ1=XSPIN(ID)                                                     SPECT140
C                                                                       SPECT141
C     TRANSFER LEVEL DENSITIES, TRANSMISSION COEFFICIENTS, LEVEL        SPECT142
C     ENERGIES, AND LEVEL SPINS TO SCM.                                 SPECT143
      IF(ID.EQ.7) GO TO 102                                             SPECT144
      NPTS= NTC(ID)                                                     SPECT145
      INDEX=ITCLC+(ID-1)*NLDIM*NEEDIM                                   SPECT146
      CALL ECRD(TC,INDEX,NPTS,IERR)                                     SPECT147
      IF(NKK(IR).LT.1) GO TO 102                                        SPECT148
      NPTS=NTC2(IP)                                                     SPECT149
      INDEX=ITLC+NKDIM*NLDIM*(IP-1)                                     SPECT150
      CALL ECRD(T,INDEX,NPTS,IERR)                                      SPECT151
  102 NK2= NKK(IR)                                                      SPECT152
      IF(NK2.LT.1) GO TO 103                                            SPECT153
      NPTS= NRHO(IP)                                                    SPECT154
      INDEX=IRHOLC+NKDIM*NJDIM*(IP-1)                                   SPECT155
      CALL ECRD(RHO,INDEX,NPTS,IERR)                                    SPECT156
  103 NLEV2=XNL(IR)                                                     SPECT157
      INDEX=IFLLC+(IR-1)*NLEVDIM                                        SPECT158
      CALL ECRD(EL,INDEX,NLEV2,IERR)                                    SPECT159
```

```
      INDEX=IAJLC+(IR-1)*NLEVDIM
      CALL ECRD(AJ,INDEX,NLEV2,IERR)
C
C     MAIN CONTINUUM-TO-CONTINUUM COMPUTATION SECTION ------------------
C
C     RESIDUAL NUCLEUS ENERGY LOOP
      KLOW=K+1
      IF(KLOW.GT.NK2) GO TO 200
      KD=0
      DO 195 KP=KLOW,NK2
      KD=KD+1
      XNLE = NLE(IP,KO)-1
      JMAX2=JRAST(KP,IP)
      XJMAX2=JMAX2
      XJMAX2=XJMAX2-0.25*(OECON(JOE2)+1.)+0.01
      XJCN= XJINI(JOECN)
      INCHKEY=I+K+M+IP+KP
C
C     ZERO INITIAL POPULATIONS IN RESIDUAL NUCLEI
      JMAX22=2*JMAX2
      IF (M.EQ.2) CALL ECRD(P,IZERDLC,JMAX22,IERR)
C
C     LOOP OVER DECAYING COMPOUND NUCLEUS SPIN,PARITY
      DO 180 JCN=1,JMAXCN
      XJCN=XJCN+1.0
      ECONJ= ECON*(2.*XJCN+1.0)*FSIGCN
      DO 180 IPICN=1,2
      PICN= PI(IPICN)
      PIPI = PI1*PICN
      JPICN=JPI(JCN,IPICN)
C
C     SET UP INITIAL POPULATIONS FOR LQ=0 CASE
      IF(INCHKEY.GT.6) GO TO 117
      CALL INCHSUM(5)
      PP(JPICN)=OP
      SIGR=SIGR+OP
  117 IF (PP(JPICN).LT.1.E-300) GO TO 180
      IF (ID.NE.7) GO TO 140
C
C     GAMMA RAY TRANSITION SECTION -- CONTINUUM TO CONTINUUM
      DO 130 MP=1,NMP
      LG= GML(MP)
      PIL=PILLL(LG+1)
      XJ2= ABS(XJCN-GML(MP))-1.0
      XJ2H=XJCN+GML(MP)+0.001
      XJ2H=AMIN1(XJ2H,XJMAX2)
      DO 128 JJ2=1,1000
      XJ2=XJ2+1.0
      PI2= PICN*GMP(MP)*PIL
      J2=XJ2+1.01
      IF(XJ2.GT.XJ2H) GO TO 130
      IPI2 = 1.501-PI2/2.
      JPI2 = JPI(J2,IPI2)
C
C     CHECK FOR 0 TO 0 TRANSITIONS
      IF(XJ2+XJCN.LT.0.1) GO TO 128
      GO TO (112,120) M
C
C     ADD CONTINUUM GAMMA WIDTH TO TOTAL WIDTH SUM
  112 DT= TGR(KD,MP)*RHO(J2,KP)*DE
      TTOT(JPICN)=TTOT(JPICN)+DT
      G(K,IP)=G(K,IP)+DT*RHOFTR(JCN)
      GO TO 128
```

```
C                                                                         SPECT223
C     COMPUTE CONTINUUM GAMMA POPULATION INCREMENTS FOR LOOPS OTHER       SPECT224
C     THAN THE FIRST                                                      SPECT225
  120 DP = PP(JPICN)*TGR(KD,MP)*RHO(J2,KP)*DE/TTOT(JPICN)                 SPECT226
  126 CALL SUMER(1,DE)                                                    SPECT227
  128 CONTINUE                                                            SPECT228
  130 CONTINUE                                                            SPECT229
      GO TO 180                                                           SPECT230
C                                                                         SPECT231
C     PARTICLE TRANSITION SECTION  -- CONTINUUM TO CONTINUUM              SPECT232
  140 XJ2= XJINI(JOE2)                                                    SPECT233
      DO 170 J2=1,JMAX2                                                   SPECT234
      XJ2=XJ2+1.0                                                         SPECT235
      S2= ABS(XJ2-XJ1)-1.0                                                SPECT236
      S2H= XJ2+XJ1+0.001                                                  SPECT237
      DO 168 IS2=1,1000                                                   SPECT238
      S2= S2+1.0                                                          SPECT239
      IF(S2.GT.S2H) GO TO 170                                             SPECT240
      L2L=ABS(XJCN-S2)+1.01                                               SPECT241
      L2H=XJCN+S2+1.01                                                    SPECT242
      L2H=MIN0(L2H,NLE(IP,KD))                                            SPECT243
      IF(L2L.GT.L2H) GO TO 168                                            SPECT244
      DO 166 L2=L2L,L2H                                                   SPECT245
      PI2=PIPI*PILLL(L2)                                                  SPECT246
      IPI2= 1.501-PI2/2.                                                  SPECT247
      JPI2= JPI(J2,IPI2)                                                  SPECT248
      GO TO (142,150) M                                                   SPECT249
C                                                                         SPECT250
C     ADD CONTINUUM PARTICLE WIDTH TO TOTAL WIDTH SUM                     SPECT251
  142 DT= T(L2,KD)*RHO(J2,KP)*DE                                          SPECT252
      TTOT(JPICN)=TTOT(JPICN)+DT                                          SPECT253
      G(K,IP)=G(K,IP)+DT*RHOFTR(JCN)                                      SPECT254
      GO TO 166                                                           SPECT255
C                                                                         SPECT256
C     COMPUTE CONTINUUM PARTICLE POPULATION INCREMENTS FOR LOOPS OTHER    SPECT257
C     THAN THE FIRST                                                      SPECT258
 150  CONTINUE                                                            MAR77  1
      IF(TTOT(JPICN).LE.0.)GO TO 166                                      MAR77  2
      DP=PP(JPICN)*T(L2,KD)*RHO(J2,KP)*DE/TTOT(JPICN)                     MAR77  3
  160 CALL SUMER(1,DE)                                                    SPECT260
  166 CONTINUE                                                            SPECT261
  168 CONTINUE                                                            SPECT262
  170 CONTINUE                                                            SPECT263
  180 CONTINUE                                                            SPECT264
C     ---------------------------------------------------------------------SPECT265
C                                                                         SPECT266
C     TRANSFER ACCUMULATED POPULATION TO LCM BUFFER                       SPECT267
      IF((M.EQ.1).OR.(IBUF(IP,I).EQ.0))GO TO 196                          SPECT268
      IB=IBUF(IP,I)                                                       SPECT269
        IF(IB.GT.NIBDIM)IB=IB-NIBDIM                                      SPECT270
      INDEX=IPBLC+(KP-1)*2*NJDIM+(IB-1)*2*NJDIM*NKDIM                     SPECT271
      CALL ECRD(SCBUF2(1),INDEX,JMAX22,IERR)                              SPECT272
      DO 190 J=1,JMAX22                                                   SPECT273
  190 SCBUF2(J) = SCBUF2(J) + P(J)                                        SPECT274
      CALL ECWR(SCBUF2(1),INDEX,JMAX22,IERR)                              SPECT275
 196  CONTINUE                                                            SPECT276
  195 CONTINUE                                                            SPECT277
  200 U2MAX= UCN-S(IR)                                                    SPECT278
C                                                                         SPECT279
C     MAIN CONTINUUM-TO-LEVEL COMPUTATION SECTION -------------------------SPECT280
C                                                                         SPECT281
C     LOOP OVER DISCRETE STATES OF THE RESIDUAL NUCLEI                    SPECT282
      DO 280 N=1,NLEV2                                                    SPECT283
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      XJ2=ABS(AJ(N))                                                    SPECT284
      PI2= SIGN(1.0,AJ(N))                                              SPECT285
      EC2 = U2MAX-EL(N)                                                 SPECT286
      IF(EC2.LE.0.0) GO TO 285                                          SPECT287
      KD = EC2/DE + 0.5                                                 SPECT288
      IF(KD.LT.1) KD=1                                                  SPECT289
C                                                                       SPECT290
C     GAMMA RAY SECTION -- CONTINUUM TO LEVELS                          SPECT291
      IF(IO.NE.7) GO TO 240                                             SPECT292
      DO 230 MP=1,NMP                                                   SPECT293
      LG = GML(MP)                                                      SPECT294
      PIL=PILLL(LG+1)                                                   SPECT295
      PICN = PIL*GMP(MP)*PI2                                            SPECT296
      IPICN = 1.501-PICN/2.                                             SPECT297
      XJCN = ABS(XJ2-GML(MP))-1.0                                       SPECT298
      XJCNH= XJ2+GML(MP)+0.001                                          SPECT299
      DO 228 JJCN=1,1000                                                SPECT300
      XJCN = XJCN+1.0                                                   SPECT301
      JCN=XJCN+1.01                                                     SPECT302
      IF((JCN.GT.JMAXCN).OR.(XJCN.GT.XJCNH)) GO TO 230                  SPECT303
      ECONJ=ECON*(2.*XJCN+1.0)*FSIGCN                                   SPECT304
      JPICN = JPI(JCN,IPICN)                                            SPECT305
      IF(XJCN+XJ2.LT.0.1) GO TO 228                                     SPECT306
      GO TO (204,206),LGROPT                                            SPECT307
  204 TGRL=WKCON*WKNORM*RE1(MP)*EC2**(2*LG+1)                           SPECT308
      GO TO 210                                                         SPECT309
  206 TGRL = 1.634928E-3*CAXEL*RE1(MP)*GAXEL*EC2**4/((ERAXEL**2         SPECT310
     1       -EC2**2)**2 + (EC2*GAXEL)**2)                              SPECT311
      TGRL=TGRL*WKCON                                                   SPECT312
  210 IF (M.EQ.2) GO TO 220                                             SPECT313
C                                                                       SPECT314
C     ADD GAMMA WIDTH TO TOTAL WIDTH SUM                                SPECT315
      DT=TGRL                                                           SPECT316
      TTOT(JPICN)=TTOT(JPICN)+DT                                        SPECT317
      G(K,IP)=G(K,IP)+DT*RHOFTR(JCN)                                    SPECT318
      GO TO 228                                                         SPECT319
C                                                                       SPECT320
C     COMPUTE LEVEL POPULATION INCREMENT FROM CONTINUUM-TO-LEVEL TRAN-  SPECT321
C     SITIONS IN OTHER THAN THE FIRST LOOP                              SPECT322
  220 IF(TTOT(JPICN).EQ.0.) GO TO 228                                   SPECT323
      DP = PP(JPICN)*TGRL/TTOT(JPICN)                                   SPECT324
  226 CALL SUMER(2,DE)                                                  SPECT325
  228 CONTINUE                                                          SPECT326
  230 CONTINUE                                                          SPECT327
      GO TO 280                                                         SPECT328
C                                                                       SPECT329
C     PARTICLE TRANSITION SECTION -- CONTINUUM TO LEVEL                 SPECT330
  240 XJCN= XJINT(JOECN)                                                SPECT331
      KE = ISERCH(EC2,ETC(1,ID),NEE(ID),AA,A5,A6)                       SPECT332
      XNLE = NLEIN(IO,KE+1)-1                                           SPECT333
      DO 270 JCN=1,JMAXCN                                               SPECT334
      XJCN= XJCN+1.0                                                    SPECT335
      ECONJ=ECON*(2.*XJCN+1.0)*FSIGCN                                   SPECT336
      S2= ABS(XJ2-XJ1)-1.0                                              SPECT337
      S2H= XJ1+XJ2+0.001                                                SPECT338
      DO 268 IS=1,1000                                                  SPECT339
      S2=S2+1.0                                                         SPECT340
      IF(S2.GT.S2H)GO TO 270                                            SPECT341
      L2L=ABS(XJCN-S2)+1.01                                             SPECT342
      L2H=XJCN+S2+1.01                                                  SPECT343
      L2H=MIN0(L2H,NLEIN(ID,KE+1))                                      SPECT344
      IF(L2L.GT.L2H) GO TO 268                                          SPECT345
      DO 266 L2=L2L,L2H                                                 SPECT346
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      PICN=PI1*PI2*PILLL(L2)                                            SPECT347
      IPICN = 1.5Ø1-PICN/2.                                             SPECT348
      JPICN = JPI(JCN,IPICN)                                            SPECT349
      CALL INTERP(ETC(1,ID),TC(1,L2),NEE(ID),2,EC2,TLEV)                SPECT350
      IF(TLEV.LT.Ø.)TLEV=Ø.                                             SPECT351
      GO TO (242,25Ø) M                                                 SPECT352
C                                                                       SPECT353
C     ADD PARTICLE WIDTH TO TOTAL WIDTH SUM                             SPECT354
 242  DT= TLEV                                                          SPECT355
      TTOT(JPICN)=TTOT(JPICN)+DT                                        SPECT356
      G(K,IP)=G(K,IP)+DT*RHOFTR(JCN)                                    SPECT357
      GO TO 266                                                         SPECT358
C                                                                       SPECT359
C     COMPUTE POPULATION INCREMENTS FOR PARTICLE-LEVEL TRANSITIONS AFTERSPECT360
C     THE FIRST LOOP                                                    SPECT361
 25Ø  IF(TTOT(JPICN).EQ.Ø.) GO TO 266                                   SPECT362
      DP = PP(JPICN)*TLEV/TTOT(JPICN)                                   SPECT363
 26Ø  CALL SUMER(2,OE)                                                  SPECT364
 266  CONTINUE                                                          SPECT365
 268  CONTINUE                                                          SPECT366
 27Ø  CONTINUE                                                          SPECT367
 28Ø  CONTINUE                                                          SPECT368
C     ------------------------------------------------------------------SPECT369
 285  CONTINUE                                                          SPECT370
C                                                                       SPECT371
C     CLOSE M AND IP LOOPS.                                             SPECT372
 3ØØ  CONTINUE                                                          SPECT373
C                                                                       SPECT374
C     CLOSE K LOOP. TRANSFER SP AND PL TO LCM.                          SPECT375
 4ØØ  CONTINUE                                                          SPECT376
      NPTS= NKDIM*NIP                                                   SPECT377
      IF(I.EQ.1.AND.LPEQ.EQ.1)CALL PRECMP                               SPECT378
      INDEX=ISPLC+NKDIM*NIPDIM*(I-1)                                    SPECT379
      CALL ECWR(SP,INDEX,NPTS,IERR)                                     SPECT380
      INDEX=IGLC+(I-1)*NKDIM*NIPDIM                                     SPECT381
      CALL ECWR(G,INDEX,NPTS,IERR)                                      SPECT382
      NPTS=NIP*NLEVDIM                                                  SPECT383
      INDEX=IPLLC+(I-1)*NLEVDIM*NIPDIM                                  SPECT384
      CALL ECWR(PL,INDEX,NPTS,IERR)                                     SPECT385
C                                                                       SPECT386
C     CLOSE I LOOP                                                      SPECT387
 5ØØ  CONTINUE                                                          SPECT388
      CALL SECOND(TIME)                                                 SPECT389
      DTIME=TIME-TKEEP                                                  SPECT390
      WRITE(6,4)    DTIME,TIME                                          SPECT391
  4   FORMAT(/* END OF I LOOP IN SUBROUTINE SPECTRA.*,                  SPECT392
     1* TIME FROM START OF THIS ENERGY =*F9.3,* SECONDS, TOTAL ELAPSED TSPECT393
     2IME =*F9.3.* SECONDS.*)                                           SPECT394
C                                                                       SPECT395
C     COMPUTE DISCRETE GAMMA-RAY CROSS SECTIONS AND ADD TO SPECTRA.     SPECT396
      CALL GRLINES                                                      SPECT397
C                                                                       SPECT398
      RETURN                                                            SPECT399
      END                                                               SPECT400
      SUBROUTINE LEVDSET(ACN,A,A2)                                      LEVDSET2
C                                                                       LEVDSET3
      COMMON/LEVDEN/DEP(6Ø),XNLGC(6Ø),ECGC(6Ø),UCUTOFF,DEFCN,TGC(6Ø),   LEVDEN 2
     1 EØGC(6Ø),EMATGC(6Ø),PAIR(6Ø),XMR3(6Ø),XNLLN(6Ø),SZ(1ØØ),SN(15Ø), LEVDEN 3
     2 PZ(1ØØ),PN(15Ø)                                                  LEVDEN 4
      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                  LEVDEN 5
      COMMON/BASIC1/NI.XNIP(1Ø),NIR,LR(6,1Ø),ZA1(6Ø),ZA2(6Ø),XM2(6Ø),   BASIC1 2
     1 ZACN(1Ø),CSGR(6Ø),CSTOT(6Ø).CSLEV(6Ø),CSID(8),EAVID(8),EAV(6Ø)   BASIC1 3
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
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     1   ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIROIM                                                    LCNDEX 4
      DIMENSION DEFCON(2),A(1),A2(1)                                    LEVOSET7
C                                                                       LEVDSET8
C     DATA TABLES OF COOK ET. AL.  AAEC/TM392                           LEVDSET9
C                                                                       LEVDSE10
      DATA  PZ/11*0.,2.46,0.,2.09,0.,1.62,0.,1.62,0.,1.83,0.,1.73,      LEVDSE11
     1 0.,1.35,0.,1.54,0.,1.28,0.26,0,88,0.19,1.35,-.05,1,52,-,09,1,17, LEVDSE12
     2 .04,1,24,0.29,1.09,.26,1.17,.23,1.15,-,08,1,35,0,34,1.05,,28,1,27LEVDSE13
     3 ,0.,1.05,0.,1,,.09,1.2,,2,1.4,,93,1.,-.2,1.19,.09,.97,0.,.92,.11,LEVOSE14
     4 .68,.05,.68,-.22,.79,,09,.69,.01,.72,0.,.4,,16,.73,0.,,46,,17,    LEVDSE15
     5 .89,0.,-79,0.,,59,0.,.81,-,06,.69,-.2,.71,-,12,.72,0.,.77,2*0./  LEVDSE16
      DATA PN/11*0.,2.67,0.,1.8,0.,1.67,0.,1.86,0.,2.04,0.,1.64,0.,1.44,LEVDSE17
     1 0.,1.54,0.,1.3,0.,1.27,0.,1.29,.08,1.41,-.08,1.5,-,05,2.24,-.47, LEVDSE18
     2 1,43,-.15,1.44,,06,1.56,.25,1.57,-,16,1.46,0.,.93,.01,.62,-,5,   LEVDSE19
     3 1.42,.13,1.52,-.65,.8,-.08,1.29,-,47,1.25,-.44,.97,.08,1,65,-.11,LEVDSE20
     4 1,26,-,46,1.06,0.22,1.55,-.07,1.37,0.1,1.2,-.27,,92,-.35,1.19,0.,LEVDSE21
     5 1.05,-.25,1.61,-.21,.9,-.21,.74,-,38,,72,-.34,.92,-.26,.94,,01,  LEVDSE22
     6 .65,-.36,.83,,11,,67,,05,1,.,51,1.04,.33,.68,-.27,.81,.09,,75,   LEVDSE23
     7 .17,.86,.14,1.1,-.22,.84,-.47,,48,.02,,88,.24,,52,.27,.41,-,05/  LEVDSE24
      DATA  (PN(IL),IL=126,150)/                                        LEVDSE25
     X  ,38,.15,.67,0.,.61,0.,-78,0.,.67,0.,.67,0.,.79,                 LEVDSE26
     1 0.,.6,.04,.64,-,06,.45,.05,.26,-.22,.39.0.0.,.39/                LEVDSE27
      DATA SZ/10*0.,-2,91,-4.17,-5.72,-7.8,-8.97,-9.7,-10,1,-10,7,-11.38LEVDSE28
     1 ,-12.07,-12.55,-13.24,-13.93,-14.71,-15,53,-16.37,-17.36,-18,6,  LEVDSE29
     2 -18.7,-18.01,-17.87,-17.08,-16.6,-16.75,-16,5,-16,35,-16,22,     LEVDSE30
     3 -16,41,-16.89,-16.43,-16,68,-16.73,-17.45,-17,29,-17.44,-17,82,  LEVDSE31
     4 -18.62,-18.27,-19.39,-19.91,-19.14,-18.26,-17.4,-16.42,-15,77,   LEVDSE32
     5 -14,37,-13.91,-13.1,-13.11,-11,43,-10.89,-10.75,-10,62,-10.41,   LEVDSE33
     6 -10.21,-9,85,-9,47,-9,03,-8.61,-8.13,-7,46,-7,48,-7.2,-7.13,-7.06LEVDSE34
     7 ,-6.78,-6,64,-6,64,-7,68,-7.89,-8,41,-8,49,-7,88,-6,3,-5.47,-4,78LEVDSE35
     8 ,-4,37,-4.17,-4.13,-4.32,-4.55,-5.04,-5.28,-6.06,-6.28,-6.87,    LEVDSE36
     9  -7.20,-7.74,2*0./                                               LEVDSE37
      DATA SN/10*0.,6,8,7.53,7.55,7.21,7.44,8.07,8.94,9.81,10.6,11.39,  LEVDSE38
     1 12.54,13,68,14,34,14.19,13.83,13.5,13.,12.13,12,6,13.26,14,13,   LEVDSE39
     2 14.92,15.52,16.38,17.16,17.55,18,03,17,59,19.03,18.71,18.8,18.99,LEVOSE40
     3 18.46,18.25,17,76,17.38,16.72,15.62,14.38,12.88,13.23,13.81,14.9,LEVDSE41
     4 14.86,15.76,16,2,17,62,17,73,18,16,18,67,19.69,19,51,20.17,19.48,LEVDSE42
     5 19.98,19.83,20.2,19.72,19.87,19.24,18.44,17.61,17.1,16.16,15.9,  LEVDSE43
     6 15.33,14.76,13,54,12.63,10,65,10,1,8.89,10.25,9.79,11,39,11.72,  LEVDSE44
     7 12.43,12.96,13.43,13.37,12.96,12.11,11.92,11.,10.8,10.42,10.39,  LEVDSE45
     8 9.69,9.27,8.93,8.57,8.02,7.59,7.33,7.23,7.05,7.42,6.75,6.6,6,38/ LEVDSE46
      DATA  (SN(IL),IL=111,150)/                                        LEVDSE47
     X  6.36,6.49,6.25,5.85,5,48,4.53,4.3,3.39,2.35,1.66,.81,           LEVDSE48
     1 0,46,-.96,-1.69,-2.53,-3.16,-1.87,-.41,.71,1.66,2.62,3.22,3,76,  LEVDSE49
     2 4,1,4.46,4.83,5.09,5,18,5.17,5,1,5,01,4.97,5,09,5.03,4.93,5,28,  LEVDSE50
     3 5.49,5.50,5.37,5.30/                                             LEVDSE51
      DATA DEFCON/0.142,0.120/                                          LEVDSE52
C                                                                       LEVOSE53
C     COMPUTE EACH LEVEL DENSITY RELATIVE TO ACN USING GILBERT-CAMERON  LEVDSE54
C     FORMULAS FOR LEVEL DENSITY                                        LEVDSE55
C                                                                       LEVOSE56
      IDEFCN= DEFCN+1.01                                                LEVOSE57
      IZACN= ZACN(1)                                                    LEVDSE58
      IACN=MOD(IZACN,1000)                                              LEVOSE59
      IZCN= IZACN/1000                                                  LEVDSE60
      INCN= IACN-IZCN                                                   LEVDSE61
      XACN= IACN                                                        LEVOSE62
      ACNGC= XACN*(0.00917*(SZ(IZCN)+SN(INCN)) + DEFCON(IDEFCN))        LEVDSE63
      IF(ACN.EQ.0.) ACN=ACNGC                                           LEVDSE64
      A2(1)=ACN                                                         LEVDSE65
      DO 60 IR=1,NIR                                                    LEVDSE66
      IDEF = DEF(IR)+1.01                                               LEVDSE67
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      IZA = ZA2(IR)                                                     LEVDSE68
      IA= MOD(IZA,1000)                                                 LEVDSE69
      IZ = IZA/1000                                                     LEVDSE70
      IN = IA-IZ                                                        LEVDSE71
      XA = IA                                                           LEVDSE72
      IF((A(IR).GT.0.).OR.(IR.EQ.1)) GO TO 50                           LEVDSE73
      AGC = XA*(0.00917*(SZ(IZ)+SN(IN)) + DEFCON(IDEF))                 LEVDSE74
      DAGC = AGC-ACNGC                                                  LEVDSE75
      A2(IR) = ACN+DAGC                                                 LEVDSE76
   50 PAIR(IR) = PZ(IZ)+PN(IN)                                          LEVDSE77
      CALL GILCAM(A2(IR),IR)                                            LEVDSE78
   60 CONTINUE                                                          LEVDSE79
      RETURN                                                            LEVDSE80
      END                                                               LEVDSE81
      SUBROUTINE GILCAM (A,LR)                                          GILCAM 2
C                                                                       GILCAM 3
      COMMON/LEVDEN/DEF(60),XNLGC(60),ECGC(60),UCUTOFF,DEFCN,TGC(60),   LEVDEN 2
     1 E0GC(60),EMATGC(60),PAIR(60),XMR3(60),XNLLN(60),SZ(100),SN(150), LEVDEN 3
     2 PZ(100),PN(150)                                                  LEVDEN 4
      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                  LEVDEN 5
      DIMENSION DE(4)                                                   GILCAM 5
C                                                                       GILCAM 6
      DATA NDE,DE/4,1.,0.1,0.01,0.001/                                  GILCAM 7
      EC=ECGC(LR)                                                       GILCAM 8
      CONST = 5.0571*XMR3(LR)                                           GILCAM 9
      E = 0.1+PAIR(LR)+2.25/A                                           GILCAM10
      DO 50 I=1,NDE                                                     GILCAM11
      DO 40 J=1,500                                                     GILCAM12
      U = E-PAIR(LR)                                                    GILCAM13
      T = 1./(SQRT(A/U)-1.5/U)                                          GILCAM14
      E01 = EC-T*XNLLN(LR)                                              GILCAM15
      E02 = E+T*(ALOG(CONST*SQRT(A*U**3)/T)-2.*SQRT(A*U))               GILCAM16
      DEL2 =E01-E02                                                     GILCAM17
      IF(I*J.EQ.1) SIGN0 = SIGN(1.,DEL2)                                GILCAM18
      SIGN2 = SIGN(1.,DEL2)                                             GILCAM19
      IF(SIGN2.NE.SIGN0) GO TO 45                                       GILCAM20
      DEL1 = DEL2                                                       GILCAM21
      E= E + DE(I)                                                      GILCAM22
   40 CONTINUE                                                          GILCAM23
   45 E = E-DE(I)                                                       GILCAM24
   50 CONTINUE                                                          GILCAM25
      DELA=ABS(DEL1-DEL2)                                               GILCAM26
      IF(DELA.GT.1.0E-300) GO TO 100                                    GILCAM27
      E=0.1+PAIR(LR)+2.25/A                                             GILCAM28
      EMATCH=E                                                          GILCAM29
      U=E-PAIR(LR)                                                      GILCAM30
      T=1./(SQRT(A/U)-1.5/U)                                            GILCAM31
      PRINT 1,LR                                                        JUL19772
    1 FORMAT(/* ++++ GILCAM SUBROUTINE UNABLE TO MATCH DISCRETE LEVELS WJUL19773
     1ITH LEVEL DENSITY FUNCTION FOR RESIDUAL NUCLEUS IN REACTION IR =*,JUL19774
     2 I3,* ++++*/)                                                     JUL19775
      GO TO 101                                                         GILCAM35
  100 EMATCH = E + DE(NDE)*(DEL1/(DEL1-DEL2))                           GILCAM36
      U = EMATCH - PAIR(LR)                                             GILCAM37
      T = 1./(SQRT(A/U)-1.5/U)                                          GILCAM38
  101 E0= EC -T*XNLLN(LR)                                               GILCAM39
      EMATGC(LR)=EMATCH                                                 GILCAM40
      TGC(LR)=T  $  E0GC(LR)=E0                                         GILCAM41
      RETURN                                                            GILCAM42
      END                                                               GILCAM43
      SUBROUTINE LCMLOAD(I)                                             LCMLOAD2
C                                                                       LCMLOAD3
C     COMPUTE TRANSMISSION COEFFICIENTS AND LEVEL DENSITIES ON          LCMLOAD4
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C     INTEGRATION ENERGY MESH AND LOAD INTO LCM                          LCMLOAD5
C                                                                        LCMLOAD6
 1    FORMAT(//* TRANSMISSION COEFFICIENTS ON SUBSET OF INTEGRATION ENERLCMLOAD7
     1GY GRID*)                                                          LCMLOAD8
 2    FORMAT(/ * ID=*I2,3X,*PARTICLE =*A10,3X,*I=*I2,3X,*IP=*I2,3X,      LCMLOAD9
     1 *IP=*I3.3X.*NK=*I4,3X,*NL=*I3)                                    LCMLOA10
 3    FORMAT(/ * ENERGY =* F7.3,* MEV*,5X,*JMAX INDEX =*I3)              LCMLOA11
 4    FORMAT(1P,10E12.5)                                                 LCMLOA12
 5    FORMAT(// * LEVEL DENSITIES ON SUBSET OF INTEGRATION ENERGY GRID*)LCMLOA13
 6    FORMAT(/ * ID=*I2,3X,*PARTICLE =*A10,3X,*I=*I2,3X,*IP=*I2,3X,      LCMLOA14
     1 *IR=*I3,3X,*NK=*I4,3X,*NJMAX=*I3)                                 LCMLOA15
 7    FORMAT(/ * ENERGY =*F7.3.* MEV*,5X,*LMAX INDEX =*I3)               LCMLOA16
C                                                                        LCMLOA17
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IFGLC,ISGLC,ITCLC,   LCNDEX 2
     1  ISTCLC.IPHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                     LCNDEX 4
      COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)     RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                           RHO    3
      COMMON/TCOFF/ETC(25,6),TC(25.30),BCD(7),XSPIN(7),NLDIM,            TCOEF  2
     1NPART,NEE(6),NO(6).NTC(6),IZAID(7),XMASS(7),NEEDIM,NLEIN(6,25),    TCOEF  3
     2NLE(6,200),JRAST(200,6)                                            TCOEF  4
      COMMON/LEVEL1/FL(50),AJ(50),AT(50).XNL(60),ELMAX(60),NLEVDIM       LEVEL1 2
     1,EG(240),SG(240).NGRAYS(60)                                        LEVEL1 3
      COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),    BASIC1 2
     1 ZACN(10),CSGR(60).CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60)    BASIC1 3
      COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,   NKKM(10),CNPI(10),  BASIC2 2
     1 CNPIP(10).S(60),SAC(10),ID1(60),IDP,IOE2(60),IBUF(6,10),          BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60),   BASIC2 4
     3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM,  IOECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2).XMP.XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                   BASIC2 7
      COMMON/LEVDEN/DEF(60),XNLGC(60),ECGC(60),UCUTOFF,DEFCN,TGC(60),    LEVDEN 2
     1 E0GC(60),EMATGC(60),PAIR(60),XMR3(60),XNLLN(60),SZ(100),SN(150),  LEVDEN 3
     2 PZ(100),PN(150)                                                   LEVDEN 4
      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                   LEVDEN 5
      COMMON/PREQ1/EPSIG(200.6),NLEV,NPIT,NIT                            PREQ1  2
      COMMON/PRNTOUT/IPRTLEV,IPRTTC,IPRTMLD,IPRTWID,IPRTSP,IPRTGC        PRNTOUT2
C                                                                        LCMLOA27
      SPLIN (B,C.D,E) = B*A5 + C*A6 - AA*(D*A5+E*A6+D+E)                 LCMLOA28
C                                                                        LCMLOA29
      NIP=XNIP(I)                                                        LCMLOA30
      DO 100 IP=1,NIP                                                    LCMLOA31
      IR=LR(IP,I)                                                        LCMLOA32
      IPRT=1                                                             LCMLOA33
      NK=NKK(IR)                                                         LCMLOA34
      IF(NK.LT.1) GO TO 100                                              LCMLOA35
      ID= ID1(IR)                                                        LCMLOA36
      DE=0.5                                                             LCMLOA37
      IF(IOE2(IR).GT.1) DE=1.0                                           LCMLOA38
      IF(ID.GT.6) GO TO 50                                               LCMLOA39
C                                                                        LCMLOA40
C     COMPUTE AND STORE TRANSMISSION COEFFICIENTS                        LCMLOA41
      NL= NO(ID)                                                         LCMLOA42
      NE= NEE(ID)                                                        LCMLOA43
      NPTS= NTC(ID)                                                      LCMLOA44
      INDEX=ITCLC+(ID-1)*NEEDIM*NLDIM                                    LCMLOA45
      CALL ECRD(TC,INDEX,NPTS,IERR)                                      LCMLOA46
      EK= 0.                                                             LCMLOA47
      DO 44 K=1,NK                                                       LCMLOA48
      EK= EK+DE                                                          LCMLOA49
      KE= ISERCH(EK,ETC(1,ID),NE,AA,A5,A6)                               LCMLOA50
      NL = NLEIN(ID,KE+1)                                                LCMLOA51
      NLE(IP,K)=NL                                                       LCMLOA52
```

```
      DO 44 L=1,NL
      CALL INTERP(ETC(1,ID),TC(1,L),NE,2,EK,YOUT)
      T(L,K)=YOUT
      IF(T(L,K).GE.1.)T(L,K)=1.
       IF(T(L,K).LE.0.)T(L,K)=0.
 44   CONTINUE
C
      IF(I.EQ.1.AND.ID.LE.6)45,55
 45   KLM=(UP-SAC(1)-S(IR))/DE+0.5
      EK=0.
      DO 51 K=1,KLM
      EPSIG(K,ID)=0.
      EK=EK+DE
      KE=ISERCH(EK,ETC(1,ID),NE,AA.A5,A6)
       NL=NLEIN(ID,KE+1)
      DO 52 L=1,NL
      CALL INTERP(ETC(1,ID),TC(1,L),NE,2,EK,YOUT)
      T(L,K)=YOUT
      IF(T(L,K).GE.1.)T(L,K)=1.
      IF(T(L,K).LE.0.)T(L,K)=0.
      EPSIG(K,ID)=EPSIG(K,ID)+(2.*(L-1)+1.)*T(L,K)
 52   CONTINUE
 51   CONTINUE
 55   CONTINUE
C     TRANSMISSION COEFFICIENT PRINT OPTION
      IF(IPRTTC.LT.2) GO TO 48
      WRITE(6,1)
      WRITE(6,2) ID,BCD(ID),I,IP,IR,NK,NL
      KPRT=IPRTTC-1
      DEFTR=KPRT
      EK = DE*(1.-DEFTR)
      DO 46 K=1,NK,KPRT
      EK=EK+DE*DEFTR
      NL = NLE(IP,K)
      WRITE(6,7) EK,NL
 46   WRITE(6,4) (T(L,K).L=1,NL)
 48   NPTS=NK*NLDIM
      NTC2(IP)=NPTS
      INDEX=ITLC+NKDIM*NLDIM*(IP-1)
      CALL ECWR(T,INDEX,NPTS,IERR)
C
C     COMPUTE AND STORE LEVEL DENSITIES AND YRASTS
 50   EKMAX= UP-SAC(I)-S(IR)
      XIEFF=7.47656E-3*XMR3(IR)**5
      EK=-DE
      DO 80 K=1,NK
      EK=EK+DE
      EX= EKMAX-EK
      U = EX-PAIR(IR)
      US= AMAX1(U,UCUTOFF)
        SJMAX=SQRT(2.*US*XIEFF)
      JMAX2=SJMAX+DE
      JMAX2=MIN0(JMAX2,NJMAX)
      JRAST(K,IP)=JMAX2
      SIG22 = 0.1776*SQRT(A2(IR)*US)*XMR3(IR)**2
      IF(EX.LE.EMATGC(IR)) GO TO 70
      AURT= SQRT(A2(IR)*U)
      RHOE = EXP(2.*AURT)/(10.1142*XMR3(IR)*U*AURT)
      GO TO 72
 70   RHOE = EXP((EX-E0GC(IR))/TGC(IR))/(2.*TGC(IR))
 72   XJJ=-1.0
      IF(IDE2(IR),EQ.1) XJJ=-0.5
      DO 76 J=1,JMAX2
```

```
      XJJ=XJJ+1.0                                                       LCML0116
   76 RHO(J,K) = RHOE*(2.*XJJ+1.0)*EXP(-(XJJ+0.5)**2/SIG22)/SIG22       LCML0117
   80 CONTINUE                                                          LCML0118
C                                                                       LCML0119
C     LEVEL DENSITY PRINT OPTION                                        LCML0120
      IF(IPRTGC.LT.2) GO TO 84                                          LCML0121
      WRITE(6,5)                                                        LCML0122
      WRITE(6,6) ID,BCD(ID),I,IP,IR,NK,NJMAX                            LCML0123
      KPRT=IPRTGC-1                                                     LCML0124
      DEFTR=KPRT                                                        LCML0125
      EK=-DE*DEFTR                                                      LCML0126
      DO 82 K=1,NK,KPRT                                                 LCML0127
      EK=EK+DE*DEFTR                                                    LCML0128
      EX=EKMAX-EK                                                       LCML0129
      JMAX2=JRAST(K,IP)                                                 LCML0130
      WRITE(6,3) EX,JMAX2                                               LCML0131
   82 WRITE(6,4) (RHO(J,K),J=1,JMAX2)                                   LCML0132
   84 NPTS=NK*NJDIM                                                     LCML0133
      NRHO(IP)=NPTS                                                     LCML0134
      INDEX=IRHOLC+NKDIM*NJDIM*(IP-1)                                   LCML0135
      CALL ECWR(RHO,INDEX,NPTS,IERR)                                    LCML0136
  100 CONTINUE                                                          LCML0137
      RETURN                                                            LCML0138
      END                                                               LCML0139
      SUBROUTINE GAMSET(I)                                              GAMSET 2
C                                                                       GAMSET 3
C     SET UP GAMMA-RAY CASCADE CALCULATION. DETERMINE WEISSKOPF OR AXEL GAMSET 4
C     PARAMETERS AND COMPUTE GAMMA RAY TRANSMISSION COEFFICIENTS        GAMSET 5
C                                                                       GAMSET 6
    1 FORMAT(// * GAMMA-RAY TRANSMISSION COEFFICIENTS*,10X,*I=*I2,      GAMSET 7
     1 3X,*IP=*I2,3X,*IR=*I3,/ *  ENERGY*,10(6X,A1,F1.0,4X))            GAMSET 8
    2 FORMAT(F8.3,1P.10(1X,E11.4))                                      GAMSET 9
C                                                                       GAMSET10
      COMMON/BASIC1/NI.XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),   BASIC1 2
     1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),EAVID(8),EAV(60)   BASIC1 3
      COMMON/BASIC2/TITLE(16).ELAB,DE,ZAP,ZAT,XMT,    NKKM(10),CNPI(10), BASIC2 2
     1 CNPIP(10).S(60).SAC(10),ID1(60),IDP,IDE2(60),IBUF(6,10),         BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),OMDP(40),A(60),A2(60),  BASIC2 4
     3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM,   IOECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2).XMP.XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                  BASIC2 7
      COMMON/LEVDEN/DEF(60),XNLGC(60),ECGC(60),UCUTOFF,DEFCN,TGC(60),   LEVDEN 2
     1 E0GC(60),EMATGC(60),PAIR(60),XMR3(60),XNLLN(60),SZ(100),SN(150), LEVDEN 3
     2 PZ(100),PN(150)                                                  LEVDEN 4
      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                  LEVDEN 5
      COMMON/GAMMA/NMP,LGROPT,SWS(10),GML(6),GMP(6),RE1(6),LMGHOL(6),   GAMMA  2
     1 TGR(200,6),WKCON,CAXEL,GAXEL,ERAXEL,EXSWS(10),WKNORM             GAMMA  3
      COMMON/PRNTOUT/IPRTLEV,IPRTTC,IPRTMLD,IPRTWID,IPRTSP,IPRTGC       PRNTOUT2
      DIMENSION ROUM(2)                                                 GAMSET16
      DATA GAXEL/5.0/,R0/1.25/                                          GAMSET17
C                                                                       GAMSET18
      NIP=XNIP(I)                                                       GAMSET19
      DO 50 IP=1,NIP                                                    GAMSET20
      IR= LR(IP,I)                                                      GAMSET21
      IO= ID1(IR)                                                       GAMSET22
      IF(IO.EQ.7) GO TO 52                                              GAMSET23
   50 CONTINUE                                                          GAMSET24
      RETURN                                                            GAMSET25
   52 CAXEL=0.013*XM2(IR)                                               GAMSET26
      ERAXEL=80.0/XMR3(IR)                                              GAMSET27
      WKNORM=1.0E-8                                                     GAMSET28
      CALL WEISSKF(I,IP,IR)                                             GAMSET29
                  WRITE(6,10) I,WKCON                                   GAMSET30
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```
10    FORMAT(/* GAMMA RAY STRENGTH NORMALIZATION CONSTANT  /  I=*,        GAMSET31
     1 I2,*, CONSTANT =*1PE12.4)                                          GAMSET32
70    RATIO = 4.48758/((R0*XM2(IR)*XMR3(IR))**2)                          GAMSET33
      DO 75 MP=1,NMP                                                      GAMSET34
      L = GML(MP)                                                         GAMSET35
      IF(GMP(MP).LT.0.) GO TO 75                                          GAMSET36
      IF (L.LT.2) GO TO 74                                                GAMSET37
      IF(RE1(MP).EQ.0.) RE1(MP)=1.0E-6                                    GAMSET38
74    RDUM(L)=RE1(MP)                                                     GAMSET39
75    CONTINUE                                                            GAMSET40
      DO 78 MP=1,NMP                                                      GAMSET41
      L = GML(MP)                                                         GAMSET42
      IF((GMP(MP).GT.0.).OR.(RE1(MP).GT.0.)) GO TO 78                     GAMSET43
      RE1(MP) = RATIO*RDUM(L)                                             GAMSET44
78    CONTINUE                                                            GAMSET45
      NK= NKK(IR)                                                         GAMSET46
      EG=0.                                                               GAMSET47
      DO 90 KD=1,NK                                                       GAMSET48
      EG=EG+DE                                                            GAMSET49
      DO 90 MP=1,NMP                                                      GAMSET50
      L = GML(MP)                                                         GAMSET51
      GO TO (81,82),LGROPT                                                GAMSET52
81    TGR(KD,MP)=WKCON*WKNORM*RE1(MP)*EG**(2*L+1)                         GAMSET53
      GO TO 90                                                            GAMSET54
   82 TGR(KD,MP)=1.634928E-3*CAXEL*RE1(MP)*GAXEL*EG**4/                   GAMSET55
     1  ((ERAXEL**2-EG**2)**2+(EG*GAXEL)**2)                              GAMSET56
      TGR(KD,MP)=TGR(KD,MP)*WKCON                                         GAMSET57
90    CONTINUE                                                            GAMSET58
C                                                                         GAMSET59
C     TRANSMISSION COEFFICIENT PRINT OPTION                               GAMSET60
      IF(IPRTTC.LT.2) GO TO 100                                           GAMSET61
      WRITE(6,1) I,IP,IR,(LMGHOL(MP),GML(MP),MP=1,NMP)                    GAMSET62
      KPRT=IPRTTC-1                                                       GAMSET63
      DEFTR=KPRT                                                          GAMSET64
      EG=0.                                                               GAMSET65
      DO 94 KD=1,NK,KPRT                                                  GAMSET66
      EG=EG+DE*DEFTR                                                      GAMSET67
      WRITE(6,2) EG,(TGR(KD,MP),MP=1,NMP)                                 GAMSET68
94    CONTINUE                                                            GAMSET69
100   RETURN                                                              GAMSET70
      END                                                                 GAMSET71
      SUBROUTINE WEISSKF(I,IP,IR)                                         WEISSKF2
C                                                                         WEISSKF3
C     OBTAIN NORMALIZATION FACTOR FOR WEISSKOPF APPROXIMATION FROM        WEISSKF4
C     INPUTTED STRENGTH FUNCTION                                          WEISSKF5
C                                                                         WEISSKF6
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,    LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                      LCNDEX 4
      COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)      RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                            RHO    3
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM        LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                         LEVEL1 3
      COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,   NKKM(10),CNPI(10),   BASIC2 2
     1 CNPIP(10),S(60),SAC(10),IO1(60),IDP,IOE2(60),IBUF(6,10),           BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMOP(40),A(60),A2(60),    BASIC2 4
     3 NRHO(6),XJT,     MPOPMAX,NTC2(6),NJDIM,  IDECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                    BASIC2 7
      COMMON/TCOEFF/ETC(25,6),TC(25,30),BCD(7),XSPIN(7),NLDIM,            TCOEF  2
     1NPART,NEE(6),NO(6),NTC(6),IZAID(7),XMASS(7),NEEDIM,NLEIN(6,25),     TCOEF  3
     2NLE(6,200),JRAST(200,6)                                             TCOEF  4
      COMMON/GAMMA/NMP,LGROPT,SWS(10),GML(6),GMP(6),RE1(6),LMGHOL(6),     GAMMA  2
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```
     1 TGR(200,6),WKCON,CAXEL,GAXEL,CRAXEL,EXSWS(10),WKNORM
C
      IF(SWS(I))20,25,30
 20   WKCON=-SWS(I)
      RETURN
 25   WKCON=1.
      RETURN
 30   GAMCON=1.634928E-3*CAXEL*GAXEL
C
C     SET WKCON=1. IF EXSWS(I) IS EQUAL TO 0.
      IF((EXSWS(I).GT.0.).AND.(NKK(IR).GE.1)) GO TO 48
      WKCON=1.0
      RETURN
C
C     READ IN LEVEL DENSITIES AND DISCRETE LEVELS
 48   NPTS=NRHO(IP)
      INDEX=IRHOLC+(IP-1)*NKDIM*NJDIM
      CALL ECRD(RHO,INDEX,NPTS,IERR)
      NLEV2=XNL(IR)
      INDEX=IELLC+(IR-1)*NLEVDIM
      CALL ECRD(EL,INDEX,NLEV2,IERR)
      INDEX=IAJLC+(IR-1)*NLEVDIM
      CALL ECRD(AJ,INDEX,NLEV2,IERR)
C
C     FIND INITIAL K FOR INTEGRATION
      NK=NKK(IR)
      EKMAX=UP-SAC(I)-S(IR)
      EX=EKMAX+DE
      DO 50 K=1,NK
      EX=EX-DE
      IF(EX.LT.EXSWS(I)) GO TO 52
  50  CONTINUE
  52  KLOW=K
      EXLOW=EX
C
C     INTEGRATE OVER COMPOUND NUCLEUS SPINS,PARITIES
      SUM=0.
      IPICOMP=-PIT
      XJCN=ABS(XJT-XJP)-1.0
      XJCNH=XJT+XJP+0.01
      DO 100 JJCN=1,1000
      XJCN=XJCN+1.0
      JCN=XJCN+1.01
      IF((XJCN.GT.XJCNH).OR.(JCN.GT.NJMAX)) GO TO 110
C
C     INTEGRATE OVER FINAL STATE SPINS,PARITIES
      XJ2=ABS(XJCN-1.)-1.0
      XJ2H=XJCN+1.01
      DO 90 JJ2=1,1000
      XJ2=XJ2+1.0
      J2=XJ2+1.01
      IF((XJ2.GT.XJ2H).OR.(J2.GT.NJMAX)) GO TO 100
      J22J=2.*XJ2+0.01
C
C     INTEGRATE OVER CONTINUUM ENERGIES
      EX=EXLOW+DE
      DO 70 KP=KLOW,NK
      IF(JRAST(KP,IP).LT.J2) GO TO 75
      EX=EX-DE
      EO=EXSWS(I)-EX
      GO TO (60,62),LGROPT
 60   SFTR=WKNORM*EO**3
      GO TO 70
```

```
 62    SFTP=GAMCON*ED**4/((ERAXEL**2-ED**2)**2+(ED*GAXEL)**2)            WEISSK75
 70    SUM=SUM+DE*RHO(J2,KP)*SFTR                                        WEISSK76
 75    CONTINUE                                                          WEISSK77
C                                                                        WEISSK78
C      INTEGRATE OVER DISCRETE STATES                                    WEISSK79
       IF(NLEV2.LT.1) GO TO 90                                           WEISSK80
       DO 80 N=1,NLEV2                                                   WEISSK81
       IAJ2J=2.*ABS(AJ(N)) +0.01                                         WEISSK82
       IF(J22J.NE.IAJ2J) GO TO 80                                        WEISSK83
       PIAJ = SIGN(1.0,AJ(N))                                            WEISSK84
       IPIAJ = PIAJ+SIGN(0.1,PIAJ)                                       WEISSK85
       IF(IPIAJ.NE.IPICOMP) GO TO 80                                     WEISSK86
       ED = EXSWS(I) -EL(N)                                              WEISSK87
       IF(ED.LE.0.) GO TO 90                                             WEISSK88
       GO TO (76,78),LGROPT                                              WEISSK89
 76    SFTR=WKNORM*ED**3                                                 WEISSK90
       GO TO 79                                                          WEISSK91
 78    SFTR=GAMCON*ED**4/((ERAXEL**2-ED**2)**2+(ED*GAXEL)**2)            WEISSK92
 79    SUM=SUM+SFTR                                                      WEISSK93
  80   CONTINUE                                                          WEISSK94
  90   CONTINUE                                                          WEISSK95
 100   CONTINUE                                                          WEISSK96
 110   WKCON = SWS(I)/SUM                                                WEISSK97
       RETURN                                                            WEISSK98
       END                                                               WEISSK99
       SUBROUTINE INCHSUM(MM)                                            INCHSUM2
C                                                                        INCHSUM3
C      PERFORM SUMS OVER S AND L OF INCIDENT CHANNEL FOR GIVEN COMPOUND  INCHSUM4
C      NUCLEUS SPIN AND PARITY                                           INCHSUM5
C                                                                        INCHSUM6
       COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)    RHO     2
      1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                          RHO     3
       COMMON/BASIC2/TITLE(16),ELAB,DE,ZAP,ZAT,XMT,    NKKM(10),CNPI(10), BASIC2 2
      1 CNPIP(10),S(60),SAC(10),ID1(60),IDP,IOE2(60),IBUF(6,10),          BASIC2 3
      2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM      ,TCP(30),QMOP(40),A(60),A2(60),   BASIC2
      3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM,  IOECN(10),NKKCN(10),ECON,BASIC2 5
      4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
      5,ICAPT,FLBUF(50,10),INPOPT,TKEEP                                  BASIC2 7
       COMMON/GAMMA/NMP,LGROPT,SWS(10),GML(6),GMP(6),RE1(6),LMGHOL(6),   GAMMA   2
      1 TGR(200,6),WKCON,CAXEL,GAXEL,ERAXEL,EXSWS(10),WKNORM             GAMMA   3
       COMMON/SUMBLK1/KP,KD,IP,ID,KNGN,JPI2,N,DP,IK                      SUMBLK12
       COMMON/SUMBLK2/XJCN,PICN,JPICN,ECONJ,MP,J2,L2,TGRL,TLEV,XJ2,      SUMBLK22
      1 TTOT(80)                                                         SUMBLK23
       COMMON/PREEQ/LPEQ,SIGR,PREQI(6),CSIGI(6),NITT(6),ALPHA(6)         INCHSU12
       MX= (MM-1)/2 + 1                                                  INCHSU13
       CS = CSL                                                          INCHSU14
       DP=0.                                                             INCHSU15
       PICOMP=PIT*PICN                                                   INCHSU16
       LPICOMP=PICOMP+SIGN(0.1,PICOMP)                                   INCHSU17
       DO  60 ISP=1,1000                                                 INCHSU18
       CS=CS+1.0                                                         INCHSU19
       IF(CS-CSH)200,200,70                                              INCHSU20
 200   LPL=ABS(XJCN-CS)+1.01                                             INCHSU21
       LPH=XJCN+CS+1.01                                                  INCHSU22
       LPH=MIN0(LPH,NLP)                                                 INCHSU23
       IF(LPL-LPH)201,201,60                                             INCHSU24
 201   CONTINUE                                                          INCHSU25
       DO 55 LP=LPL,LPH                                                  INCHSU26
       LPPI=PILLL(LP)                                                    INCHSU27
       IF(LPPI-LPICOMP) 55,202,55                                        INCHSU28
 202   CONTINUE                                                          INCHSU29
   50  DP=ECONJ*TCP(LP) + DP                                             INCHSU30
 55    CONTINUE                                                          INCHSU31
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 60   CONTINUE                                                          INCHSU32
 70   RETURN                                                            INCHSU33
      END                                                               INCHSU34
      SUBROUTINE SUMER(NN,DE)                                           SUMER  2
C                                                                       SUMER  3
C     ADD POPULATION INCREMENT INTO POPULATION ARRAY AND INTO SPECTRA   SUMER  4
C                                                                       SUMER  5
      COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)    RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                          RHO    3
      COMMON/SUMBLK1/KP,KD,IP,ID,KNGN,JPI2,N,DP,IK                      SUMBLK12
      COMMON/TOTALS/SIGTOT(10)                                          SUMER  8
C                                                                       SUMER  9
      GO TO (51,52),NN                                                  SUMER 10
 51   P(JPI2) = P(JPI2)+DP                                              SUMER 11
      GO TO 58                                                          SUMER 12
 52   PL(N,IP) = PL(N,IP)+DP                                            SUMER 13
 58   DS= DP/DE                                                         SUMER 14
      SP(KD,IP) = SP(KD,IP)+DS                                          SUMER 15
      SPP(KD.ID)= SPP(KD,ID)+DS                                         SUMER 16
      IF(IK-2)70,70,72                                                  SUMER 17
 70   SIGTOT(IP)=SIGTOT(IP)+DP                                          SUMER 18
 72   GO TO (61,62),KNGN                                                SUMER 19
 61   SPNGN(KD)=SPNGN(KD)+DS                                            SUMER 20
 62   RETURN                                                            SUMER 21
      END                                                               SUMER 22
      SUBROUTINE GRLINES                                                GRLINES2
C                                                                       GRLINES3
C     CALCULATE DISCRETE GAMMA-RAY CROSS SECTIONS AND SUM  SPECTRA      GRLINES4
C     TO GET INTEGRAL CROSS SECTIONS                                    GRLINES5
C                                                                       GRLINES6
 1    FORMAT(//* LEVEL DATA OUT OF ORDER. ZA=*I5,2X,*ZA2=*I5,4X,*NL=*I3,GRLINES7
     1 4X,*LDATE=*I7.* ABORT JOB.*)                                     GRLINES8
C                                                                       GRLINES9
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                    LCNDEX 4
      COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)    RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                          RHO    3
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM      LEVEL1 2
     1,EG(240),SG(240).NGRAYS(60)                                       LEVEL1 3
      COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),   BASIC1 2
     1 ZACN(10).CSGR(60).CSTOT(60).CSLEV(60),CSID(8),EAVIO(8),EAV(60)   BASIC1 3
      COMMON/BASIC2/TITLE(16),ELAB.DE,ZAP,ZAT,XMT,    NKKM(10),CNPI(10), BASIC2 2
     1 CNPIP(10),S(60),SAC(10),ID1(60),IDP,IDE2(60),IBUF(6,10),         BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60),  BASIC2 4
     3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM.  IDECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2),XMP.XJP.PIT,NLP,XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                  BASIC2 7
      DIMENSION NTT(50),IG(50,40),NFF(50,40),PR(50,40),CPR(50,40)       GRLINE15
      EQUIVALENCE (IG,RHO),(NFF,RHO(1,101)),(PR,T),(CPR,T(1,101))       GRLINE16
C                                                                       GRLINE17
C     MAIN CALCULATION LOOPS                                            GRLINE18
      CALL ECRD(PLBUF,IZEROLC,500,IERR)                                 GRLINE19
      CALL ECRD(CSGR.IZEROLC,NIR,IERR)                                  GRLINE20
      CALL ECRD(CSTOT,IZEROLC,NIR,IERR)                                 GRLINE21
      CALL ECRD(EAV,IZEROLC,NIR,IERR)                                   GRLINE22
      CALL ECRD(CSLEV,IZEROLC,NIR,IERR)                                 GRLINE23
      REWIND KL                                                         GRLINE24
      DO 100 I=1.NI                                                     GRLINE25
      NIP=XNIP(I)                                                       GRLINE26
      NPTS=NIP*NLEVDIM                                                  GRLINE27
      INDEX=IPLLC+(I-1)*NLEVDIM*NIPDIM                                  GRLINE28
      CALL ECRD(PL,INDEX,NPTS,IERR)                                     GRLINE29
```

```
      NPTS= NKDIM*NIP
      INDEX=ISPLC+(I-1)*NKDIM*NIPDIM
      CALL ECRD(SP,INDEX,NPTS,IERR)
      DO 100 IP=1,NIP
      IR= LR(IP,I)
      NLEV2 = XNL(IR)
C
C     ADD PARTICLE-INDUCED POPULATIONS TO STATES THAT GAMMA DECAY
      IB=IBUF(IP,I)
      IF(IB.LE.0)GO TO 90
      DO 40 N=1,NLEV2
   40 PLBUF(N,IB) = PLBUF(N,IB)+PL(N,IP)
      ID = ID1(IR)
      IF(ID.NE.7) GO TO 90
C
C     COMPUTE DISCRETE GAMMA CROSS SECTIONS
      IZA2=ZA2(IR)
      READ(KL) IZA,NL,LDATE
      IF(IZA.EQ.IZA2) GO TO 50
      WRITE(6,1) IZA,IZA2,NL,LDATE
      STOP
   50 NG=0
      DO 60 N=1,NL
      PL(N,IP) = PLBUF(N,IB)
      READ (KL) EL(N),AJ(N),AT(N),TAU,NTT(N)
      NT=NTT(N)
      IF(NT.LT.1) GO TO 60
      DO 58 KN=1,NT
      NG=NG+1
      IG(N,KN)=NG
   58 READ(KL) NFF(N,KN),PR(N,KN),CPR(N,KN),AMR,LL1,LL2
   60 CONTINUE
      NGRAYS(IR)=NG
      NGR=NG
      DO 70 NN=2,NL
      N=NL-NN+2
      NT=NTT(N)
      IF(NT.LT.1) GO TO 70
      DO 66 KN=1,NT
      NG=IG(N,KN)
      NF=NFF(N,KN)
      EG(NG)=EL(N)-EL(NF)
      DP=PL(N,IP)*PR(N,KN)
      PL(NF,IP)=PL(NF,IP)+DP
      DP=DP*CPR(N,KN)
      SG(NG)= DP
      CSGR(IR)=CSGR(IR)+DP
      KD= EG(NG)/DE + 0.5
      IF(KD.LT.1) KD=1
      DS = DP/DE
      SP(KD,IP) = SP(KD,IP) + DS
   66 SPP(KD,ID) = SPP(KD,ID) + DS
   70 CONTINUE
      INDEX=IEGLC+(IR-1)*NGRDIM
      CALL ECWR(EG,INDEX,NGR,IERR)
      INDEX=ISGLC+(IR-1)*NGRDIM
      CALL ECWR(SG,INDEX,NGR,IERR)
      NPTS=NIP*NLEVDIM
      INDEX=IPLLC+(I-1)*NLEVDIM*NIPDIM
      CALL ECWR(PL,INDEX,NPTS,IERR)
      NPTS= NKDIM*NIP
      INDEX=ISPLC+(I-1)*NKDIM*NIPDIM
      CALL ECWR(SP,INDEX,NPTS,IERR)
```

```
C                                                                       GRLINE93
C     SUM INDIVIDUAL SPECTRA                                            GRLINE94
 90   ED=0.                                                             GRLINE95
      NK=NKK(IR)                                                        GRLINE96
       DO 92 K=1,NKMAX                                                  GRLINE97
      ED=ED+DE                                                          GRLINE98
      EAV(IR)=EAV(IR)+ED*SP(K,IP)                                       GRLINE99
 92   CSTOT(IR)= CSTOT(IR)+SP(K,IP)                                     GRLIN100
      IF(CSTOT(IR).GT.0.) EAV(IR)=EAV(IR)/CSTOT(IR)                     GRLIN101
      CSTOT(IR)= CSTOT(IR)*DE                                           GRLIN102
C                                                                       GRLIN103
C     SUM LEVEL POPULATIONS FROM CONTINUUM AND LEVEL TRANSITIONS        GRLIN104
      DO 94 N=1,NLEV2                                                   GRLIN105
 94   CSLEV(IR)= CSLEV(IR)+PL(N,IP)                                     GRLIN106
 100  CONTINUE                                                          GRLIN107
C                                                                       GRLIN108
C     SUM COMPOSITE SPECTRA                                             GRLIN109
      DO 110 ID=1,7                                                     GRLIN110
      CSID(ID)=0.                                                       GRLIN111
      EAVID(ID)=0.                                                      GRLIN112
      ED=0.                                                             GRLIN113
      IF(IDSTAT(ID).LT.1) GO TO 110                                     GRLIN114
      DO 108 K=1,NKMAX                                                  GRLIN115
      ED=ED+DE                                                          GRLIN116
      EAVID(ID)=EAVID(ID)+ED*SPP(K,ID)                                  GRLIN117
 108  CSID(ID)= CSID(ID)+SPP(K,ID)                                      GRLIN118
      IF(CSID(ID).GT.0.) EAVID(ID)=EAVID(ID)/CSID(ID)                   GRLIN119
      CSID(ID)= CSID(ID)*DE                                             GRLIN120
 110  CONTINUE                                                          GRLIN121
      CSID(8)=0.                                                        GRLIN122
      EAVID(8)=0.                                                       GRLIN123
      ED=0.                                                             GRLIN124
      DO 120 K=1,NKMAX                                                  GRLIN125
      ED=ED+DE                                                          GRLIN126
      EAVID(8)=EAVID(8)+ED*SPNGN(K)                                     GRLIN127
 120  CSID(8)=CSID(8)+SPNGN(K)                                          GRLIN128
      IF(CSID(8).GT.0.) EAVID(8)=EAVID(8)/CSID(8)                       GRLIN129
      CSID(8)=CSID(8)*DE                                                GRLIN130
      RETURN                                                            GRLIN131
      END                                                               GRLIN132
      SUBROUTINE DATAOUT                                                DATAOUT2
C                                                                       DATAOUT3
C     MAIN OUTPUT ROUTINE                                               DATAOUT4
C                                                                       DATAOUT5
 1    FORMAT(1H1,10X,*R A D I A T I O N   W I D T H S* /)               DATAOUT6
 2    FORMAT(1H1,10X,*S P E C T R A   F R O M   I N D I V I D U A L     DATAOUT7
     1 R E A C T I O N S* /)                                            DATAOUT8
 3    FORMAT(16X,10(A6,F5.0))                                           DATAOUT9
 4    FORMAT(A6,A10,10(1X,A10))                                         DATAOU10
 5    FORMAT(A10,A7,1P,10(E10.3,1X))                                    DATAOU11
 6    FORMAT(I5,F10.3,2X,1P,10(E10.3,1X))                               DATAOU12
 7    FORMAT(1H1,30X,*C O M P O S I T E   S P E C T R A* /)             DATAOU13
 8    FORMAT(1H1,10X,*D I S C R E T E   L E V E L   I N F O R M A T I   DATAOU14
     10 N*   )                                                          DATAOU15
 9    FORMAT(// 3H I=I2,3X,3HIP=I2,3X,3HIR=I2,3X,4HZA1=,F4.0,3X,4HZA2=F5DATAOU16
     1.0,3X,19HSEPARATION ENERGY =F7.3,4H MEV,3X,31HACCUMULATED SEPARATIDATAOU17
     20N ENERGY =F7.3,4H MEV)                                           DATAOU18
 10   FORMAT( 38H NUMBER OF LEVEL IN RESIDUAL NUCLEUS =I3,3X,22HNUMBER ODATAOU19
     1F GAMMA RAYS =I3,3X, *RESIDUAL NUCLEUS ID =*I5)                   DATAOU20
 11   FORMAT(// * LEVEL   LEVEL   SPIN,   PRODUCTION    NUMBER OF   FINDATAOU21
     1AL   FINAL   TRANSITION  CONDITIONAL   GAMMA   GAMMA   PRODUCTION DATAOU22
     2 * /      *  NO    ENERGY  PARITY  CROSS SECTION  TRANSITIONS  LEVDATAOU23
     3EL  ENERGY  PROBABILITY  PROBABILITY  NUMBER  ENERGY  CROSS SECTIODATAOU24
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     4N* /        *            (MEV)              (BARNS)                     NODATAOU25
     5     (MEV)                                              (MEV)     (BARNS)*) DATAOU26
  12  FORMAT(/ I4,F10.4,F7.1,3X,1PE11.4,I10)                                     DATAOU27
  13  FORMAT(45X,I10,F10.4,F11.4,F13.4,I8,F10.4,3X,1PE11.4)                     DATAOU28
  14  FORMAT(1H1. 10X,*L E V E L   D E N S I T Y   P A R A M E T E R JUL19776
     1S* )                                                                       DATAOU30
  15  FORMAT(/ * . I IP IR  IZA1  IZA2    A      TEMP     E0    EMATCH     DATAOU31
     1ECUT   LEVELS   PN      PZ       SN       SZ        S        SAC * /  DATAOU32
     2        *                        (/MEV)  (MEV)    (MEV)    (MEV)   (DATAOU33
     3MEV)  AT ECUT (MEV)   (MEV)    (MEV)    (MEV)     (MEV)     (MEV)* )  DATAOU34
  16  FORMAT(3I3,F5.0,F7.0,1X,2F7.3,3F8.3,F6.2,1X,4F8.2,2F9.3)              DATAOU35
  17  FORMAT(* NUMBER OF LEVELS IN RESIDUAL NUCLEUS =*,I3///               DATAOU36
     1* LEVEL    LEVEL    SPIN,    ISO-   PRODUCTION*/                        DATAOU37
     2*  NO     ENERGY  PARITY    SPIN  CROSS SECTION*/                       DATAOU38
     3*        (MEV)                     (BARNS)*/)                           DATAOU39
  18  FORMAT(I4,F10.4,2F7.1,3X,1PE11.4)                                         DATAOU40
 219  FORMAT(1H1.8A10,/1H ,8A10)                                                DATAOU41
 220  FORMAT(/* LAB NEUTRON ENERGY =*1PE11.4,* MEV*/)                           DATAOU42
 221  FORMAT(/* BINARY REACTION SUMMARIES (COMPOUND NUCLEUS ONLY)*,//          DATAOU43
     1*    REACTION       SIGMA *,/*      PRODUCT         (BARNS)*,/            DATAOU44
     2*    --------       ---------*)                                           DATAOU45
 222  FORMAT(1X,A10,2X,1PE11.4)                                                 DATAOU46
C                                                                               DATAOU47
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,  LCNDEX 2
     1  ISTCLC.IRHOLC,ITLC,IELLC.IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,LCNDEX 3
     2 NIDDIM,NIRDIM                                                     LCNDEX 4
      COMMON RHO(40,200),T(30,200).P(80),SP(200,6),PP(80),SPP(200,7)    RHO    2
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)                          RHO    3
      COMMON/LEVEL1/EL(50),AJ(50),AT(50),XNL(60),ELMAX(60),NLEVDIM      LEVEL1 2
     1,EG(240),SG(240),NGRAYS(60)                                       LEVEL1 3
      COMMON/BASIC1/NI.XNIP(10),NIR,LR(6,10),ZA1(60),ZA2(60),XM2(60),   BASIC1 2
     1 ZACN(10),CSGR(60),CSTOT(60),CSLEV(60),CSID(8),FAVIO(8),EAV(60)   BASIC1 3
      COMMON/BASIC2/TITLE(16).ELAB.DE,ZAP,ZAT,XMT,    NKKM(10),CNPI(10), BASIC2 2
     1 CNPIP(10).S(60).SAC(10),IO1(60),IDP,IOF2(60),IBUF(6,10),          BASIC2 3
     2 ECM,UP,NKMAX,NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60),  BASIC2 4
     3 NRHO(6),XJT,    NPOPMAX,NTC2(6),NJDIM,  IOECN(10),NKKCN(10),ECON,BASIC2 5
     4 JPI(40,2),XMP,XJP,PIT,NLP,XNLP,KL,IOSTAT(7),SIC,CSL,CSH,PILLL(30)BASIC2 6
     5,ICAPT,PLBUF(50,10),INPOPT,TKEEP                                  BASIC2 7
      COMMON/PRNTOUT/IPRTLEV,IPRTTC,IPRTMLD,IPRTWIO,IPRTSP,IPRTGC        PRNTOUT2
      COMMON/LEVDEN/DEF(60),XNLGC(60),ECGC(60),UCUTOFF,DEFCN,TGC(60),   LEVDEN 2
     1 E0GC(60),EMATGC(60),PAIR(60),XMR3(60),XNLLN(60),SZ(100),SN(150), LEVDEN 3
     2 PZ(100),PN(150)                                                   LEVDEN 4
      COMMON /SPNPAR/ SPIN,PARITY,KGRD                                   LEVDEN 5
      DIMENSION SCBUF3(200,10),HK(2),HGAM(2),HLEV(2),HTOT(2),ZADUM(60), DATAOU55
     1 SCBUF4(200,6,10),BLANK(2),BCD2(8),HEAV(2)                         DATAOU56
      COMMON/PREEQ/LPEQ,SIGR,PREQI(6),CSIGI(6),NITT(6),ALPHA(6)         DATAOU57
      COMMON/TOTALS/SIGTOT(10)                                          DATAOU58
      EQUIVALENCE (RHO,SCBUF3),(RHO(1,51),SCBUF4)                        DATAOU59
      DIMENSION MTA(50),SPX(200),XE(200)                                 DATAOU60
      DIMENSION INT(1),NBT(1)                                            DATAOU61
      DATA MTA/18,18.17,17,16.16,4,91,102,0,0,0,0,0,0,0,32,28,0,0,0,0,  DATAOU62
     X105,33,104.22,34.0,0,103,0.0.0,107,0,106,14*0/                     DATAOU63
      DATA C1,L1.L2,NR,MC/0,.0,0,1,1/                                    DATAOU64
C                                                                        DATAOU65
      DATA BCD2/10H  NEUTRON ,10H   PROTON ,10H  DEUTERON,10H   TRITON ,DATAOU66
     1         10H  HELIUM-3,10H  HELIUM-4,10H GAMMA-RAY,10H G.NEUTRON/DATAOU67
      DATA HWID,HMEV.HSIG,HBARN,HBMEV,HDASH,HK.HGAM,HLEV,HTOT,HZACN,    DATAOU68
     1 HZA1,HZA2/10H    WIDTH ,10H     (MEV) ,10H    SIGMA ,10H    (BARNS)DATAOU69
     2,10H   (B/MEV).10H ---------, 6H     K ,10H   ENERGY ,10H LEVEL DECDATAOU70
     3, 7HAY C/S=,10H LEVEL EXC,7HIT C/S=,10H TOTAL PRO,7HD. C/S=,      DATAOU71
     4 6H ZACN=,6H  ZA1=,6H  ZA2=/.BLANK/10H          ,10H          /  DATAOU72
      DATA HSPEC/10H  SPECTRUM/,HEAV/10H AVG.ENERG,7HY (MEV)/           DATAOU73
      DATA HNON/10HNONELASTIC/                                          DATAOU74
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C
C     ENERGY AND BINARY CROSS SECTION PRINT
      NIP=XNIP(1)
      DO 250 IP=1,NIP
 250  SIGTOT(10)=SIGTOT(10)+SIGTOT(IP)
      WRITE(6,219) TITLE
      WRITE(6,220) ELAB
      WRITE(6,221)
      WRITE(6,222) HNON,SIGTOT(10)
      DO 260 IP=1,NIP
      IR=LR(IP,1)
      ID=ID1(IR)
 260  WRITE(6,222) BCD2(ID),SIGTOT(IP)
      IF(LPEQ.NE.1)GO TO 248
      WRITE(6,246)
      DO 249 IP=1,NIP
      IR=LR(IP,1)
      ID=ID1(IR)
      NK=NKK(IR)
      IF(NK.LT.1)GO TO 249
      IF(ID.EQ.7)GO TO 249
      WRITE(6,247)IP,ID,BCD2(ID),NITT(ID),ALPHA(ID),CSIGI(ID),PREQI(ID)
246    FORMAT(///15X*------- PRE-EQUILIBRIUM SUMMARY -------*/)
247    FORMAT(/5X*IP =  *I3,2X*ID =  *I3,2X*OUTGOING PARTICLE =  *A10/5X
     X*INITIAL EXCITON NUMBER =  *I3,5X*PREQ NORMALIZATION =  *E14.5/5X*
     X COMPOUND X-SEC(BARNS) =  *E14.5,5X* PREEQ X-SEC(BARNS) =  *E14.5/
     X)
249   CONTINUE
248   CONTINUE
C
C     WIDTH PRINT OPTION
      IF(IPRTWID.LT.1) GO TO 60
      NPTS=NKDIM*6*NI
      CALL ECRD(SCBUF4,IGLC,NPTS,IERR)
      ICT=0
      DO 58 I=1,NI
      NIP= XNIP(I)
      DO 58 IP=1.NIP
      IR=LR(IP,I)
      ZADUM(IR)= ZACN(I)
      ICT=ICT+1
      DO 52 K=1,NKMAX
 52   SCBUF3(K,ICT) = SCBUF4(K,IP,I)
      IF((ICT.LT.10).AND.(IR.LT.NIR)) GO TO 58
      IRH=IR
      NICT=ICT
      IRL=IRH-NICT+1
C
C     PRINT WIDTHS
      WRITE (6,1)
      WRITE(6,3) (HZACN,ZADUM(II),II=IRL,IRH)
      WRITE(6,3) (HZA1, ZA1(II),II=IRL,IRH)
      WRITE(6,3) (HZA2. ZA2(II),II=IRL,IRH)
      WRITE(6,4) BLANK,       (HDASH,II=IRL,IRH)
      WRITE(6,4) HK,(HWID,II=IRL,IRH)
      WRITE(6,4) BLANK(1),HMEV,(HMEV,II=IRL,IRH)
      EK=UP+DE
      DO 54 K=1,NKMAX
      EK=EK-DE
 54   WRITE(6,6) K,EK,(SCBUF3(K,II),II=1,NICT)
      ICT=0
 58   CONTINUE
```

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C     INDIVIDUAL SPECTRA PRINT OPTION
 60   IF(IPRTSP.LT.2) GO TO 70
      ICT=0
      DO 68 I=1,NI
      NIP= XNIP(I)
      NPTS= NKDIM*NIP
      INDEX=ISPLC+(I-1)*NKDIM*NIPDIM
      CALL ECRD(SP,INDEX,NPTS,IERR)
      DO 68 IP=1,NIP
      IR = LR(IP,I)
      ZADUM(IR)= ZACN(I)
      ICT = ICT+1
      DO 62 K=1,NKMAX
 62   SCBUF3(K,ICT)= SP(K,IP)
      IF((ICT.LT.10).AND.(IR.LT.NIR)) GO TO 68
      IRH=IR
      NICT=ICT
      IRL=IRH-NICT+1
C
C     PRINT CROSS SECTIONS AND SPECTRA
      WRITE(6,2)
      WRITE(6,3) (HZACN,ZADUM(II),II=IRL,IRH)
      WRITE(6,3) (HZA1,   ZA1(II),II=IRL,IRH)
      WRITE(6,3) (HZA2,   ZA2(II),II=IRL,IRH)
      WRITE(6,4) BLANK,     (HDASH,II=IRL,IRH)
      WRITE(6,4) BLANK,      (HSIG,II=IRL,IRH)
      WRITE(6,4) BLANK,     (HBARN,II=IRL,IRH)
      WRITE(6,5) HGAM,   (CSGR(II),II=IRL,IRH)
      WRITE(6,5) HLEV,  (CSLEV(II),II=IRL,IRH)
      WRITE(6,5) HTOT,  (CSTOT(II),II=IRL,IRH)
      WRITE(6,4) BLANK,     (HDASH,II=IRL,IRH)
      WRITE(6,5) HEAV,    (EAV(II),II=IRL,IRH)
      WRITE(6,4) BLANK,     (HDASH,II=IRL,IRH)
      WRITE(6,4) HK,         (HSIG,II=IRL,IRH)
      WRITE(6,4) BLANK(1),HMEV,(HBMEV,II=IRL,IRH)
      EK=0.
      DO 64 K=1,NKMAX
      EK=EK+DE
 64   WRITE(6,6) K,EK,(SCBUF3(K,II),II=1,NICT)
      ICT=0
 68   CONTINUE
 70   IF((IPRTSP.NE.1).AND.(IPRTSP.NE.3)) GO TO 80
C
C     PRINT COMPOSITE SPECTRA
      WRITE(6,7)
      WRITE(6,4) BLANK,(BCO2(ID),ID=1,8)
      WRITE(6,4) BLANK,(HSPEC,ID=1,8)
      WRITE(6,4) BLANK,(HDASH,ID=1,8)
      WRITE(6,4) BLANK,(HSIG ,ID=1,8)
      WRITE(6,4) BLANK,(HBARN,ID=1,8)
      WRITE(6,5) HTOT,(CSID(ID),ID=1,8)
      WRITE(6,4) BLANK,(HDASH,ID=1,8)
      WRITE(6,5) HEAV,(EAVID(ID),ID=1,8)
      WRITE(6,4) BLANK,(HDASH,ID=1,8)
      WRITE(6,4) HK,   (HSIG ,ID=1,8)
      WRITE(6,4) BLANK(1),HMEV,(HBMEV,ID=1,8)
      EK=0.
      DO 74 K=1,NKMAX
      EK=EK+DE
 74   WRITE(6,6) K,EK,(SPP(K,ID),ID=1,7),SPNGN(K)
 80   IF(IPRTLEV.LT.1) GO TO 90
C
C     PRINT DISCRETE LEVEL AND GAMMA-RAY DATA
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      WRITE(6,8)                                                        DATA0201
      REWIND KL                                                         DATA0202
      DO 88 I=1,NI                                                      DATA0203
      NIP= XNIP(I)                                                      DATA0204
      NPTS= NIP*NLEVDIM                                                 DATA0205
      INDEX=IPLLC+(I-1)*NLEVDIM*NIPDIM                                  DATA0206
      CALL ECRD(PL,INDEX,NPTS,IERR)                                     DATA0207
      DO 88 IP=1,NIP                                                    DATA0208
      IF((PL(1,IP).EQ.0.).AND.(NKKCN(I).LT.1)) GO TO 88                 DATA0209
      IR= LR(IP,I)                                                      DATA0210
      NLEV2= XNL(IR)                                                    DATA0211
      WRITE(6,9) I,IP,IR,ZA1(IR),ZA2(IR),S(IR),SAC(I)                   DATA0212
      IF(ID1(IR).EQ.7) GO TO 82                                         DATA0213
      WRITE(6,17) NLEV2                                                 DATA0214
      INDEX=IELLC+(IR-1)*NLEVDIM                                        DATA0215
      CALL ECRD(EL,INDEX,NLEV2,IERR)                                    DATA0216
      INDEX=IAJLC+(IR-1)*NLEVDIM                                        DATA0217
      CALL ECRD(AJ,INDEX,NLEV2,IERR)                                    DATA0218
      INDEX=IATLC+(IR-1)*NLEVDIM                                        DATA0219
      CALL ECRD(AT,INDEX,NLEV2,IERR)                                    DATA0220
      DO 81 N=1,NLEV2                                                   DATA0221
   81 WRITE(6,18) N,EL(N),AJ(N),AT(N),PL(N,IP)                          DATA0222
      GO TO 88                                                          DATA0223
   82 READ(KL) IZA,NL,LOATE                                             DATA0224
      NGR = NGRAYS(IR)                                                  DATA0225
      INDEX=IEGLC+(IR-1)*NGRDIM                                         DATA0226
      CALL ECRD(EG,INDEX,NGR,IERR)                                      DATA0227
      INDEX=ISGLC+(IR-1)*NGRDIM                                         DATA0228
      CALL ECRD(SG,INDEX,NGR,IERR)                                      DATA0229
      WRITE(6,10) NLEV2,NGR,IZA                                         DATA0230
      WRITE(6,11)                                                       DATA0231
      NG=0                                                              DATA0232
      DO 86 N=1,NL                                                      DATA0233
      READ(KL)EL(N),AJJ,ATT,TAU,NT                                      DATA0234
      WRITE(6,12) N,EL(N),AJJ,PL(N,IP),NT                               DATA0235
      IF(NT.LT.1) GO TO 86                                              DATA0236
      DO 84 K=1,NT                                                      DATA0237
      NG=NG+1                                                           DATA0238
      READ(KL) NF,PROB,CPROB,AMIX,LL1,LL2                               DATA0239
   84 WRITE(6,13) NF,EL(NF),PROB,CPROB,NG,EG(NG),SG(NG)                 DATA0240
   86 CONTINUE                                                          DATA0241
   88 CONTINUE                                                          DATA0242
   90 IF(IPRTGC.LT.1) GO TO 100                                         DATA0243
C                                                                       DATA0244
C     PRINT GILBERT-CAMERON PARAMETERS                                  DATA0245
      WRITE(6,14)                                                       DATA0246
      WRITE(6,15)                                                       DATA0247
      DO 98 I=1,NI                                                      DATA0248
      NIP= XNIP(I)                                                      DATA0249
      DO 98 IP=1,NIP                                                    DATA0250
      IR= LR(IP,I)                                                      DATA0251
      IZA= ZA2(IR)                                                      DATA0252
      IA= MOD(IZA,1000)                                                 DATA0253
      IZ= IZA/1000                                                      DATA0254
      IN= IA-IZ                                                         DATA0255
   98 WRITE(6,16) I,IP,IR,ZA1(IR),ZA2(IR),A2(IR),TGC(IR),E0GC(IR),EMATGCDATA0256
     1(IR),ECGC(IR),XNLGC(IR),PN(IN),PZ(IZ),SN(IN),SZ(IZ),S(IR),SAC(I)  DATA0257
  100 CONTINUE                                                          DATA0258
      RETURN                                                            DATA0259
      END                                                               DATA0260
      FUNCTION ISERCH (X,EE,NE,A,A1,A2)                                 ISERCH 2
C                                                                       ISERCH 3
C     FIND PARAMETERS NECESSARY FOR SPLINE INTERPOLATION                ISERCH 4
```

```
C
C        X - ENERGY AT WHICH FUNCTION IS TO BE EVALUATED
C        EE - ARRAY OF FUNCTION ENERGIES
C        NE - NUMBER OF ENERGIES STORED IN EE
C        A,A1,A2 - SPLINE INTERPOLATION PARAMETERS
C
C
 1    FORMAT(//* SPLINE FUNCTION ISERCH OUT OF RANGE, K = *I4,5H   NE=I4)
      DIMENSION  EE(NE)
C
      K = 0
      IF((X.LT.EE(1)).OR.(X.GT.EE(NE))) GO TO 50
      K = 1
   10 IF(X.LT.EE(K))   GO TO 20
      IF (X.LT.EE(K+1))    GO TO 40
      K = K + 1
      IF(K.LT.NE)    GO TO 10
      K = K - 1
      GO TO 40
   20 IF(K.EQ.1)     GO TO 40
      K = 1
      GO TO 10
   40 H = EE(K+1) - EE(K)
      H1 = X - EE(K)
      H2 = EE(K+1) - X
      A = H2*H1/6.
      A1 = H1/H
      A2 = H2/H
      ISERCH = K
C
      RETURN
 50   IF(X.GT.EE(NE)) K=999
      WRITE(6,1) K,NE
      RETURN
      END
      SUBROUTINE PRECMP
C
C
C
      COMMON/LCINDEX/IPBLC,IGLC,IZEROLC,ISPLC,IPLLC,IEGLC,ISGLC,ITCLC,
     1  ISTCLC,IRHOLC,ITLC,IELLC,IAJLC,IATLC,NIDIM,NIPDIM,NIBDIM,NGRDIM,
     2 NIDDIM,NIRDIM
      COMMON RHO(40,200),T(30,200),P(80),SP(200,6),PP(80),SPP(200,7)
     1,SPNGN(200),PL(50,6),G(200,6),RHOFTR(40)
      COMMON/TCOEF/ETC(25,6),TC(25,30),BCO(7),XSPIN(7),NLDIM,
     1NPART,NEE(6),ND(6),NTC(6),IZAID(7),XMASS(7),NEEDIM,NLEIN(6,25),
     2NLF(6,200).JRAST(200,6)
      COMMON/LEVFL1/EL(50),AJ(50),AT(50).XNL(60),ELMAX(60),NLEVDIM
     1,EG(240),SG(240),NGRAYS(60)
      COMMON/BASIC1/NI,XNIP(10),NIR,LR(6,10).ZA1(60),ZA2(60),XM2(60),
     1 ZACN(10).CSGR(60),CSTOT(60),CSLEV(60).CSID(8),FAVID(8),EAV(60)
      COMMON/BASIC2/TITLE(16),ELAB.DE,ZAP,ZAT,XMT,    NKKM(10),CNPI(10),
     1 CNPIP(10).S(60).SAC(10),IO1(60),IDP,IOE2(60),IBUF(6,10),
     2 ECM,UP,NKMAX.NJMAX,NKK(60),NKDIM,TCP(30),QMDP(40),A(60),A2(60),
     3 NRHO(6),XJT,     NPOPMAX,NTC2(6),NJDIM,   IOECN(10),NKKCN(10),ECON,
     4 JPI(40,2),XMP,XJP,PIT,NLP.XNLP,KL,IDSTAT(7),SIC,CSL,CSH,PILLL(30)
     5.ICAPT,PLBUF(50.10),INPOPT,TKEEP
      COMMON/PREEQ/LPEQ,SIGR,PREQI(6),CSIGI(6),NITT(6),ALPHA(6)
      COMMON/PREQ1/EPSIG(200,6),NLEV,NPIT,NIT
      COMMON/FITTING/ACN.FSIGCN,SIGPEQ
      DIMENSION SPZ(200)
       DIMENSION PREQ(200),PREQID(6,200)     ,SPZID(6,200)
      DIMENSION PPREP(80),PREP(80)
      NIP=XNIP(1)
```

```
      X=0.$Y=0.                                                         PRECMP19
      DO 2000 IP=1,NIP                                                  PRECMP20
      KMAX=NKMAX                                                        PRECMP21
      IR=LR(IP,1)                                                       PRECMP22
      ID=ID1(IR)                                                        PRECMP23
      IF(ID.EQ.7)GO TO 2000                                             PRECMP24
      NK=NKK(IR)                                                        PRECMP25
      IF(NK.LT.1)GO TO 2000                                             PRECMP26
      E=(KMAX+.5)*DE                                                    PRECMP27
      PII=3.14159                                                       PRECMP28
      GGG= 6.*ACN/PII**2                                                JUL29775
      AAA=XMT+1.                                                        PRECMP30
      NFIN=SQRT(1.5*GGG*E)                                              JUL29776
      XMO=XMASS(ID)*XMT/(XMT+XMASS(ID))                                 PRECMP32
      ALPH1=(14.+SIC)*ALPHA(ID)                                         PRECMP33
      ALPH=ALPH1/E                                                      PRECMP34
      PCON=SIGR*(2.*XSPIN(ID)+1.)/(ALPH*12.*PII**2)                     PRECMP35
      PCON=PCON/(AAA*E**3)                                              PRECMP36
      NIT=NITT(ID)                                                      PRECMP37
      KMAX=NKMAX                                                        PRECMP38
      EGR=SAC(1)+S(IR)                                                  PRECMP39
      KGR=EGR/DE                                                        PRECMP40
      KLM=(UP-SAC(1)-S(IR))/DE+0.5                                      PRECMP41
      DO 2 I=1,KLM                                                      PRECMP42
      U=(KLM-I+.5)*DE                                                   PRECMP43
      PREQ(I)=0.                                                        PRECMP44
      DO 4 N=NIT,NFIN,2                                                 PRECMP45
      PREQ(I)=PREQ(I)+EPSIG(I,ID)*((N-1)*(N+1)**2)*(U/E)**(N-2)         PRECMP46
4     CONTINUE                                                          PRECMP47
      PREQ(I)=PREQ(I)*PCON                                              PRECMP48
      IF(SPP(I,ID).LE.0.)PREQ(I)=0.                                     PRECMP49
      PREQID(ID,I)=PREQ(I)                                              PRECMP50
      X=X+PREQ(I)$Y=Y+SPP(I,ID)                                         PRECMP51
2     CONTINUE                                                          PRECMP52
2000   CONTINUE                                                         PRECMP53
      IF (Y.LE.0.)PRINT 3006                                            PRECMP54
       FRACT1=1.                                                        PRECMP55
      IF((X.GE.Y).AND.(X.GT.1.E-99)) FRACT1=Y/X                         PRECMP56
3006   FORMAT(///25X* ----- SPECTRUM SUM =0,  NO PRECMP -----*///)      PRECMP57
      IF(Y.LE.0.)GO TO 3007                                             PRECMP58
       FRACT=(1.-X/Y)                                                   PRECMP59
       IF(FRACT.LE.0.)FRACT=0.                                          PRECMP60
       X=X*DE$Y=Y*DE                                                    PRECMP61
      DO 3000 IP=1,NIP                                                  PRECMP68
      IR=LR(IP,1)$ID=ID1(IR)                                            PRECMP69
      NK=NKK(IR)                                                        PRECMP70
      IF(ID.EQ.7.OR.NK.LT.1)GO TO 3000                                  PRECMP71
      U=0.$PREQI(ID)=0.$CSIGI(ID)=0.                                    PRECMP72
      KLM=(UP-SAC(1)-S(IR))/DE+0.5                                      PRECMP73
      DO 30 II=1,KLM                                                    PRECMP74
      PREQ(II)=FRACT1*PREQID(ID,II)                                     PRECMP75
      PREQID(ID,II)=PREQ(II)                                            PRECMP76
      YY=FRACT*SPP(II,ID)                                               PRECMP77
      Z=YY+PREQ(II)                                                     PRECMP78
      IF(SPP(II,ID).EQ.0.)Z=0.                                          PRECMP79
      U=U+DE                                                            PRECMP80
      I30=KMAX-II                                                       PRECMP81
      SPZ(II)=Z                                                         PRECMP82
       SPZID(ID,II)=Z                                                   PRECMP83
      PREQI(ID)=PREQ(II)*DE+PREQI(ID)                                   PRECMP84
      CSIGI(ID)=YY*DE+CSIGI(ID)                                         PRECMP85
30    CONTINUE                                                          PRECMP86
3000   CONTINUE                                                         PRECMP87
```

```
C                                                                  PRECMP88
C      NORMALIZAION OF PREEQ                                       PRECMP89
C                                                                  PRECMP90
       DO 1000 IP=1,NIP                                            PRECMP91
       IR=LR(IP,1)$ID=ID1(IR)                                      PRECMP92
       NK=NKK(IR)                                                  PRECMP93
       IF(ID.EQ.7.OR.NK.LT.1)GO TO 1000                            PRECMP94
       KLM=(UP-SAC(1)-S(IR))/DE+0.5                                PRECMP95
       DO 31 I=1,KLM                                               PRECMP96
31      PREQ(I)=PREQID(ID,I)                                       PRECMP97
C                                                                  PRECMP98
       NK2=NKK(IR)                                                 PRECMP99
                                                                   PRECM101
C      MOD OF CONTINUUM                                            PRECM102
C                                                                  PRECM103
C                                                                  PRECM104
       NKCN=1                                                      PRECM105
C                                                                  PRECM106
C                                                                  PRECM108
C                                                                  PRECM109
       IB=IBUF(IP,1)                                               PRECM110
       IF(IB.EQ.0)GO TO 999                                        PRECM111
       DO 400 K=1,NKCN                                             PRECM112
        KD=0                                                       PRECM113
       KLOW=K+1                                                    PRECM114
       IF(KLOW-NK2)250,250,400                                     JUL29777
 250   DO 399 KP=KLOW,NK2                                          JUL29778
       KD=KD+1                                                     PRECM116
       JMAX22=2.*JRAST(KP,IP)                                      PRECM117
       INDEX=IPBLC+(KP-1)*2*NJDIM+(IB-1)*2*NJDIM*NKDIM             PRECM118
       CALL ECRD(PREP(1),INDEX,JMAX22,IERR)                        PRECM119
       DO 300 J=1,JMAX22                                           PRECM120
       PPREP(J)=PREP(J)                                            PRECM121
       IF(SPP(KD,ID).LE.0.)299,298                                 PRECM122
298     CONTINUE                                                   PRECM123
       PREQF=(FRACT+PREQ(KD)/SPP(KD,ID))                           PRECM124
       PREP(J)=PREP(J)*PREQF                                       PRECM125
299    CONTINUE                                                    PRECM126
300    CONTINUE                                                    PRECM127
       CALL ECWR(PREP(1),INDEX,JMAX22,IERR)                        PRECM128
399    CONTINUE                                                    PRECM129
       I=1                                                         PRECM130
400     CONTINUE                                                   PRECM131
999    CONTINUE                                                    PRECM132
       NLEV=XNL(IR)                                                PRECM133
       INDEX=IELLC+(IR-1)*NLEVDIM                                  PRECM134
       CALL ECRD(EL,INDEX,NLEV,IERR)                               PRECM135
          UUCN=UP-SAC(1)                                           PRECM136
       UU2MAX=UUCN-S(IR)                                           PRECM137
       DO 80 II=1,NLEV                                             PRECM138
       ECC2=UU2MAX-EL(II)                                          PRECM139
       KKD=ECC2/DE+0.5                                             PRECM140
       IF(SPP(KKD,ID).LE.0.)GO TO 110                              PRECM141
        PL(II,IP)=PL(II,IP)*(FRACT+PREQ(KKD)/SPP(KKD,ID))          PRECM142
110    CONTINUE                                                    PRECM143
80     CONTINUE                                                    PRECM144
       IF(IBUF(IP,1).EQ.0)GO TO 81                                 PRECM145
       I=1                                                         PRECM146
81     CONTINUE                                                    PRECM147
       DO 401 I=1,KLM                                              PRECM148
        SP(I,IR)=SPZID(ID,I)$SPP(I,ID)=SPZID(ID,I)                 PRECM149
401    CONTINUE                                                    PRECM150
402    CONTINUE                                                    PRECM151
```

```
1000  CONTINUE
3007  CONTINUE
      RETURN
      END
      SUBROUTINE INTERP(X,Y,NPTS,NTERMS,XIN,YOUT)
      DIMENSION X(1),Y(1),DELTA(10),A(10)
C
C     SEARCH FOR X(1)
C
11    DO 19 I=1,NPTS
      IF(XIN-X(I))13,17,19
13    I1=I-NTERMS/2
      IF(I1.GT.0)GO TO 21
15    I1=1
      GO TO 21
17      YOUT=Y(I)
18     GO TO 61
19    CONTINUE
      I1=NPTS-NTERMS+1
21     I2=I1+NTERMS-1
      IF(NPTS.GE.I2)GO TO 31
23    I2=NPTS
      I1=I2-NTERMS+1
25    IF(I1.GT.0)GO TO 31
26     I1=1
27    NTERMS=I2-I1+1
C
C     EVALUATE DEVIATIONS DATA
31    CONTINUE
      DENOM=X(I1+1)-X(I1)
      IF(DENOM.EQ.0.)100,101
100    YOUT=Y(I1)
      GO TO 61
101    CONTINUE
      DELTAX=(XIN-X(I1))/DENOM
      DO 35 I=1,NTERMS
      IX=I1+I-1
       DELTA(I)=(X(IX)-X(I1))/DENOM
35    CONTINUE
C
C     ACCUM COEF A
C
40     A(1)=Y(I1)
41    DO 50 K=2,NTERMS
      PROD=1.
      SUM=0.
      IMAX=K-1
      IXMAX=I1+IMAX
      DO 49 I=1,IMAX
      J=K-I
       PROD=PROD*(DELTA(K)-DELTA(J))
      SUM=SUM-A(J)/PROD
49    CONTINUE
       A(K)=SUM+Y(IXMAX)/PROD
50    CONTINUE
C
C     ACCUM SUM OF EXPANSION
C
      SUM=A(1)
      DO 57 J=2,NTERMS
      PROD=1.
      IMAX=J-1
      DO 56 I=1,IMAX
```

```
      DO 56 I=1,IMAX                                                    INTERP60


       PROD=PROD*(DELTAX-DELTA(I))                                      INTERP61
 56   CONTINUE                                                          INTERP62
      SUM=SUM+A(J)*PROD                                                 INTERP63
 57   CONTINUE                                                          INTERP64
 60    YOUT=SUM                                                         INTERP65
 61   CONTINUE                                                          INTERP66
      RETURN                                                            INTERP67
      END                                                               INTERP68
```

APPENDIX B

GROUND2: GROUND-STATE MASS, SPIN AND PARITY DATA FILE

11	14	18	19	30	20	26	29
26	26	16	-4	-3	-34	4	3
13	13	-61	25	-59	43	6	10
-17	22	32	32	38	-33	50	-34
58	18	10	9	11	7	8	8
10	4	7	12	0	18	28	37
48	55	63	71	81	85	92	104
0	198	338	500	709	919	1079	1287
1577	1681	1863	2055				

.100000E+07	.100000E+07	.100000E+07	.100000E+07	.100000E+07	.807169E+01
.161434E+02	.242151E+02	.322868E+02	.403585E+02	.484302E+02	.100000E+07
.100000E+07	.100000E+07	.728922E+01	.131363E+02	.149504E+02	.259000E+02
.340000E+02	.460003E+02	.585000E+02	.763387E+02	.100000E+07	.100000E+07
.100000E+07	.149317E+02	.242494E+01	.113900E+02	.175973E+02	.261110E+02
.316500E+02	.540126E+02	.621981E+02	.100000E+07	.100000E+07	.251300E+02
.116800E+02	.140875E+02	.149086E+02	.209475E+02	.249660E+02	.353000E+02
.434000E+02	.672440E+02	.100000E+07	.348700E+02	.183750E+02	.157703E+02
.494180E+01	.113484E+02	.126081E+02	.201770E+02	.249500E+02	.357200E+02
.507410E+02	.475554E+02	.279400E+02	.229223E+02	.124157E+02	.120523E+02
.866795E+01	.133704E+02	.165670E+02	.242300E+02	.294100E+02	.475524E+02
.355996E+02	.289120E+02	.157027E+02	.106522E+02	.400010E-05	.312527E+01
.301995E+01	.987350E+01	.136930E+02	.175600E+02	.283093E+02	.414892E+02
.254500E+02	.173440E+02	.534570E+01	.286382E+01	.101804E+00	.568350E+01
.787100E+01	.132740E+02	.163500E+02	.250052E+02	.328972E+02	.231060E+02
.800859E+01	.286110E+01	-.473668E+01	-.807396E+00	-.782496E+00	.333230E+01
.380000E+01	.106700E+02	.137301E+02	.342073E+02	.176600E+02	.106930E+02
.195180E+01	.872804E+00	-.148610E+01	-.156960E-01	-.459960E-01	.282800E+01
.579432E+01	.100070E+02	.237120E+02	.164800E+02	.531900E+01	.175210E+01
-.704170E+01	-.573120E+01	-.802510E+01	-.515000E+01	-.594800E+01	-.193576E+01
-.926066E+00	.253598E+02	.129800E+02	.684000E+01	-.218300E+01	-.518290E+01
-.952930E+01	-.841670E+01	-.935600E+01	-.751000E+01	-.658000E+01	-.337215E+01
.175100E+02	.109110E+02	-.383996E+00	-.547240E+01	-.139313E+02	-.131915E+02
-.162134E+02	-.145547E+02	-.150170E+02	-.125529E+02	-.126582E+02	.180500E+02
.677000E+01	-.489960E-01	-.891230E+01	-.122088E+02	-.171950E+02	-.168488E+02
-.182130E+02	-.158900E+02	-.167240E+02	-.129243E+02	.107600E+02	.382000E+01
-.714700E+01	-.123854E+02	-.214911E+02	-.218933E+02	-.244313E+02	-.229479E+02
-.240910E+02	-.210651E+02	-.208304E+02	.838467E+01	.210004E+00	-.715400E+01
-.169500E+02	-.202039E+02	-.244396E+02	-.243042E+02	-.263370E+02	-.248300E+02
-.249132E+02	-.208925E+02	-.159162E+01	-.315000E+01	-.140650E+02	-.189980E+02
-.260143E+02	-.265860E+02	-.299292E+02	-.288456E+02	-.306659E+02	-.269070E+02
-.268630E+02	.375294E+00	-.720000E+01	-.132630E+02	-.210024E+02	-.244384E+02
-.290130E+02	-.295218E+02	-.317615E+02	-.298000E+02	-.298020E+02	-.275400E+02
-.900000E+01	-.183950E+02	-.230494E+02	-.302305E+02	-.309474E+02	-.347144E+02
-.332400E+02	-.350392E+02	-.330661E+02	-.344200E+02	-.318900E+02	-.327463E+02
-.298806E+02	-.304730E+02	-.112500E+02	-.173170E+02	-.247984E+02	-.287920E+02
-.338753E+02	-.335341E+02	-.355583E+02	-.350214E+02	-.365820E+02	-.358050E+02
-.366110E+02	-.354260E+02	-.357040E+02	-.333870E+02	-.132300E+02	-.220230E+02
-.272830E+02	-.348457E+02	-.351371E+02	-.385381E+02	-.383990E+02	-.414636E+02
-.408063E+02	-.431380E+02	-.423430E+02	-.442220E+02	-.412920E+02	-.395780E+02
-.201185E+02	-.205210E+02	-.286410E+02	-.321070E+02	-.361790E+02	-.378140E+02
-.410631E+02	-.417584E+02	-.443289E+02	-.444950E+02	-.465520E+02	-.445450E+02
-.432270E+02	-.399582E+02	-.202779E+02	-.251210E+02	-.293200E+02	-.375480E+02
-.390007E+02	-.441258E+02	-.449292E+02	-.484856E+02	-.485573E+02	-.514336E+02
-.497390E+02	-.494700E+02	-.465660E+02	-.456353E+02	-.200612E+02	-.273295E+02
-.319000E+02	-.370714E+02	-.420048E+02	-.444702E+02	-.479561E+02	-.492167E+02
-.521974E+02	-.514369E+02	-.518610E+02	-.499300E+02	-.493301E+02	-.460904E+02
-.242108E+02	-.335182E+02	-.345000E+02	-.428160E+02	-.453880E+02	-.502557E+02
-.514460E+02	-.554150E+02	-.552838E+02	-.569323E+02	-.551210E+02	-.552660E+02
-.524991E+02	-.520815E+02	-.288027E+02	-.334937E+02	-.377200E+02	-.426246E+02
-.482400E+02	-.507350E+02	-.546865E+02	-.555570E+02	-.577100E+02	-.569087E+02
-.576200E+02	-.560600E+02	-.557332E+02	-.529505E+02	-.296617E+02	-.374329E+02
-.413293E+02	-.483330E+02	-.509420E+02	-.562517E+02	-.574784E+02	-.606094E+02

-.601838E+02	-.621551E+02	-.606700E+02	-.614350E+02	-.590300E+02	-.593966E+02
-.319169E+02	-.373940E+02	-.444751E+02	-.480020E+02	-.540124E+02	-.560412E+02
-.593470E+02	-.598472E+02	-.622357E+02	-.616556E+02	-.629200E+02	-.615300E+02
-.618630E+02	-.601100E+02	-.125189E+02	-.190916E+02	-.287213E+02	-.348710E+02
-.424793E+02	-.479704E+02	-.539080E+02	-.561040E+02	-.602350E+02	-.611626E+02
-.644792E+02	-.642270E+02	-.667519E+02	-.655215E+02	-.671093E+02	-.651330E+02
-.660600E+02	-.632000E+02	-.220830E+02	-.280396E+02	-.387301E+02	-.438107E+02
-.497644E+02	-.516680E+02	-.563630E+02	-.583520E+02	-.619818E+02	-.628050E+02
-.655874E+02	-.654318E+02	-.672648E+02	-.662598E+02	-.673020E+02	-.654200E+02
-.659400E+02	-.632075E+02	-.361565E+02	-.410192E+02	-.461136E+02	-.498766E+02
-.541930E+02	-.565800E+02	-.611150E+02	-.622220E+02	-.660064E+02	-.659141E+02
-.688945E+02	-.678767E+02	-.700043E+02	-.684162E+02	-.695597E+02	-.673320E+02
-.681310E+02	-.651689E+02	-.397151E+02	-.428894E+02	-.499122E+02	-.512830E+02
-.567200E+02	-.589340E+02	-.626550E+02	-.637190E+02	-.668760E+02	-.670890E+02
-.693230E+02	-.689060E+02	-.701381E+02	-.685876E+02	-.697400E+02	-.679200E+02
-.685400E+02	-.665803E+02	-.437306E+02	-.467574E+02	-.540190E+02	-.563600E+02
-.616170E+02	-.624500E+02	-.666980E+02	-.670975E+02	-.705595E+02	-.699330E+02
-.725807E+02	-.712932E+02	-.734224E+02	-.718410E+02	-.732123E+02	-.711600E+02
-.717800E+02	-.693900E+02	-.459347E+02	-.504423E+02	-.560974E+02	-.584437E+02
-.631300E+02	-.643380E+02	-.678940E+02	-.682300E+02	-.709540E+02	-.708587E+02
-.730297E+02	-.722862E+02	-.739170E+02	-.727600E+02	-.736900E+02	-.717600E+02
-.725900E+02	-.705530E+02	-.535412E+02	-.562485E+02	-.615868E+02	-.628900E+02
-.676300E+02	-.682140E+02	-.722130E+02	-.721649E+02	-.752546E+02	-.746014E+02
-.770268E+02	-.759330E+02	-.777570E+02	-.763870E+02	-.775870E+02	-.754400E+02
-.759200E+02	-.726914E+02	-.564326E+02	-.589439E+02	-.635100E+02	-.652100E+02
-.691550E+02	-.701500E+02	-.732369E+02	-.734530E+02	-.760741E+02	-.758853E+02
-.779740E+02	-.775030E+02	-.790180E+02	-.777300E+02	-.786700E+02	-.759600E+02
-.742000E+02	-.709228E+02	-.621100E+02	-.640500E+02	-.691500E+02	-.702370E+02
-.741470E+02	-.744430E+02	-.778960E+02	-.776800E+02	-.805910E+02	-.799870E+02
-.824332E+02	-.814726E+02	-.832613E+02	-.807000E+02	-.797000E+02	-.765600E+02
-.748900E+02	-.715000E+02	-.670567E+02	-.709200E+02	-.721000E+02	-.754200E+02
-.761940E+02	-.789490E+02	-.797530E+02	-.821596E+02	-.827383E+02	-.845926E+02
-.826040E+02	-.817100E+02	-.793000E+02	-.780000E+02	-.750200E+02	-.730500E+02
-.696176E+02	-.677659E+02	-.634302E+02	-.703588E+02	-.716200E+02	-.755900E+02
-.766990E+02	-.806390E+02	-.810960E+02	-.845094E+02	-.848661E+02	-.879076E+02
-.861960E+02	-.859279E+02	-.836840E+02	-.829200E+02	-.799500E+02	-.787400E+02
-.755400E+02	-.741857E+02	-.700380E+02	-.683543E+02	-.681409E+02	-.722000E+02
-.736900E+02	-.778360E+02	-.792360E+02	-.829840E+02	-.842890E+02	-.876856E+02
-.864739E+02	-.863490E+02	-.848340E+02	-.842540E+02	-.822600E+02	-.812360E+02
-.786300E+02	-.768300E+02	-.737288E+02	-.718211E+02	-.678574E+02	-.711049E+02
-.729400E+02	-.779400E+02	-.794840E+02	-.836100E+02	-.848510E+02	-.887626E+02
-.878935E+02	-.884569E+02	-.871437E+02	-.872631E+02	-.856660E+02	-.854260E+02
-.829330E+02	-.812730E+02	-.783600E+02	-.770900E+02	-.729000E+02	-.726145E+02
-.687930E+02	-.742800E+02	-.764100E+02	-.809800E+02	-.826520E+02	-.866320E+02
-.864530E+02	-.872071E+02	-.863603E+02	-.867885E+02	-.856090E+02	-.856050E+02
-.835100E+02	-.828600E+02	-.801900E+02	-.794000E+02	-.762000E+02	-.753382E+02
-.718365E+02	-.718100E+02	-.750100E+02	-.801650E+02	-.821880E+02	-.868084E+02
-.868090E+02	-.884099E+02	-.877133E+02	-.887959E+02	-.875402E+02	-.881109E+02
-.859560E+02	-.861851E+02	-.835040E+02	-.836000E+02	-.805000E+02	-.801900E+02
-.771353E+02	-.763106E+02	-.706912E+02	-.765900E+02	-.788600E+02	-.836230E+02
-.841500E+02	-.860120E+02	-.858600E+02	-.871950E+02	-.865200E+02	-.873280E+02
-.858500E+02	-.863250E+02	-.846000E+02	-.849000E+02	-.827900E+02	-.825300E+02
-.798200E+02	-.787624E+02	-.758277E+02	-.746133E+02	-.774200E+02	-.825690E+02
-.834500E+02	-.860730E+02	-.860400E+02	-.882230E+02	-.876202E+02	-.892219E+02
-.879557E+02	-.891002E+02	-.872530E+02	-.880940E+02	-.859300E+02	-.863230E+02
-.837100E+02	-.837100E+02	-.807255E+02	-.800638E+02	-.729964E+02	-.784500E+02
-.796300E+02	-.825500E+02	-.831660E+02	-.855680E+02	-.855920E+02	-.874020E+02
-.867780E+02	-.880160E+02	-.869440E+02	-.878470E+02	-.863620E+02	-.868600E+02
-.850300E+02	-.851100E+02	-.829400E+02	-.819186E+02	-.792349E+02	-.766824E+02
-.777500E+02	-.813700E+02	-.821630E+02	-.851900E+02	-.854120E+02	-.879270E+02
-.874630E+02	-.894110E+02	-.884130E+02	-.899020E+02	-.883730E+02	-.895260E+02
-.876060E+02	-.883400E+02	-.860200E+02	-.862800E+02	-.834117E+02	-.832950E+02
-.735545E+02	-.761300E+02	-.778900E+02	-.810100E+02	-.823670E+02	-.847800E+02

-.853110E+02	-.870780E+02	-.869280E+02	-.884080E+02	-.876050E+02	-.887210E+02
-.874555E+02	-.882240E+02	-.865800E+02	-.870350E+02	-.850100E+02	-.849100E+02
-.824200E+02	-.701753E+02	-.741956E+02	-.754800E+02	-.794700E+02	-.803800E+02
-.840100E+02	-.842800E+02	-.871300E+02	-.869910E+02	-.892480E+02	-.885390E+02
-.903464E+02	-.892516E+02	-.905769E+02	-.890449E+02	-.900142E+02	-.880900E+02
-.887150E+02	-.864080E+02	-.867040E+02	-.842100E+02	-.838867E+02	-.808251E+02
-.807374E+02	-.777437E+02	-.771780E+02	-.740533E+02	-.732636E+02	-.699719E+02
-.687532E+02	-.683704E+02	-.696700E+02	-.737800E+02	-.755100E+02	-.791800E+02
-.803900E+02	-.835030E+02	-.841000E+02	-.865200E+02	-.864200E+02	-.884260E+02
-.879890E+02	-.893420E+02	-.885840E+02	-.895410E+02	-.882480E+02	-.889290E+02
-.874500E+02	-.877140E+02	-.854900E+02	-.858200E+02	-.832400E+02	-.834200E+02
-.808300E+02	-.804427E+02	-.778720E+02	-.771294E+02	-.742997E+02	-.731560E+02
-.701173E+02	-.658800E+02	-.709100E+02	-.725800E+02	-.770900E+02	-.782000E+02
-.820000E+02	-.827200E+02	-.858240E+02	-.859180E+02	-.886480E+02	-.883170E+02
-.905650E+02	-.900270E+02	-.915218E+02	-.903926E+02	-.916483E+02	-.900616E+02
-.910943E+02	-.892027E+02	-.899356E+02	-.878090E+02	-.882290E+02	-.858900E+02
-.860130E+02	-.835100E+02	-.834000E+02	-.804644E+02	-.798127E+02	-.767561E+02
-.756564E+02	-.631800E+02	-.656900E+02	-.701000E+02	-.722020E+02	-.760200E+02
-.776200E+02	-.810200E+02	-.818500E+02	-.844190E+02	-.848700E+02	-.869970E+02
-.870230E+02	-.886400E+02	-.879530E+02	-.894830E+02	-.884140E+02	-.895899E+02
-.883256E+02	-.892191E+02	-.876142E+02	-.882620E+02	-.863300E+02	-.867080E+02
-.847000E+02	-.845910E+02	-.823500E+02	-.820900E+02	-.795900E+02	-.790000E+02
-.733794E+02	-.600500E+02	-.652900E+02	-.674200E+02	-.721200E+02	-.736200E+02
-.776500E+02	-.785200E+02	-.821700E+02	-.824600E+02	-.854600E+02	-.851500E+02
-.876500E+02	-.871800E+02	-.894020E+02	-.885900E+02	-.903038E+02	-.891620E+02
-.905141E+02	-.890273E+02	-.900649E+02	-.882890E+02	-.889889E+02	-.870040E+02
-.873454E+02	-.851910E+02	-.851930E+02	-.829002E+02	-.825700E+02	-.777800E+02
-.749845E+02	-.588877E+02	-.613890E+02	-.654013E+02	-.674926E+02	-.713200E+02
-.734700E+02	-.769600E+02	-.781600E+02	-.808400E+02	-.815500E+02	-.839900E+02
-.841000E+02	-.862200E+02	-.861600E+02	-.879600E+02	-.873540E+02	-.888793E+02
-.879140E+02	-.889814E+02	-.877351E+02	-.885030E+02	-.868880E+02	-.874432E+02
-.856980E+02	-.858600E+02	-.839700E+02	-.837760E+02	-.794200E+02	-.768100E+02
-.727766E+02	-.555988E+02	-.605741E+02	-.625914E+02	-.671987E+02	-.694900E+02
-.736600E+02	-.747700E+02	-.782500E+02	-.790000E+02	-.819000E+02	-.824300E+02
-.850600E+02	-.852900E+02	-.874500E+02	-.871400E+02	-.891650E+02	-.883170E+02
-.898601E+02	-.886940E+02	-.898801E+02	-.884140E+02	-.892784E+02	-.876600E+02
-.881230E+02	-.865020E+02	-.864230E+02	-.822130E+02	-.800700E+02	-.759800E+02
-.732400E+02	-.810900E+02	-.815500E+02	-.840700E+02	-.841600E+02	-.862270E+02
-.859530E+02	-.875900E+02	-.868570E+02	-.880590E+02	-.871790E+02	-.880870E+02
-.869060E+02	-.876590E+02	-.863560E+02	-.865610E+02	-.828700E+02	-.807800E+02
-.775400E+02	-.748700E+02	-.710700E+02	-.795700E+02	-.823600E+02	-.827300E+02
-.852500E+02	-.851500E+02	-.872970E+02	-.867190E+02	-.884510E+02	-.875720E+02
-.889650E+02	-.878680E+02	-.889040E+02	-.877340E+02	-.882740E+02	-.849260E+02
-.832410E+02	-.799700E+02	-.777700E+02	-.740100E+02	-.718000E+02	-.777300E+02
-.784500E+02	-.811500E+02	-.816000E+02	-.837600E+02	-.837400E+02	-.856700E+02
-.852550E+02	-.868300E+02	-.860300E+02	-.872300E+02	-.864800E+02	-.871860E+02
-.842767E+02	-.829690E+02	-.799700E+02	-.792100E+02	-.749000E+02	-.729100E+02
-.694400E+02	-.761962E+02	-.793065E+02	-.794600E+02	-.823400E+02	-.823700E+02
-.847500E+02	-.845300E+02	-.864620E+02	-.860300E+02	-.875360E+02	-.869110E+02
-.880420E+02	-.853990E+02	-.844870E+02	-.815930E+02	-.804030E+02	-.771100E+02
-.757400E+02	-.722300E+02	-.706800E+02	-.742923E+02	-.750606E+02	-.781059E+02
-.785500E+02	-.809500E+02	-.812600E+02	-.832800E+02	-.830990E+02	-.847990E+02
-.846540E+02	-.859800E+02	-.837527E+02	-.830380E+02	-.807190E+02	-.795990E+02
-.768200E+02	-.754370E+02	-.724800E+02	-.713800E+02	-.686600E+02	-.722634E+02
-.755467E+02	-.763020E+02	-.788000E+02	-.792800E+02	-.818000E+02	-.820000E+02
-.841800E+02	-.841750E+02	-.859160E+02	-.839700E+02	-.837160E+02	-.814040E+02
-.808980E+02	-.781290E+02	-.773810E+02	-.743770E+02	-.736620E+02	-.708990E+02
-.701260E+02	-.703454E+02	-.712640E+02	-.744951E+02	-.752684E+02	-.775000E+02
-.782830E+02	-.804500E+02	-.811000E+02	-.829010E+02	-.813400E+02	-.812340E+02
-.794210E+02	-.790230E+02	-.768520E+02	-.760460E+02	-.735300E+02	-.733650E+02
-.713500E+02	-.707400E+02	-.684500E+02	-.680765E+02	-.715358E+02	-.723531E+02
-.752745E+02	-.760500E+02	-.790500E+02	-.794220E+02	-.819040E+02	-.805960E+02
-.809470E+02	-.792480E+02	-.793170E+02	-.771180E+02	-.770330E+02	-.745530E+02

-.747490E+02	-.775440E+02	-.724510E+02	-.701930E+02	-.693790E+02	-.696620E+02
-.660029E+02	-.701692E+02	-.713875E+02	-.744200E+02	-.755770E+02	-.778760E+02
-.770750E+02	-.774860E+02	-.762170E+02	-.763600E+02	-.747190E+02	-.746290E+02
-.728630E+02	-.733470E+02	-.717130E+02	-.718180E+02	-.700720E+02	-.694610E+02
-.672500E+02	-.659200E+02	-.635300E+02	-.621724E+02	-.592427E+02	-.574750E+02
-.539323E+02	-.629867E+02	-.667580E+02	-.681373E+02	-.718800E+02	-.728800E+02
-.758800E+02	-.751580E+02	-.762070E+02	-.780720E+02	-.757280E+02	-.741650E+02
-.746910E+02	-.731060E+02	-.736910E+02	-.720650E+02	-.725240E+02	-.708210E+02
-.706800E+02	-.685530E+02	-.679340E+02	-.654900E+02	-.642900E+02	-.620074E+02
-.604327E+02	-.571640E+02	-.553764E+02	-.605478E+02	-.624901E+02	-.660294E+02
-.677800E+02	-.705600E+02	-.705900E+02	-.713750E +02	-.710600E+02	-.715570E+02
-.708710E+02	-.713100E+02	-.702900E+02	-.712200E+02	-.702200E+02	-.707570E+02
-.694400E+02	-.695030E+02	-.678130E+02	-.674450E+02	-.656900E+02	-.646700E+02
-.625900E+02	-.607045E+02	-.579338E+02	-.562081E+02	-.529554E+02	-.582119E+02
-.623942E+02	-.642165E+02	-.677900E+02	-.674800E+02	-.691000E+02	-.685520E+02
-.700570E+02	-.690900E+02	-.703560E+02	-.691210E+02	-.704910E+02	-.693940E+02
-.703840E+02	-.691380E+02	-.696480E+02	-.680270E+02	-.681510E+02	-.663510E+02
-.659340E+02	-.635770E+02	-.625630E+02	-.601486E+02	-.588259E+02	-.558282E+02
-.538745E+02	-.557699E+02	-.581452E+02	-.615800E+02	-.620000E+02	-.635000E+02
-.636700E+02	-.648320E+02	-.645980E+02	-.658200E+02	-.653900E+02	-.668900E+02
-.664070E+02	-.674400E+02	-.667280E+02	-.672100E+02	-.659810E+02	-.663420E+02
-.649550E+02	-.648730E+02	-.630440E+02	-.622980E+02	-.602000E+02	-.587500E+02
-.563900E+02	-.544163E+02	-.515466E+02	-.531970E+02	-.579000E+02	-.582000E+02
-.604300E+02	-.602500E+02	-.624000E+02	-.620100E+02	-.636900E+02	-.629900E+02
-.649100E+02	-.643400E+02	-.659300E+02	-.651610E+02	-.662990E+02	-.651340E+02
-.659180E+02	-.645010E+02	-.649040E+02	-.632680E+02	-.629680E+02	-.608990E+02
-.600910E+02	-.577000E+02	-.564800E+02	-.534200E+02	-.521077E+02	-.509000E+02
-.519300E+02	-.539000E+02	-.544900E+02	-.563100E+02	-.566900E+02	-.581900E+02
-.583100E+02	-.601400E+02	-.601300E+02	-.616400E+02	-.616000E+02	-.627170E+02
-.619560E+02	-.629360E+02	-.618690E+02	-.625210E+02	-.612700E+02	-.612510E+02
-.597730E+02	-.591900E+02	-.573690E+02	-.562150E+02	-.538700E+02	-.522800E+02
-.493400E+02	-.473000E+02	-.500100E+02	-.504200E+02	-.530700E+02	-.532100E+02
-.553100E+02	-.551400E+02	-.573300E+02	-.571400E+02	-.593000E+02	-.590200E+02
-.628600E+02	-.601840E+02	-.616090E+02	-.605660E+02	-.615490E+02	-.603440E+02
-.607410E+02	-.592870E+02	-.592390E+02	-.575350E+02	-.569330E+02	-.546810E+02
-.534850E+02	-.509750E+02	-.494700E+02	-.316633E+02	-.367097E+02	-.383730E+02
-.426900E+02	-.439300E+02	-.463100E+02	-.471100E+02	-.489400E+02	-.495300E+02
-.516400E+02	-.522000E+02	-.542200E+02	-.544600E+02	-.561800E+02	-.561100E+02
-.575000E+02	-.571900E+02	-.580740E+02	-.573010E+02	-.578900E+02	-.567400E+02
-.568450E+02	-.555620E+02	-.551490E+02	-.533700E+02	-.523710E+02	-.501700E+02
-.491000E+02	-.464700E+02	-.312697E+02	-.346710E+02	-.390500E+02	-.421800E+02
-.427400E+02	-.452300E+02	-.455400E+02	-.482000E+02	-.486200E+02	-.510600E+02
-.510820E+02	-.534100E+02	-.532000E+02	-.551900E+02	-.547000E+02	-.561000E+02
-.552900E+02	-.563400E+02	-.552500E+02	-.557600E+02	-.545420E+02	-.545590E+02
-.528680E+02	-.524220E+02	-.504500E+02	-.497660E+02	-.473890E+02	-.459000E+02
-.432190E+02	-.277361E+02	-.307684E+02	-.320957E+02	-.348350E+02	-.357814E+02
-.415200E+02	-.424600E+02	-.448800E+02	-.456100E+02	-.478000E+02	-.481900E+02
-.501000E+02	-.501200E+02	-.515900E+02	-.513400E+02	-.523500E+02	-.517600E+02
-.523400E+02	-.514600E+02	-.517100E+02	-.505100E+02	-.503310E+02	-.488400E+02
-.484120E+02	-.464030E+02	-.452590E+02	-.426370E+02	-.413800E+02	-.385800E+02
-.249025E+02	-.281628E+02	-.293871E+02	-.327844E+02	-.377800E+02	-.406100E+02
-.414000E+02	-.439900E+02	-.443000E+02	-.466000E+02	-.465900E+02	-.485400E+02
-.483500E+02	-.498600E+02	-.493400E+02	-.504600E+02	-.497100E+02	-.504200E+02
-.492300E+02	-.496500E+02	-.482290E+02	-.482080E+02	-.463270E+02	-.456670E+02
-.433450E+02	-.424750E+02	-.398700E+02	-.386340E+02	-.354400E+02	-.206629E+02
-.243342E+02	-.260315E+02	-.337000E+02	-.349900E+02	-.375000E+02	-.384000E+02
-.406900E+02	-.412400E+02	-.431500E+02	-.434600E+02	-.450400E+02	-.449600E+02
-.461100E+02	-.457600E+02	-.465400E+02	-.488600E+02	-.464300E+02	-.453480E+02
-.457710E+02	-.440600E+02	-.437740E+02	-.418810E+02	-.411810E+02	-.389830E+02
-.379420E+02	-.354900E+02	-.344600E+02	-.310085E+02	-.108713E+02	-.226026E+02
-.296000E+02	-.326000E+02	-.334900E+02	-.361400E+02	-.367500E+02	-.390600E+02
-.393400E+02	-.413600E+02	-.414100E+02	-.429600E+02	-.427400E+02	-.439600E+02
-.434000E+02	-.442500E+02	-.433700E+02	-.441580E+02	-.427590E+02	-.429580E+02

-.411840E+02	-.411010E+02	-.[illegible]E+02	-.[illegible]740E+02	-.363620E+02	-.398500E+02
-.333570E+02	-.323970E+02	-.298500E+02	-.152037E+02	-.252300E+02	-.266200E+02
-.293000E+02	-.303700E+02	-.327400E+02	-.335800E+02	-.355900E+02	-.359600E+02
-.376400E+02	-.378600E+02	-.391000E+02	-.389500E+02	-.399700E+02	-.394400E+02
-.402600E+02	-.391270E+02	-.396800E+02	-.382680E+02	-.384500E+02	-.366200E+02
-.366720E+02	-.347990E+02	-.344990E+02	-.324940E+02	-.318510E+02	-.294600E+02
-.284100E+02	-.255100E+02	-.208400E+02	-.240000E+02	-.249700E+02	-.278500E+02
-.286800E+02	-.310700E+02	-.316500E+02	-.336800E+02	-.338500E+02	-.355900E+02
-.354800E+02	-.369400E+02	-.364600E+02	-.375000E+02	-.367800E+02	-.377280E+02
-.365500E+02	-.372930E+02	-.356720E+02	-.362560E+02	-.344380E+02	-.347330E+02
-.327860E+02	-.326350E+02	-.304140E+02	-.299060E+02	-.274060E+02	-.266100E+02
-.235000E+02	-.108105E+02	-.206200E+02	-.218900E+02	-.243400E+02	-.253800E+02
-.274200E+02	-.280900E+02	-.297500E+02	-.301400E+02	-.314900E+02	-.315000E+02
-.327500E+02	-.324300E+02	-.335500E+02	-.328900E+02	-.337700E+02	-.327420E+02
-.334400E+02	-.322240E+02	-.325570E+02	-.311530E+02	-.311610E+02	-.296020E+02
-.290990E+02	-.273100E+02	-.261600E+02	-.238500E+02	-.227700E+02	-.201900E+02
-.161300E+02	-.193000E+02	-.201200E+02	-.226600E+02	-.234200E+02	-.255900E+02
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-.304700E+02	-.318400E+02	-.311000E+02	-.321740E+02	-.311600E+02	-.318370E+02
-.307460E+02	-.309750E+02	-.295520E+02	-.295090E+02	-.276620E+02	-.273460E+02
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-.266700E+02	-.279600E+02	-.274400E+02	-.283500E+02	-.275100E+02	-.261500E+02
-.270550E+02	-.272500E+02	-.261090E+02	-.257580E+02	-.243420E+02	-.238110E+02
-.222440E+02	-.210140E+02	-.167490E+02	-.136320E+02	-.922400E+01	-.652614E+01
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-.234700E+02	-.233600E+02	-.250400E+02	-.246500E+02	-.260100E+02	-.253500E+02
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-.237770E+02	-.224460E+02	-.217430E+02	-.176090E+02	-.147200E+02	-.104630E+02
-.754400E+01	-.313000E+01	-.146996E+00	-.123700E+02	-.129400E+02	-.150000E+02
-.153700E+02	-.172600E+02	-.174400E+02	-.191500E+02	-.191100E+02	-.205500E+02
-.203500E+02	-.214500E+02	-.208600E+02	-.215900E+02	-.207100E+02	-.210640E+02
-.201250E+02	-.200410E+02	-.188750E+02	-.182570E+02	-.147830E+02	-.118390E+02
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.839000E+01	-.332000E+01	-.547000E+01	-.606000E+01	-.806000E+01	-.842000E+01
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.106160E+02	.143900E+02	.164020E+02	.203998E+02	.227885E+02	.679480E+01
.164000E+01	.112000E+01	-.769996E+00	-.108000E+01	-.259000E+01	-.266000E+01
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.331004E+00	.297600E+01	.431800E+01	.701300E+01	.861400E+01	.114830E+02
.132800E+02	.163640E+02	.184060E+02	.217300E+02	.241518E+02	.276424E+02
.301661E+02	.863641E+01	.429000E+01	.389000E+01	.203000E+01	.196000E+01
.500004E+00	.710004E+00	-.299996E+00	.170004E+00	-.259960E-01	.254700E+01
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.289620E+02	.327000E+02	.345900E+02	.127550E+02	.939000E+01	.895000E+01
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.178210E+02	.202310E+02	.216390E+02	.243270E+02	.258710E+02	.289070E+02
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.123000E+02	.143700E+02	.146800E+02	.169430E+02	.172150E+02	.192710E+02
.200280E+02	.223190E+02	.232120E+02	.258270E+02	.267700E+02	.296040E+02

.308860E+02	.330290E+02	.354670E+02	.387520E+02	.406450E+02	.444253E+02
.469190E+02	.218812E+02	.199649E+02	.192296E+02	.178733E+02	.191150E+02
.194177E+02	.206954E+02	.207211E+02	.218700E+02	.223520E+02	.237990E+02
.243310E+02	.259800E+02	.268270E+02	.288830E+02	.298990E+02	.321900E+02
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.729700E+02	.752800E+02	.785600E+02	.579543E+02	.581300E+02	.592100E+02
.593530E+02	.609300E+02	.614740E+02	.634030E+02	.641210E+02	.662200E+02
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102.500	199.000	9999.000	9999.000	100.000	102.500	100.000	101.500
100.000	102.500	100.000	100.500	100.000	9999.000	100.000	9999.000
102.500	104.000	102.500	105.000	102.500	103.000	102.500	199.000
9999.000	9999.000	100.000	102.500	100.000	102.500	100.000	100.500
100.000	101.500	100.000	9999.000	100.000	9999.000	9999.000	103.000
103.500	101.000	100.500	101.000	100.500	101.000	9999.000	9999.000
100.000	9999.000	100.000	100.500	100.000	101.500	100.000	101.500
100.000	-96.500	100.000	9999.000	9999.000	102.000	101.500	100.000
101.500	102.000	101.500	-98.000	101.500	-98.000	9999.000	100.000

101.500	100.000	101.500	100.000	-96.500	100.000	-96.500	100.000
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-96.500	104.000	-96.500	102.000	-96.500	105.000	-96.500	105.000
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9999.000	101.000	-98.500	102.000	-98.500	101.000	-98.500	101.000
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100.000	103.500	100.000	104.500	100.000	104.500	100.000	102.500
100.000	102.500	100.000	102.500	9999.000	-98.500	101.000	-98.500
101.000	-97.500	-98.000	-97.500	-98.000	-98.500	-98.000	-98.500
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102.500	100.000	102.500	100.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	9999.000	9999.000	-96.000	104.500	-96.000	-99.500
-96.000	-99.500	-98.000	-99.500	-98.000	-99.500	-98.000	-1.000
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9999.000	100.000	104.500	100.000	102.500	100.000	102.500	100.000
102.500	100.000	109.500	100.000	9999.000	100.000	9999.000	100.000
9999.000	9999.000	108.000	104.500	108.000	104.500	107.000	104.500
106.000	104.500	103.000	104.500	101.000	104.500	9999.000	9999.000
9999.000	9999.000	9999.000	100.000	9999.000	100.000	104.500	100.000
102.500	100.000	102.500	100.000	102.500	100.000	100.500	100.000
100.500	100.000	9999.000	100.000	9999.000	100.000	9999.000	9999.000
199.000	104.500	199.000	104.500	107.000	104.500	199.000	104.500
101.000	104.500	101.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.003	100.000	9999.000	100.000	102.500	100.000	102.500	100.000
102.500	100.000	102.500	100.000	102.500	100.000	102.500	100.000
9999.000	100.000	9999.000	100.000	9999.000	9999.000	9999.000	104.500
102.000	-99.500	-99.000	-99.500	-99.000	-99.500	101.000	103.500
101.000	122.500	101.000	9999.000	101.000	9999.000	9999.000	100.000
9999.000	100.000	102.500	100.000	102.500	100.000	102.500	100.000
102.500	100.000	102.500	100.000	102.500	100.000	102.500	100.000
9999.000	100.000	9999.000	9999.000	105.000	104.500	105.000	103.500
105.000	-99.500	101.000	-99.500	101.000	-99.500	101.000	-99.500

-98.000	-99.500	9999.000	-99.500	9999.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	102.500	100.000	102.500	100.000	102.500
100.000	100.500	100.000	100.500	100.000	100.500	100.000	100.500
100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	104.500	102.000	104.500	102.000	104.500	101.000	104.500
101.000	104.500	101.000	104.500	101.000	104.500	101.000	104.500
9999.000	104.500	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	103.500	100.000	100.500	100.000	100.500	100.000	100.500
100.000	100.500	100.000	101.500	100.000	-94.500	100.000	-94.500
100.000	-94.500	100.000	9999.000	100.000	9999.000	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	103.000	102.500
103.000	102.500	103.000	102.500	101.000	102.500	101.000	102.500
-98.000	103.500	-97.000	103.500	-92.000	103.500	-92.000	103.500
105.000	103.500	-1.000	103.500	9999.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	100.500	100.000	100.500
100.000	100.500	100.000	100.500	100.000	100.500	100.000	100.500
100.000	101.500	100.000	101.500	100.000	101.500	100.000	101.500
100.000	9999.000	100.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	102.500	9999.000	102.500	9999.000	102.500
101.000	102.500	-98.000	102.500	-98.000	102.500	101.000	103.500
-95.000	103.500	104.000	103.500	104.000	103.500	-98.000	9999.000
9999.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	100.500	100.000	100.500
100.000	100.500	100.000	100.500	100.000	101.500	100.000	101.500
100.000	101.500	100.000	-96.500	100.000	9999.000	100.000	9999.000
9999.000	100.500	101.000	100.500	101.000	100.500	101.000	102.500
-98.000	103.500	104.000	103.500	105.000	103.500	-97.000	9999.000
9999.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	100.500	100.000	100.500	100.000	101.500	100.000	101.500
100.000	-96.500	100.000	9999.000	100.000	9999.000	100.000	9999.000
9999.000	101.500	103.000	100.500	-98.000	102.500	101.000	102.500
101.000	103.500	-95.000	103.500	-97.000	9999.000	-98.000	9999.000
9999.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000	102.500
100.000	100.500	100.000	101.500	100.000	101.500	100.000	-96.500
100.000	-98.500	100.000	9999.000	100.000	9999.000	100.000	9999.000
9999.000	9999.000	9999.000	102.500	102.000	102.500	101.000	102.500
101.000	102.500	-98.000	103.500	-100.000	103.500	-97.000	9999.000
9999.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000	100.500
100.000	101.500	100.000	101.500	100.000	-96.500	100.000	-96.500
100.000	-97.500	100.000	-97.500	100.000	9999.000	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	102.500	101.000	102.500
-94.000	102.500	-1.000	103.500	-99.000	103.500	9901.000	102.500
9999.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	101.500	100.000	-96.500	100.000	-96.500	100.000	-96.500
100.000	-98.500	100.000	101.500	100.000	-98.500	100.000	9999.000
9999.000	9999.000	101.000	102.500	101.000	102.500	-96.000	102.500
-95.000	102.500	-1.000	102.500	-97.000	102.500	-97.000	102.500
100.000	9999.000	9999.000	102.500	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	100.000	9999.000	100.000	100.500	100.000	-96.500
100.000	-96.500	100.000	-96.500	100.000	101.500	100.000	-98.500
100.000	-98.500	100.000	-98.500	100.000	-97.500	100.000	9999.000
102.000	9999.000	100.000	9999.000	9999.000	9999.000	9999.000	-97.500
9999.000	9999.000	9999.000	9900.500	-98.000	-97.500	9999.000	101.500
-97.000	101.500	-97.000	101.500	-97.000	101.500	-99.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	9903.500	100.000	9903.500	100.000	-98.500
100.000	-98.500	100.000	-98.500	100.000	102.500	100.000	-97.500
100.000	103.500	100.000	9999.000	100.000	9999.000	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9901.000	9902.500
9901.000	9903.500	105.000	-96.500	105.000	-96.500	100.000	-96.500
101.000	-96.900	-100.000	-96.500	9999.000	9999.000	9999.000	9999.000

9999.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	9901.500	100.000	-98.500	100.000	-98.500	100.000	-97.500
100.000	-97.500	100.000	103.500	100.000	-99.500	100.000	-97.500
100.000	9999.000	100.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9903.500	-99.000	100.500
101.000	100.500	102.000	100.500	103.000	100.500	-99.000	100.500
-98.000	100.500	-96.000	100.500	9999.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	-97.500	100.000	102.500	100.000	103.500	100.000	-99.500
100.000	-97.500	100.000	-96.500	100.000	104.500	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	-99.000
103.500	100.000	103.500	-96.000	103.500	-99.000	103.500	-93.000
103.500	101.000	103.500	-97.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	-97.500	100.000	9999.000	100.000	-99.500	100.000
-97.500	100.000	-96.500	100.000	104.500	100.000	-99.500	100.000
-98.500	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
103.500	-96.000	103.500	-99.000	103.500	101.000	103.500	108.000
103.500	-97.000	103.500	-95.000	103.500	9999.000	9999.000	100.000
9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	9999.000	100.000	-99.500	100.000	9999.000	100.000
-96.500	100.000	104.500	100.000	-99.500	100.000	-98.500	100.000
-98.500	100.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	-95.000	102.500	-99.000	102.500	107.000	102.500	-97.000
102.500	-99.000	102.500	-99.000	102.500	9999.000	9999.000	9999.000
9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000
104.500	100.000	-99.500	100.000	-99.500	100.000	-98.500	100.000
-95.500	100.000	-98.500	100.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	-95.000	9999.000	9999.000	101.500	-94.000	101.500	-98.000
101.500	104.000	101.500	-96.000	101.500	-99.000	-94.500	9999.000
9999.000	9999.000	9999.000	100.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	9999.000	100.000	-98.500	100.000	-99.500	100.000
-99.500	100.000	-99.500	100.000	-97.500	100.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	-99.000	101.500	-99.000
101.500	-99.000	101.500	-98.000	101.500	-98.000	101.500	-99.000
9999.000	-99.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000
9999.000	100.000	-98.500	100.000	-99.500	100.000	-99.500	100.000
-99.500	100.000	-98.500	100.000	-97.500	100.000	-99.500	100.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	-98.000	100.500
-98.000	100.500	-98.000	100.500	-98.000	100.500	-98.000	100.500
-98.000	100.500	-98.000	100.500	-100.000	100.500	105.000	100.500
9999.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	-98.500	100.000	-97.500	100.000	-97.500
100.000	-97.500	100.000	-97.500	100.000	-99.500	100.000	104.500
100.000	104.500	100.000	9999.000	100.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9904.500	107.000	-95.500
105.000	-95.500	106.000	-95.500	106.000	-95.500	105.000	-95.500
-99.000	-95.500	-99.000	-95.500	-99.000	-95.500	9999.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	-98.500
100.000	-97.500	100.000	-97.500	100.000	-97.500	100.000	-99.500
100.000	104.500	100.000	104.500	100.000	104.500	100.000	9999.000
100.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	107.000	-95.500	105.000
-95.500	-99.000	9999.000	9999.000	9999.000	-99.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000	9999.000

100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	-99.500
100.000	9999.000	100.000	9999.000	100.000	104.500	100.000	101.500
100.000	9999.000	100.000	9999.000	100.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	-99.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	101.500	9999.000	9999.000	9999.000	9999.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	100.500	100.000	-97.500	100.000	9999.000	100.000	9999.000
100.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
-97.500	9999.000	-98.500	9999.000	-98.500	103.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	9999.000	100.000	9999.000
100.000	101.500	100.000	101.500	100.000	102.500	100.000	102.500
100.000	100.500	100.000	9999.000	100.000	9999.000	9999.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	9999.000	-97.500	103.000	-97.500	-98.000	-98.500	9999.000
-98.500	104.000	-98.500	-99.000	-98.500	9999.000	9999.000	9999.000
100.000	101.500	100.000	-97.500	100.000	102.500	100.000	-96.500
100.000	100.500	100.000	102.500	100.000	9999.000	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	100.000	102.500	-94.000	102.500
102.000	102.500	105.000	102.500	9999.000	9999.000	9999.000	9999.000
100.000	9999.000	100.000	102.500	100.000	-96.500	100.000	100.500
100.000	102.500	100.000	103.500	100.000	-95.500	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	-97.500	-97.000	-97.500
-99.000	-97.500	-94.000	102.500	102.000	9902.500	9999.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	100.500	100.000	102.500
100.000	103.500	100.000	-95.500	100.000	100.500	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	-98.500	-96.000	-98.500
-98.000	-98.500	-92.000	103.500	-98.000	103.500	9999.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	100.500	100.000	103.500
100.000	-95.500	100.000	100.500	100.000	103.500	100.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	103.500
9999.000	-98.500	107.000	103.500	107.000	9999.000	9999.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	103.500	100.000	9999.000
100.000	100.500	100.000	103.500	100.000	104.500	0.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
9999.000	-96.500	-100.000	9999.000	0.000	0.000	0.000	9999.000
100.000	9999.000	100.000	9999.000	100.000	-95.500	100.000	100.500
100.000	9999.000	0.000	0.000	0.000	0.000	0.000	9999.000
9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000	9999.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	

APPENDIX C

SAMPLE PROBLEM INPUT FOR MAIN PROGRAM

```
 N + CO-59   --  H-1 AND HE-4 PRODUCTION  --  10 TO 40 MEV RUNS
 APRIL 7, 1977  --  STANDARD PARAMETERS
   1    0    0    3    1
  -1   12   12    4    0
   5    3    2    1
1.          27059.        1.
   1
14.
 27060.     4.         -0.683     1.         1001.      2004.
 26059.     4.         -1.008     1.         1001.      2004.
 25056.     4.         -1.003     1.         1001.      2004.
 27059.     4.         -0.173     1.         1001.      2004.
 27058.     4.         -0.476     1.         1001.      2004.
         E1  1.
         M1  0.
         E2  0.
0.           0.        .001       .001       .001       .003
```

APPENDIX D

SAMPLE PROBLEM SUPPLEMENTARY INPUT: DISCRETE-LEVEL DATA AND TRANSMISSION COEFFICIENTS

```
23052    7          99.   52.                   99.    040676
  1 0.          3.       99.   99.               0                        23052
  2  .0172        2.     99.   99.               1.                       23052
         1    1   1.           1.               99.       99 99           23052
  3  .0228        4.     99.   99.               1.                       23052
         1    1   1.           1.               99.       99 99           23052
  4  .1416        1.     99.   99.               1.                       23052
         1    2   1.           1.               99.       99 99           23052
  5  .1478        3.     99.   99.               2.                       23052
         1    1    .17         1.               99.       99 99           23052
         2    3    .83         1.               99.       99 99           23052
  6  .4366        2.     99.   99.               3.                       23052
         1    1    .48         1.               99.       99 99           23052
         2    2    .31         1.               99.       99 99           23052
         3    4    .21         1.               99.       99 99           23052
  7  .7935        2.     99.   99.               2.                       23052
         1    5    .80         1.               99.       99 99           23052
         2    1    .2          1.               99.       99 99           23052
24055     5         99.   99.                          092976
  1 0.         -1.5      99.   99.               0                        24055
  2 .244       -0.5      99.   99.               1.                       24055
         1    1   1.           1.               99.       99 99           24055
  3 .521       -2.5      99.   99.               2.                       24055
         1    1    .6          1.               99.       99 99           24055
         2    2    .4          1.               99.       99 99           24055
  4 .572       -1.5      99.   99.               1.                       24055
         1    3   1.           1.               99.       99 99           24055
  5 .885       -2.5      99.   99.               1.                       24055
         1    4   1.           1.               99.       99 99           24055
25052     3  99.000000   99.000000   -0.000000   929760
  1     0.000000   6.0  99.0  .99000E+02     0                            25052
  2      .377800   2.0  99.0  .99000E+02     1                            25052
         1    1    1.000000    1.000000  .99000E+02 99 99               25052
  3      .546000   1.0  99.0  .99000E+02     1                            25052
         1    2    1.000000    1.000000  .99000E+02 99 99               25052
25053     3  99.000000   99.000000   -0.000000   929760
  1     0.000000  -3.5  99.0  .99000E+02     0                            25053
  2      .377500  -2.5  99.0  .99000E+02     1                            25053
         1    1    1.000000    1.000000  .99000E+02 99 99               25053
  3     1.288400   1.5  99.0  .99000E+02     2                            25053
         1    1     .600000    1.000000  .99000E+02 99 99               25053
         2    2     .400000    1.000000  .99000E+02 99 99               25053
25054     1   0.000000   53.940357  -55.557000   100975
  1     0.000000   3.0  99.0  .27000E+08     0                            25054
25055     7  99.000000   55.000000   -0.000000       -0
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```
   1     0.000000  -2.5   99.0  .99000E+02       0                                 25055
   2      .126000  -3.5   99.0  .99000E+02       1                                 25055
          1     1     1.000000    1.000000   .99000E+02 99 99                      25055
   3      .984000  -4.5   99.0  .99000E+02       2                                 25055
          1     1      .090000    1.000000   .99000E+02 99 99                      25055
          2     2      .910000    1.000000   .99000E+02 99 99                      25055
   4     1.292000  -5.5   99.0  .99000E+02       2                                 25055
          1     3      .300000    1.000000   .99000E+02 99 99                      25055
          2     2      .700000    1.000000   .99000E+02 99 99                      25055
   5     1.528000  -1.5   99.0  .99000E+02       1                                 25055
          1     1     1.000000    1.000000   .99000E+02 99 99                      25055
   6     1.883000  -2.5   99.0  .99000E+02       2                                 25055
          1     1      .620000    1.000000   .99000E+02 99 99                      25055
          2     2      .380000    1.000000   .99000E+02 99 99                      25055
   7     2.199000  -3.5   99.0  .99000E+02       1                                 25055
          1     3     1.000000    1.000000   .99000E+02 99 99                      25055
25056     3    99.000000    56.000000    -0.000000   510760
   1     0.000000   3.0   99.0  .99000E+02       0                                 25056
   2      .026000   2.0   99.0  .99000E+02       1                                 25056
          1     1     1.000000    1.000000   .99000E+02 99 99                      25056
   3      .110000   1.0   99.0  .99000E+02       1                                 25056
          1     2     1.000000    1.000000   .99000E+02 99 99                      25056
25058     1           99.   99.                         051377
 1  0.          -0.         99.   99.                0                             25058
26055     8     0.000000    54.938294   -57.478400   100775
   1     0.000000  -1.5   99.0  .84000E+08       0                                 26055
   2      .411400   -.5   99.0  .99000E+02       1                                 26055
          1     1     1.000000    1.000000   .99000E+02 99 99                      26055
   3      .931200  -2.5   99.0  .99000E+02       2                                 26055
          1     2      .012000    1.000000   .99000E+02 99 99                      26055
          2     1      .988000    1.000000   .99000E+02 99 99                      26055
   4     1.316400  -2.5   99.0  .99000E+02       2                                 26055
          1     3      .084000    1.000000   .99000E+02 99 99                      26055
          2     1      .916000    1.000000   .99000E+02 99 99                      26055
   5     1.408400  -3.5   99.0  .99000E+02       3                                 26055
          1     4      .044000    1.000000   .99000E+02 99 99                      26055
          2     3      .450000    1.000000   .99000E+02 99 99                      26055
          3     1      .506000    1.000000   .99000E+02 99 99                      26055
   6     1.918000   -.5   99.0  .99000E+02       2                                 26055
          1     2      .324000    1.000000   .99000E+02 99 99                      26055
          2     1      .676000    1.000000   .99000E+02 99 99                      26055
   7     2.050000  -1.5   99.0  .99000E+02       2                                 26055
          1     2      .421000    1.000000   .99000E+02 99 99                      26055
          2     1      .579000    1.000000   .99000E+02 99 99                      26055
   8     2.153000  -2.5   99.0  .99000E+02       1                                 26055
          1     1     1.000000    1.000000   .99000E+02 99 99                      26055
26056    34    99.000000    99.000000    -0.000000   929760
   1     0.000000   0.0   99.0  .99000E+02       0                                 26056
   2      .846000   2.0   99.0  .99000E+02       1                                 26056
          1     1     1.000000    1.000000   .99000E+02 99 99                      26056
   3     2.085100   4.0   99.0  .99000E+02       1                                 26056
          1     2     1.000000    1.000000   .99000E+02 99 99                      26056
   4     2.657600   2.0   99.0  .99000E+02       2                                 26056
          1     2      .980000    1.000000   .99000E+02 99 99                      26056
          2     1      .020000    1.000000   .99000E+02 99 99                      26056
   5     2.941700   0.0   99.0  .99000E+02       1                                 26056
          1     2     1.000000    1.000000   .99000E+02 99 99                      26056
   6     2.960000   2.0   99.0  .99000E+02       2                                 26056
          1     2      .980000    1.000000   .99000E+02 99 99                      26056
          2     1      .020000    1.000000   .99000E+02 99 99                      26056
   7     3.120000   1.0   99.0  .99000E+02       2                                 26056
          1     2      .970000    1.000000   .99000E+02 99 99                      26056
          2     1      .030000    1.000000   .99000E+02 99 99                      26056
```

8	3.123000	4.0 99.0	.99000E+02	1	26056
	1 3	1.000000	1.000000	.99000E+02 99 99	26056
9	3.370200	2.0 99.0	.99000E+02	2	26056
	1 2	.840000	1.000000	.99000E+02 99 99	26056
	2 1	.160000	1.000000	.99000E+02 99 99	26056
10	3.388000	6.0 99.0	.99000E+02	1	26056
	1 3	1.000000	1.000000	.99000E+02 99 99	26056
11	3.445000	3.0 99.0	.99000E+02	3	26056
	1 4	.030000	1.000000	.99000E+02 99 99	26056
	2 3	.190000	1.000000	.99000E+02 99 99	26056
	3 2	.780000	1.000000	.99000E+02 99 99	26056
12	3.450000	1.0 99.0	.99000E+02	2	26056
	1 2	.540000	1.000000	.99000E+02 99 99	26056
	2 1	.460000	1.000000	.99000E+02 99 99	26056
13	3.601900	2.0 99.0	.99000E+02	1	26056
	1 2	1.000000	1.000000	.99000E+02 99 99	26056
14	3.607000	0.0 99.0	.99000E+02	2	26056
	1 2	.510000	1.000000	.99000E+02 99 99	26056
	2 1	.490000	1.000000	.99000E+02 99 99	26056
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	1 3	1.000000	1.000000	.99000E+02 99 99	26056
16	3.832000	2.0 99.0	.99000E+02	3	26056
	1 4	.280000	1.000000	.99000E+02 99 99	26056
	2 2	.640000	1.000000	.99000E+02 99 99	26056
	3 1	.080000	1.000000	.99000E+02 99 99	26056
17	3.856000	3.0 99.0	.99000E+02	3	26056
	1 8	.010000	1.000000	.99000E+02 99 99	26056
	2 3	.920000	1.000000	.99000E+02 99 99	26056
	3 2	.070000	1.000000	.99000E+02 99 99	26056
18	4.046000	3.0 99.0	.99000E+02	2	26056
	1 3	.140000	1.000000	.99000E+02 99 99	26056
	2 2	.860000	1.000000	.99000E+02 99 99	26056
19	4.099000	3.0 99.0	.99000E+02	2	26056
	1 3	.330000	1.000000	.99000E+02 99 99	26056
	2 2	.670000	1.000000	.99000E+02 99 99	26056
20	4.120000	4.0 99.0	.99000E+02	1	26056
	1 1	1.000000	1.000000	.99000E+02 99 99	26056
21	4.298000	4.0 99.0	.99000E+02	3	26056
	1 2	.250000	1.000000	.99000E+02 99 99	26056
	2 3	.090000	1.000000	.99000E+02 99 99	26056
	3 8	.660000	1.000000	.99000E+02 99 99	26056
22	4.302000	0.0 99.0	.99000E+02	1	26056
	1 2	1.000000	1.000000	.99000E+02 99 99	26056
23	4.395000	3.0 99.0	.99000E+02	1	26056
	1 2	1.000000	1.000000	.99000E+02 99 99	26056
24	4.401000	2.0 99.0	.99000E+02	3	26056
	1 2	.770000	1.000000	.99000E+02 99 99	26056
	2 5	.080000	1.000000	.99000E+02 99 99	26056
	3 11	.150000	1.000000	.99000E+02 99 99	26056
25	4.458000	3.0 99.0	.99000E+02	2	26056
	1 3	.500000	1.000000	.99000E+02 99 99	26056
	2 8	.500000	1.000000	.99000E+02 99 99	26056
26	4.510000	-3.0 99.0	.99000E+02	4	26056
	1 2	.350000	1.000000	.99000E+02 99 99	26056
	2 3	.150000	1.000000	.99000E+02 99 99	26056
	3 4	.480000	1.000000	.99000E+02 99 99	26056
	4 11	.020000	1.000000	.99000E+02 99 99	26056
27	4.539500	1.0 99.0	.99000E+02	3	26056
	1 1	.080000	1.000000	.99000E+02 99 99	26056
	2 4	.130000	1.000000	.99000E+02 99 99	26056
	3 6	.790000	1.000000	.99000E+02 99 99	26056
28	4.554000	3.0 99.0	.99000E+02	3	26056
	1 3	.780000	1.000000	.99000E+02 99 99	26056

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          2     8       .160000     1.000000   .99000E+02 99 99              26056
          3    11       .060000     1.000000   .99000E+02 99 99              26056
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          1     2       .330000     1.000000   .99000E+02 99 99              26056
          2     6       .670000     1.000000   .99000E+02 99 99              26056
   30     4.660000   3.0  99.0   .99000E+02     2                            26056
          1     2       .500000     1.000000   .99000E+02 99 99              26056
          2     8       .500000     1.000000   .99000E+02 99 99              26056
   31     4.684700   3.0  99.0   .99000E+02     1                            26056
          1     6      1.000000     1.000000   .99000E+02 99 99              26056
   32     4.729900   0.0  99.0   .99000E+02     1                            26056
          1     2      1.000000     1.000000   .99000E+02 99 99              26056
   33     4.739600   2.0  99.0   .99000E+02     2                            26056
          1     4       .800000     1.000000   .99000E+02 99 99              26056
          2     8       .200000     1.000000   .99000E+02 99 99              26056
   34     4.878000   2.0  99.0   .99000E+02     3                            26056
          1     2       .430000     1.000000   .99000E+02 99 99              26056
          2     3       .250000     1.000000   .99000E+02 99 99              26056
          3     6       .320000     1.000000   .99000E+02 99 99              26056
26057     5       .021400    56.935391   -60.183800   100975
    1     0.000000   -.5  99.0   .10000E+99     0                            26057
    2      .014408  -1.5  99.0   .97810E-07     1                            26057
          1     1      1.000000     1.000000   .99000E+02 99 99              26057
    3      .136460  -2.5  99.0   .87000E-08     2                            26057
          1     2       .880000     1.000000   .99000E+02 99 99              26057
          2     1       .120000     1.000000   .99000E+02 99 99              26057
    4      .366800  -1.5  99.0   .99000E+02     3                            26057
          1     3       .120000     1.000000   .99000E+02 99 99              26057
          2     2       .740000     1.000000   .99000E+02 99 99              26057
          3     1       .140000     1.000000   .99000E+02 99 99              26057
    5      .706600  -2.5  99.0   .33000E-11     4                            26057
          1     4       .022000     1.000000   .99000E+02 99 99              26057
          2     3       .081000     1.000000   .99000E+02 99 99              26057
          3     2       .864000     1.000000   .99000E+02 99 99              26057
          4     1       .033000     1.000000   .99000E+02 99 99              26057
26058     9     99.000000    58.000000    99.000000   406760
    1     0.000000   0.0  99.0   .99000E+02     0                            26058
    2      .810600   2.0  99.0   .99000E+02     1                            26058
          1     1      1.000000     1.000000   .99000E+02 99 99              26058
    3     1.675000   2.0  99.0   .99000E+02     2                            26058
          1     1       .390000     1.000000   .99000E+02 99 99              26058
          2     2       .610000     1.000000   .99000E+02 99 99              26058
    4     2.133400   3.0  99.0   .99000E+02     2                            26058
          1     2       .740000     1.000000   .99000E+02 99 99              26058
          2     3       .260000     1.000000   .99000E+02 99 99              26058
    5     2.257000   0.0  99.0   .99000E+02     1                            26058
          1     2      1.000000     1.000000   .99000E+02 99 99              26058
    6     2.596000   4.0  99.0   .99000E+02     1                            26058
          1     4      1.000000     1.000000   .99000E+02 99 99              26058
    7     2.782000   1.0  99.0   .99000E+02     4                            26058
          1     1       .220000     1.000000   .99000E+02 99 99              26058
          2     2       .480000     1.000000   .99000E+02 99 99              26058
          3     3       .220000     1.000000   .99000E+02 99 99              26058
          4     5       .080000     1.000000   .99000E+02 99 99              26058
    8     2.876000   1.0  99.0   .99000E+02     1                            26058
          1     2      1.000000     1.000000   .99000E+02 99 99              26058
    9     3.084000   2.0  99.0   .99000E+02     1                            26058
          1     1      1.000000     1.000000   .99000E+02 99 99              26058
26059     3     99.000000    59.000000    99.000000   406760
    1     0.000000  -1.5  99.0   .99000E+02     0                            26059
    2      .289000   -.5  99.0   .99000E+02     1                            26059
          1     1      1.000000     1.000000   .99000E+02 99 99              26059
    3      .475000  -2.5  99.0   .99000E+02     2                            26059
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         1     1      .750000    1.000000  .99000E+02 99 99         26059
         2     2      .250000    1.000000  .99000E+02 99 99         26059
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  1     0.000000  -3.5  99.0  .99000E+02      0                     27055
  2     2.168000  -1.5  99.0  .99000E+02      1                     27055
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  3     2.564000  -1.5  99.0  .99000E+02      1                     27055
         1     1     1.000000    1.000000  .99000E+02 99 99         27055
  4     2.661000  -1.5  99.0  .99000E+02      1                     27055
         1     1     1.000000    1.000000  .99000E+02 99 99         27055
  5     2.932000   -.5  99.0  .99000E+02      1                     27055
         1     4     1.000000    1.000000  .99000E+02 99 99         27055
  6     3.301000  -2.5  99.0  .99000E+02      1                     27055
         1     5     1.000000    1.000000  .99000E+02 99 99         27055
  7     3.321000   -.5  99.0  .99000E+02      2                     27055
         1     3      .500000    1.000000  .99000E+02 99 99         27055
         2     2      .500000    1.000000  .99000E+02 99 99         27055
  8     3.682000  -1.5  99.0  .99000E+02      1                     27055
         1     1     1.000000    1.000000  .99000E+02 99 99         27055
27056    2    99.000000   56.000000   -0.000000  512760
  1     0.000000   4.0  99.0  .99000E+02      0                     27056
  2      .158300   3.0  99.0  .99000E+02      1                     27056
         1     1     1.000000    1.000000  .99000E+02 99 99         27056
27057    8     0.000000   56.936289  -59.347000  100975
  1     0.000000  -3.5  99.0  .23300E+08      0                     27057
  2     1.223500  -4.5  99.0  .99000E+02      1                     27057
         1     1     1.000000    1.000000  .99000E+02 99 99         27057
  3     1.377900  -1.5  99.0  .19400E-10      1                     27057
         1     1     1.000000    1.000000  .99000E+02 99 99         27057
  4     1.505000   -.5  99.0  .60000E-09      1                     27057
         1     3     1.000000    1.000000  .99000E+02 99 99         27057
  5     1.757700  -1.5  99.0  .99000E+02      3                     27057
         1     4      .005000    1.000000  .99000E+02 99 99         27057
         2     3      .012000    1.000000  .99000E+02 99 99         27057
         3     1      .983000    1.000000  .99000E+02 99 99         27057
  6     1.896500  -3.5  99.0  .99000E+02      2                     27057
         1     2      .710000    1.000000  .99000E+02 99 99         27057
         2     1      .290000    1.000000  .99000E+02 99 99         27057
  7     1.920100  -2.5  99.0  .99000E+02      2                     27057
         1     5      .001000    1.000000  .99000E+02 99 99         27057
         2     1      .999000    1.000000  .99000E+02 99 99         27057
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27058    6     0.000000   57.935751  -59.847200  100775
  1     0.000000   2.0  99.0  .61600E+07      0                     27058
  2      .024900   5.0  99.0  .32900E+05      1                     27058
         1     1     1.000000    1.000000  .99000E+02 99 99         27058
  3      .054000   3.0  99.0  .10200E-04      1                     27058
         1     1     1.000000    1.000000  .99000E+02 99 99         27058
  4      .116000   4.0  99.0  .99000E+02      2                     27058
         1     2      .030000    1.000000  .99000E+02 99 99         27058
         2     1      .970000    1.000000  .99000E+02 99 99         27058
  5      .367000   3.0  99.0  .99000E+02      1                     27058
         1     1     1.000000    1.000000  .99000E+02 99 99         27058
  6      .432000   2.0  99.0  .99000E+02      1                     27058
         1     1     1.000000    1.000000  .99000E+02 99 99         27058
27059    8    99.000000   59.000000   99.000000  406760
  1     0.000000  -3.5  99.0  .99000E+02      0                     27059
  2     1.099300  -1.5  99.0  .99000E+02      1                     27059
         1     1     1.000000    1.000000  .99000E+02 99 99         27059
  3     1.190000  -4.5  99.0  .99000E+02      1                     27059
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  4     1.291500  -1.5  99.0  .99000E+02      2                     27059
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          1      1        ,940000     1,000000    ,99000E+02 99 99                   27059
          2      2        ,060000     1,000000    ,99000E+02 99 99                   27059
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          1      2        ,500000     1,000000    ,99000E+02 99 99                   27059
          2      4        ,500000     1,000000    ,99000E+02 99 99                   27059
    6   1,460000    -5,5  99,0    ,99000E+02     1                                   27059
          1      1       1,000000     1,000000    ,99000E+02 99 99                   27059
    7   1,481000    -2,5  99,0    ,99000E+02     2                                   27059
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          2      1        ,400000     1,000000    ,99000E+02 99 99                   27059
    8   1,744000    -3,5  99,0    ,99000E+02     2                                   27059
          1      1        ,550000     1,000000    ,99000E+02 99 99                   27059
          2      3        ,450000     1,000000    ,99000E+02 99 99                   27059
 27060   11   -1,000000    60,000000    99,000000   406760
    1   0,000000   5,0  99,0    ,99000E+02     0                                     27060
    2    ,059000   2,0  99,0    ,99000E+02     1                                     27060
          1      1       1,000000     1,000000    ,99000E+02 99 99                   27060
    3    ,278000   4,0  99,0    ,99000E+02     1                                     27060
          1      1       1,000000     1,000000    ,99000E+02 99 99                   27060
    4    ,288000   3,0  99,0    ,99000E+02     1                                     27060
          1      2       1,000000     1,000000    ,99000E+02 99 99                   27060
    5    ,436000   5,0  99,0    ,99000E+02     2                                     27060
          1      1        ,170000     1,000000    ,99000E+02 99 99                   27060
          2      3        ,830000     1,000000    ,99000E+02 99 99                   27060
    6    ,505000   3,0  99,0    ,99000E+02     1                                     27060
          1      2       1,000000     1,000000    ,99000E+02 99 99                   27060
    7    ,541000   2,0  99,0    ,99000E+02     2                                     27060
          1      2        ,420000     1,000000    ,99000E+02 99 99                   27060
          2      4        ,580000     1,000000    ,99000E+02 99 99                   27060
    8    ,614000   3,0  99,0    ,99000E+02     2                                     27060
          1      2        ,970000     1,000000    ,99000E+02 99 99                   27060
          2      3        ,030000     1,000000    ,99000E+02 99 99                   27060
    9    ,736000   2,0  99,0    ,99000E+02     1                                     27060
          1      8       1,000000     1,000000    ,99000E+02 99 99                   27060
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          1      1        ,460000     1,000000    ,99000E+02 99 99                   27060
          2      4        ,540000     1,000000    ,99000E+02 99 99                   27060
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          3      4        ,150000     1,000000    ,99000E+02 99 99                   27060
          4      3        ,120000     1,000000    ,99000E+02 99 99                   27060
          5      2        ,140000     1,000000    ,99000E+02 99 99                   27060
 3  N + CO-59 TRAN, COEFS, FOR N, P, HE-4   ----  W-H FOR N   9-28-76                    1
   ENERGIES AND PENETRABILITIES FOR THE  NEUTRON  CONTINUUM       25  40                 2
 ,10000E+00  ,30000E+00  ,50000E+00  ,10000E+01  ,20000E+01  ,30000E+01                  3
 ,40000E+01  ,50000E+01  ,60000E+01  ,70000E+01  ,80000E+01  ,90000E+01                  4
 ,10000E+02  ,12000E+02  ,14000E+02  ,16000E+02  ,18000E+02  ,21000E+02                  5
 ,24000E+02  ,28000E+02  ,32000E+02  ,36000E+02  ,40000E+02  ,44000E+02                  6
 ,54861E+00  ,25062E-01  ,22374E-02  ,25062E-01  ,22374E-02  ,21556E-05                  7
 ,17144E-07  ,21556E-05  ,17144E-07  ,14375E-10 0,           ,14375E-10                  8
0,          0,          0,          0,          0,          0,                           9
0,          0,          0,          0,          0,          0,                          10
0,          0,          0,          0,          0,          0,                          11
0,          0,          0,          0,          0,          0,                          12
0,          0,          0,          0,          0,          0,                          13
 ,73332E+00  ,10248E+00  ,30858E-01  ,10248E+00  ,30858E-01  ,96899E-04                 14
 ,23001E-05  ,96899E-04  ,23001E-05  ,59370E-08  ,14642E-10  ,59370E-08                 15
 ,14642E-10 0,          0,          0,          0,          0,                          16
0,          0,          0,          0,          0,          0,                          17
0,          0,          0,          0,          0,          0,                          18
0,          0,          0,          0,          0,          0,                          19
0,          0,          0,          0,          0,          0,                          20
 ,80316E+00  ,17799E+00  ,94165E-01  ,17799E+00  ,94165E-01  ,56903E-03                 21
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.21070E-04	.56703E-05	.21070E-04	.96762E-07	.39329E-09	.96762E-07	22
.39329E-09	.19243E-11	0.	.19243E-11	0.	0.	23
0.	0.	0.	0.	0.	0.	24
0.	0.	0.	0.	0.	0.	25
0.	0.	0.	0.	0.	0.	26
0.	0.	0.	0.	0.	0.	27
.86390E+00	.32390E+00	.31692E+00	.32390E+00	.31692E+00	.59095E-02	28
.43919E-03	.59095E-02	.43919E-03	.41889E-05	.33084E-07	.41889E-05	29
.33084E-07	.31939E-09	.31795E-11	.31939E-09	.31795E-11	0.	30
0.	0.	0.	0.	0.	0.	31
0.	0.	0.	0.	0.	0.	32
0.	0.	0.	0.	0.	0.	33
0.	0.	0.	0.	0.	0.	34
.87744E+00	.48790E+00	.61151E+00	.48790E+00	.61151E+00	.56278E-01	35
.74769E-02	.56278E-01	.74769E-02	.17611E-03	.25989E-05	.17611E-03	36
.25989E-05	.48765E-07	.95632E-09	.48765E-07	.95632E-09	.18302E-10	37
.33000E-12	.18302E-10	.33000E-12	0.	0.	0.	38
0.	0.	0.	0.	0.	0.	39
0.	0.	0.	0.	0.	0.	40
0.	0.	0.	0.	0.	0.	41
.86504E+00	.57164E+00	.71428E+00	.57164E+00	.71428E+00	.18725E+00	42
.33208E-01	.18725E+00	.33208E-01	.15338E-02	.31675E-04	.15338E-02	43
.31675E-04	.86451E-06	.25016E-07	.86451E-06	.25016E-07	.71218E-09	44
.19212E-10	.71218E-09	.19212E-10	.47981E-12	0.	.47981E-12	45
0.	0.	0.	0.	0.	0.	46
0.	0.	0.	0.	0.	0.	47
0.	0.	0.	0.	0.	0.	48
.84895E+00	.61988E+00	.74931E+00	.61988E+00	.74931E+00	.38067E+00	49
.83104E-01	.38067E+00	.83104E-01	.70687E-02	.18160E-03	.70687E-02	50
.18160E-03	.63641E-05	.24124E-06	.63641E-05	.24124E-06	.90717E-08	51
.32517E-09	.90717E-08	.32517E-09	.10836E-10	.33042E-12	.10836E-10	52
.33042E-12	0.	0.	0.	0.	0.	53
0.	0.	0.	0.	0.	0.	54
0.	0.	0.	0.	0.	0.	55
.83306E+00	.64972E+00	.76016E+00	.64972E+00	.76016E+00	.57250E+00	56
.15100E+00	.57250E+00	.15100E+00	.22993E-01	.68753E-03	.22993E-01	57
.68753E-03	.29006E-04	.13486E-05	.29006E-04	.13486E-05	.62734E-07	58
.27986E-08	.62734E-07	.27986E-08	.11659E-09	.44575E-11	.11659E-09	59
.44575E-11	.15481E-12	0.	.15481E-12	0.	0.	60
0.	0.	0.	0.	0.	0.	61
0.	0.	0.	0.	0.	0.	62
.81813E+00	.66896E+00	.76112E+00	.66896E+00	.76112E+00	.71567E+00	63
.22549E+00	.71567E+00	.22549E+00	.59524E-01	.20123E-02	.59524E-01	64
.20123E-02	.97794E-04	.53471E-05	.97794E-04	.53471E-05	.29508E-06	65
.15714E-07	.29508E-06	.15714E-07	.78506E-09	.36112E-10	.78506E-09	66
.36112E-10	.15119E-11	.57272E-13	.15119E-11	.57272E-13	0.	67
0.	0.	0.	0.	0.	0.	68
0.	0.	0.	0.	0.	0.	69
.80421E+00	.68161E+00	.75756E+00	.68161E+00	.75756E+00	.80425E+00	70
.29724E+00	.80425E+00	.29724E+00	.12921E+00	.49434E-02	.12921E+00	71
.49434E-02	.26922E-03	.16744E-04	.26922E-03	.16744E-04	.10647E-05	72
.65745E-07	.10647E-05	.65745E-07	.38269E-08	.20580E-09	.38269E-08	73
.20580E-09	.10095E-10	.44860E-12	.10095E-10	.44860E-12	0.	74
0.	0.	0.	0.	0.	0.	75
0.	0.	0.	0.	0.	0.	76
.79119E+00	.68992E+00	.75176E+00	.68992E+00	.75176E+00	.85221E+00	77
.36136E+00	.85221E+00	.36136E+00	.23967E+00	.10700E-01	.23967E+00	78
.10700E-01	.63636E-03	.44163E-04	.63636E-03	.44163E-04	.31667E-05	79
.22191E-06	.31667E-05	.22191E-06	.14732E-07	.90681E-09	.14732E-07	80
.90681E-09	.51036E-10	.26055E-11	.51036E-10	.26055E-11	.12023E-12	81
0.	.12023E-12	0.	0.	0.	0.	82
0.	0.	0.	0.	0.	0.	83
.77892E+00	.69527E+00	.74480E+00	.69527E+00	.74480E+00	.87458E+00	84

.41634E+00	.87458E+00	.41634E+00	.38232E+00	.21040E-01	.38232E+00	85
.21040E-01	.13434E-02	.10249E-03	.13434E-02	.10249E-03	.81313E-05	86
.63600E-06	.81313E-05	.63600E-06	.47367E-07	.32833E-08	.47367E-07	87
.32833E-08	.20862E-09	.12042E-10	.20862E-09	.12042E-10	.62878E-12	88
0.	.62878E-12	0.	0.	0.	0.	89
0.	0.	0.	0.	0.	0.	90
.76727E+00	.69850E+00	.73722E+00	.69850E+00	.73722E+00	.88197E+00	91
.46248E+00	.88197E+00	.46248E+00	.53017E+00	.38339E-01	.53017E+00	92
.38339E-01	.25967E-02	.21443E-03	.25967E-02	.21443E-03	.18607E-04	93
.16030E-05	.18607E-04	.16030E-05	.13218E-06	.10184E-07	.13218E-06	94
.10184E-07	.72126E-09	.46481E-10	.72126E-09	.46481E-10	.27120E-11	95
.14303E-12	.27120E-11	.14303E-12	0.	0.	0.	96
0.	0.	0.	0.	0.	0.	97
.74541E+00	.70076E+00	.72122E+00	.70076E+00	.72122E+00	.87500E+00	98
.53253E+00	.87500E+00	.53253E+00	.74047E+00	.10612E+00	.74047E+00	99
.10612E+00	.79522E-02	.74571E-03	.79522E-02	.74571E-03	.75031E-04	100
.76039E-05	.75031E-04	.76039E-05	.74539E-06	.68851E-07	.74539E-06	101
.68851E-07	.58804E-08	.45874E-09	.58804E-08	.45874E-09	.32470E-10	102
.20793E-11	.32470E-10	.20793E-11	.12046E-12	0.	.12046E-12	103
0.	0.	0.	0.	0.	0.	104
.72497E+00	.69944E+00	.70494E+00	.69944E+00	.70494E+00	.85682E+00	105
.58035E+00	.85682E+00	.58035E+00	.81731E+00	.23860E+00	.81731E+00	106
.23860E+00	.20038E-01	.20715E-02	.20038E-01	.20715E-02	.23482E-03	107
.27070E-04	.23482E-03	.27070E-04	.30579E-05	.32837E-06	.30579E-05	108
.32837E-06	.32822E-07	.30099E-08	.32822E-07	.30099E-08	.25107E-09	109
.18974E-10	.25107E-09	.18974E-10	.12977E-11	.80402E-13	.12977E-11	110
.80402E-13	0.	0.	0.	0.	0.	111
.70558E+00	.69589E+00	.68883E+00	.69589E+00	.68883E+00	.83579E+00	112
.61289E+00	.83579E+00	.61289E+00	.82554E+00	.43930E+00	.82554E+00	113
.43930E+00	.43748E-01	.48968E-02	.43748E-01	.48968E-02	.61045E-03	114
.78332E-04	.61045E-03	.78332E-04	.99601E-05	.12150E-05	.99601E-05	115
.12150E-05	.13895E-06	.14652E-07	.13895E-06	.14652E-07	.14098E-08	116
.12310E-09	.14098E-08	.12310E-09	.97348E-11	.69744E-12	.97348E-11	117
.69744E-12	0.	0.	0.	0.	0.	118
.68708E+00	.69082E+00	.67315E+00	.69082E+00	.67315E+00	.81455E+00	119
.63483E+00	.81455E+00	.63483E+00	.80992E+00	.66383E+00	.80992E+00	120
.66383E+00	.85214E-01	.10252E-01	.85214E-01	.10252E-01	.13826E-02	121
.19436E-03	.13826E-02	.19436E-03	.27260E-04	.37086E-05	.27260E-04	122
.37086E-05	.47668E-06	.56813E-07	.47668E-06	.56813E-07	.62011E-08	123
.61548E-09	.62011E-08	.61548E-09	.55379E-10	.45155E-11	.55379E-10	124
.45155E-11	.33410E-12	0.	.33410E-12	0.	0.	125
.66081E+00	.68115E+00	.65082E+00	.68115E+00	.65082E+00	.78381E+00	126
.65440E+00	.78381E+00	.65440E+00	.77631E+00	.90752E+00	.77631E+00	127
.90752E+00	.19301E+00	.26126E-01	.19301E+00	.26126E-01	.38853E-02	128
.60960E-03	.38853E-02	.60960E-03	.96641E-04	.15069E-04	.96641E-04	129
.15069E-04	.22470E-05	.31366E-06	.22470E-05	.31366E-06	.40358E-07	130
.47402E-08	.40358E-07	.47402E-08	.50575E-09	.48937E-10	.50575E-09	131
.48937E-10	.42967E-11	.34295E-12	.42967E-11	0.	0.	132
.63632E+00	.66955E+00	.63023E+00	.66955E+00	.63023E+00	.75458E+00	133
.66349E+00	.75458E+00	.66349E+00	.74304E+00	.99397E+00	.74304E+00	134
.99397E+00	.35720E+00	.56662E-01	.35720E+00	.56662E-01	.91787E-02	135
.15738E-02	.91787E-02	.15738E-02	.27575E-03	.47950E-04	.27575E-03	136
.47950E-04	.80843E-05	.12894E-05	.80843E-05	.12894E-05	.19102E-06	137
.25962E-07	.19102E-06	.25962E-07	.32140E-08	.36132E-09	.32140E-08	138
.36132E-09	.36868E-10	.34190E-11	.36868E-10	0.	0.	139
.60650E+00	.65168E+00	.60573E+00	.65168E+00	.60573E+00	.71747E+00	140
.66544E+00	.71747E+00	.66544E+00	.70346E+00	.98016E+00	.70346E+00	141
.98016E+00	.60724E+00	.13007E+00	.60724E+00	.13007E+00	.23660E-01	142
.44772E-02	.23660E-01	.44772E-02	.87154E-03	.17058E-03	.87154E-03	143
.17058E-03	.32788E-04	.60575E-05	.32788E-04	.60575E-05	.10520E-05	144
.16900E-06	.10520E-05	.16900E-06	.24855E-07	.33281E-08	.24855E-07	145
.33281E-08	.40491E-09	.44772E-10	.40491E-09	0.	0.	146
.57994E+00	.63165E+00	.58446E+00	.63165E+00	.58446E+00	.68205E+00	147

.65992E+00	.68205E+00	.65992E+00	.66933E+00	.92382E+00	.66933E+00	148
.92382E+00	.79384E+00	.24471E+00	.79384E+00	.24471E+00	.51184E-01	149
.10585E-01	.51184E-01	.10585E-01	.22447E-02	.48195E-03	.22447E-02	150
.48195E-03	.10290E-03	.21384E-04	.10290E-03	.21384E-04	.42363E-05	151
.78427E-06	.42363E-05	.78427E-06	.13382E-06	.20870E-07	.13382E-06	152
.20870E-07	.29628E-08	.38248E-09	.29628E-08	0.	0.	153
.55648E+00	.60998E+00	.56588E+00	.60998E+00	.56588E+00	.64813E+00	154
.64936E+00	.64813E+00	.64936E+00	.63996E+00	.86289E+00	.63996E+00	155
.86289E+00	.88296E+00	.38562E+00	.88296E+00	.38562E+00	.96068E-01	156
.21744E-01	.96068E-01	.21744E-01	.49687E-02	.11509E-02	.49687E-02	157
.11509E-02	.26716E-03	.61077E-04	.26716E-03	.61077E-04	.13493E-04	158
.28179E-05	.13493E-04	.28179E-05	.54705E-06	.97583E-07	.54705E-06	159
.97583E-07	.15891E-07	.23561E-08	.15891E-07	0.	0.	160
.53574E+00	.58718E+00	.54929E+00	.58718E+00	.54929E+00	.61577E+00	161
.63518E+00	.61577E+00	.63518E+00	.61464E+00	.80574E+00	.61464E+00	162
.80574E+00	.90372E+00	.52268E+00	.90372E+00	.52268E+00	.15952E+00	163
.39901E-01	.15952E+00	.39901E-01	.97814E-02	.24183E-02	.97814E-02	164
.24183E-02	.60127E-03	.14865E-03	.60127E-03	.14865E-03	.35892E-04	165
.83015E-05	.35892E-04	.83015E-05	.18027E-05	.36219E-06	.18027E-05	166
.36219E-06	.66705E-07	.11208E-07	.66705E-07	0.	0.	167
.51722E+00	.56371E+00	.53397E+00	.56371E+00	.53397E+00	.58509E+00	168
.61827E+00	.58509E+00	.61827E+00	.59259E+00	.75357E+00	.59259E+00	169
.75357E+00	.88892E+00	.63070E+00	.88892E+00	.63070E+00	.23762E+00	170
.66577E-01	.23762E+00	.66577E-01	.17517E-01	.45948E-02	.17517E-01	171
.45948E-02	.12112E-02	.31917E-03	. 12112E-02	.31917E-03	.82961E-04	172
.20906E-04	.82961E-04	.20906E-04	.50016E-05	.11165E-05	.50016E-05	173
.11165E-05	.22969E-06	.43240E-07	.22969E-06	0.	0.	174

ENERGIES AND PENETRABILITIES FOR THE PROTON CONTINUUM 25 40 2

.30000E+00	.60000E+00	.10000E+01	.20000E+01	.30000E+01	.40000E+01	3
.50000E+01	.60000E+01	.70000E+01	.80000E+01	.90000E+01	.10000E+02	4
.12000E+02	.14000E+02	.16000E+02	.18000E+02	.21000E+02	.24000E+02	5
.28000E+02	.32000E+02	.36000E+02	.40000E+02	.44000E+02	.50000E+02	6
0.	0.	0.	0.	0.	0.	7
0.	0.	0.	0.	0.	0.	8
0.	0.	0.	0.	0.	0.	9
0.	0.	0.	0.	0.	0.	10
0.	0.	0.	0.	0.	0.	11
0.	0.	0.	0.	0.	0.	12
0.	0.	0.	0.	0.	0.	13
.29016E-08	.86600E-09	.11094E-09	.74456E-09	.13107E-09	.58323E-11	14
.17346E-12	.48812E-11	.19828E-12	0.	0.	0.	15
0.	0.	0.	0.	0.	0.	16
0.	0.	0.	0.	0.	0.	17
0.	0.	0.	0.	0.	0.	18
0.	0.	0.	0.	0.	0.	19
0.	0.	0.	0.	0.	0.	20
.46752E-05	.13688E-05	.20519E-06	.11751E-05	.24348E-06	.12252E-07	21
.46507E-09	.10378E-07	.53472E-09	.11197E-10	.23070E-12	.11973E-10	22
.23720E-12	0.	0.	0.	0.	0.	23
0.	0.	0.	0.	0.	0.	24
0.	0.	0.	0.	0.	0.	25
0.	0.	0.	0.	0.	0.	26
0.	0.	0.	0.	0.	0.	27
.64915E-02	.17568E-02	.39774E-03	.15261E-02	.47478E-03	.29618E-04	28
.18190E-05	.26263E-04	.21155E-05	.68288E-07	.23389E-08	.73941E-07	29
.24165E-08	.71833E-10	.19664E-11	.72868E-10	.19794E-11	0.	30
0.	0.	0.	0.	0.	0.	31
0.	0.	0.	0.	0.	0.	32
0.	0.	0.	0.	0.	0.	33
0.	0.	0.	0.	0.	0.	34
.11938E+00	.31382E-01	.11032E-01	.28181E-01	.13068E-01	.95543E-03	35
.86099E-04	.90776E-03	.10087E-03	.43218E-05	.20524E-06	.47487E-05	36
.21326E-06	.89460E-08	.35319E-09	.90960E-08	.35588E-09	.12520E-10	37

.39611E-12	.12566E-10	.39685E-12	0.	0.	0.	38
0.	0.	0.	0.	0.	0.	39
0.	0.	0.	0.	0.	0.	40
0.	0.	0.	0.	0.	0.	41
.43843E+00	.13253E+00	.74825E-01	.12529E+00	.85547E-01	.73938E-02	42
.94098E-03	.76347E-02	.10875E-02	.57992E-04	.34929E-05	.64815E-04	43
.36532E-05	.19642E-06	.10121E-07	.20025E-06	.10210E-07	.47214E-09	44
.19771E-10	.47410E-09	.19812E-10	.73952E-12	0.	.74035E-12	45
0.	0.	0.	0.	0.	0.	46
0.	0.	0.	0.	0.	0.	47
0.	0.	0.	0.	0.	0.	48
.72635E+00	.28044E+00	.24096E+00	.27882E+00	.25727E+00	.28778E-01	49
.50293E-02	.32593E-01	.56384E-02	.36499E-03	.26329E-04	.41633E-03	50
.27746E-04	.18059E-05	.11461E-06	.18468E-05	.11577E-06	.66321E-08	51
.34620E-09	.66634E-08	.34701E-09	.16194E-10	.67674E-12	.16215E-10	52
.67722E-12	0.	0.	0.	0.	0.	53
0.	0.	0.	0.	0.	0.	54
0.	0.	0.	0.	0.	0.	55
.87315E+00	.41905E+00	.47401E+00	.43172E+00	.46885E+00	.74963E-01	56
.17756E-01	.92948E-01	.18793E-01	.14705E-02	.12300E-03	.17161E-02	57
.13081E-03	.98919E-05	.74432E-06	.10152E-04	.75295E-06	.51402E-07	58
.32173E-08	.51679E-07	.32258E-08	.18101E-09	.91143E-11	.18126E-09	59
.91214E-11	.41025E-12	0.	.41044E-12	0.	0.	60
0.	0.	0.	0.	0.	0.	61
0.	0.	0.	0.	0.	0.	62
.93384E+00	.52613E+00	.67869E+00	.55356E+00	.63458E+00	.14990E+00	63
.47609E-01	.20028E+00	.46191E-01	.44450E-02	.41917E-03	.53240E-02	64
.45037E-03	.38531E-04	.33451E-05	.39703E-04	.33896E-05	.26825E-06	65
.19588E-07	.26989E-06	.19646E-07	.12896E-08	.76133E-10	.12916E-08	66
.76198E-10	.40216E-11	.19017E-12	.40237E-11	.19023E-12	0.	67
0.	0.	0.	0.	0.	0.	68
0.	0.	0.	0.	0.	0.	69
.95422E+00	.60388E+00	.81182E+00	.64243E+00	.73503E+00	.24861E+00	70
.10403E+00	.34817E+00	.90439E-01	.11002E-01	.11470E-02	.13564E-01	71
.12470E-02	.11825E-03	.11585E-04	.12245E-03	.11762E-04	.10568E-05	72
.88204E-07	.10642E-05	.88500E-07	.66590E-08	.45164E-09	.66704E-08	73
.45206E-09	.27437E-10	.14928E-11	.27453E-10	.14933E-11	.72854E-13	74
0.	.72871E-13	0.	0.	0.	0.	75
0.	0.	0.	0.	0.	0.	76
.95567E+00	.65990E+00	.88433E+00	.70548E+00	.78787E+00	.35960E+00	77
.19213E+00	.51157E+00	.14880E+00	.23513E-01	.26718E-02	.29901E-01	78
.29439E-02	.30360E-03	.33066E-04	.31610E-03	.33647E-04	.33765E-05	79
.31702E-06	.34033E-05	.31820E-06	.27012E-07	.20721E-08	.27064E-07	80
.20743E-08	.14254E-09	.87855E-11	.14263E-09	.87888E-11	.48577E-12	81
0.	.48590E-12	0.	0.	0.	0.	82
0.	0.	0.	0.	0.	0.	83
.94764E+00	.70059E+00	.91812E+00	.74984E+00	.81200E+00	.47020E+00	84
.30655E+00	.66188E+00	.21482E+00	.44866E-01	.55042E-02	.58879E-01	85
.61585E-02	.68068E-03	.81338E-04	.71305E-03	.82975E-04	.91763E-05	86
.95669E-06	.92593E-05	.96077E-06	.90853E-07	.77850E-08	.91047E-07	87
.77939E-08	.59893E-09	.41308E-10	.59932E-09	.41325E-10	.25561E-11	88
.14223E-12	.25568E-11	.14225E-12	0.	0.	0.	89
0.	0.	0.	0.	0.	0.	90
.91843E+00	.75206E+00	.92711E+00	.80199E+00	.81755E+00	.65655E+00	91
.54406E+00	.86779E+00	.34582E+00	.12604E+00	.17820E-01	.17418E+00	92
.20685E-01	.25366E-02	.35441E-03	.26970E-02	.36392E-03	.47242E-04	93
.58916E-05	.47795E-04	.59236E-05	.67460E-06	.70056E-07	.67639E-06	94
.70154E-07	.65513E-08	.54998E-09	.65564E-08	.55024E-09	.41441E-10	95
.28072E-11	.41453E-10	.28078E-11	.17141E-12	0.	.17144E-12	96
0.	0.	0.	0.	0.	0.	97
.89433E+00	.79908E+00	.90990E+00	.84177E+00	.81266E+00	.79055E+00	98
.69015E+00	.95842E+00	.47188E+00	.27123E+00	.44926E-01	.37173E+00	99
.54493E-01	.71809E-02	.11361E-02	.77797E-02	.11760E-02	.17368E-03	100

.25077E-04	.17637E-03	.25250E-04	.33576E-05	.41024E-06	.33688E-05	101
.41094E-06	.45303E-07	.44995E-08	.45345E-07	.45019E-08	.40138E-09	102
.32188E-10	.40152E-09	.32195E-10	.23257E-11	.15181E-12	.23261E-11	103
.15183E-12	0.	0.	0.	0.	0.	104
.87571E+00	.83251E+00	.89014E+00	.86643E+00	.80833E+00	.87035E+00	105
.75204E+00	.98559E+00	.58218E+00	.46644E+00	.94003E-01	.58729E+00	106
.11968E+00	.16675E-01	.29233E-02	.18488E-01	.30567E-02	.49999E-03	107
.81632E-04	.51000E-03	.82351E-04	.12483E-04	.17544E-05	.12535E-04	108
.17580E-05	.22385E-06	.25752E-07	.22410E-06	.25768E-07	.26636E-08	109
.24772E-09	.26647E-08	.24779E-09	.20750E-10	.15689E-11	.20754E-10	110
.15691E-11	.10659E-12	0.	.10660E-12	0.	0.	111
.86157E+00	.85461E+00	.87296E+00	.88033E+00	.80637E+00	.91300E+00	112
.77465E+00	.98445E+00	.67127E+00	.66620E+00	.16982E+00	.73629E+00	113
.22660E+00	.33390E-01	.63925E-02	.38052E-01	.67673E-02	.12009E-02	114
.21768E-03	.12318E-02	.22020E-03	.37262E-04	.59151E-05	.37457E-04	115
.59303E-05	.85712E-06	.11233E-06	.85828E-06	.11242E-06	.13257E-07	116
.14073E-08	.13263E-07	.14078E-08	.13455E-09	.11612E-10	.13458E-09	117
.11614E-10	.90683E-12	.63779E-13	.90693E-12	0.	0.	118
.84819E+00	.87407E+00	.85511E+00	.88962E+00	.80887E+00	.93795E+00	119
.78032E+00	.96370E+00	.76645E+00	.88370E+00	.33028E+00	.81787E+00	120
.46205E+00	.76769E-01	.16514E-01	.91832E-01	.17894E-01	.34837E-02	121
.71706E-03	.36117E-02	.72894E-03	.14150E-03	.26207E-04	.14258E-03	122
.26299E-04	.44776E-05	.69619E-06	.44856E-05	.69687E-06	.97791E-07	123
.12373E-07	.97847E-07	.12377E-07	.14100E-08	.14495E-09	.14103E-08	124
.14497E-09	.13465E-10	.11214E-11	.13466E-10	0.	0.	125
.84265E+00	.88347E+00	.84650E+00	.89148E+00	.81629E+00	.93980E+00	126
.80432E+00	.93822E+00	.82458E+00	.97875E+00	.51815E+00	.82260E+00	127
.72170E+00	.14555E+00	.34940E-01	.18367E+00	.38977E-01	.81141E-02	128
.18485E-02	.85309E-02	.18916E-02	.40871E-03	.85967E-04	.41310E-03	129
.86383E-04	.16879E-04	.30400E-05	.16920E-04	.30439E-05	.49697E-06	130
.73342E-07	.49732E-06	.73374E-07	.97555E-08	.11705E-08	.97582E-08	131
.11707E-08	.12694E-09	.12465E-10	.12696E-09	0.	0.	132
.84388E+00	.88772E+00	.84573E+00	.88909E+00	.82976E+00	.92852E+00	133
.82824E+00	.90870E+00	.86417E+00	.99037E+00	.73735E+00	.81292E+00	134
.94556E+00	.27130E+00	.75568E-01	.36579E+00	.88360E-01	.19616E-01	135
.49796E-02	.21129E-01	.51566E-02	.12397E-02	.29873E-03	.12602E-02	136
.30107E-03	.68245E-04	.14506E-04	.68489E-04	.14532E-04	.28230E-05	137
.49836E-06	.28258E-05	.49865E-06	.79461E-07	.11433E-07	.79490E-07	138
.11436E-07	.14862E-08	.17094E-09	.14864E-08	0.	0.	139
.85077E+00	.88782E+00	.85192E+00	.88551E+00	.84352E+00	.91378E+00	140
.85000E+00	.88802E+00	.87894E+00	.95649E+00	.87126E+00	.81288E+00	141
.99861E+00	.41240E+00	.13406E+00	.58001E+00	.16540E+00	.38571E-01	142
.10704E-01	.42841E-01	.11261E-01	.29213E-02	.78115E-03	.29933E-02	143
.79032E-03	.20141E-03	.49019E-04	.20256E-03	.49148E-04	.11058E-04	144
.22794E-05	.11073E-04	.22811E-05	.42595E-06	.71932E-07	.42615E-06	145
.71953E-07	.10975E-07	.15155E-08	.10978E-07	0.	0.	146
.85990E+00	.88709E+00	.86068E+00	.88309E+00	.85546E+00	.90131E+00	147
.86555E+00	.87605E+00	.88143E+00	.92091E+00	.92595E+00	.82003E+00	148
.96933E+00	.53832E+00	.20375E+00	.76250E+00	.26571E+00	.64722E-01	149
.19422E-01	.74593E-01	.20850E-01	.57101E-02	.16554E-02	.59127E-02	150
.16838E-02	.46908E-03	.12754E-03	.47299E-03	.12807E-03	.32566E-04	151
.76777E-05	.32630E-04	.76859E-05	.16506E-05	.32160E-06	.16517E-05	152
.32172E-06	.56662E-07	.90323E-08	.56676E-07	0.	0.	153
.86924E+00	.88718E+00	.86950E+00	.88271E+00	.86508E+00	.89305E+00	154
.87484E+00	.87099E+00	.87881E+00	.89641E+00	.93123E+00	.82862E+00	155
.92444E+00	.62974E+00	.27365E+00	.87141E+00	.37586E+00	.95462E-01	156
.30748E-01	.11479E+00	.33836E-01	.96284E-02	.29772E-02	.10104E-01	157
.30496E-02	.90808E-03	.26963E-03	.91895E-03	.27124E-03	.76335E-04	158
.20203E-04	.76547E-04	.20233E-04	.49162E-05	.10891E-05	.49202E-05	159
.10896E-05	.21861E-06	.39718E-07	.21868E-06	0.	0.	160
.87783E+00	.88869E+00	.87731E+00	.88449E+00	.87267E+00	.88907E+00	161
.87954E+00	.87071E+00	.87505E+00	.88309E+00	.91386E+00	.83566E+00	162
.88831E+00	.68293E+00	.33273E+00	.90909E+00	.47782E+00	.12615E+00	163

.43266E-01	.15908E+00	.49048E-01	.14300E-01	.46637E-02	.15267E-01	164
.48217E-02	.15078E-02	.47980E-03	.15330E-02	.48383E-03	.14781E-03	165
.43136E-04	.14845E-03	.43223E-04	.11703E-04	.29095E-05	.11716E-04	166
.29114E-05	.65768E-06	.13473E-06	.65793E-06	0.	0.	167
.88877E+00	.89355E+00	.88680E+00	.88994E+00	.88151E+00	.88931E+00	168
.88213E+00	.87530E+00	.87141E+00	.87621E+00	.88085E+00	.84202E+00	169
.85678E+00	.70668E+00	.38584E+00	.89121E+00	.58421E+00	.15990E+00	170
.58752E-01	.21902E+00	.70469E-01	.20681E-01	.71730E-02	.22801E-01	171
.75485E-02	.24750E-02	.84994E-03	.25411E-02	.86109E-03	.28785E-03	172
.94385E-04	.28986E-03	.94702E-04	.29337E-04	.84749E-05	.29388E-04	173
.84830E-05	.22447E-05	.54103E-06	.22462E-05	0.	0.	174

ENERGIES AND PENETRABILITIES FOR THE ALPHA CONTINUUM 25 40 2

.30000E+00	.60000E+00	.10000E+01	.30000E+01	.50000E+01	.60000E+01	3
.70000E+01	.80000E+01	.90000E+01	.10000E+02	.11000E+02	.12000E+02	4
.14000E+02	.16000E+02	.18000E+02	.21000E+02	.24000E+02	.28000E+02	5
.32000E+02	.36000E+02	.40000E+02	.44000E+02	.48000E+02	.52000E+02	6
0.	0.	0.	0.	0.	0.	7
0.	0.	0.	0.	0.	0.	8
0.	0.	0.	0.	0.	0.	9
0.	0.	0.	0.	0.	0.	10
0.	0.	0.	0.	0.	0.	11
0.	0.	0.	0.	0.	0.	12
0.	0.	0.	0.	0.	0.	13
0.	0.	0.	0.	0.	0.	14
0.	0.	0.	0.	0.	0.	15
0.	0.	0.	0.	0.	0.	16
0.	0.	0.	0.	0.	0.	17
0.	0.	0.	0.	0.	0.	18
0.	0.	0.	0.	0.	0.	19
0.	0.	0.	0.	0.	0.	20
0.	0.	0.	0.	0.	0.	21
0.	0.	0.	0.	0.	0.	22
0.	0.	0.	0.	0.	0.	23
0.	0.	0.	0.	0.	0.	24
0.	0.	0.	0.	0.	0.	25
0.	0.	0.	0.	0.	0.	26
0.	0.	0.	0.	0.	0.	27
.28379E-08	0.	0.	.19483E-08	.98933E-09	0.	28
0.	.34848E-09	.94676E-10	0.	0.	.19180E-10	29
.31969E-11	0.	0.	.43587E-12	.51690E-13	0.	30
0.	0.	0.	0.	0.	0.	31
0.	0.	0.	0.	0.	0.	32
0.	0.	0.	0.	0.	0.	33
0.	0.	0.	0.	0.	0.	34
.29977E-03	0.	0.	.21721E-03	.11846E-03	0.	35
0.	.46885E-04	.14608E-04	0.	0.	.35181E-05	36
.69998E-06	0.	0.	.11758E-06	.17567E-07	0.	37
0.	.23963E-08	.30033E-09	0.	0.	.34652E-10	38
.36326E-11	0.	0.	.34523E-12	0.	0.	39
0.	0.	0.	0.	0.	0.	40
0.	0.	0.	0.	0.	0.	41
.71342E-02	0.	0.	.53904E-02	.30550E-02	0.	42
0.	.13250E-02	.44185E-03	0.	0.	.11699E-03	43
.24999E-04	0.	0.	.46131E-05	.75005E-06	0.	44
0.	.11360E-06	.15999E-07	0.	0.	.21210E-08	45
.25874E-09	0.	0.	.28917E-10	.29357E-11	0.	46
0.	.27064E-12	0.	0.	0.	0.	47
0.	0.	0.	0.	0.	0.	48
.67096E-01	0.	0.	.53736E-01	.32224E-01	0.	49
0.	.15503E-01	.56023E-02	0.	0.	.16507E-02	50
.38419E-03	0.	0.	.77118E-04	.13477E-04	0.	51
0.	.22282E-05	.34430E-06	0.	0.	.51287E-07	52
.71261E-08	0.	0.	.91781E-09	.10804E-09	0.	53

0.	.11589E-10	.11122E-11	0.	0.	.10086E-12	54
0.	0.	0.	0.	0.	0.	55
.28791E+00	0.	0.	.25043E+00	.16869E+00	0.	56
0.	.94876E-01	.38740E-01	0.	0.	.12971E-01	57
.32973E-02	0.	0.	.73279E-03	.13638E-03	0.	58
0.	.24149E-04	.40116E-05	0.	0.	.65761E-06	59
.10209E-06	0.	0.	.14896E-07	.20006E-08	0.	60
0.	.24582E-09	.27559E-10	0.	0.	.28203E-11	61
.26394E-12	0.	0.	0.	0.	0.	62
.60731E+00	0.	0.	.57041E+00	.45494E+00	0.	63
0.	.31805E+00	.16150E+00	0.	0.	.64878E-01	64
.18610E-01	0.	0.	.45854E-02	.91278E-03	0.	65
0.	.17329E-03	.30273E-04	0.	0.	.53540E-05	66
.91188E-06	0.	0.	.14840E-06	.22435E-07	0.	67
0.	.31169E-08	.39599E-09	0.	0.	.45960E-10	68
.48796E-11	0.	0.	.47487E-12	0.	0.	69
.82058E+00	0.	0.	.80089E+00	.72414E+00	0.	70
0.	.60907E+00	.40884E+00	0.	0.	.21341E+00	71
.74724E-01	0.	0.	.20927E-01	.45171E-02	0.	72
0.	.91170E-03	.16733E-03	0.	0.	.31161E-04	73
.57215E-05	0.	0.	.10227E-05	.17194E-06	0.	74
0.	.26713E-07	.38058E-08	0.	0.	.49581E-09	75
.59101E-10	0.	0.	.64564E-11	0.	0.	76
.91924E+00	0.	0.	.90941E+00	.87293E+00	0.	77
0.	.80857E+00	.66937E+00	0.	0.	.45857E+00	78
.21610E+00	0.	0.	.72903E-01	.17664E-01	0.	79
0.	.37984E-02	.72787E-03	0.	0.	.14146E-03	80
.27403E-04	0.	0.	.52965E-05	.97873E-06	0.	81
0.	.16837E-06	.26662E-07	0.	0.	.38652E-08	82
.51285E-09	0.	0.	.62352E-10	0.	0.	83
.96191E+00	0.	0.	.95594E+00	.94068E+00	0.	84
0.	.90733E+00	.83660E+00	0.	0.	.68989E+00	85
.44336E+00	0.	0.	.19431E+00	.56451E-01	0.	86
0.	.13131E-01	.26452E-02	0.	0.	.52758E-03	87
.10692E-03	0.	0.	.21887E-04	.43939E-05	0.	88
0.	.82914E-06	.14478E-06	0.	0.	.23185E-07	89
.33995E-08	0.	0.	.45668E-09	0.	0.	90
.99032E+00	0.	0.	.98670E+00	.98543E+00	0.	91
0.	.97407E+00	.96105E+00	0.	0.	.91337E+00	92
.82388E+00	0.	0.	.60179E+00	.30989E+00	0.	93
0.	.97507E-01	.23307E-01	0.	0.	.48356E-02	94
.10312E-02	0.	0.	.22663E-03	.51476E-04	0.	95
0.	.11360E-04	.23603E-05	0.	0.	.45247E-06	96
.79579E-07	0.	0.	.12823E-07	0.	0.	97
.99736E+00	0.	0.	.99472E+00	.99607E+00	0.	98
0.	.99063E+00	.98971E+00	0.	0.	.97263E+00	99
.95272E+00	0.	0.	.86640E+00	.69863E+00	0.	100
0.	.37254E+00	.12883E+00	0.	0.	.29854E-01	101
.66521E-02	0.	0.	.14727E-02	.35933E-03	0.	102
0.	.88432E-04	.21232E-04	0.	0.	.47639E-05	103
.98508E-06	0.	0.	.18684E-06	0.	0.	104
.99932E+00	0.	0.	.99745E+00	.99895E+00	0.	105
0.	.99590E+00	.99703E+00	0.	0.	.98980E+00	106
.98599E+00	0.	0.	.95645E+00	.90102E+00	0.	107
0.	.71467E+00	.40905E+00	0.	0.	.13185E+00	108
.32646E-01	0.	0.	.71917E-02	.17685E-02	0.	109
0.	.46431E-03	.12418E-03	0.	0.	.31791E-04	110
.75926E-05	0.	0.	.16690E-05	0.	0.	111
.99993E+00	0.	0.	.99891E+00	.99984E+00	0.	112
0.	.99851E+00	.99937E+00	0.	0.	.99718E+00	113
.99677E+00	0.	0.	.99096E+00	.97896E+00	0.	114
0.	.94171E+00	.82170E+00	0.	0.	.54664E+00	115
.21389E+00	0.	0.	.55763E-01	.13112E-01	0.	116

0.	.34407E-02	.99051E-03	0.	0.	.29507E-03	117
.84190E-04	0.	0.	.22490E-04	0.	0.	118
.99991E+00	0.	0.	.99947E+00	.99986E+00	0.	119
0.	.99939E+00	.99964E+00	0.	0.	.99916E+00	120
.99864E+00	0.	0.	.99813E+00	.99344E+00	0.	121
0.	.98895E+00	.95420E+00	0.	0.	.87897E+00	122
.61500E+00	0.	0.	.27764E+00	.73362E-01	0.	123
0.	.18721E-01	.51328E-02	0.	0.	.16268E-02	124
.52804E-03	0.	0.	.16539E-03	0.	0.	125
.99979E+00	0.	0.	.99976E+00	.99975E+00	0.	126
0.	.99978E+00	.99961E+00	0.	0.	.99984E+00	127
.99919E+00	0.	0.	.99990E+00	.99779E+00	0.	128
0.	.99879E+00	.99089E+00	0.	0.	.98164E+00	129
.92557E+00	0.	0.	.76605E+00	.41406E+00	0.	130
0.	.13377E+00	.34410E-01	0.	0.	.99783E-02	131
.33918E-02	0.	0.	.12170E-02	0.	0.	132
.99972E+00	0.	0.	.99982E+00	.99969E+00	0.	133
0.	.99985E+00	.99961E+00	0.	0.	.99991E+00	134
.99944E+00	0.	0.	.99996E+00	.99908E+00	0.	135
0.	.99957E+00	.99810E+00	0.	0.	.99509E+00	136
.98892E+00	0.	0.	.94751E+00	.84214E+00	0.	137
0.	.50939E+00	.19066E+00	0.	0.	.49948E-01	138
.15384E-01	0.	0.	.54972E-02	0.	0.	139
.99970E+00	0.	0.	.99981E+00	.99968E+00	0.	140
0.	.99982E+00	.99964E+00	0.	0.	.99983E+00	141
.99958E+00	0.	0.	.99979E+00	.99957E+00	0.	142
0.	.99946E+00	.99970E+00	0.	0.	.99771E+00	143
.99879E+00	0.	0.	.98657E+00	.96959E+00	0.	144
0.	.85735E+00	.58415E+00	0.	0.	.22031E+00	145
.63384E-01	0.	0.	.19861E-01	0.	0.	146
.99969E+00	0.	0.	.99977E+00	.99968E+00	0.	147
0.	.99976E+00	.99966E+00	0.	0.	.99974E+00	148
.99966E+00	0.	0.	.99966E+00	.99971E+00	0.	149
0.	.99942E+00	.99990E+00	0.	0.	.99874E+00	150
.99971E+00	0.	0.	.99653E+00	.99138E+00	0.	151
0.	.97193E+00	.86834E+00	0.	0.	.60963E+00	152
.23235E+00	0.	0.	.70509E-01	0.	0.	153
.99968E+00	0.	0.	.99971E+00	.99968E+00	0.	154
0.	.99970E+00	.99967E+00	0.	0.	.99967E+00	155
.99968E+00	0.	0.	.99959E+00	.99972E+00	0.	156
0.	.99944E+00	.99977E+00	0.	0.	.99925E+00	157
.99945E+00	0.	0.	.99928E+00	.99594E+00	0.	158
0.	.99585E+00	.96214E+00	0.	0.	.88735E+00	159
.57958E+00	0.	0.	.23557E+00	0.	0.	160
.99967E+00	0.	0.	.99967E+00	.99966E+00	0.	161
0.	.99965E+00	.99966E+00	0.	0.	.99962E+00	162
.99966E+00	0.	0.	.99956E+00	.99966E+00	0.	163
0.	.99948E+00	.99961E+00	0.	0.	.99949E+00	164
.99925E+00	0.	0.	.99983E+00	.99773E+00	0.	165
0.	.99921E+00	.98987E+00	0.	0.	.96700E+00	166
.86740E+00	0.	0.	.55014E+00	0.	0.	167
.99964E+00	0.	0.	.99963E+00	.99964E+00	0.	168
0.	.99961E+00	.99963E+00	0.	0.	.99958E+00	169
.99961E+00	0.	0.	.99954E+00	.99958E+00	0.	170
0.	.99951E+00	.99949E+00	0.	0.	.99955E+00	171
.99921E+00	0.	0.	.99973E+00	.99869E+00	0.	172
0.	.99905E+00	.99798E+00	0.	0.	.98681E+00	173
.97075E+00	0.	0.	.81966E+00	0.	0.	174

APPENDIX E

SAMPLE PROBLEM OUTPUT

```
N + CO-59  --  H-1 AND HE-4 PRODUCTION  --  10 TO 40 MEV RUNS
APRIL 7, 1977  --  STANDARD PARAMETERS

IPRTLEV= 1   IPRTTC= 0   IPRTWID= 0   IPRTSP= 3   IPRTGC= 1
INPOPT=-1   KLIN=12   KTIN=12   NIBO= 4   LMAXOPT= 0

   +++++ GROUND STATE OF   25058  IS INCOMPLETELY DESCRIBED,   SPIN,PARITY  =   99.00   99.00  +++++
   +++++                           ASSIGNMENTS CHANGED TO,     SPIN,PARITY  =    0.00    1.00  +++++

LCM SPACE REQUIRED (EXCLUDING DISC BUFFERS) IS  225300
NUMBER OF LCM BUFFERS IS  4
MAXIMUM NUMBER OF ENERGY BINS IS  200

NI=  5   NMP= 3   LGROPT= 2   LPEQ= 1   NJMAX= 40   ICAPT=-0

ZAP=    1   ZAT= 27059   QE= 1.000 MEV   XMT=  58.93319 AMU   SP= 7.492 MEV   ECUTOFF=  .10 MEV
ACN=  0.000 /MEV   FSIGCN=  1.000   DEFCN= 0   SPINT =  3.5   PIT= -1

INCIDENT ENERGIES (MEV) = 1.400E+01
```

I	ZACN	NIP	PARENT I	PARENT IP	S-WAVE STRENGTH,	ENERGY	IP	ZA1	ZA2	XMR (AMU)	S (MEV)	NLEV	DEF	A (/MEV)	NLGC	ECGC (MEV)	BUFFER NUMBER
--	-----	---					--	----	-----			--	---		----		
1	27060	4	1	1	-6.830E-01	7.492											
							1	0	27060	59.934	0.000	0	0	0.000	0	0.000	1
							2	1	27059	58.933	7.492	0	0	0.000	0	0.000	4
							3	1001	26059	58.935	8.275	0	0	0.000	0	0.000	2
							4	2004	25056	55.939	7.172	0	0	0.000	0	0.000	3
2	26059	4	1	3	-1.008E+00	6.587											
							1	0	26059	58.935	0.000	0	0	0.000	0	0.000	2
							2	1	26058	57.933	6.587	0	0	0.000	0	0.000	0
							3	1001	25058	57.940	11.899	0	0	0.000	0	0.000	0
							4	2004	24055	54.941	7.974	0	0	0.000	0	0.000	0
3	25056	4	1	4	-1.003E+00	7.270											
							1	0	25056	55.939	0.000	0	0	0.000	0	0.000	3
							2	1	25055	54.938	7.270	0	0	0.000	0	0.000	0
							3	1001	24055	54.941	9.077	0	0	0.000	0	0.000	0
							4	2004	23052	51.945	7.897	0	0	0.000	0	0.000	0
4	27059	4	1	2	-1.730E-01	10.460											
							1	0	27059	58.933	0.000	0	0	0.000	0	0.000	4
							2	1	27058	57.936	10.460	0	0	0.000	0	0.000	1
							3	1001	26058	57.933	7.370	0	0	0.000	0	0.000	0
							4	2004	25055	54.938	6.951	0	0	0.000	0	0.000	0
5	27058	4	4	2	-4.760E-01	8.572											
							1	0	27058	57.936	0.000	0	0	0.000	0	0.000	1
							2	1	27057	56.936	8.572	0	0	0.000	0	0.000	0
							3	1001	26057	56.935	6.953	0	0	0.000	0	0.000	0
							4	2004	25054	53.940	6.715	0	0	0.000	0	0.000	0

AXEL APPROXIMATION USED FOR GAMMA-RAY TRANSMISSION COEFFICIENTS

INDEX	L	PARITY	MULTIPOLARITY	RATIO TO E1
1	1	1	E1	1.000
2	1	-1	M1	0.
3	2	1	E2	0.

COLLI-MILAZZO CLOSED FORM USED FOR ABSOLUTE CAL OF PRE-EQUILIBRIUM CROSS SECTION

PRE-EQUILIBRIUM NORMALIZATION CONSTANTS ARE /	NEUTRON	PROTON	DEUTERON	TRITON	HE-3	ALPHA
(INPUT)	0,	0.	1.000E-03	1.000E-03	1.000E-03	3.000E-03
(USED)	5.000E-04	5.000E-04	1.000E-03	1.000E-03	1.000E-03	3.000E-03

TRANSMISSION COEFFICIENT DATA
3 N + CO-59 TRAN. COEFS. FOR N. P, HE-4 ---- W-H FOR N 9-28-76 1

```
START OF SPECTRA SUBROUTINE. TIME FROM START OF THIS ENERGY =      .002 SECONDS, TOTAL ELAPSED TIME =   22.122 SECONDS,

**** GILCAM SUBROUTINE UNABLE TO MATCH DISCRETE LEVELS WITH LEVEL DENSITY FUNCTION FOR RESIDUAL NUCLEUS IN REACTION IR = 20 ****

START OF I= 1 LOOP. TIME FROM START OF THIS ENERGY =     .082 SECONDS. TOTAL ELAPSED TIME =   22.202 SECONDS.

GAMMA RAY STRENGTH NORMALIZATION CONSTANT  /  I= 1, CONSTANT =  6.8300E-01

START OF I= 2 LOOP. TIME FROM START OF THIS ENERGY =    2.477 SECONDS. TOTAL ELAPSED TIME =   24.597 SECONDS.

GAMMA RAY STRENGTH NORMALIZATION CONSTANT  /  I= 2, CONSTANT =  1.0080E+00

START OF I= 3 LOOP. TIME FROM START OF THIS ENERGY =    3.274 SECONDS. TOTAL ELAPSED TIME =   25.395 SECONDS.

GAMMA RAY STRENGTH NORMALIZATION CONSTANT  /  I= 3, CONSTANT =  1.0030E+00

START OF I= 4 LOOP. TIME FROM START OF THIS ENERGY =    5.065 SECONDS. TOTAL ELAPSED TIME =   27.185 SECONDS.

GAMMA RAY STRENGTH NORMALIZATION CONSTANT  /  I= 4, CONSTANT =  1.7300E-01

START OF I= 5 LOOP. TIME FROM START OF THIS ENERGY =    6.366 SECONDS. TOTAL ELAPSED TIME =   28.486 SECONDS.

GAMMA RAY STRENGTH NORMALIZATION CONSTANT  /  I= 5, CONSTANT =  4.7600E-01

END OF I LOOP IN SUBROUTINE SPECTRA. TIME FROM START OF THIS ENERGY =    6.387 SECONDS, TOTAL ELAPSED TIME =   28.507 SECONDS,
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N + CO-59 -- H-1 AND HE-4 PRODUCTION -- 10 TO 40 MEV RUNS
APRIL 7, 1977 -- STANDARD PARAMETERS

LAB NEUTRON ENERGY = 1.4000E+01 MEV

BINARY REACTION SUMMARIES (COMPOUND NUCLEUS ONLY)

REACTION PRODUCT	SIGMA (BARNS)
NONELASTIC	1.4142E+00
GAMMA-RAY	1.2395E-03
NEUTRON	1.3276E+00
PROTON	6.9175E-02
HELIUM-4	1.6112E-02

------ PRE-EQUILIBRIUM SUMMARY ------

IP = 2 ID = 1 OUTGOING PARTICLE = NEUTRON
INITIAL EXCITON NUMBER = 3 PREQ NORMALIZATION = .50000E-03 PREEQ X-SEC(BARNS) = .34940E+00
COMPOUND X-SEC(BARNS) = .93545E+00

IP = 3 ID = 2 OUTGOING PARTICLE = PROTON
INITIAL EXCITON NUMBER = 3 PREQ NORMALIZATION = .50000E-03 PREEQ X-SEC(BARNS) = .62595E-01
COMPOUND X-SEC(BARNS) = .48740E-01

IP = 4 ID = 6 OUTGOING PARTICLE = HELIUM-4

INITIAL EXCITON NUMBER = 3 PREQ NORMALIZATION = .30000E-02 PREEQ X-SEC(BARNS) = .53801E-02
COMPOUND X-SEC(BARNS) = .11352E-01

S P E C T R A   F R O M   I N D I V I D U A L   R E A C T I O N S

		ZACN=27060	ZACN=27060	ZACN=27060	ZACN=27060	ZACN=26059	ZACN=26059	ZACN=26059	ZACN=26059	ZACN=25056	ZACN=25056
		ZA1= 0	ZA1= 1	ZA1= 1001	ZA1= 2004	ZA1= 0	ZA1= 1	ZA1= 1001	ZA1= 2004	ZA1= 0	ZA1= 1
		ZA2=27060	ZA2=27059	ZA2=26059	ZA2=25056	ZA2=26059	ZA2=26058	ZA2=25058	ZA2=24059	ZA2=25056	ZA2=25055
		SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)
LEVEL DECAY C/S=		5.753E-06	0.	0.	0.	5.783E-02	0.	0.	0.	9.571E-03	0.
LEVEL EXCIT C/S=		9.141E-06	1.609E-02	1.339E-03	4.560E-04	1.265E-01	4.269E-02	0.	5.294E-11	2.603E-02	2.773E-04
TOTAL PROD. C/S=		1.245E-03	1.285E+00	1.113E-01	1.673E-02	2.097E-01	4.269E-02	0.	5.294E-11	4.336E-02	2.773E-04
AVG.ENERGY (MEV)		8.389E+00	3.252E+00	6.658E+00	9.739E+00	1.897E+00	1.321E+00	0.	2.838E+00	1.812E+00	1.126E+00
K	ENERGY (MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)
1	1.000	7.366E-06	3.416E-01	1.118E-06	0.	1.144E-01	3.085E-02	0.	4.958E-12	2.450E-02	2.496E-04
2	2.000	1.512E-05	3.038E-01	7.676E-04	7.021E-10	2.913E-02	1.009E-02	0.	1.569E-12	9.432E-03	2.038E-05
3	3.000	4.469E-05	2.105E-01	7.324E-03	7.145E-10	5.002E-02	1.616E-03	0.	4.351E-11	4.965E-03	7.293E-06
4	4.000	8.214E-05	1.411E-01	1.624E-02	2.116E-05	9.345E-03	1.304E-04	0.	2.904E-12	2.660E-03	3.979E-10
5	5.000	1.160E-04	9.221E-02	1.879E-02	2.043E-05	3.693E-03	9.129E-08	0.	0.	1.240E-03	1.001E-10
6	6.000	1.385E-04	5.971E-02	1.672E-02	2.487E-04	2.364E-03	0.	0.	0.	4.575E-04	0.
7	7.000	1.467E-04	4.032E-02	1.380E-02	1.215E-03	7.171E-04	0.	0.	0.	1.051E-04	0.
8	8.000	1.422E-04	2.888E-02	1.116E-02	2.889E-03	1.991E-06	0.	0.	0.	1.592E-08	0.
9	9.000	1.284E-04	2.174E-02	9.095E-03	3.746E-03	5.762E-07	0.	0.	0.	1.326E-09	0.
10	10.000	1.093E-04	1.666E-02	7.221E-03	3.313E-03	1.649E-07	0.	0.	0.	6.084E-10	0.
11	11.000	8.863E-05	1.235E-02	5.391E-03	2.354E-03	1.753E-08	0.	0.	0.	2.279E-14	0.
12	12.000	6.880E-05	8.863E-03	3.484E-03	1.554E-03	1.660E-11	0.	0.	0.	1.089E-14	0.
13	13.000	5.131E-05	5.349E-03	1.339E-03	9.156E-04	0.	0.	0.	0.	0.	0.
14	14.000	3.673E-05	1.875E-03	0.	4.560E-04	0.	0.	0.	0.	0.	0.
15	15.000	2.555E-05	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	16.000	1.704E-05	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	17.000	1.133E-05	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	18.000	7.445E-06	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	19.000	4.569E-06	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	20.000	6.558E-07	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	21.000	2.732E-06	0.	0.	0.	0.	0.	0.	0.	0.	0.

S P E C T R A   F R O M   I N D I V I D U A L   R E A C T I O N S

		ZACN=25056	ZACN=25056	ZACN=27059	ZACN=27059	ZACN=27059	ZACN=27059	ZACN=27058	ZACN=27058	ZACN=27058	ZACN=27058
		ZA1= 1001	ZA1= 2004	ZA1= 0	ZA1= 1	ZA1= 1001	ZA1= 2004	ZA1= 0	ZA1= 1	ZA1= 1001	ZA1= 2004
		ZA2=24053	ZA2=23052	ZA2=27059	ZA2=27058	ZA2=26058	ZA2=25055	ZA2=27058	ZA2=27057	ZA2=26057	ZA2=25054
		SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)
LEVEL DECAY C/S=		0.	0.	2.752E-01	0.	0.	0.	7.204E-01	0.	0.	0.
LEVEL EXCIT C/S=		3.353E-11	3.646E-14	6.534E-01	7.317E-01	9.556E-02	1.197E-03	1.530E+00	0.	0.	0.
TOTAL PROD. C/S=		3.353E-11	3.646E-14	1.015E+00	8.099E-01	9.556E-02	1.197E-03	7.978E-01	0.	0.	0.
AVG.ENERGY (MEV)		1.048E+00	2.462E+00	2.775E+00	1.307E+00	2.450E+00	4.689E+00	1.000E+00	0.	0.	0.
K	ENERGY (MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)
1	1.000	3.240E-11	7.898E-15	3.773E-01	5.612E-01	9.973E-03	6.239E-09	7.978E-01	0.	0.	0.
2	2.000	6.511E-13	1.461E-14	1.370E-01	2.487E-01	5.561E-02	1.427E-06	0.	0.	0.	0.
3	3.000	4.780E-13	3.153E-15	2.047E-01	0.	1.360E-02	1.462E-06	0.	0.	0.	0.
4	4.000	0.	1.080E-14	1.229E-01	0.	9.759E-03	6.970E-04	0.	0.	0.	0.
5	5.000	0.	0.	7.608E-02	0.	6.611E-03	1.660E-04	0.	0.	0.	0.
6	6.000	0.	0.	4.301E-02	0.	0.	3.315E-04	0.	0.	0.	0.
7	7.000	0.	0.	2.397E-02	0.	0.	0.	0.	0.	0.	0.
8	8.000	0.	0.	1.809E-02	0.	0.	0.	0.	0.	0.	0.
9	9.000	0.	0.	8.908E-03	0.	0.	0.	0.	0.	0.	0.
10	10.000	0.	0.	2.711E-03	0.	0.	0.	0.	0.	0.	0.
11	11.000	0.	0.	1.444E-05	0.	0.	0.	0.	0.	0.	0.
12	12.000	0.	0.	5.611E-06	0.	0.	0.	0.	0.	0.	0.
13	13.000	0.	0.	2.359E-06	0.	0.	0.	0.	0.	0.	0.
14	14.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
15	15.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
16	16.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
17	17.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
18	18.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
19	19.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
20	20.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
21	21.000	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

C O M P O S I T E   S P E C T R A

		NEUTRON SPECTRUM	PROTON SPECTRUM	DEUTERON SPECTRUM	TRITON SPECTRUM	HELIUM-3 SPECTRUM	HELIUM-4 SPECTRUM	GAMMA-RAY SPECTRUM	G.NEUTRON SPECTRUM
		SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)	SIGMA (BARNS)
TOTAL PROD. C/S=		2.138E+00	2.069E-01	0.	0.	0.	1.793E-02	2.067E+00	0.
AVG.ENERGY (MEV)		2.476E+00	4.714E+00	0.	0.	0.	9.402E+00	1.984E+00	0.
K	ENERGY (MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)	SIGMA (B/MEV)
1	1.000	9.338E-01	9.974E-03	0.	0.	0.	6.244E-09	1.314E+00	0.
2	2.000	5.626E-01	5.638E-02	0.	0.	0.	1.428E-06	1.756E-01	0.
3	3.000	2.121E-01	2.093E-02	0.	0.	0.	1.462E-06	2.597E-01	0.
4	4.000	1.412E-01	2.600E-02	0.	0.	0.	7.181E-04	1.350E-01	0.
5	5.000	9.221E-02	2.540E-02	0.	0.	0.	1.864E-04	8.113E-02	0.
6	6.000	5.971E-02	1.672E-02	0.	0.	0.	5.802E-04	4.597E-02	0.
7	7.000	4.032E-02	1.380E-02	0.	0.	0.	1.215E-03	2.493E-02	0.
8	8.000	2.888E-02	1.116E-02	0.	0.	0.	2.889E-03	1.824E-02	0.
9	9.000	2.174E-02	9.095E-03	0.	0.	0.	3.746E-03	9.037E-03	0.
10	10.000	1.666E-02	7.221E-03	0.	0.	0.	3.313E-03	2.821E-03	0.
11	11.000	1.235E-02	5.391E-03	0.	0.	0.	2.354E-03	1.031E-04	0.
12	12.000	8.863E-03	3.484E-03	0.	0.	0.	1.554E-03	7.441E-05	0.
13	13.000	5.349E-03	1.339E-03	0.	0.	0.	9.156E-04	5.366E-05	0.
14	14.000	1.875E-03	0.	0.	0.	0.	4.560E-04	3.673E-05	0.
15	15.000	0.	0.	0.	0.	0.	0.	2.555E-05	0.
16	16.000	0.	0.	0.	0.	0.	0.	1.704E-05	0.
17	17.000	0.	0.	0.	0.	0.	0.	1.133E-05	0.
18	18.000	0.	0.	0.	0.	0.	0.	7.445E-06	0.
19	19.000	0.	0.	0.	0.	0.	0.	4.569E-06	0.
20	20.000	0.	0.	0.	0.	0.	0.	6.558E-07	0.
21	21.000	0.	0.	0.	0.	0.	0.	2.732E-06	0.

D I S C R E T E   L E V E L   I N F O R M A T I O N

I= 1   IP= 1   IR= 1   ZA1=   0   ZA2=27060   SEPARATION ENERGY = 0.000 MEV   ACCUMULATED SEPARATION ENERGY = 0.000 MEV
NUMBER OF LEVEL IN RESIDUAL NUCLEUS = 11   NUMBER OF GAMMA RAYS = 18   RESIDUAL NUCLEUS ID =27060

LEVEL NO	LEVEL ENERGY (MEV)	SPIN. PARITY	PRODUCTION CROSS SECTION (BARNS)	NUMBER OF TRANSITIONS	FINAL LEVEL NO	FINAL ENERGY (MEV)	TRANSITION PROBABILITY	CONDITIONAL PROBABILITY	GAMMA NUMBER	GAMMA ENERGY (MEV)	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	5.0	3.3880E-06	0							
2	.0590	2.0	1.8459E-06	1	1	0.0000	1.0000	1.0000	1	.0590	1.8459E-06
3	.2780	4.0	8.2750E-07	1	1	0.0000	1.0000	1.0000	2	.2780	8.2750E-07
4	.2880	3.0	6.5204E-07	1	2	.0590	1.0000	1.0000	3	.2290	6.5204E-07
5	.4360	5.0	4.7466E-07	2	1	0.0000	.1700	1.0000	4	.4360	8.0693E-08
					3	.2780	.8300	1.0000	5	.1580	3.9397E-07
6	.5050	3.0	2.8702E-07	1	2	.0590	1.0000	1.0000	6	.4460	2.8702E-07
7	.5410	2.0	2.0741E-07	2	2	.0590	.4200	1.0000	7	.4820	8.7111E-08
					4	.2880	.5800	1.0000	8	.2530	1.2030E-07
8	.6140	3.0	6.1643E-07	2	2	.0590	.9700	1.0000	9	.5550	5.9794E-07
					3	.2780	.0300	1.0000	10	.3360	1.8493E-08
9	.7360	2.0	1.8657E-07	1	8	.6140	1.0000	1.0000	11	.1220	1.8657E-07
10	.7820	4.0	3.8003E-07	2	1	0.0000	.4600	1.0000	12	.7820	1.7481E-07
					4	.2880	.5400	1.0000	13	.4940	2.0521E-07
11	1.0060	3.0	2.7578E-07	5	8	.6140	.5200	1.0000	14	.3920	1.4340E-07
					7	.5410	.0700	1.0000	15	.4650	1.9304E-08
					4	.2880	.1500	1.0000	16	.7180	4.1367E-08
					3	.2780	.1200	1.0000	17	.7280	3.3093E-08
					2	.0590	.1400	1.0000	18	.9470	3.8609E-08

I= 1   IP= 2   IR= 2   ZA1=   1   ZA2=27059   SEPARATION ENERGY = 7.492 MEV   ACCUMULATED SEPARATION ENERGY = 0.000 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 8

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-3.5	99.0	1.8750E-03
2	1.0993	-1.5	99.0	1.4973E-03
3	1.1900	-4.5	99.0	3.8514E-03
4	1.2915	-1.5	99.0	1.1044E-03
5	1.4340	-.5	99.0	5.3715E-04
6	1.4600	-5.5	99.0	3.2654E-03
7	1.4810	-2.5	99.0	1.6832E-03
8	1.7440	-3.5	99.0	2.2726E-03

I= 1   IP= 3   IR= 3   ZA1=1001   ZA2=26059   SEPARATION ENERGY = 8.275 MEV   ACCUMULATED SEPARATION ENERGY = 0.000 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 3

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-1.5	99.0	4.5654E-04
2	.2890	-.5	99.0	2.1616E-04
3	.4750	-2.5	99.0	6.6594E-04

I= 1   IP= 4   IR= 4   ZA1=2004   ZA2=25056   SEPARATION ENERGY = 7.172 MEV   ACCUMULATED SEPARATION ENERGY = 0.000 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 3

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	3.0	99.0	2.1183E-04
2	.0260	2.0	99.0	1.5207E-04
3	.1100	1.0	99.0	9.2096E-05

I= 2   IP= 1   IR= 5   ZA1=   0   ZA2=26059   SEPARATION ENERGY = 0.000 MEV   ACCUMULATED SEPARATION ENERGY = 8.275 MEV
NUMBER OF LEVEL IN RESIDUAL NUCLEUS = 3   NUMBER OF GAMMA RAYS = 3   RESIDUAL NUCLEUS ID =26059

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	PRODUCTION CROSS SECTION (BARNS)	NUMBER OF TRANSITIONS	FINAL LEVEL NO	FINAL ENERGY (MEV)	TRANSITION PROBABILITY	CONDITIONAL PROBABILITY	GAMMA NUMBER	GAMMA ENERGY (MEV)	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-1.5	6.8647E-02	0							
2	.2890	-.5	1.6409E-02	1							
					1	0.0000	1.0000	1.0000	1	.2890	1.6409E-02
3	.4750	-2.5	4.1424E-02	2							
					1	0.0000	.7500	1.0000	2	.4750	3.1068E-02
					2	.2890	.2500	1.0000	3	.1860	1.0356E-02

I= 2 IP= 2 IR= 6 ZA1= 1 ZA2=26058 SEPARATION ENERGY = 6.587 MEV ACCUMULATED SEPARATION ENERGY = 8.275 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 9

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	0.0	99.0	8.5725E-03
2	.8106	2.0	99.0	2.2615E-02
3	1.6730	2.0	99.0	3.0559E-03
4	2.1334	3.0	99.0	5.1458E-03
5	2.2570	0.0	99.0	1.2544E-04
6	2.5960	4.0	99.0	2.7356E-03
7	2.7820	1.0	99.0	1.4346E-04
8	2.8760	1.0	99.0	1.2230E-04
9	3.0840	2.0	99.0	1.7128E-04

I= 2 IP= 3 IR= 7 ZA1=1001 ZA2=25058 SEPARATION ENERGY = 11.899 MEV ACCUMULATED SEPARATION ENERGY = 8.275 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 1

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-0.0	99.0	0.

I= 2 IP= 4 IR= 8 ZA1=2004 ZA2=24055 SEPARATION ENERGY = 7.974 MEV ACCUMULATED SEPARATION ENERGY = 8.275 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 5

LEVEL NO	LEVEL ENERGY (MEV)	SPIN. PARITY	ISO- SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-1.5	99.0	4.0766E-11
2	.2440	-.5	99.0	9.0508E-13
3	.5210	-2.5	99.0	7.7826E-12
4	.5720	-1.5	99.0	1.4270E-12
5	.8850	-2.5	99.0	2.0583E-12

I= 3 IP= 1 IR= 9 ZA1= 0 ZA2=25056 SEPARATION ENERGY = 0.000 MEV ACCUMULATED SEPARATION ENERGY = 7.172 MEV
NUMBER OF LEVEL IN RESIDUAL NUCLEUS = 3 NUMBER OF GAMMA RAYS = 2 RESIDUAL NUCLEUS ID =25056

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	PRODUCTION CROSS SECTION (BARNS)	NUMBER OF TRANSITIONS	FINAL LEVEL NO	FINAL ENERGY (MEV)	TRANSITION PROBABILITY	CONDITIONAL PROBABILITY	GAMMA NUMBER	GAMMA ENERGY (MEV)	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	3.0	1.6455E-02	0							
2	.0260	2.0	7.5421E-03	1							
					1	0.0000	1.0000	1.0000	1	.0260	7.5421E-03
3	.1100	1.0	2.0286E-03	1							
					2	.0260	1.0000	1.0000	2	.0840	2.0286E-03

I= 3 IP= 2 IR=10 ZA1= 1 ZA2=25055 SEPARATION ENERGY = 7.270 MEV ACCUMULATED SEPARATION ENERGY = 7.172 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 7

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO- SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-2.5	99.0	9.7831E-05
2	.1260	-3.5	99.0	1.5538E-04
3	.9840	-4.5	99.0	9.0889E-06
4	1.2920	-5.5	99.0	1.0837E-05
5	1.5280	-1.5	99.0	1.8085E-06
6	1.8830	-2.5	99.0	1.2467E-06
7	2.1990	-3.5	99.0	1.1196E-06

I= 3 IP= 3 IR=11 ZA1=1001 ZA2=24055 SEPARATION ENERGY = 9.077 MEV ACCUMULATED SEPARATION ENERGY = 7.172 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 5

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-1.5	99.0	3.2107E-11
2	.2440	-.5	99.0	7.7307E-13
3	.5210	-2.5	99.0	3.5826E-13
4	.5720	-1.5	99.0	1.8115E-13
5	.8850	-2.5	99.0	1.1267E-13

I= 3 IP= 4 IR=12 ZA1=2004 ZA2=23052 SEPARATION ENERGY = 7.897 MEV ACCUMULATED SEPARATION ENERGY = 7.172 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 7

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	3.0	99.0	6.9296E-15
2	.0172	2.0	99.0	4.3148E-15
3	.0228	4.0	99.0	1.5509E-14
4	.1416	1.0	99.0	1.8203E-15
5	.1478	3.0	99.0	4.7770E-15
6	.4366	2.0	99.0	2.0365E-15
7	.7935	2.0	99.0	1.0685E-15

I= 4 IP= 1 IR=13 ZA1= 0 ZA2=27059 SEPARATION ENERGY = 0.000 MEV ACCUMULATED SEPARATION ENERGY = 7.492 MEV
NUMBER OF LEVEL IN RESIDUAL NUCLEUS = 8 NUMBER OF GAMMA RAYS = 11 RESIDUAL NUCLEUS ID =27059

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	PRODUCTION CROSS SECTION (BARNS)	NUMBER OF TRANSITIONS	FINAL LEVEL NO	FINAL ENERGY (MEV)	TRANSITION PROBABILITY	CONDITIONAL PROBABILITY	GAMMA NUMBER	GAMMA ENERGY (MEV)	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-3.5	3.7819E-01	0							
2	1.0993	-1.5	4.2541E-02	1							
					1	0.0000	1.0000	1.0000	1	1.0993	4.2541E-02
3	1.1900	-4.5	7.9069E-02	1							
					1	0.0000	1.0000	1.0000	2	1.1900	7.9069E-02
4	1.2915	-1.5	2.2122E-02	2							
					1	0.0000	.9400	1.0000	3	1.2915	2.0795E-02
					2	1.0993	.0600	1.0000	4	.1922	1.3273E-03

5	1.4340	-.5	8.6454E-03	2	2	1.0993	.5000	1.0000	5	.3347	4.3227E-03
					4	1.2915	.5000	1.0000	6	.1425	4.3227E-03
6	1.4600	-5.5	8.7962E-02	1	1	0.0000	1.0000	1.0000	7	1.4600	8.7962E-02
7	1.4810	-2.5	1.8790E-02	2	2	1.0993	.6000	1.0000	8	.3817	1.1274E-02
					1	0.0000	.4000	1.0000	9	1.4810	7.5158E-03
8	1.7440	-3.5	1.6091E-02	2	1	0.0000	.5500	1.0000	10	1.7440	8.8281E-03
					3	1.1900	.4500	1.0000	11	.5540	7.2230E-03

I= 4 IP= 2 IR=14 ZA1= 1 ZA2=27058 SEPARATION ENERGY = 10.460 MEV ACCUMULATED SEPARATION ENERGY = 7.492 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 6

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	2.0	99.0	6.7070E-02
2	.0249	5.0	99.0	3.3623E-01
3	.0540	3.0	99.0	9.5163E-02
4	.1160	4.0	99.0	1.5206E-01
5	.3670	3.0	99.0	5.1398E-02
6	.4320	2.0	99.0	2.9767E-02

I= 4 IP= 3 IR=15 ZA1=1001 ZA2=26058 SEPARATION ENERGY = 7.370 MEV ACCUMULATED SEPARATION ENERGY = 7.492 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 9

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	0.0	99.0	3.7731E-02
2	.8106	2.0	99.0	4.0844E-02
3	1.6750	2.0	99.0	3.5876E-03
4	2.1334	3.0	99.0	2.8888E-03
5	2.2570	0.0	99.0	2.1366E-04
6	2.5960	4.0	99.0	1.6681E-03
7	2.7820	1.0	99.0	2.1757E-04
8	2.8760	1.0	99.0	1.8641E-04
9	3.0840	2.0	99.0	2.1991E-04

I= 4 IP= 4 IR=16 ZA1=2004 ZA2=25055 SEPARATION ENERGY = 6.951 MEV ACCUMULATED SEPARATION ENERGY = 7.492 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 7

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-2,5	99,0	1.5360E-04
2	.1260	-3,5	99,0	6,8662E-04
3	.9840	-4,5	99.0	5.2054E-05
4	1.2920	-5.5	99,0	2.9761E-04
5	1.5280	-1.5	99,0	2.2376E-06
6	1.8830	-2.5	99,0	1,0058E-06
7	2.1990	-3.5	99.0	3.4425E-06

I= 5 IP= 1 IR=17 ZA1= 0 ZA2=27058 SEPARATION ENERGY = 0.000 MEV ACCUMULATED SEPARATION ENERGY = 17.952 MEV
NUMBER OF LEVEL IN RESIDUAL NUCLEUS = 6 NUMBER OF GAMMA RAYS = 6 RESIDUAL NUCLEUS ID =27058

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	PRODUCTION CROSS SECTION (BARNS)	NUMBER OF TRANSITIONS	FINAL LEVEL NO	FINAL ENERGY (MEV)	TRANSITION PROBABILITY	CONDITIONAL PROBABILITY	GAMMA NUMBER	GAMMA ENERGY (MEV)	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	2.0	8.0915E-01	0							
2	.0249	5.0	3.4826E-01	1							
					1	0.0000	1.0000	1.0000	1	.0249	3.4826E-01
3	.0540	3.0	1.1611E-01	1							
					1	0.0000	1.0000	1.0000	2	.0540	1.1611E-01
4	.1160	4.0	1.6295E-01	2							
					2	.0249	.0300	1.0000	3	.0911	4.8885E-03
					1	0.0000	.9700	1.0000	4	.1160	1.5806E-01
5	.3670	3.0	5.7994E-02	1							
					1	0.0000	1.0000	1.0000	5	.3670	5.7994E-02
6	.4320	2.0	3.5064E-02	1							
					1	0.0000	1.0000	1.0000	6	.4320	3.5064E-02

I= 5 IP= 2 IR=18 ZA1= 1 ZA2=27057 SEPARATION ENERGY = 8.572 MEV ACCUMULATED SEPARATION ENERGY = 17.952 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 8

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-3.5	99.0	0.
2	1.2235	-4.5	99.0	0.
3	1.3779	-1.5	99.0	0.
4	1.5050	-.5	99.0	0.
5	1.7577	-1.5	99.0	0.
6	1.8965	-3.5	99.0	0.
7	1.9201	-2.5	99.0	0.
8	2.1329	-2.5	99.0	0.

I= 5 IP= 3 IR=19 ZA1=1001 ZA2=26057 SEPARATION ENERGY = 6.953 MEV ACCUMULATED SEPARATION ENERGY = 17.952 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 5

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	-.5	99.0	0.
2	.0144	-1.5	99.0	0.
3	.1365	-2.5	99.0	0.
4	.3668	-1.5	99.0	0.
5	.7066	-2.5	99.0	0.

I= 5 IP= 4 IR=20 ZA1=2004 ZA2=25054 SEPARATION ENERGY = 6.715 MEV ACCUMULATED SEPARATION ENERGY = 17.952 MEV
NUMBER OF LEVELS IN RESIDUAL NUCLEUS = 1

LEVEL NO	LEVEL ENERGY (MEV)	SPIN, PARITY	ISO-SPIN	PRODUCTION CROSS SECTION (BARNS)
1	0.0000	3.0	99.0	0.

LEVEL DENSITY PARAMETERS

I	IP	IR	IZA1	IZA2	A (/MEV)	TEMP (MEV)	E0 (MEV)	EMATCH (MEV)	ECUT (MEV)	LEVELS AT ECUT	PN (MEV)	PZ (MEV)	SN (MEV)	SZ (MEV)	S (MEV)	SAC (MEV)
1	1	1	0	27060	7.508	1.135	-1.714	5.837	1.006	11	.08	0.00	15.52	-17.36	0.000	0.000
1	2	2	1	27059	7.058	1.231	-.816	7.769	1.744	8	1.29	0.00	14.92	-17.36	7.492	0.000
1	3	3	1001	26059	7.918	1.162	-.802	8.375	.475	3	.08	1.54	15.52	-16.37	8.275	0.000
1	4	4	2004	25056	7.233	1.583	-1.629	.436	.110	3	0.00	0.00	14.13	-15.53	7.172	0.000
2	1	5	0	26059	7.918	1.162	-.802	8.375	.475	3	.08	1.54	15.52	-16.37	0.000	8.275
2	2	6	1	26058	7.465	1.214	.416	9.708	3.084	9	1.29	1.54	14.92	-16.37	6.587	8.275
2	3	7	1001	25058	8.231	.758	0.000	.846	0.000	1	.08	0.00	15.52	-15.53	11.899	8.275
2	4	8	2004	24055	7.517	1.204	-1.052	8.152	.885	5	0.00	1.35	14.13	-14.71	7.974	8.275
3	1	9	0	25056	7.233	1.583	-1.629	.436	.110	3	0.00	0.00	14.13	-15.53	0.000	7.172
3	2	10	1	25055	6.665	1.181	-.099	6.410	2.199	7	1.27	0.00	13.26	-15.53	7.270	7.172
3	3	11	1001	24055	7.517	1.204	-1.052	8.152	.885	5	0.00	1.35	14.13	-14.71	9.077	7.172
3	4	12	2004	23052	6.750	1.188	-1.517	5.366	.794	7	0.00	0.00	12.60	-13.93	7.897	7.172
4	1	13	0	27059	7.058	1.231	-.816	7.769	1.744	8	1.29	0.00	14.92	-17.36	0.000	7.492
4	2	14	1	27058	6.518	1.277	-1.855	6.201	.432	6	0.00	0.00	14.13	-17.36	10.460	7.492
4	3	15	1001	26058	7.465	1.214	.416	9.708	3.084	9	1.29	1.54	14.92	-16.37	7.370	7.492
4	4	16	2004	25055	6.665	1.181	-.099	6.410	2.199	7	1.27	0.00	13.26	-15.53	6.951	7.492
5	1	17	0	27058	6.518	1.277	-1.855	6.201	.432	6	0.00	0.00	14.13	-17.36	0.000	17.952
5	2	18	1	27057	5.951	1.399	-.776	8.073	2.133	8	1.27	0.00	13.26	-17.36	8.572	17.952
5	3	19	1001	26057	6.923	1.354	-1.473	9.664	.707	5	0.00	1.54	14.13	-16.37	6.953	17.952
5	4	20	2004	25054	6.217	2.373	0.000	.462	0.000	1	0.00	0.00	12.60	-15.53	6.715	17.952

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