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**A User's Manual to the ICRP Code—
A Series of Computer Programs to
Perform Dosimetric Calculations
for the ICRP Committee 2 Report**

S. B. Watson
M. R. Ford

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Health and Safety Research Division

A USER'S MANUAL TO THE ICRP CODE — A SERIES OF
COMPUTER PROGRAMS TO PERFORM DOSIMETRIC
CALCULATIONS FOR THE ICRP COMMITTEE
2 REPORT

S. B. Watson* and M. R. Ford

*Computer Sciences Division

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A USER'S MANUAL TO THE ICRP CODE — A SERIES OF
COMPUTER PROGRAMS TO PERFORM DOSIMETRIC
CALCULATIONS FOR THE ICRP
COMMITTEE 2 REPORT

S. B. Watson and M. R. Ford

ABSTRACT

A computer code has been developed that implements the recommendations of ICRP Committee 2 for computing limits for occupational exposure of radionuclides. The purpose of this report is to describe the various modules of the computer code and to present a description of the methods and criteria used to compute the tables published in the Committee 2 report. The computer code contains three modules of which: (1) one computes specific effective energy; (2) one calculates cumulated activity; and (3) one computes dose and the series of ICRP tables. The description of the first two modules emphasizes the new ICRP Committee 2 recommendations in computing specific effective energy and cumulated activity. For the third module, the complex criteria are discussed for calculating the tables of committed dose equivalent, weighted committed dose equivalents, annual limit of intake, and derived air concentration.

I. INTRODUCTION

A computer code has been written to compute committed dose equivalent and the secondary and derived limits on occupational exposure for the report by Committee 2 of the International Commission on Radiological Protection (ICRP) (ref. 1). The committed dose equivalent (H_{50T}) in a particular organ or tissue T is the total dose equivalent (DE) to which that organ or tissue would be committed during the 50 years after intake of a radionuclide. Total dose equivalent measured in Sieverts (Sv) in an organ T of the body from an internally deposited emitter is given by

$$DE(T,t) = K \sum_i U_{Y_i}(t) \cdot SEE(T \leftarrow Y_i), \quad (1.1)$$

where $U_{Y_i}(t)$ represents the cumulated activity measured in transformations per Becquerel (1 Bq = 1 transformation/second) in the various source organs Y_i at some time t after deposition, and $SEE(T \leftarrow Y_i)$ measured in MeV per gram per transformation represents the specific effective energy absorbed in the target organ T from each transformation in Y_i . The factor K has the value $1.6 \times 10^{-10}(\text{joules/MeV}) \cdot (\text{g/kg})$. Thus, the product of U and SEE represents the total dose equivalent to the organ T from source organ Y_i in the time interval up to t . If $t = 50$ years, $H_{50T} \equiv DE(T, 50)$.

In order to compute the quantity DE , the ICRP computer code is separated into three modules. The first module, called the SEE program, calculates specific effective energy. The second module, the ICRP TIMED program, computes the cumulated activity $U_{Y_i}(t)$ at a specified time t after intake. A third module, called the DOSE program, combines the output of the SEE and ICRP TIMED program segments to compute dose equivalent and the secondary and derived limits for the control of internal dose. The interaction of these modules is shown in Fig. 1.1. The SEE and ICRP TIMED modules may be used as "stand alone" codes for a specific calculational need; however, DOSE requires input from the other modules for execution.

The purpose of this report is to describe the methodologies and computer programs and to provide user information for the three modules of the ICRP code. The appendices contain program listings and sample input and output of the various modules of the ICRP computer code. This report is intended primarily for the person who would execute the computer code and contains many details essential for the user. The reader interested only in the ICRP Committee 2 recommendations may skip the parts of the text concerning program description and user information, and ICRP Publications 26 (ref. 2) and 30 (ref. 1) should be consulted.

II. THE SEE PROGRAM

The formula for computing SEE from source organ Y_i to target organ T is given as follows:

Fig. 1.1. Interaction of ICRP Program Modules.

$$SEE(T \leftarrow Y_i) = \sum_j f_j \bar{E}_j \phi_j(T \leftarrow Y_i) Q_j N_j(T) , \quad (2.1)$$

where

f_j = the yield in particles per disintegration for radiation type j ,

$\bar{E}_j$ = the average energy or unique energy of the j^{th} type of radiation,

$\phi_j(T \leftarrow Y_i)$ = the specific absorbed fraction of energy (or fraction of energy absorbed per gram of target organ T) from the j^{th} type radiation in source organ Y_i , and

Q_j and $N_j(T)$ = the appropriate quality factor and modifying factor for the j -type radiation in the target organ. $N_j(T)$ should be taken as one for all types of radiation.

Source and target organs of interest to the ICRP are given in Table 2.1 along with their masses. A thorough explanation of the methodologies used in computing SEE (or $S = 51.15 \cdot SEE$) are described in refs. 3 and 4, which also contain calculated values of S for about 160 radionuclides for 22 source and 24 target organs. Thus, a brief summary of the methodologies used, with references to the appropriate sources, is presented. In addition, some ICRP modifications to the description given in ref. 3 are discussed. The reader is referred to ref. 1 for a detailed discussion of these ICRP assumptions.

Decay Scheme Data

Dillman has published detailed decay data^{5,6} of the type required for the calculation of dose, together with average beta energies for many radionuclides of interest, and he has designed a computer code which produces these data.⁷ For the ICRP report by Committee 2, Dillman has obtained decay data from the Nuclear Data Group at Oak Ridge National Laboratory and interfaced it with his code⁷ to produce the f_j and $\bar{E}_j$ in Eq. (2.1) required as input to the SEE program. In addition, for spontaneous fission calculations Dillman's code produces f , the spontaneous fission yield, and $\bar{V}$, the average number of neutrons per spontaneous fission.

Table 2.1. Source and Target Organs and Their Masses

Source Organ	Mass(g)	Target Organ	Mass(g)
Adrenals	14	Adrenals	14
Bladder Contents	200	Bone Surfaces	120
Stomach Contents	250	Bladder Wall	45
Small Intestine Contents	400	Stomach Wall	150
Upper Lg. Intestine Contents	220	Small Intestine Wall	640
Lower Lg. Intestine Contents	135	Upper Large Intestine Wall	210
Kidneys	310	Lower Large Intestine Wall	160
Liver	1800	Kidneys	310
Lungs	1000	Liver	1800
Muscle	28000	Lungs	1000
Ovaries	11	Muscle	28000
Pancreas	100	Ovaries	11
Cortical Bone	4000	Pancreas	100
Trabecular Bone	1000	Red Marrow	1500
Red Marrow	1500	Skin	2600
Skin	2600	Spleen	180
Spleen	180	Testes	35
Testes	35	Thymus	20
Thyroid	20	Thyroid	20
Total Body	70000	Uterus	80

Absorbed Fractions for Photons

The absorbed fractions, $\phi_j(T \leftarrow Y_i)$ where $\phi_j(T \leftarrow Y_i) = \phi_j(T \leftarrow Y_i)/\text{mass of } T$, for photons used in calculating SEE were obtained principally by two methods. The primary method was by use of the Monte Carlo technique. All organ pairs for which the coefficient of variation ($cv = 100\sigma_\phi/\phi$) did not exceed 50% were accepted using this method. Detailed descriptions of the mathematical phantom and the Monte Carlo method of calculation are given in Appendices I and II of ref. 3. The secondary method makes use of the buildup factor formulation reported by Berger⁸ in MIRD Pamphlet No. 2. This method is used to compute an absorbed fraction for all organ pairs failing to meet the criterion mentioned above ($cv \leq 50\%$). The table of photon specific absorbed fractions used in the calculation of SEE values is given in Appendix III of ref. 3 for 12 monoenergetic photons ranging in energy from 0.01 to 4 McV and distributed uniformly in 22 source organs of a mathematical anthropomorphic phantom whose organs approximate those of their prototypes in size, shape, composition, and density. The quality factor Q_j is taken to be 1 for photon emissions.

Electrons and Beta Rays

For electrons, positrons, and beta rays, the absorbed fraction is generally taken equal to zero if the source and target organ are separated or one if they coincide. The exceptions to this are the walled organs, which have absorbed fractions equal to one-half the ratio of the mass of the wall to the mass of the contents times v_j , a factor representing the degree to which radiation type j penetrates the gastrointestinal mucosa. The factor v_j is 1 for beta particles. Additional exceptions are the absorbed fractions for dosimetry of radionuclides in bone. A summary of these values taken from ref. 1 is given in Table 2.2. The beta absorbed fraction for bone dosimetry is a function not only of the source and target organs in question but also the class of the radionuclide (surface or volume seeker) and, for the case of surface seekers, the value of the average energy. The factor Q_j is taken to be 1 for electrons and beta rays.

Table 2.2. Summary of Beta-Absorbed Fractions
For Bone Dosimetry

Source Organ	Target Organ	Class of Radionuclides ^a		
		β emitter uniform in volume	β emitter on bone surfaces $\bar{E}_{\beta} \geq 0.2$ MeV	β emitter on bone surfaces $\bar{E}_{\beta} < 0.2$ MeV
Trabecular Bone	Bone Surfaces	0.025	0.025	0.250
Cortical Bone	Bone Surfaces	0.015	0.015	0.250
Trabecular Bone	Red Marrow	0.350	0.500	0.500
Cortical Bone	Red Marrow	0.000	0.000	0.000

^aReport of the International Commission on Radiological Protection by Committee 2, *Limits for Intake of Radionuclides by Workers*, ICRP Publication 30, Section 7 (1979).

Alpha Particles and Recoil Nuclei

For alpha particles and recoil nuclei, the energy is assumed to be absorbed in the source tissue except for organs with walls where the energy contribution is estimated for surface dose (i.e., the absorbed fraction is generally taken equal to zero if the source and target organ are separated and to one if they coincide). Exceptions are the walled organs for which the alpha absorbed fractions are defined to be one-half the ratio of the mass of the wall to the mass of the contents times v_j , which equals 0.01 for alpha particles. The absorbed fractions for recoil nuclei are taken to be zero for the segments of the gastrointestinal (GI) tract. In addition, the absorbed fractions for dosimetry of radionuclides in bone are special cases. The ICRP has recommended alpha and alpha recoil absorbed fractions for bone, and a summary of these values taken from ref. 1 is shown in Table 2.3.

The quality factor Q_j is taken as 20 for alpha and alpha recoils.

Spontaneous Fission

The dosimetric methods for nonfissioning radionuclides have been extended by the method of Dillman and Jones⁹ to produce SEE values for spontaneously fissioning radionuclides. These methods have been used by Ford et al.¹⁰ to compute maximum permissible concentration values for several spontaneously fissioning radionuclides. SEE values for the contributions arising in spontaneous fission from fission fragments, neutrons, gammas, and betas are calculated by the SEE code.

The SEE values for fission fragments are calculated according to Eq. (2.1) where f is the spontaneous fission yield, and

$$\bar{E} = 0.139601(Z^2/A^{1/3}) - 21.975 \text{ MeV} , \quad (2.2)$$

where Z and A are the atomic and mass numbers of the nuclide. The $\phi(T \leftarrow Y_j)$ is taken to be the alpha specific absorbed fraction for a source target pair, Y_j and T . Just as for alpha emission, the quality factor Q_j for fission fragments is 20 and $v_j = 0.01$.

Table 2.3. Summary of Alpha and Alpha Recoil Absorbed Fractions for Bone Dosimetry

Source Organ	Target Organ	Class of Radionuclide ^a		
		α emitter uniform in volume	α emitter on bone surfaces	α recoil uniform in volume or on bone surfaces
Trabecular Bone	Bone Surfaces	0.025	0.25	0.0
Cortical Bone	Bone Surfaces	0.010	0.25	0.0
Trabecular Bone	Red Marrow	0.050	0.50	0.0
Cortical Bone	Red Marrow	0.000	0.00	0.0

^aReport of the International Commission on Radiological Protection by Committee 2, *Limits for Intake of Radionuclides by Workers*, ICRP Publication 30, Section 7 (1979).

For the spontaneous fission beta SEE value, Eq. (2.1) will be used where

$$f = \left(5.98 + \frac{92}{236} A - Z\right)^2 / 2 \quad (2.3)$$

and

$$\bar{E} = 0.4116f \quad (2.4)$$

The $\phi(T + Y_i)$ is taken equal to the beta specific absorbed fraction. The quality factor is equal to one for the spontaneous fission beta.

In the case of neutrons and gamma rays, the computation of SEE is modified somewhat. For neutrons, Dillman and Jones⁹ have assumed (1) that the prompt and delayed neutrons can be grouped together since their energy distributions are similar, and (2) that the neutron doses calculated for ²⁵²Cf can be scaled on the energy emitted to give a reasonable approximation to the doses for other spontaneously fissioning radionuclides. Thus, for neutrons

$$SEE_n(T + Y_i) = 3.1968 \times 10^{-5} / 51.15 \bar{E}_n f D_{n_0}(T + Y_i) Q_n / \bar{E}_{n_0} \quad (2.5)$$

where

$\bar{V}$ = the average number of neutrons per fission,

$\bar{E}_n$ = the average neutron energy defined by the formula
 $\bar{E}_n = 0.75 + 0.65 (\bar{V} + 1)^{1/2}$,

f = the spontaneous fission yield,

$\bar{E}_{n_0}$ = the average energy (= 2.164 MeV) of ²⁵²Cf, the reference nuclide.

The constant 3.1968×10^{-5} is the product of 3.7×10^4 disintegrations/second per μCi times 8.64×10^4 seconds/day times 10^{-12} rad/picorad. Values of $D_{n_0}(T + Y_i)$, the neutron dose for the reference nuclide, are given in Table 2.4 for the body organs of interest. This table is an extension of a similar table of Dillman and Jones⁹ computed by Monte

Table 2.4. Neutron Dose in Picorads per Neutron from a Californium-252
Source Uniformly Distributed in the Source Organ

Target Organ	Source Organ									
	Bladder Contents	Stomach Contents	Small Intestine	Lower Large Intestine Contents	Upper Large Intestine Contents	Kidneys	Liver	Lungs	Muscle	Ovaries
Bladder Wall	0.250E 02	0.977E-01	0.699E 00	0.181E 01	0.829E 00	0.104E 00	0.686E-01	0.104E-01	0.663E 00	0.195E 01
Stomach Wall	0.101E 00	0.186E 02	0.999E 00	0.490E 00	0.112E 01	0.947E 00	0.574E 00	0.763E 00	0.626E 00	0.241E 00
Small Intestine	0.688E 00	0.901E 00	0.979E 01	0.281E 01	0.669E 01	0.861E 00	0.530E 00	0.687E-01	0.303E 00	0.323E 01
Lower Large Intestine Wall	0.211E 01	0.350E 00	0.244E 01	0.178E 02	0.999E 00	0.225E 00	0.739E-01	0.268E-01	0.639E 00	0.506E 01
Upper Large Intestine Wall	0.578E 00	0.104E 01	0.737E 01	0.130E 01	0.100E 02	0.790E 00	0.730E 00	0.672E-01	0.400E 00	0.360E 01
Kidneys	0.102E 00	0.950E 00	0.861E 00	0.275E 00	0.646E 00	0.233E 02	0.118E 01	0.253E 00	0.408E 00	0.309E 00
Liver	0.680E-01	0.561E 00	0.530E 00	0.874E-01	0.570E 00	0.118E 01	0.904E 01	0.221E 00	0.339E 00	0.166E 00
Lungs	0.103E-01	0.679E 00	0.687E-01	0.332E-01	0.591E-01	0.253E 00	0.222E 00	0.882E 01	0.514E 00	0.246E-01
Muscle	0.663E 00	0.626E 00	0.303E 00	0.639E 00	0.400E 00	0.408E 00	0.339E 00	0.514E 00	0.459E 00	0.570E 00
Ovaries	0.189E 01	0.232E 00	0.323E 01	0.593E 01	0.185E 01	0.309E 00	0.166E 00	0.246E-01	0.570E 00	0.158E 03
Pancreas	0.648E-01	0.551E 01	0.540E 00	0.213E 00	0.485E 00	0.189E 01	0.122E 01	0.585E 00	0.588E 00	0.168E 00
Red Marrow	0.325E 00	0.272E 00	0.731E 00	0.103E 01	0.563E 00	0.243E-01	0.298E 00	0.365E 00	0.329E 00	0.918E 00
Skin	0.190E 00	0.192E 00	0.167E 00	0.173E 00	0.178E 00	0.215E 00	0.209E 00	0.212E 00	0.270E 00	0.157E 00
Spleen	0.549E-01	0.290E 01	0.428E 00	0.252E 00	0.345E 00	0.288E 01	0.292E 00	0.581E 00	0.392E 00	0.151E 00
Testes	0.169E 01	0.242E-01	0.146E 00	0.174E 01	0.607E 00	0.299E-01	0.180E-01	0.292E-02	0.595E 00	0.383E 00
Thymus	0.363E-02	0.109E 00	0.218E-01	0.243E-01	0.202E-01	0.610E-01	0.163E 00	0.105E 01	0.613E 00	0.795E-02
Thyroid	0.874E-03	0.244E-01	0.479E-02	0.193E-02	0.440E-02	0.136E-01	0.304E-01	0.264E 00	0.468E 00	0.185E-02
Uterus	0.520E 01	0.216E 00	0.266E 01	0.175E 01	0.105E 01	0.260E 00	0.148E 00	0.223E-01	0.610E 00	0.558E 01
Adrenals	0.394E-01	0.786E 00	0.298E 00	0.102E 00	0.250E 00	0.385E 01	0.151E 01	0.750E 00	0.461E 00	0.110E 00
Bone Surfaces	0.126E 00	0.123E 00	0.127E 00	0.173E 00	0.383E 00	0.375E 00	0.185E 00	0.274E 00	0.415E 00	0.123E 00

Table 2.4. (Cont'd)

Target Organ	Source Organ									
	Pancreas	Cortical Bone	Trabecular Bone	Red Marrow	Skin	Spleen	Testes	Thyroid	Total Body	Adrenals
Bladder Wall	0.656E-01	0.135E 00	0.135E 00	0.330E 00	0.190E 00	0.555E-01	0.243E-01	0.879E-03	0.522E 00	0.399E-01
Stomach Wall	0.589E 01	0.132E 00	0.132E 00	0.287E 00	0.207E 00	0.295E 01	0.252E-01	0.251E-01	0.563E 00	0.795E 00
Small Intestine	0.540E 00	0.127E 00	0.127E 00	0.731E 00	0.167E 00	0.428E 00	0.146E 00	0.479E-02	0.545E 00	0.298E 00
Lower Large Intestine Wall	0.170E 00	0.225E 00	0.225E 00	0.100E 01	0.169E 00	0.200E 00	0.253E 01	0.559E-02	0.555E 00	0.843E-01
Upper Large Intestine Wall	0.551E 00	0.104E 00	0.104E 00	0.683E 00	0.172E 00	0.379E 00	0.131E 00	0.529E-02	0.565E 00	0.298E 00
Kidneys	0.189E 01	0.375E 00	0.375E 00	0.243E-01	0.215E 00	0.288E 01	0.299E-01	0.136E-01	0.512E 00	0.385E 01
Liver	0.122E 01	0.185E 00	0.185E 00	0.298E 00	0.209E 00	0.292E 00	0.180E-01	0.304E-01	0.551E 00	0.151E 01
Lungs	0.585E 00	0.274E 00	0.274E 00	0.355E 00	0.212E 00	0.581E 00	0.292E-02	0.264E 00	0.567E 00	0.750E 00
Muscle	0.588E 00	0.415E 00	0.415E 00	0.329E 00	0.270E 00	0.392E 00	0.595E 00	0.468E 00	0.429E 00	0.461E 00
Ovaries	0.168E 00	0.123E 00	0.123E 00	0.918E 00	0.157E 00	0.151E 00	0.383E 00	0.185E-02	0.580E 00	0.110E 00
Pancreas	0.549E 02	0.204E 00	0.204E 00	0.529E 00	0.157E 00	0.631E 01	0.170E-01	0.308E-01	0.609E 00	0.260E 01
Red Marrow	0.529E 00	0.609E 00	0.609E 00	0.234E 01	0.276E 00	0.322E 00	0.214E 00	0.252E 00	0.431E 00	0.816E 00
Skin	0.157E 00	0.286E 00	0.286E 00	0.276E 00	0.555E 00	0.205E 00	0.219E 00	0.256E 00	0.277E 00	0.224E 00
Spleen	0.631E 01	0.192E 00	0.192E 00	0.322E 00	0.205E 00	0.413E 02	0.159E-01	0.232E-01	0.479E 00	0.201E 01
Testes	0.170E-01	0.372E 00	0.372E 00	0.214E 00	0.219E 00	0.159E-01	0.992E 02	0.254E-03	0.537E 00	0.116E-01
Thymus	0.147E 00	0.207E 00	0.207E 00	0.279E 00	0.222E 00	0.912E-01	0.103E-02	0.133E 01	0.549E 00	0.150E 00
Thyroid	0.308E-01	0.257E 00	0.257E 00	0.252E 00	0.266E 00	0.232E-01	0.264E-03	0.122E 03	0.430E 00	0.327E-01
Uterus	0.154E 00	0.100E 00	0.100E 00	0.519E 00	0.163E 00	0.125E 00	0.527E 00	0.173E-02	0.606E 00	0.952E-01
Adrenals	0.260E 01	0.392E 00	0.392E 00	0.316E 00	0.224E 00	0.201E 01	0.116E-01	0.327E-01	0.514E 00	0.103E 03
Bone Surfaces	0.204E 00	0.146E 01	0.146E 01	0.539E 00	0.286E 00	0.192E 00	0.372E 00	0.257E 00	0.513E 00	0.392E 00

Carlo techniques in a reference man phantom. The entries in the table are the sum of the doses contributed by the recoil ions and neutron-produced gamma rays. For neutrons, Q_n is taken as 10.

In like manner for the prompt and delayed gamma rays emitted in spontaneous fission, Dillman and Jones have used ^{236}U as a prototype for all spontaneously fissioning nuclides and have given in their paper a list of prompt and delayed gamma rays emitted in the fission of ^{236}U . This list of 42 prompt gamma rays and 28 delayed gamma rays is used to simulate the essentially continuous spectra. In the case of prompt gamma rays, both the total energy released per decay and the spectral shapes are considered to be the same for all spontaneously fissioning nuclides, but for the delayed gamma rays the total energy released per decay varies from one nuclide to another. Thus

$$\begin{aligned} \text{SEE}_Y(T \leftarrow Y_i) = & \left[\sum_{i=1}^{42} E_{ip} f_{ip} \phi_{ip}(T \leftarrow Y_i) \right. \\ & \left. + R \sum_{i=1}^{28} E_{id} f_{id} \phi_{id}(T \leftarrow Y_i) \right] Q_Y, \end{aligned} \quad (2.6)$$

where p and d refer to prompt and delayed gamma rays, respectively, and R is the ratio of the total energy released by the delayed gamma rays for the fissioning nuclide of interest to the corresponding energy released for ^{236}U . R is given by

$$R = 0.02796 \left[5.98 + \frac{92}{236} A - Z \right]^2, \quad (2.7)$$

where A and Z are the mass and atomic numbers of the fissioning nuclide. For prompt and delayed gammas Q_Y is set to 1. A complete list of qualifying factors for all types of radiation is given in Table 2.5.

Table 2.5. Quality Factors for Various Radiations

Type of Radiation	Q
α	20
α -recoil	20
β^- or electron	1
γ	1
Fission Fragment	20
Neutron	10

Program Description

The SEE computer program consists of 13 routines that are programmed in a well-structured manner and are heavily augmented with program comment cards. The SEE program implements the methodology described in refs. 3 and 9; hence to anyone familiar with these methods, the details of the computer code are self-explanatory. However, to supplement this material, the diagram of program structure and a description of each routine is included.

Figure 2.1 shows the overall structure of the SEE program. Arrows indicate the calling sequence of routines. A listing of the SEE routines is given in Appendix A.

The MAIN routine performs the following functions:

1. calls the routines (INGAFR, INBEFR, INALFR, and INCFAD) that read the tables of specific absorbed fractions (SAF) for photons, betas, alphas, and the neutron doses for ^{252}Cf , respectively;
2. reads the list of source and target organs for which SEE values will be calculated;
3. reads the decay data;
4. calls the routines (GAMLIN, BETFRA, ALPFRA, and RECØIL) that determine the photon, beta, or alpha SAF for a particular source-target pair, then tabulates photon, beta, alpha, and recoil SEE values, respectively;
5. calls SPNFNS which tabulates the spontaneous fission SEE values; and
6. calls the routine to output the data.

The subroutines may be broken down into three categories: (1) those which read data, (2) those which calculate SAF or SEE, and (3) those which are used to produce output. The routines that read data are described as follows: INGAFR reads the SAF data set for photon energies for 12 monoenergetic photons ranging in energy from 0.01 to 4.0 MeV. These are defined for each possible source-target pair in Table 2.1. INGAFR also prints the SAF at the 0.01 MeV level for each source-target pair so that the user can verify the data. INBEFR reads the beta SAF

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Fig. 2.1. Program Structure of SEE.

data. The routine INALFR reads the alpha SAF data. INCFAD reads the table of neutron doses calculated for ^{252}Cf for each source-target pair.

The routines in category 2 are the following: GAMLIN performs a linear interpolation on the range of SAF's for a given source-target pair to determine the SAF corresponding to a certain energy for a photon radiation. BETFRA determines the beta SAF for a source-target pair. The routine ALPFRA determines the alpha SAF for a given source and target pair. RECOIL calculates the recoil energy used in tabulating SEE for alpha recoils. SPNFIS tabulates the spontaneous fission SEE values.

The routines in category 3 are: OUTPUT, which prints the SEE values for the source-target pairs requested by the user; TITLE, which is called by OUTPUT to compose and center the titles for the tables; and PRDPKT, which writes the SEE values to disk and/or tape.

User Information

The SEE program is written in the IBM System/360 and System/370 FORTRAN IV language. The routines have been compiled using the FORTRAN H-level compiler. The SEE program has been executed on both the IBM 360/91 and 360/75 at ORNL and requires about 200K (1K = 1024 bytes; 1 byte = 8 bits) of core storage for execution. The program requires about 16 seconds to compile on the IBM 360/91. Execution time depends upon the number of radionuclides for which SEE values must be calculated and the number of radiations per radionuclide. For example, the radionuclide ^{131m}Te , which decays by isomeric transition and beta minus and has 1450 radiations, requires approximately 29 seconds; ^{234}Pu decays by alpha emission, has 1111 radiations, and requires approximately 24 seconds; ^{238}Pu decays by spontaneous fission and alpha emission, has 282 radiations, and requires approximately 10 seconds execution time. The execution time for ^{54}Mn , the example in Appendix B, is approximately 3 seconds. Manganese-54 has 34 radiations and decays by electron capture.

The remainder of this section describes the content of the input which must be prepared in order to execute the program and the output produced by the program. Sample input and the corresponding output are presented in Appendix B.

The card input data are to be prepared in the order shown in Table 2.6. In Table 2.6, the heading "Subroutine" indicates the subroutine in which the card is read. "Card number" denotes the quantity of cards for each group to be input and the order within the group. "Columns" refers to the actual columns on the cards in which the data must be punched. "Remarks, Variables, Etc." gives an explanation as to the variable name, definition, and the form of the data to be punched on the cards. The FORMAT description indicates the content and length of the fields on the cards. In the FORMAT descriptor, the letter "A" denotes alphabetic data; "I" refers to integer data (no decimal point), which must always be right-justified in the field, "F" or "E" indicates a real number with or without a signed exponent (decimal point should be punched). The variable names are those used in the FORTRAN program.

The output produced by the program may be grouped into three categories: (1) line printer output on unit 6, (2) output to disk on unit 14, and (3) output to tape on unit 15. An explanation of each is given below.

Printout to unit 6 is produced in subroutine OUTPUT and consists of the specific effective energies corresponding to the source and target pairs requested by the user for each radiation type. The specific effective energies are printed for each radionuclide for which there are decay data in the input (see Decay Data in Table 2.6).

The output to disk (unit 14) is produced in subroutine PRDKTP for possible use in a following job step such as calculating dose as in Eq. (1.1). The data set is written unformatted on a disk pack (2314 or 3330) with a record format of variable blocked spanned, a logical record length of 164, and a blocksize of 1644. The temporary data set is given the name &&SEE and is created with the disposition of (NEW,PASS). See Appendix C for the summary of Job Control Language (JCL) needed to execute the code. Output to disk is explained in Table 2.7. In Table 2.7, "Subroutine" refers to the subroutine in which the record is produced. "Record Number" denotes the order in which the records are created. "Remarks, Variables, etc." gives an explanation of the variable name. "Internal Form of Data" gives the form of the internal data

Table 2.6. Input to the SEE Program

Subroutine	Card Number	Columns	Remarks, Variables, etc.
<u>Organ in the Mathematical Phantom</u>			
MAIN	1		FØRMAT(214)
		1-4	NSØRS - number of source organs in the phantom (NSØRS ≤ 30).
		5-8	NTARG - number of target organs in the phantom (NTARG ≤ 40).
	2 to NSØRS+1 (one for each source organ)		FØRMAT(8A2)
			SØRG(I,J) - name of source organ I. Since the source organ title will be printed on two lines, the first 8 characters (J = 1,...,4) should be the first line of the name and the next 8 (J = 5,...,8) should be the second line of the name.
	NSØRS+2 to NSØRS+NTARG+1 (one for each target organ)		FØRMAT(10A2)
			TØRG(I,J) - name of target organ I. Since the target organ title will be printed on two lines, the first 10 characters (J = 1,...,5) should be the first line of the name and the next 10 (J = 6,...,10) should be the second line of the name.
<p>The setting of SØRG(I,J) and TØRG(I,J) implicitly defines the index I associated with a given source or target organ. The source and target organs in the mathematical phantom are given below with their associated source or target index. This ordering is fixed by the SEE input and is used throughout many computer codes which have been written by the authors. The SEE, ICRP-TIMED and DOSE programs rely heavily on this assignment of organ indices even though many source-target pairs are not of interest to ICRP. (see Table 2.1).</p>			
<u>Source Organs</u>		<u>Target Organs</u>	
1. Bladder Content		1. Bladder Wall	26. Spleen
2. ST Content		2. ST Wall	27. Testes
3. SI Content		3. SI Wall	28. Thymus
4. ULI Content		4. ULI Wall	29. Thyroid
5. LLI Content		5. LLI Wall	30. Uterus
6. Kidneys		6. Kidneys	31. Total Body
7. Liver		7. Liver	32. Adrenals
8. Salivary Gland		8. Lungs	33. Bone Surfaces
9. TB Region		9. Salivary Gland	
10. P Region (Lungs)		10. TB Region	
11. Lymph		11. P Region	
12. Muscle (Breast)		12. Lymph	
13. Ovaries		13. Muscle (Breast)	
14. Pancreas		14. Ovaries	
15. Cortical Bone		15. Pancreas	
16. Trabecular Bone		16. Bone	
17. Red Marrow		17. Cortical Bone	
18. Yellow Marrow		18. Trabecular Bone	
19. Skin		19. Red Marrow	
20. Spleen		20. Yellow Marrow	
21. Testes		21. Total Marrow	
22. Thyroid		22. Cortical Endosteal Cells	
23. Total Body		23. Trabecular Endosteal Cells	
24. Cloud		24. Total Endosteal Cells	
25. Adrenals		25. Skin	

Table 2.6. (Cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
<u>Gamma Specific Absorbed Fractions</u>			
The two cards described below must be included for each source-target pair in the model (i.e., there must be NSORS*NTARG*2 cards describing the gamma specific absorbed fractions)..			
INGAFR	1		F0RMAT(7E10.0)
		1-10	G(1) - gamma specific absorbed fraction (SAF) associated with the monenergetic photon 0.01 for a given source-target pair.
		11-20	G(2) - gamma SAF for 0.015 energy.
		21-30	G(3) - gamma SAF for 0.02 energy.
		31-40	G(4) - gamma SAF for 0.03 energy.
		41-50	G(5) - gamma SAF for 0.05 energy.
		51-60	G(6) - gamma SAF for 0.1 energy.
		61-70	G(7) - gamma SAF for 0.2 energy.
	72-30	Descriptive tag to indicate source organ and target organ not read by program.	
	2		F0RMAT(5E10.0)
		1-10	G(8) - gamma SAF for 0.5 energy.
		11-20	G(9) - gamma SAF for 1.0 energy.
		21-30	G(10) - gamma SAF for 1.5 energy.
		31-40	G(11) - gamma SAF for 2.0 energy.
		41-50	G(12) - gamma SAF for 4.0 energy.
		72-80	Descriptive tag to indicate source and target organ - not read by program.
<u>Target Organ Masses</u>			
MAIN	1		F0RMAT(8E10.0)
		1-10	TMASS(1) - mass(g) of first target organ used in extrapolation of gamma SAF's.
		11-20	TMASS(2) - mass(g) of second target organ.
		:	:
		71-80	TMASS(8) - mass(g) of eighth target organ.
Continuc on additional cards until the NTARG masses are listed.			

Table 2.6. (Cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc..
<u>Beta Specific Absorbed Fractions</u>			
A card is present for each beta specific absorbed fraction that is non-zero. (See the section "Electrons and Beta Rays"). For purposes of this data set, the fraction on the cards will contain the quality factor and modifying factor for beta radiations.			
INBEFR			FØRMAT(2I5,3E10.0)
		1-5	I - source organ index.
		6-10	K - target organ index.
		11-20	BETFR(I,K,1) - beta specific absorbed fraction for source organ I, target organ K. If I and K are a source-target pair given in Table 2.2, BETFR(I,K,1) is the SAF for a beta emitter uniform in volume.
		21-30	BETFR(I,K,2) - beta SAF for source-target pairs in Table 2.2 for beta emitter on bone surfaces and $\bar{E}_\beta > 0.2$ MeV.
		31-40	BETFR(I,K,3) - beta SAF for source-target pairs in Table 2.2 for beta emitters on bone surfaces with $\bar{E}_\beta \leq 0.2$ MeV.
End of beta SAF data is indicated by a card where I = 30 and K = 40.			
<u>Alpha Specific Absorbed Fractions</u>			
A card is present for each alpha specific absorbed fraction that is non-zero. (See the section "Alpha Particles and Recoil Nuclei"). For purposes of this data set, the fraction on the cards should contain the quality factor and modifying factors for alpha radiations.			
INALFR			FØRMAT(2I5,2E10.0)
		1-5	I - source organ index.
		6-10	K - target organ index.
		11-20	ALPFR(I,K,1) - alpha specific absorbed fraction for source organ I, target organ K. If I and K are a source-target pair given in Table 2.3, ALPFR(I,K,1) is the SAF for an alpha emitter uniform in volume.
		21-30	ALPFR(I,K,2) - alpha SAF for source-target pairs in Table 2.3 for alpha emitters on bone surfaces.
End of alpha SAF data is indicated by a card with I = 30 and K = 40.			
<u>Neutron Dose for a ^{252}Cf Source</u>			
INDFAD	1		FØRMAT(I2,8X,7F10.0/(10X,710.0))
		1-2	K - target organ index.
		11-20	CFAD(1,K) $\bar{E}_n$ neutron dose for the first source organ, K $\bar{E}_n$ target organ.

Table 2.6. (Cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
		21-30	CFAD(2,K) $\bar{\epsilon}_h$ neutron dose for the second source organ, K^{th} target organ.
		⋮	⋮
		71-80	CFAD(7,K) $\bar{\epsilon}_h$ neutron dose for the seventh source organ, K^{th} target organ.
Continue on additional cards until the neutron doses for the NSORS source organs are listed for target organ K.			
A group of the previous description is present for each of the NTARG target organs in the model. End of neutron data is indicated by a group of cards with K = 40.			
<u>Output Information</u>			
MAIN	1		FØRMAT(I4)
		1-4	IPØ = 1 write SEE values to disk data set; ≠ 1 write SEE values to both disk and tape.
	2		FØRMAT(2I2)
		1-2	NPRS — the number of source organs for which SEE values will be printed.
	3	3-4	NPRT — the number of target organs for which SEE values will be printed.
			FØRMAT(40I2)
		1-2	IPRS(1) — the index of the first source organ to be printed.
		3-4	IPRS(2) — the index of the second source organ to be printed.
		⋮	⋮
		(2*NPRS - 1) - (2*NPRS)	IPRS(NPRS) — the index of the NPRS source organ to be printed.
Continuing on the same card			
	(2*NPRS + 1) - (2*NPRS + 2)	IPRT(1) — the index of the first target organ to be printed.	
		⋮	
		IPRT(NPRT) — the index of the NPRT target organ to be printed.	
Indices may require more than one card.			

Table 2.6. (Cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
<u>Decay Data</u>			
MAIN	1		FØRMAT(214)
		1-4	IVØL = 1 radionuclide is a volume seeker.
	2	5-8	ISURF = 1 radionuclide is a surface seeker.
			FØRMAT(F4.0,A1,1X,3A4,F4.0,E11.0,1X,2A4,I4, 3(1X,A3),14X,A2)
		1-4	AHØ — mass number of the radionuclide.
		5	EXCH — M indicated metastable state of the radio- nuclide; otherwise EXCH is blank.
		7-18	LEME — name of the element.
		19-22	ZHØ — atomic number of the radionuclide.
		23-33	HLIFE — half-life of the radionuclide.
		35-42	UNITS — units in which the half-life is given.
		43-46	NRAD — the number of radiations associated with the radionuclide.
		48-50	TY(1) — first type of decay.
		52-54	TY(2) — second type of decay.
		56-58	TY(3) — third type of decay.
		72-74	CHEMH — chemical symbol of element.
There should be NRAD cards of the following form to describe the radiations of the radionuclide.			
			FØRMAT(2I2,4E13.0)
		1-2	ICØDE — stores the code number for the type of radiation. 1 — gamma rays 2 — x-rays 3 — annihilation quanta 4 — beta plus 5 — beta minus 6 — internal conversion electrons 7 — auger electrons 8 — alpha particles 9 — spontaneous fission radiations
		3-4	INDEX — stores various indexing information depending on the value of ICØDE — not used.
		5-17	P — percent per decay intensity value for the radiation.
		18-30	E — energy in MeV (average energy for beta plus or beta minus) except for spontaneous fission (ICØDE = 9) in which case the average number of neutrons per spontaneous fission is stored.
		31-43	EM — is only used when ICØDE = 4 or 5, in which case it is the value of the beta endpoint energy in MeV, or when ICØDE = 8, in which case it is the value of the recoil nucleus energy in MeV.
If SEE values are to be calculated for more than one radionuclide, a group of "Decay Data" cards is included for each radionuclide, and these cards follow any other "Decay Data."			
Data in the form described in the "Decay Data" grouping is produced by the computer code described refs. 6 and 7.			

Table 2.7. Form of Data Set on Unit 14

Subroutine	Record Number	Remarks, Variables, etc.	Internal Form of Data
PRKDPT	1	AH0 — mass number of the radio-nuclide.	real (4)
		EXCH — indication of metastable state.	alphameric(4)
		LEME(I), I=1,3 — name of the element.	real (4)
		ZH0 — atomic number of the radionuclides.	real (4)
		NS0RS — number of source organs in phantom.	integer (4)
		NTARG — number of target organs in phantom.	integer (4)
		T0DAY — date of run.	alphameric (8)
	NTARG records	GEFE(I,K), I = 1, NS0RS — gamma SEE value from each source organ I to a target organ K.	real (4)
	NTARG records	BEFE(I,K), I = 1, NS0RS — beta SEE values for each source organ I to a target organ K.	real (4)
	NTARG records	AEFE(I,K), I = 1, NS0RS — alpha SEE values for each source organ I to a target organ K.	real (4)
	NTARG records	REFE(I,K), I = 1, NS0RS — alpha recoil SEE values for each source organ I to a target organ K.	real (4)
	5*NTARG records	(SPEFE(J,I,K), I = 1, NS0RS), J = 1,5 spontaneous fission SEE values for each source organ I to a target organ K for the 5 types of spontaneous fission.	real (4)
	NTARG records	TEFE(I,K), I = 1, NS0RS — total SEE values for each source organ I to a target organ K.	real (4)

storage. "Alphanumeric," "integer," and "real" refer to internal computer representation of data. The number in parenthesis gives the declared length in bytes of the variable.

The SEE values may also be written to tape. The values output to tape will be the same values requested by the user to be printed. A description of the tape output is given in Table 2.8. The tape data set is written formatted with a record format of variable blocked, a logical record length of 140, and a blocksize of 1404. The tape should be 9-track, 800 bpi. See Appendix C for corresponding JCL.

III. THE ICRP TIMED PROGRAM

This second module of the ICRP code, the ICRP TIMED program, computes the cumulated activity $U_{Y_i}(t)$ at some time t after intake. This module is a revision of the TIMED code,¹¹ which has been used to calculate the cumulated activities used in Appendix VI of the report WASH-1400.¹² The original TIMED code has been modified to fulfill the recommendations of ICRP Committee 2. This section discusses the model of activity transfer (which is similar to the presentation in ref. 13), a description of the program, and detailed user information. Also, a comparison between the original and ICRP version of TIMED is presented. For continuity, the entire section is presented in the international system of units; however, the actual computer code assumes 1 μCi intake, but the conversion is a constant factor —

$$\frac{3600 \times 24 \times 3.7 \times 10^4}{3.7 \times 10^4} \mu\text{Ci-days}/\mu\text{Ci} = .1 \text{ Bq-s/Bq}, 1 \mu\text{Ci} = 3.7 \times 10^4 \text{ Bq} .$$

Description of the Model

The model of activity transfer in the body is based on the concept of a system of compartments with constant rates of transfer to other compartments or out of the body. These compartments may be an organ or some subsystem of the body (lungs, gastrointestinal tract, etc.). The system must be general enough to allow for delay of transfer of some of the activity and must also account for radioactive daughters.

Table 2.8. Description of Output to Tape

Subroutine	Record Number	Columns	Remarks, Variables, etc.
PRKDPT	1		FORMAT(F5.0,A1,1X,3A4,F5.0,1PE11.4,1X,2A4,3I3,A8)
		1-5	AH0 - mass number of the radionuclide.
		6	EXCH - indication of metastable state.
		8-19	LEME - name of the element.
		20-24	ZH0 - atomic number of the radionuclide.
		25-35	HLIFE - half-life of the radionuclide.
	2	37-44	UNITS - units in which the half-life is given.
		45-47	NPRS - the number of source organs for which SEE values will be printed.
		48-50	NPRT - the number of target organs for which SEE values will be printed.
		51-63	IC - the number of modes of decay of the radionuclide.
		54-61	TODAY - date program is run.
			FORMAT(65I2)
		1-2	IPRS(1) - index of the first source organ printed.
		3-4	IPRS(2) - index of the second source organ printed.
		⋮	⋮
		(2*NPRS - 1) - (2*NPRS)	IPRS(NPRS) - the index of the NPRS source organ to be printed.

Table 2.8. (Cont'd)

Subroutine	Record Number	Columns	Remarks, Variables, etc.
Continuing on the same record			
			IPRT(1) — the index of the first target organ to be printed. :
			IPRT(NPRT) — index of the NPRT target organ to be printed.
	NPRT Records		FØRMAT(1P12E11.3) GEFE(IPRS(I),IPRT(K)), I=1,NPRS — gamma SEE values.
	NPRT Records		FØRMAT(1PE11.3) BEFE(IPRS(I),IPRT(K)), I = 1,NPRS — beta SEE values.
	NPRT Records		FØRMAT(1PE11.3) AEFE(IPRS(I),IPRT(K)), I = 1,NPRS — alpha SEE values.
	NPRT Records		FØRMAT(1PE11.3) REFE(IPRS(I),IPRT(K)), I = 1,NPRS — alpha recoil SEE values.
	5*NPRT Records		FØRMAT(1PE11.3) (SPEFE(J,IPRS(I),IPRT(K)), I = 1,NRPS), J = 1,5 — spontaneous fission SEE values for the 5 types of spontaneous fission.
	NPRT Records		TEFE(IPRS(I),IPRT(K)), I = 1,NPRS — total SEE values.

The lung model, as described in the report of the ICRP Task Group on Lung Dynamics¹⁴ and as revised in ICRP Publication¹⁹ (ref. 15) consists of a nasal-pharyngeal region (N-P), a tracheo-bronchial region (T-B), a pulmonary region (P), and the lymph nodes (L). Deposition is governed by the activity median aerodynamic diameter (AMAD) of the aerosol (see ref. 14). The pathways of transfer and the deposition and transfer constants are shown in Fig. 3.1.

The differential equations appropriate for this model are given below. Taking X_{ξ}^n as the activity of the n^{th} member of the chain (i.e., $n = 1$ for parent, $n = 2$ for first daughter, etc.) in a compartment cleared by the pathway ξ , and using $\dot{X}$ to represent the derivative with respect to time [$X \equiv X(t)$ and $\dot{X} = \dot{X}(t) = \frac{dX(t)}{dt}$], the equation for the lungs are the following:

$$\begin{aligned}
 \dot{X}_{\xi}^n &= -X_{\xi}^n(\lambda_{\xi} + \lambda_r^n) + X_{\xi}^{n-1}\lambda_r^n[1 - \delta(n-1)] , \\
 \dot{X}_d^n &= -X_d^n(\lambda_d + \lambda_r^n) + X_d^{n-1}\lambda_r^n[1 - \delta(n-1)] + X_f^n\lambda_f + X_g^n\lambda_g , \\
 \dot{X}_i^n &= -X_i^n(\lambda_i + \lambda_r^n) + X_h^n\lambda_h F_i + X_i^{n-1}\lambda_r^n[1 - \delta(n-1)] , \\
 \dot{X}_j^n &= X_j^n\lambda_r^n + X_h^n\lambda_h(1 - F_i) + X_j^{n-1}\lambda_r^n[1 - \delta(n-1)] .
 \end{aligned} \tag{3.1}$$

In these equations, ξ may be any one of the pathways a, b, c, e, f, g, or h. The equations for the d, i, and j pathways differ from those of the other pathways and are shown explicitly. Also, in these equations $\delta(n-1)$ is the Kronecker delta of argument $n-1$ [i.e., $\delta(n-1) = 1$ for $n = 1$ and $\delta(n-1) = 0$ for $n \neq 1$]. The Kronecker delta is needed since for the first member of the chain (the parent), there is no feeding of activity from a prior member. The λ_{ξ} is $(\ln 2)/T_{\xi}$ where T_{ξ} is the removal half-time in days taken from Fig. 3.1 for the parent radionuclide of the chain for pathway ξ . Note that λ_{ξ} for a given ξ is the same for all radionuclides in the chain and depends only on the clearance due to the parent. Similarly, λ_r^n is $(\ln 2)/T_r^n$ where T_r^n is the radioactive half-life of the n^{th} member of the chain.

CLEARANCE MODEL

REGION	COMPARTMENT	CLASS					
		D		W		Y	
		T	F	T	F	T	F
N-P ($D_{N-P}=0.30$)	a	C.01	0.5	0.01	0.1	0.01	0.01
	b	C.01	0.5	0.40	0.9	0.40	0.99
T-B ($D_{T-B}=0.08$)	c	0.01	0.95	0.01	0.5	0.01	0.01
	d	0.2	0.05	0.2	0.5	0.2	0.99
P ($D_P=0.25$)	e	0.5	0.8	50	0.15	500	0.05
	f	n.a.	n.a.	1.0	0.4	1.0	0.4
	g	n.a.	n.a.	50	0.4	500	0.4
	h	0.5	0.2	50	0.05	500	0.15
L	i	0.5	1.0	50	1.0	1000	0.9
	j	n.a.	n.a.	n.a.	n.a.	∞	0.1

The values for the removal half times, T_{a-j} , and compartmental fractions, F_{a-j} , are given in the tabular portion of the figure for each of the three classes of retained materials. The values given for D_{N-P} , D_{T-B} , and D_P (left column) are the regional depositions based on an aerosol with and AMAD of $1\mu m$. The schematic drawing identifies the various clearance pathways in the model, a - j, in relation to the depositions D_{N-P} , D_{T-B} , D_P and the three respiratory regions, N-P, T-B, and P. The entry n.a. indicates not applicable.

Fig. 3.1. Lung Clearance Model.

The terms with negative signs correspond to elimination by biological transfer or by radioactive decay. The terms involving a superscript $n - 1$ refer to activity in becquerels of the preceding radionuclide of the chain which produces $X^{n-1}_{\lambda_r^n}$ Bq of the following radionuclide per unit time.

The initial conditions for the differential equations are based on the assumption that 1 Bq of an aerosol of AMAD = 1 has been inhaled, although other starting values of $D_3 \equiv D_{N-P}$, $D_4 \equiv D_{T-B}$, and $D_5 \equiv D_P$ may be used. Therefore the initial conditions of the differential equation are:

$$\begin{aligned} X_{\xi}^1(0) &= D_3 F_{\xi}, & \xi &= a, b; \\ X_{\xi}^1(0) &= D_4 F_{\xi}, & \xi &= c, d; \\ X_{\xi}^1(0) &= D_5 F_{\xi}, & \xi &= e, f, g, h; \\ X_{\xi}^1(0) &= 0, & \xi &= i, j; \\ X_{\xi}^m(0) &= 0, & m &> 1, \text{ all } \xi; \end{aligned} \tag{3.2}$$

where F_{ξ} is the fraction of the deposition clearing by pathway ξ as given in Fig. 3.1. Upon solution of the differential equations for the X 's, which are given as activity in becquerels, one calculates the cumulated activity (Bq-s) in each lung compartment during the time interval 0 to t_1 by

$$Y_{\xi}^n = \int_0^{t_1} X_{\xi}^n dt, \tag{3.3}$$

where Y_{ξ}^n represents $Y_{\xi}^n(t_1)$, $t_1 = 50$ years = 18,250 days for the Committee 2 report.

The cumulated activity for each region of the respiratory system is given by

$$\begin{aligned}
U_{NP}^n &= Y_a^n + Y_b^n , \\
U_{TB}^n &= Y_c^n + Y_d^n , \\
U_P^n &= Y_e^n + Y_f^n + Y_g^n + Y_h^n , \\
U_L^n &= Y_i^n + Y_j^n .
\end{aligned}
\tag{3.4}$$

Here the U_ξ^n are the cumulated activity (Bq-s) in the region ξ of the respiratory system. The total activity (Bq) to body fluids, B_{Lung}^n , and to the gastrointestinal tract, G_{Lung}^n , are given by

$$\begin{aligned}
B_{Lung}^n &= Y_a^n \lambda_a + Y_c^n \lambda_c + Y_e^n \lambda_e + Y_i^n \lambda_i , \\
G_{Lung}^n &= Y_b^n \lambda_b + Y_d^n \lambda_d .
\end{aligned}
\tag{3.5}$$

Any exposure by inhalation also leads to some activity entering the GI tract. The dosimetric model for the GI tract is essentially due to Eve¹⁶ as far the subdivisions of the tract and the transit times through the sections are concerned. Four subdivisions of the tract are defined: the stomach (S), the small intestine (SI), the upper large intestine (UL), and the lower large intestine (LL). The estimates of dose are considered to be averaged over these sections. Table 3.1 provides data on average masses and the amount of time that food remains in each of these sections. Table 3.1 is quoted from ICRP Publication 23 (ref. 17).

Let x_S^n , x_{SI}^n , x_{UL}^n , and x_{LL}^n be the activities present at time t in the four GI tract sections, then

$$\begin{aligned}
\dot{x}_S^n &= -x_S^n(\lambda_S + \lambda_r^n) + x_b^n \lambda_b^n + x_d^n \lambda_d^n + x_S^{n-1} \lambda_r^n [1 - \delta(n-1)] , \\
\dot{x}_{SI}^n &= -x_{SI}^n(\lambda_{SI} + \lambda_r^n + \lambda_{ab}^n) + x_S^n \lambda_S + x_{SI}^{n-1} \lambda_r^n [1 - \delta(n-1)] ,
\end{aligned}
\tag{3.6}$$

Table 3.1. Gastrointestinal Tract Model of Reference Man^a

Portion of GI Tract	Mass of Wall (g)	Mass of Contents (g)	Average Time Food Remains (days)
Stomach	150	250	1/24
Small Intestine	640	400	4/24
Upper Large Intestine	210	220	13/24
Lower Large Intestine	160	135	24/24

^aInternational Commission on Radiological Protection, *Report of the Task Group on Reference Man*, ICRP Publication 23 (1975).

$$\dot{X}_{UL}^n = -X_{UL}^n (\lambda_{UL} + \lambda_r^n) + X_{SI}^n \lambda_{SI} + X_{UL}^{n-1} \lambda_r^n [1 - \delta(n-1)] , \quad (3.6)$$

$$\dot{X}_{LL}^n = -X_{LL}^n (\lambda_{LL} + \lambda_r^n) + X_{UL}^n \lambda_{UL} + X_{LL}^{n-1} \lambda_r^n [1 - \delta(n-1)] .$$

From Table 3.1, $\lambda_S = 24 \cdot \text{days}^{-1}$, $\lambda_{SI} = 6 \text{ days}^{-1}$, $\lambda_{UL} = 24/13 \text{ days}^{-1}$, and $\lambda_{LL} = 1 \text{ day}^{-1}$. The $\lambda_{ab} = [(\lambda_{SI} \cdot f_1)/(1 - f_1)] \text{ days}^{-1}$ is the fraction of activity present in the SI that is absorbed to blood per unit time, and f_1 is the fraction of material ingested which is absorbed to blood.

Initial conditions for the GI tract following intake by inhalation are $X_{\xi}^n(0) = 0$ for all n and all subscripts ξ . This is easily adapted for oral intake.

The cumulated activity (Bq-s) from time 0 to time t_1 for each section of the GI tract is computed by

$$U_{\xi}^n = Y_{\xi}^n = \int_0^{t_1} X_{\xi}^n dt , \quad \text{for the ICRP } t_1 = 18,250 \text{ days} . \quad (3.7)$$

The activity (Bq) transferred to body fluids is

$$B_{GI}^n = Y_{SI}^n \lambda_{ab}^n . \quad (3.8)$$

In the report of Committee 2, a transfer compartment is defined representing body fluids. This transfer compartment, p , receives material from inhalation or ingestion at a rate determined by the rate constants for the different compartments in the respiratory and gastrointestinal tracts. Removal from the transfer compartment is assumed to be exponential in character with a biological half-time of 0.25 day unless otherwise stated in the metabolic model for the particular element. Thereafter, the radionuclide is translocated to various organs and tissues of the body, which are assumed to consist of one or more compartments and to be cleared in exponential fashion according to the metabolic model of the element.

From the above model, the transfer of activity, $X_p(\text{Bq})$, in the transfer compartment can be represented by the following differential equation

$$\begin{aligned} \dot{X}_p^n = & -X_p^n(\lambda_p + \lambda_r^n) + X_p^{n-1}\lambda_r^n[1 - \delta(n-1)] + X_a^n\lambda_a \\ & + X_c^n\lambda_c + X_e^n\lambda_e + X_i^n\lambda_i + X_{SI}^n\lambda_{ab}, \end{aligned} \quad (3.9)$$

where λ_p is the biological rate of clearance of the parent radionuclide in the transfer compartment. Initial conditions for the transfer compartment following intake by inhalation or ingestion are $X_p^n(0) = 0$ for all n . This is easily adapted for injection studies. The cumulated activity (Bq-s) from time 0 to time t_1 for the transfer compartment is

$$U_p^n = Y_p^n = \int_0^{t_1} X_p^n dt. \quad (3.10)$$

In addition, the transfer of activity, $X_q(\text{Bq})$, in tissue compartment q of systemic organs can be expressed as follows

$$\dot{X}_q^n = -X_q^n(\lambda_q + \lambda_r^n) + X_q^{n-1}\lambda_r^n[1 - \delta(n-1)] + \alpha_q\lambda_p X_p^n, \quad (3.11)$$

where α_q is the fraction of the radionuclide residing in compartment q , and λ_q is the clearance rate of the radionuclide from compartment q . These quantities are defined in retention functions of the form

$$R(t) = \sum_{q=1}^m \alpha_q e^{-\lambda_q t}, \quad (3.12)$$

where m is the total number of exponentials (compartments) for a given organ.

Initial conditions for the body organs following intake by inhalation, ingestion, or injection are $X_q^n(0) = 0$ for all n and subscripts q .

The cumulated activity from time 0 to time t_1 for some compartment q of the body organs is given by

$$Y_q^n = \int_0^{t_1} X_q^n dt . \quad (3.13)$$

The cumulated activity for a given organ described by Eq. (3.12) is obtained by summing the cumulated activity for the compartments associated with the organ as follows:

$$U^n = \sum_{q=1}^m Y_q^n , \quad (3.14)$$

where m is the number of compartments associated with the organ.

Many chains of radionuclides involve branching. To account for this, the differential Eqs. (3.1), (3.6), (3.9), and (3.11) are modified as follows: change the term involving X^{n-1} to be $\sum_{\ell=1}^{n-1} \beta_{\ell} X_{\xi}^{\ell} \lambda_r^n [1 - \delta(\ell)]$ for any compartment ξ where β_{ℓ} is the branching ratio for the ℓ^{th} member of the chain relative to member n .

The ordinary differential equations (ODE) previously described may be expressed in the form

$$\dot{X} = AX \quad (3.15)$$

given the initial conditions $X(t_0) = X(0)$ where $\dot{X}$ and X are vectors containing the derivative of activity and the activity at time t , respectively. The matrix A contains the coefficients of the components of X in the differential equations. A is lower triangular and very sparse. The solution to Eq. (3.15) gives the activity (Bq) for each compartment of the

body. However, it is the cumulated activity which is of interest; therefore, Eq. (3.15) may be reformulated as shown in ref. 11 to be

$$\dot{Y} = AY + X(0) , \quad (3.16)$$

where $Y(0) = 0$ and the components of Y are the cumulated activity in the various body compartments from time 0 to t_1 . Equations (3.15) and (3.16) are a stiff system of ODE's because they involve both very rapidly changing terms and very slowly changing terms, all of a decaying nature.

Program Description

As previously commented, ICRP TIMED is a revision of the TIMED program, which is documented in ref. 11. Thus, several computational considerations such as the specific form of the coefficient matrix, computer storage of this matrix, the ingestion and injection modes of intake, and the calculation of cumulated activity [Eqs. (3.3), (3.7), (3.10), and (3.13)] are not discussed in this paper since they are covered in ref. 11. Also, the techniques involved in the solution of the differential equations are omitted from this paper but may be studied in refs. 11, 18, 19, 20, and 21. Therefore, this section includes the diagram of program structure and a description of each routine — even though some routines are not substantially changed from those documented in ref. 11.

Figure 3.2 shows the overall structure of the ICRP TIMED program. Arrows indicate the calling sequence of the routines. Routines DRIVES, STIFF, YOUT, YOUTD, YNA, and TESOC have been taken from the GEAR package¹⁸ and have been specialized for use in this program by D. E. Arnurius at Oak Ridge National Laboratory.²² MAIN, YPAY, and AXEB have been written by him for use on this particular program with our computer, the IBM System/360. The remainder of the routines have been written by one author (S. B. Watson) to implement the model previously described.

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Fig. 3.2. Overall Structure of ICRP TIMED.

Except for AXEB and YPAY, all routines are written in the IBM System/360 and System/370 FORTRAN IV language. AXEB and YPAY are IBM System/360 Assembler language routines. A listing of ICRP TIMED is given in Appendix D. The MAIN routine functions as follows:

1. Read the values $N\emptyset$, TLAST, H1, EPS.
 - $N\emptyset$ — the number of first-order differential equations.
 - TLAST — the final value of T (i.e., integration proceeds from $T = T\emptyset$ to $T = \text{TLAST}$).
 - H1 — initial step size for the integration procedure.
 - EPS — the local error tolerance parameter. The estimated errors δ_i in y_i are compared to $\text{YMAX}(i)$, which is roughly the largest value of $|y_i|$ seen so far, for error control purposes, this is done by comparing the root-mean-square (RMS) norm (i.e., Euclidean norm divided by $\sqrt{N}$ of the vector $[\delta_i/\text{YMAX}(i)]_{i=1}^N$ to EPS. This ratio is kept less than EPS.
2. Read the number of print intervals, NPRT, and the arrays defining the print times, TPRL, DTPR, and NARPRT by
 - $D\emptyset \text{ TO } I = 1, \text{NPRT}$
 - $\text{TPRINT} = \text{TPRL}(I) + Q * \text{DTPR}(I)$
 - where $Q = 0, \dots, \text{NARPRT}(I)$.
3. Check to see if $\text{NPRT} \leq 10$.
4. Check to see if $\text{TPRL}(\text{NPRT}) + \text{NARPRT}(\text{NPRT}) * \text{DTPR}(\text{NPRT}) = \text{TLAST}$.
5. Check to see that consecutive time intervals do not overlap.
6. Set TPRINT to TPRL(1).
7. Check to see that $13 * N\emptyset \leq 2400$ for Adams procedure (i.e., $N\emptyset \leq 126$) or $6 * N\emptyset \leq 2400$ for stiff procedure (i.e., $N\emptyset \leq 400$).
8. Call DRIVES.
9. STOP.

The routine DRIVES is an interface between the user and the rest of the GEAR package. It oversees the integration of the $\emptyset$ DE over the interval between two of the user's output points. DRIVES proceeds as follows:

1. Test input parameters for correctness and initialize variables.
2. Call STIFF.
3. KFLAG is set in STIFF and returned to DRIVES as one of the following values:
 - 0 — problem was completed successfully.
 - 1 — the integration was halted after failing to pass the error test even after reducing H by a factor of 10^{10} from its initial value.
 - 2 — after some initial success, the integration was halted when a reduction in H by a factor of more than 10^4 was indicated in order to pass the error test.
 - 3 — the integration was halted after failing to achieve corrector convergence even after reducing H by a factor of 10^{10} from its initial value.
 - 4 — immediate halt because of illegal values of input parameter.
 - 5 — H is such that $T + H = T$.
4. If $KFLAG = 0$ or -4 , call $Y\emptyset UT$ for normal output of Y at time $TPRINT$; go to step 2.
5. If $KFLAG = -1$, print message; try 10 more reductions of H ; call $Y\emptyset UTD$ if convergence continues to fail; return.
6. If $KFLAG = -2, -3, -5$, print error message; call $Y\emptyset UTD$; return.

$Y\emptyset UT$ computes interpolated values of the dependent variable Y , and calls YNA to print these values. YNA prints the solution vector Y , Eq. (3.16), and also computes Eqs. (3.4), (3.5), (3.7), (3.8), (3.10), and (3.14) and prints these quantities. YNA calls the routine $\emptyset THER$ to print the "other tissues" information to disk. (See User Information in this section.) $Y\emptyset UTD$ is a dummy routine which could be expanded by the user to print diagnostic information.

STIFF performs one step on the integration of an initial value problem for a system of ordinary differential equations. Figure 4.2 of ref. 11 shows the general flow structure of the routine if required by the user.

AXEB is an IBM 360 Assembler language routine called by STIFF to solve the matrix equation $AX = b$ where A is an N by N lower triangular

matrix, and A is stored as a vector consisting of the nonzero entries in A stored sequentially by rows. It is assumed that the maximum number of nonzero entries in a row of A is less than or equal to 52.

YPAY is also an Assembler language routine. It is called by STIFF to form $\dot{Y} = AY + X(0)$ [see Eq. (3.16)]. The matrix A is stored as in AXEB, and this routine assumes a maximum of 52 nonzero entries in any row. AXEB and YPAY were written so as to make use of most efficiently the properties of the matrix A and of the computer storage.

TESOC is called by STIFF and sets the coefficients that are used there, both for the basic integration step and for error control. TESOC also sets MAXDER, the maximum order of the method available. Currently, it is 12 for Adam's method and 5 for the GEAR method.

MATRIX directs the formation of the coefficient matrix, A [see Eq. (3.16)], and may be outlined as follows:

1. Read descriptive information about the chain of radionuclides.
 - NISØ — number of radionuclides in the chain
 - D3, D4, D5 — regional deposition values
 - NØRG — number of organs (excluding lung and GIT)
 - IØPT — mode of intake (0 - inhalation, 1 - ingestion, 2 - injection).
2. Call LUNG to assign regional deposition for each pathway a,...,h (see Fig. 3.1 for explanation of lung pathways).
3. Read for each radionuclide
 - TAG atomic number and symbol
 - TR — half-life
 - ICLASS — inhalation class
 - NBRNCH,IBRNCH,P — branching information
 - ILAB — (0 - absorption in SI only, 1 - absorption in other regions of GI tract).
4. Set LAMR.
 - $LAMR = \ln 2/TR$
5. Call ENTRY LUNG1 to set LAMX and FRAC according to inhalation class.
 - $LAMX = \lambda_{\xi} = \ln 2/T_{\xi}$, T_{ξ} is the removal half time described in Fig. 3.1.
 - $FRAC = F_{\xi}$ is the compartmental fraction from Fig. 3.1.

6. Initialize row and column indices.
7. For each nuclide:
 - a. If intake is by inhalation, call ENTRY LUNG2 to set up portion of matrix corresponding to lung differential equations.
 - b. If intake is by inhalation or ingestion, call routine GI to set up portion of matrix corresponding to GI tract differential equations.
 - c. Call ØRGAN to set up coefficient matrix for differential equations corresponding to organs other than lungs and GI tract for which we have retention models.
8. Print coefficient matrix.
9. Print nonzero elements of the coefficient matrix and the row and column in which each one appears. Due to the sparse nature of the coefficient matrix, it is stored as three vectors — A, RINDEX, and CINDEX. A(I) is a nonzero element of the coefficient matrix, RINDEX(I) contains the row index of A(I), and CINDEX(I) is the column index of A(I). The coefficient matrix is filled from left to right, one row at a time, proceeding from top to bottom of the matrix, so that the vector A is formed correctly. Note that the components of the vector RINDEX form an increasing sequence [i.e., $RINDEX(I) \leq RINDEX(I + 1)$], while the components of CINDEX do not.

Routine LUNG has three entry points as noted above, which are called from MATRIX and function as follows:

Entry LUNG — assigns the regional deposition values for each pathway [these are used in setting the initial values for inhalation, Eq. (3.2)],

Entry LUNG1 — determines inhalation class and sets λ_{ξ} and F_{ξ} , from Fig. 3.1 which appear in Eq. (3.1). LUNG1 also sets the initial values, Eq. (3.2).

Entry LUNG2 — forms the coefficient matrix for Eq. (3.1).

Routine GI is called from MATRIX and determines the entries of the coefficient matrix corresponding to the compartments of the GI tract, Eq. (3.6). If intake is by ingestion, initial conditions are set by placing 1 Bq in the stomach for the parent, zero elsewhere.

ØRGAN functions as follows:

1. Read the rate of clearance in the transfer compartment (TRANS).
2. For each organ, read organ number (ISØRS), the organ name (ØRGNM), and the number of compartments (ICOM) {i.e., the number of terms in the retention function [see Eq. (3.12)]}, and the retention function.
3. Form the entries of the coefficient matrix corresponding to Eq. (3.9) for each compartment.
4. If intake is by injection, put 1 Bq in transfer compartment for the parent with zero elsewhere.

INDEX is called by MATRIX and determines the first column of the matrix entries for each daughter. (Recall the way the matrix entries are filled — from left to right and top to bottom.) This is especially important when branching is considered. Whereas daughter entries begin in a regularly indented fashion for nonbranching radionuclides, the daughter entries have a somewhat irregular pattern in branching chains. (See "Comparison of ICRP TIMED and TIMED" and "User Information.")

User Information

ICRP TIMED is written in the IBM System/360 and System/370 FORTRAN IV language with the exception of two routines, AXED and YPAY, that are written in IBM System/360 Assembler language. The FORTRAN routines have been compiled using the FORTRAN H-level compiler; the Assembler routines have been compiled with the Assembler F-level compiler. TIMED has been executed on both the IBM 360/91 and 360/75 at ORNL. The program requires about 320 K of core storage for execution. The FORTRAN routines require about 20 seconds to compile; the Assembler routines require 0.7 second for compilation. Execution time depends upon many factors: the number of differential equations, the number of nonzero entries in the coefficient matrix, the length of time period of integration, etc. The execution time for the chain of ^{232}U involving 8 radionuclides and 200 differential equations is approximately 4.5 seconds; the chain ^{133m}Te involving 3 radionuclides and 71 differential equations is approximately 0.75 second; the radionuclide ^{54}Mn involving 23 different equations is approximately 0.34 second.

The remainder of this section describes the content of the card input which must be prepared in order to execute the program and the output produced by the program. Sample input and the corresponding output are presented in Appendix E.

The card input data are to be prepared in the order shown in Table 3.2. The description of Table 2.6 applies to this table.

Output may be grouped in four categories: (1) line printer output on unit 6, (2) line printer output on unit 10, (3) disk output on unit 16, and (4) punched output on unit 7. An explanation of each is given below.

1. Printout on unit 6 consists of the following:
 - a. Summary printout of input — printed in MAIN.
 - b. Error messages concerning incorrect input — MAIN.
 - c. Coefficient matrix printed by rows — MATRIX.
 - d. The nonzero elements of the coefficient matrix and the corresponding row and column index for each nonzero entry — MATRIX.
 - e. Output for each print interval consisting of possible error messages from DRIVES and value of T and the vector Y printed in YNA.
2. Printout on unit 10 consists of the following:
 - a. Summary of percent deposition — printed in MAIN.
 - b. Listing of the isotope, half-life, class, absorption coefficient and branching information for each nuclide — MAIN.
 - c. Retention information for each organ and for each member of the chain — ØRGAN.
 - d. For each time period YNA prints the value of T, the cumulated activity ($\mu\text{Ci-days}$), and activity (μCi) entering blood and GI tract for each organ, and for each member of the chain.

Note again that output is not in the international standard of units.

The printout is divided into two output units so that either unit 6 or unit 10 output may be suppressed. We commonly suppress unit 6 output unless the program abnormally terminates after which unit 6 output should be printed in an additional run for diagnostic purposes.

Table 3.2. Card Input to ICRP TIMED

Subroutine	Card Number	Columns	Remarks, Variables, etc.
<u>Information Concerning the Differential Equations</u>			
MAIN	1		F0RMAT(I5,7E10.0)
		1-5	N0 - order of lower triangular matrix A, i.e., the number of differential equations.
		6-15	TLAST - integrate $\dot{Y}(t) = AY(t) + X(0)$ from $t = 0$ to $t = \text{TLAST}$. TLAST given in units of days.
		16-25	H1 - initial step size for the integration procedure. If left blank, then default is $H1 = 10^{-7}$.
	2	26-35	LP3 - controls the local truncation error during the integration procedure. If left blank, then default is $\text{EPS} = 10^{-6}$.
			F0RMAT(I5)
		1-5	NPRT - number of print intervals, $\text{NPRT} \leq 10$.
			F0RMAT(2E10.2,I5)
		1-10	TPRL(I) - first print time in this print interval.
		11-20	DTPR(I) - print time step for this interval.
		21-25	NARPRT(I) - number of time steps to use in the current interval.
	2 + I, I = 1,...,NPRT		
TPRL, DTPR, and NARPRT are defined by:			
$\text{DO } 10 \text{ I} = 1, \text{NPRT}$ $10 \text{ TPRINT} = \text{TPRL(I)} + \text{Q} * \text{DTPR(I)} \quad \text{Q} = 0, \dots, \text{NARPRT(I)}$			
The values assumed by TPRINT must form an increasing sequence.			
For the ICRP runs TLAST = 18,262.5 days = 50 years, NPRT = 1, TPRL(1) = 18,262.5, DTPR(1) = 0, and NARPRT(1) = 0.			
<u>General Information for Chain of Radionuclides</u>			
MATRIX	1		FORMAT(I10,3F10.0,E110)
		1-10	NIS0 - number of isotopes in the chain, $\text{NIS0} < 15$.
		11-20	U3 - fraction of intake deposited in the NP region.
		21-30	D4 - fraction of intake deposited in the TD region.
		31-40	D5 - fraction of intake deposited in the P region.
		41-50	N0RG - number of organs (excluding lungs and GI tract), $\text{N0RG} \leq 10$.
		51-60	I0PT - mode of intake. 0 - inhalation 1 - ingestion 2 - injection
		61-70	N0RAL - number of ingestion cases to be run (used only with ICRP work). Leave blank if I0PT $\neq 1$.

Table 3.2. (Cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
	1 + I, I = 1,...,NISØ		FORMAT(A8,2X,F10.0,8X,A2,2F10.0,6I2,5F5.0,I3)
		1-8	TAG(I) - atomic symbol and mass number of I th member of the chain.
		11-20	TR(I) - half-life of I th member of chain in days.
		29-30	ICLASS(I) - inhalation class of I th member of chain. Should be one of the characters D, W, or Y right justified in the field. Leave blank if IØPT = Ø.
		31-40	LAMAB(I,2) - absorption coefficient in the small intestine (SI) $\lambda_{ab} = \frac{6 \cdot f_1}{1 - f_1}$
		41-42	NBRNCH(I) - the number of nuclides in the chain that have member I as an immediate daughter, NBRNCH(I) ≤ 5.
		43-44	IBRNCH(1) - the index of the 1 st nuclide that has member I as an immediate daughter.
		45-46	IBRNCH(2) - the index of the 2 nd nuclide that has member I as an immediate daughter.
		⋮	⋮
		51-52	IBRNCH(5) - the index of the 5 th radionuclide that has member I as an immediate daughter.
		The array IBRNCH should form an increasing sequence.	
		53-57	P(1) - the branching ratio of nuclide IBRNCH(1) to nuclide I.
		⋮	⋮
		73-77	P(5) - the branching ratio of nuclide IBRNCH(5) to nuclide I.
<p>The setting of the NBRNCH, IBRNCH, and P arrays assumes that members in the chain of radio-nuclides have been ordered in some logical fashion and an index associated with each member, e.g., given the chain</p> <pre> graph LR A -- 30% --> B A -- 70% --> C B --> D C -- 50% --> D C -- 50% --> E D --> E E --> F["F(stable)"] </pre> <p>a logical ordering might be 1-A, 2-B, 3-C, 4-D, and 5-E so that for nuclide B, NBRNCH(2) = 1, IBRNCH(1) = 1, P(1) = 0.3, and for nuclide E, NBRNCH(5) = 2, IBRNCH(1) = 3, P(1) = .5, IBRNCH(2) = 4, P(2) = 1. Values for NBRNCH, IBRNCH, and P must be set for C and D.</p>			
		77-80	ILAB - switch to indicate if there is absorption in some section of the GI tract other than the small intestine (SI). 0 - absorption only in small intestine. 1 - absorption in stomach (S), upper large intestine (UL), or lower large intestine (LL) in addition of small intestine absorption.

Table 3.2. (Cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
	$2*I+1$ $I = 1, \dots, NISØ$		FORMAT(3F10.0)
Card required only if ILAB = 1.			
		1-10	LAMAB(I,1) - adsorption coefficient for S.
		11-20	LAMAB(I,3) - adsorption coefficient for UL.
		21-30	LAMAB(I,4) - adsorption coefficient for LL.
<u>Description of Retention</u>			
This set of cards describes retention in those organs other than the lungs and GI tract. These cards must be included for each radionuclide in the chain.			
	1		FORMAT(I2,A8,I2)
		1-2	ISØRS(I) - index of organ I taken from the following list. ISØRS(I) is used for indexing purposes when calculating dose.
<div style="display: flex; justify-content: space-between;"> <div style="width: 48%;"> 1. Bladder Contents 2. Stomach Contents 3. SI + Content 4. Upper Lower Intestine Contents 5. Lower Large Intestine Contents 6. Kidneys 7. Liver 8. Salivary Gland 9. TB Region 10. P Region 11. Lymph 12. Muscle </div> <div style="width: 48%;"> 13. Ovaries 14. Pancreas 15. Cortical Bone 16. Trabecular Bone 17. Red Marrow 18. Yellow Marrow 19. Skin 20. Spleen 21. Testes 22. Thyroid 23. Total Body (used for other tissues, also) 25. Adrenals </div> </div>			
(24. Cloud should not be used as a source organ in this code. In addition, ICRP restricts the list of source organs to those included in Table 2.1).			
		3-10	ØRGNM(I) - name of organ I (at most 8 characters).
		11-12	ICØM(K,I) - number of compartments for organ I, radionuclide K (number of terms in the retention function), $ICØM(K,I) \leq 10$.
	3		FORMAT(8F10.0)
This card describes the retention function and contains the coefficients of the exponential, $AS(JJ,I)$, $JJ = 1, \dots, ICØM(K,I)$, and the exponential constants, $TBS(JJ,I)$, $JJ = 1, \dots, ICØM(K,I)$, respectively. Obviously, for more than four compartments (i.e., terms in the retention function, another card is needed.)			
In reference to cards 2 and 3, cards describing Total Body or "Other Tissues" should be placed last.			
For each nuclide, the organs and associated information must appear in the same order.			

Table 3.2. (Cont'd)

Subroutine	Card Number	Columns	Remarks, Variables, etc.
<u>Other Tissues Transformation</u>			
If one of the source organs is "Other Tissues," a card must be included for each print interval of the form:			
ØTHER	1		FØRMAT(1012)
		1-2	NØTØP - nonzero integer
		3-4	IØTHER(1) - ISØRS(1)
		5-6	IØTHER(2) - ISØRS(2)
		⋮	⋮
Do not include 23 as a source number on this card.			
If you do not wish this option, include a blank card for each print interval.			
<u>Solving Same ØDE - Different Initial Conditions</u>			
If the user wishes to solve the same system of differential equations with a different set of initial conditions, the following cards should be included:			
1:	All cards in the group <u>Information Concerning the Differential Equations</u> should be repeated. Card #1 should have a 1. in columns 44-45.		
2:	Card #1 in the group <u>General Information for the Chain of Radionuclides</u> with the new values of D3, D4, and D5. The values NISØ, NØRG, IØPT, and NØRAL are ignored at this reading of the card and may be left blank.		
3:	The card in the group <u>Other Tissues Transformation</u> .		

3. Disk output on unit 16 may be passed to another job step for use in dose calculations as in Eq. (1.1). The unit 16 data set is written unformatted on a disk pack (3330 or 2314), with a record format of variable blocked spanned, a logical record length of 150, and a blocksize of 1504. The temporary data set is given the name &&UCIDAY and is created with the disposition of (NEW,PASS). See Appendix C for the summary of Job Control Language (JCL) needed to execute the code. For some elements, such as the alkaline earths, the ICRP TIMED code will not be used due to the fact that the metabolic model may not be expressed as a sum of exponentials as in Eq. 3.12. Thus if the cumulated activity can be determined by some method and written to the data set &&UCIDAY in a job step replacing ICRP TIMED, the ICRP code will complete the dose calculations.
4. Punched output to unit 7 is performed in exactly the same sequence as unit 16 output. Table 3.3 describes the sequence of output to units 16 and 7. The column "Internal Form of Data" describes the form of internal data storage for the unformatted writes to unit 16: the column "Format Descriptor" shows the format of the variables as they are written formatted on unit 7.

Comparison of Original TIMED and ICRP TIMED

ICRP TIMED is very similar to the TIMED program documented in ref. 10; however, the ICRP version of the code embodies some important differences which correspond to Committee 2 guidelines.

First, similarities between the two programs include:

1. same compartmental model of activity transfer in the body,
2. same lung and GI tract models,
3. retention in body organs required to be a sum of exponentials, and
4. same methods of solving the system of differential equations.

The main differences in methodologies between the two codes are pointed out in Table 3.4. Entries 1, 4, 6, 7, and 8 are actual programming changes. Entries 2, 3, and 5 could have been programmed;

Table 3.3. Form of Data Set Written on Unit 16 and Unit 7

Subroutine	Record Number	Remarks, Variables, etc.	Internal Form of Data	Format Descriptor
MATRIX	1	NISØ - number of radionuclides in the chain. NØRG - number of organs (excluding lung and GI tract). IØPT - mode of intake. 0 - inhalation 1 - ingestion 2 - injection	integer (4) integer (4) integer (4)	I5 I5 I5
MATRIX	2	NØRAL - number of oral (or inhalation) intakes.	integer (4)	I5
MATRIX	3	TAG(ID), ID = 1,...,NISØ - atomic symbol and mass number for each member of the chain.	alphameric (8)	10A8
MATRIX	4	ISØRS(ISØ), ISØ = 1,...,NØRG + 8 - indices for organs in the order NP, TB, P, L, S, SI, UL, LL, other organs in their order of input.	integer (4)	16I5
For each time period read:				
YNA	1	NØTØP - switch to indicate "other tissues" as source organ. 0 - total body source 1 - other tissues source IØTHER(1) - ISØRS(1) IØTHER(2) - ISØRS(2) : : IØTHER(NØRG - 1) = ISØRS(NØRG)	integer (4) integer (4)	I2 I2 I2 : : I2
	2	TIME(ITM) - right end point of the total interval	real (4)	1PE10.3
For each radionuclide read:				
YNA	1	VECTØR(ISØ), ISØ = 1,...,NØRG + 8 - cumulated activity for each of the organs in the order stated in ISØRS. TRANS - cumulated activity in the transfer compartment.	real (8) real (8)	1P8E10.3 1P8E10.3
If IØPT = 0 read:				
YNA	2	F(I), I = 1, 2, 3. F(1) - activity entering blood from lungs. F(2) - activity entering GI tract from lungs. F(3) - activities entering blood from GI tract.	real (8)	1P8E10.3

Table 3.4. Differences Between ICRP TIMED and Original TIMED Calculations

Original TIMED	ICRP TIMED
<p>1. A radionuclide following a given pathway from a certain lung region may produce a daughter which follows a different pathway; e.g., in the N-P region</p>	<p>1. A daughter produced by a parent following a given pathway must also follow that pathway; e.g., in the N-P region</p>
<pre> graph TD PA[Pathway A (parent)] --> DA[Pathway A (daughter)] PA --> DB[Pathway B (daughter)] PB[Pathway B (parent)] --> DA PB --> DB DA --> OutA[] DB --> OutB[] </pre>	<pre> graph TD PA[Pathway A (parent)] --> DA[Pathway A (daughter)] PB[Pathway B (parent)] --> DB[Pathway B (daughter)] DA --> OutA[] DB --> OutB[] </pre>
<p>A parent in Pathway A may produce a daughter in Pathway A or B.</p>	<p>A parent in Pathway A produces a daughter in Pathway A only.</p>
<p>2. Daughter may have different lung clearance class than the parent.</p>	<p>2. Daughter must have same clearance class as the parent.</p>
<p>3. Material entering GI tract may cross into blood from any of the four sections.</p>	<p>3. Material entering the GI tract may cross into blood from SI only.</p>
<p>4. Material leaving lungs and GI deposited immediately in body organs.</p>	<p>4. Holdup time in body fluids (transfer compartment) before material is translocated to body organs.</p>
<p>5. Daughters have metabolic model associated with their element.</p>	<p>5. Daughters have metabolic model of the parent or the chain.</p>
<p>6. Daughter which is born in an organ is subject to the same retention function as the freshly deposited radionuclide.</p>	<p>6. Daughter born in an organ is not repartitioned according to the retention function but remains in the compartment where it was born.</p>
<p>7. Three specific branching cases allowable.</p>	<p>7. All modes of branching are handled.</p>
<p>8. "Other tissues" transformation performed before being sent to another job step for dose calculations.</p>	<p>8. "Other tissues" transformation omitted and left for further job step.</p>

however, it was the choice of the authors to allow the program to handle the more general case and to accomplish these modifications through the input data.

IV. THE DØSE PROGRAM

The purpose of the DØSE program is to combine the SEE values computed in Section II and the cumulated activities calculated in Section III to calculate dose equivalent using Eq. (1.1). Using the dose equivalent values, the program determines the annual limit on intake (ALI) and the derived air concentration (DAC) for a given chain of radionuclides. The purpose of this section is to describe the methodology outlined by the ICRP in ref. 1 and its implementation into this program. In addition, the program description and user information are presented.

Description of the Method

The general purpose of this section of the ICRP code is to calculate ALI values according to the principles recommended in ICRP Publication 26 (ref. 2). Preliminary ALI values have been computed by Adams et al.^{2,3} The intake in any year is restricted so that the risk of stochastic effects from the committed dose equivalent to the various body organs does not exceed the risk of stochastic effects associated with uniform irradiation of the whole body to the annual dose equivalent limit of 0.05 Sv (5 rems). However, there is an overriding requirement that the committed dose equivalent in the lens of the eye must not exceed 0.3 Sv (external exposure only) and that the committed dose equivalent in any other organ must not exceed 0.5 Sv.

The stochastic risk attributed to the irradiation of a given organ or tissue by intake of radionuclides is considered by ICRP (ref. 2) to be proportional to the committed dose equivalent, H_{50T} . The total stochastic risks incurred from the irradiation of all body tissues following intakes of radionuclides is proportional to the effective dose equivalent quantity, H_E , which is given by Eq. (4.1) where w_T is the weighting factor for tissue T, and the sum is over selected tissues that are significantly irradiated.

$$H_E = \sum_T w_T H_{50T} \quad (4.1)$$

The tissues included in the summation and their weighting factors are given in Table 4.1. (The first six organs are termed "risk" organs for convenient reference). The values of w_T are equal to the fractions of the total stochastic risk attributed to the individual tissues T when the whole body is irradiated uniformly.

The value of ALI for a radionuclide is the greatest intake that satisfies both the requirements:

$$H_E \leq 0.05 \text{ Sv}$$

$$H_{50T} \leq 0.5 \text{ Sv for all organs T.} \quad (4.2)$$

The first requirement limits the total stochastic risk from the intake. The second requirement is to prevent the occurrence of non-stochastic effects in tissue from a lifetime of exposure.

The general mode and sequence of computing data for the ICRP tables is given below; an example follows.

Mode and Sequence of Computing Data for ICRP Tables

I. Preliminary Data

1. Values of SEE for all source and target organs are computed for the radionuclides being considered. (Computed in the SEE program).
2. The number of nuclear transformations (cumulated activity) in each given source organ or tissue is computed according to the metabolic model for intake of unit activity of the nuclide (ICRP TIMED program).
3. Committed dose equivalent values, H_{50T} , in all target organs or tissues from the given list of source organs are computed per intake of unit activity of the nuclide by each route of intake and/or class or aerosol. (This step and all following steps are performed in DØSE). For a chain of parent and daughter nuclides the committed dose equivalent is found by summing over all members of the decay chain.

Table 4.1. Selected Organs and their Weighting Factors

Organ		Weighting Factors
Risk Organs	Gonads	0.25
	Breast	0.15
	Red Marrow	0.12
	Lungs	0.12
	Thyroid	0.03
	Bone Surface	0.03
	Remainder	0.30 (i.e., 0.06 for each of the five remaining organs)

4. Weighted committed dose equivalent values are computed for all target organs by multiplying the doses as computed in (3) above by the appropriate weighting factor listed in Table 4.1.
5. The ICRP-30 10% rule is performed on the values computed in (4) to eliminate target organs, whose weighted committed dose equivalent is not 10% of the maximum weighted dose equivalent. The 10% rule is applied separately for each route of intake and/or class of aerosol.
6. A check is made after the 10% rule is applied in (5) to determine that not more than five organs remain other than risk organs for each route of intake and/or class of aerosol. If there are more than five, the five highest are retained.
7. The ICRP-30 1% rule is performed to eliminate source organs that contribute less than 1% to the committed dose equivalent in a target organ not eliminated by the 10% rule. The 1% rule is applied separately for each route of intake and/or class of aerosol. The 1% rule is performed on the total dose for parent plus daughters (i.e., the dose for a source to each target for the parent plus the same dose for each daughter are added and compared to the total dose in a target organ not eliminated by the 10% rule).
8. The committed dose equivalent values are recalculated based on the revised lists of source and target organs.

II. Final Tables for Inclusion in the ICRP-30 Report

1. After the computations in (7) are performed, the SEE and the nuclear transformations (cumulated activity) tables are printed. They are a composite of all the source and/or target organs with corresponding values that were not eliminated by the 10% and the 1% rule for each route of intake and/or class of aerosol. The ordering and abbreviations of source and target organs in the tables are those given in Table 4.2.

Table 4.2. Order and Abbreviations of Source
and Target Organs Used in Estimating Dose
Values for ICRP Committee 2 Report

Source Organs		Target Organs	
1.	GONADS { maximum of ovaries or testes }	GONADS { maximum of ovaries or testes }	
2.	BREAST (muscle)	BREAST (muscle)	
3.	R MARROW	R MARROW	
4.	LUNGS	LUNGS	
5.	THYROID	THYROID	
6.	ST CONTENT	BONE SURF	
7.	SI CONTENT	ST WALL	
8.	ULI CONTENT	SI WALL	
9.	LLI CONTENT	ULI WALL	
10.	KIDNEYS	LLI WALL	
11.	LIVER	KIDNEYS	
12.	PANCREAS	LIVER	
13.	CORT BONE	PANCREAS	
14.	TRAB BONE	SKIN	
15.	SKIN	SPLEEN	
16.	SPLEEN	THYMUS	
17.	ADRENALS	UTERUS	
18.	BLADDER CONTENT	ADRENALS	
19.	TOTAL BODY	BLAD WALL	

2. The committed dose equivalent table is compiled by considering from (8) the list of target organs [there will be no more than 11 organs (i.e., a maximum of six risk organs and five others)]. From the preliminary list the final list will include the organs that are (a) risk organs, (b) part of the metabolic model, or (c) a section of the GI tract. If any organ or organs appear on the preliminary list that are not a member of the above three classes the organ or organs will be aggregated as "remainder" in the final listing. The numerical value of the committed dose equivalent listed with the "remainder" is the maximum value from among the organs aggregated to form "remainder." Beneath the "remainder" organ, a weighting factor, WT, is written. The value of WT will be an integer multiple of 0.06 depending on the number of organs aggregated to form the "remainder," (i.e., 0.06 for 1 organ, 0.12 for 2 organs, etc.). This final list of organs with numerical values is given separately for each route of intake and/or class of aerosol. The percent of dose accruing for deposition in each region of the lung is listed in parentheses beneath the dose value.
3. The weighted committed dose equivalent table consists of entries from the committed dose equivalent table multiplied by the appropriate weighting factors listed in Table 4.1. The values for the "remainder" organs are found by multiplying the "remainder" values by the associated value of WT.
4. Values for the ALI and DAC table are estimated as follows: an ALI based on stochastic effects is computed for each route of intake and/or class of aerosol by the formula

$$ALI_S = \frac{0.05}{\sum w_T H_{50T}} \text{ Bq} , \quad (4.3)$$

and a check is made to determine whether or not the stochastic value is limiting.

$$ALI_S \times \max H_{50T} > 0.5 \text{ Sv} \quad (4.4)$$

If it is not limiting, an ALI based on nonstochastic effects is computed by the formula

$$ALI_{NS} = \frac{0.5}{\max H_{50T}} \text{ Bq} . \quad (4.5)$$

Corresponding DAC values are computed and listed for the limiting ALI (minimum of ALI_S and ALI_{NS}) values for each inhalation class that is applicable.

$$DAC = ALI / (2000 \times 60 \times 0.02) \text{ Bq/m}^3 , \quad (4.6)$$

where DAC is defined as that concentration in air (Bq/m^3) which, if breathed by Reference Man for a working year of 2000 hours under conditions of "light" activity, would result in the ALI by inhalation. The value 0.02 m^3 is the volume of air breathed per minute under conditions of "light activity." The ALI values are listed. If the ALI is based on nonstochastic effects, the stochastic value is given in parentheses beneath the nonstochastic ALI, and the organ used to compute the nonstochastic ALI is given beneath the stochastic ALI.

An example of the mode and sequence of computing data is shown from ^{54}Mn for the inhalation class D. The ^{54}Mn decays by electron capture and beta plus; the SEE values are based primarily on the gamma component. The element manganese is retained primarily in bone and liver. Suppose that the SEE values and the cumulated activities for ^{54}Mn have been computed and combined to form committed dose equivalent values (Steps I.1, 2, and 3). Weighted committed dose equivalents are calculated according to Step I.4 as shown in Table 4.3.

The 10% rule (Step I.5) eliminates all targets whose weighted committed dose equivalent is not 10% of the maximum weighted dose which in this example is $2.77\text{E}-10$ corresponding to liver. The only organ eliminated by the 10% rule is thyroid. The 10% rule generally eliminates

Table 4.3. Calculation of Weighted Committed Dose Equivalent Values

Target Organ	Committed Dose Equivalent		Weighting Factors		Weighted Committed Dose Equivalent
Gonads	8.85E-10	x	0.25	=	2.21E-10
Breast	9.13E-10	x	0.15	=	1.37E-10
R. Marrow	1.66E-9	x	0.12	=	1.99E-10
Lungs	1.18E-9	x	0.12	=	1.42E-10
Thyroid	6.52E-10	x	0.03	=	1.96E-11
Bone Surf	2.56E-9	x	0.03	=	7.68E-11
ST Wall	9.44E-10	x	0.06	=	5.66E-11
SI Wall	1.11E-9	x	0.06	=	6.66E-11
ULI Wall	1.25E-9	x	0.06	=	7.50E-11
LLI Wall	1.18E-9	x	0.06	=	7.08E-11
Kidneys	1.37E-9	x	0.06	=	8.22E-11
Liver	4.61E-9	x	0.06	=	2.77E-10
Pancreas	1.41E-9	x	0.06	=	8.46E-11
Skin	6.21E-10	x	0.06	=	3.73E-11
Spleen	9.18E-10	x	0.06	=	5.51E-11
Thymus	7.82E-10	x	0.06	=	4.69E-11
Uterus	9.24E-10	x	0.06	=	5.54E-11
Adrenals	1.81E-9	x	0.06	=	1.09E-10
Blad Wall	7.24E-10	x	0.06	=	4.34E-11

several organs. Step I.6 eliminates all but the five highest nonrisk organs leaving the results in Table 4.4.

In order to perform the 1% rule, it is necessary to determine the fraction of dose that is contributed by each source organ. The source organs for manganese are lungs, S contents, SI contents, ULI contents, LLI contents, cort bone, trab bone, liver, and other tissues. Thus, for the first target, gonads, the following doses are calculated in Table 4.5 and compared to $8.85\text{E-}10$ to see if any source contributes 1%.

The source organs ULI, LLI, liver, cort bone, trab bone, and other tissues contribute 1%; thus, they are retained as source organs. This type of computation is continued for each target organ until all sources are found to contribute 1% or until the list of targets is exhausted. If a source organ contributes 1% to any organ in any inhalation or oral intake, it is retained as a source organ. For the example ^{54}Mn , no source organs are eliminated after completion of calculation of the 1% rule.

After the 10% rule and 1% rule, the SEE tables and number of nuclear transformation tables (not shown here) are printed for the sources in Table 4.5 and the targets in Table 4.4.

According to Step II.2 the list of target organs is further compressed as shown in Table 4.6. The kidneys, pancreas, and adrenals are lumped together under the title "remainder" having the associated dose value $1.81\text{E-}9$ and a weighting factor of 0.18. The appropriate dose and weighted dose tables are printed.

Next the values of ALI are estimated by Eq. (4.3) where $\sum w_T H_{50T}$ is the sum of the entries in the last column of Table 4.6.

$$ALI_S = \frac{0.05}{\sum w_T H_{50T}} = \frac{0.05}{1.4538\text{E-}9} = 3.44\text{E7 Bq} . \quad (4.7)$$

By Eq. (4.4), $ALI_S \times \max H_{50T} = 3.44\text{E7} \times 4.61\text{E-}9 = 0.15$, which is less than 0.5 Sv so that the stochastic ALI is accepted. The corresponding DAC is

$$DAC = \frac{3.44\text{E7}}{2000 \times 60 \times 0.02} = 1.4\text{E4 Bq/m}^3 . \quad (4.8)$$

Table 4.4. Remaining Values After the 10% Rule is Performed

Target Organ	Committed Dose Equivalent		Weighting Factors		Weighted Committed Dose Equivalent
Gonads	8.85E-10	x	0.25	=	2.21E-10
Breast	9.13E-10	x	0.15	=	1.37E-10
R Marrow	1.66E-9	x	0.12	=	1.99E-10
Lungs	1.18E-9	x	0.12	=	1.42E-10
Bone Surf	2.56E-9	x	0.03	=	7.68E-11
ULI Wall	1.25E-9	x	0.06	=	7.50E-11
Kidneys	1.37E-9	x	0.06	=	8.22E-11
Liver	4.61E-9	x	0.06	=	2.77E-10
Pancreas	1.41E-9	x	0.06	=	8.46E-11
Adrenals	1.81E-9	x	0.06	=	1.09E-10

Table 4.5. Sample Calculations for 1% Rule

Source→Target	SEE (Source→Gonads)		Cumulated Activity (source)		Conversion Factor		Committed Dose Equivalent
Lungs→Gonads	4.66E-7	x	1.886E4	x	1.6E-10	=	1.406E-12
ST→Gonads	3.31E-6	x	5.543E2	x	1.6E-10	=	2.936E-13
SI→Gonads	2.72E-5	x	1.995E3	x	1.6E-10	=	8.682E-12
ULI→Gonads	2.50E-5	x	6.476E3	x	1.6E-10	=	2.590E-11
LLI→Gonads	4.57E-5	x	1.193E4	x	1.6E-10	=	8.723E-11
Liver→Gonads	1.57E-6	x	3.490E5	x	1.6E-10	=	8.787E-11
Cort Bone→Gonads	2.80E-6	x	3.803E5	x	1.6E-10	=	1.704E-10
Trab Bone→Gonads	2.80E-6	x	3.797E5	x	1.6E-10	=	1.701E-10
Oth Tiss→Gonads	4.09E-6	x	4.958E5	x	1.6E-10	=	3.245E-10

Table 4.6. Final List of Target Organs and the Associated Dose and Weighted Dose

Target Organs	Committed Dose Equivalent		Weighting Factor		Weighted Committed Dose Equivalent
Gonads	8.85E-10	x	0.25	=	2.21E-10
Breast	9.13E-10	x	0.15	=	1.37E-10
R Marrow	1.66E-9	x	0.12	=	1.99E-10
Lungs	1.18E-9	x	0.12	=	1.42E-10
Bone Surf	2.56E-9	x	0.03	=	7.68E-11
ULI Wall	1.25E-9	x	0.06	=	7.50E-11
Liver	4.61E-9	x	0.06	=	2.77E-10
Remainder	1.81E-9	x	0.18	=	3.26E-10

Program Description

The DØSE program consists of 17 routines that are related by the diagram in Fig. 4.1. Arrows indicate the calling sequence of the routines. All of the routines except CØRE have been written in the IBM System/360 and System/370 FORTRAN IV language. The routine CØRE is a nonstandard library function included in the FORTRAN link library at ORNL. A listing of the DØSE program is given in Appendix F. The remainder of this section gives a description of each routine.

The MAIN routine completes Step I.3 of the section, "Mode and Sequence of Computing Data for ICRP Tables." The MAIN routine performs the following functions:

1. Reads lists of source and target organ names (abbreviations).
2. Reads the data set of cumulated activities that ICRP TIMED code has written to disk (or cards) in the order shown in Table 3.3.
3. Adds to each organ, other than lungs and GI tract, a fraction of the cumulated activity in the transfer compartment proportional to the mass of the organ.
4. Converts cumulated activity from units of microcurie-days to becquerel-seconds.
5. Reads the specific effective energies that the SEE program has written to disk in the order shown in Table 2.7.
6. Transforms the SEE value for source total body to a target organ T to the SEE value for "other tissue" to a target organ T as follows:

$$\begin{aligned}
 \text{SEE}(T \leftarrow Y_{OT}) &= \frac{M_{TB}}{M_{TB} - \sum_i M_i} \cdot \text{SEE}(T \leftarrow Y_{TB}) \\
 &\quad - \sum_j \frac{M_j}{M_{TB} - \sum_i M_i} \cdot \text{SEE}(T \leftarrow Y_j) , \quad (4.9)
 \end{aligned}$$

Fig. 4.1. Structure of the DØSE Program.

where $SEE(T \leftarrow Y_{\emptyset T})$ is the SEE value from other tissues to target organ T, $SEE(T \leftarrow Y_{TB})$ is the SEE value from total body to target T, M_{TB} is the mass of the total body, and M_i is the mass of a source organ i. The summations are taken over all source organs in the metabolic model other than lungs and GI tract.

7. Calculates dose values to all targets for each inhalation/oral class for each member of the chain of radionuclides. In addition, the fractions of dose resulting from deposition in the various regions of the lung are computed for each organ. The fractions of dose F_{NP} , F_{TB} , and F_P , resulting from deposition in the N-P, T-B, and P regions of the lungs, respectively, may be used to determine dose for aerosols with an AMAD different from 1 μm . The following is the formula to convert the dose from deposition of a particle with AMAD = 1 to a particle with a different AMAD.

$$\frac{D\emptyset SE(AMAD)}{D\emptyset SE(1 \mu\text{m})} = F_{NP} \frac{D_{NP}(AMAD)}{D_{NP}(1 \mu\text{m})} + F_{TB} \frac{D_{TB}(AMAD)}{D_{TB}(1 \mu\text{m})} + F_P \frac{D_P(AMAD)}{D_P(1 \mu\text{m})},$$

where D_{NP} , D_{TB} , and D_P are the deposition probabilities in the respiratory system for a given AMAD (see ref. 14).

8. Prints working tables of cumulated activity, dose, and the fraction of dose from each member of the chain.
9. Prints working tables of total dose values and fractions of dose F_{NP} , F_{TB} , and F_P for the entire chain.
10. Calls subroutine TAB4 to compute the tables printed in the ICRP Committee 2 Report.

MAIN also creates three temporary data sets that are used by other subroutines in the code. These are described in the next section in the discussion of output produced by the code.

The subroutine TAB4 directs the computations and calls the routines which print the ICRP tables. TAB4 progresses very similarly to Step I.4 and the steps following I.4 in the section "Mode and Sequence of Computing Data in the ICRP Tables." The TAB4 subroutine performs the following functions:

1. Calculates weighted committed dose equivalent values for each organ and inhalation/oral class.
2. Calls SØRT to sort the weighted doses from maximum to minimum.
3. Eliminates all weighted doses which are not 10% of the maximum weighted dose.
4. If there are more than five organs other than the six risk organs remaining after the 10%, all but the five highest are eliminated.
5. Eliminates source organs which do not contribute at least 1% to the committed dose for at least one target organ in one inhalation/oral class.
6. Sorts target organs in the order specified in Table 4.2.
7. Recalculates dose and weighted dose due to the fact that some source organs have been eliminated.
8. Calls MAXTAB to determine the cumulative list of target organs for all inhalation and oral classes and the length of the list.
9. Calls CHNLEN to eliminate radionuclides which do not contribute 0.1% to the total committed dose equivalent for the chain.
10. Calls TABU to print SEE tables.
11. Determines "remainder" organ described in II.2 of "Mode and Sequence of Computing Data in the ICRP Tables."
12. Calls FØØTNT to form matrix of footnote indications.
13. Calls WEIGHT to form the array of weights to be printed with the target organs in the committed dose table.
14. Calls ØRG TBL to determine maximum length of dose and weighted dose tables.

15. Calls TAB3 and TAB5 to print dose and weighted dose equivalents, respectively.
16. Calls TAB6 to calculate and print table of ALI and DAC.

The subroutine SORT is called by TAB4 and sorts an array in descending order. It is used to sort weighted committed doses. RESORT rearranges elements within an array, moving a given element to the end and compressing the remainder of the array. This subroutine is called by TAB4 when the number of nonrisk organs is being held to five.

The subroutine MAXTAB determines the cumulative list of target organs for all inhalation/oral classes used in the committed dose equivalent tables. The length of this list is also tabulated. MAXTAB is called by TAB4 in order to determine the target list to be printed in the SEE tables.

The subroutine CHNLEN calculates the maximum contribution in each inhalation and oral class for each radionuclide to the total committed dose equivalents. If a member of the chain (starting from the end of the chain) does not contribute 0.1% to the total dose, the member is dropped from the printout in the ICRP tables.

The subroutine TAB0 executes in the following manner:

1. Counts the number of source organs not eliminated by the 1% rule.
2. Sorts source and target organs according to the present scheme in Table 4.2.
3. Writes a table of SEE values for each member of the chain of radionuclides.

The subroutine TITLE is called by TAB0 to center the title of the SEE table.

The subroutine TAB1 is called by TAB4 to print the cumulated activities (number of nuclear transformations) for each inhalation and oral class for each member of the chain of radionuclides.

The subroutines SORT01, FOOTNT, WEIGHT, and ORGTBL perform functions that are prerequisite to the printing of the committed dose equivalent and weighted committed dose equivalent tables. The SORT01 subroutine is

called by TAB4 to sort two arrays, one of which contains the indices of target organs left after the 10% rule is applied and another filled with zeros and ones. A zero in a given position of the latter array indicates that the corresponding organ indexed by the former array is part of the "remainder organ" (see Step II.2, "Mode and Sequence of Computing Data for ICRP Tables"). The array of zeros and ones is sorted so that the ones are at the end of the array; the array of target indices is sorted accordingly. This is preliminary to the determination of the "remainder organ," and its associated dose, weighted dose, and weighting factor, which are determined in TAB4.

The subroutine F00TNT was originally used to determine footnotes for the tables of committed dose and weighted committed dose, but at present footnotes are being omitted. WEIGHT determines the position and forms the array of weights to be printed beneath the "remainder organ" in the table of committed dose equivalents. The subroutine 0RGTBL determines the maximum length (number of target organs) for the committed dose and weighted committed dose tables. In addition, this routine sets up a matrix of the organ names that are to be printed in the various inhalation and oral columns of both of these tables.

TAB3 produces the table of total committed dose equivalents for the chain of radionuclides for each inhalation and oral class. TAB5 produces the corresponding weighted committed dose equivalent table. The subroutine TAB6 performs the calculations described in Step II.4 of "Modes and Sequence of Computing Data for ICRP Tables" and prints the tables of ALI and DAC. The subroutine C0RE, which is called by TAB3, TAB4, and TAB6, is a system library routine available at ORNL. Calling C0RE permits the next formatted READ or WRITE statement to process to or from an in-core area rather than to or from a physical device. C0RE performs functions similar to the ENC0DE and DEC0DE statements of other non-IBM F0RTRAN languages.

User Information

The D0SE program is written in the IBM System/360 and System/370 F0RTRAN IV. The routines have been compiled using the F0RTRAN H-level

compiler. The program requires about 240K of storage for execution. The routines require about 70 seconds to compile. Execution time varies with the number of radionuclides in the chain, the number of source organs in the metabolic model, number of inhalation and oral classes, etc. The execution time for the chain ^{233}U involving eight radionuclides, nine source organs, three inhalation and two oral classes is approximately 11.6 seconds; the chain ^{133m}Te involving three radionuclides, eight source organs, two inhalation and one oral class requires approximately 3.5 seconds; the radionuclide ^{54}Mn involving nine source organs, two inhalations and one oral class requires approximately 1.5 seconds.

The remainder of this section describes the input that is necessary in order to execute the program and the output produced by the program. Sample input and the corresponding output are presented in Appendix G.

Input to the DØSE program consists of three data sets:

1. The cumulated activities are read from the unformatted data set &&UCIDAY, which is written by ICRP TIMED in the form described in Table 3.3. This data set is retrieved as unit 16 in the MAIN routine of the DØSE program.
2. The specific effective energies are read from the unformatted data set &&SEE, which is written by the SEE program in the form described in Table 2.7. This data set is retrieved as unit 14 in the MAIN routine of the DØSE program.
3. The card input is read from unit 5 and must be prepared in the order shown in Table 4.7. The description of Table 2.6 also applies to this table. Each chain of radionuclides must have a data set of this form. The order in which the data for the chains of radionuclides are placed must be the same as the ordering in the ICRP TIMED input, Table 3.2. For example, if cumulated activity is obtained for ^{54}Mn and ^{56}Mn , respectively, in ICRP TIMED, the card data for ^{54}Mn must precede the card input for ^{56}Mn in the DØSE program.

Table 4.7. Input to DOSE Program

Subroutine	Card Number	Columns	Remarks, Variables, etc.
MAIN	one card for each source organ		FORMAT(10A2)
		1-2	SØRGO(1,1)- first two letters of the name of the 1th source organ.
		3-4	SØRGO(1,2) - second two letters of the name of the 1th source organ.
		.	.
		19-20	SØRGO(1,10) - tenth two letters of the name of the 1th source organ.
The SØRGO array of source organ names is used in the table of specific effective energies. The source organ names are put on two lines in this table, so the first line of the name should be centered in columns 1-10 on the card and the second line of the name should be centered in columns 11-20 of the card. Thus, these source organ titles can be 20 characters. The ordering of organs must be the same as for the input to the SEE code.			
MAIN	one card for each source organ		FORMAT (3A4)
		1-4	SØRGI(1,1) - first four letters of the name of the 1th source organ.
		5-8	SØRGI(1,2) = second four letters of the name of the 1th source organ.
		9-12	SØRGI(1,3) - third four letters of the name of the 1th source organ.
The SØRGI array of source organ names is used in the table of number of nuclear transformations. The name is only one line and must be restricted to twelve characters. The ordering of organs must be the same as for SØRGO.			
MAIN	one card for each target organ		FORMAT(5A2)
		1-2	TARGO(1,1) - first two letters of the name of the 1th target organ.
		.	.
		9-10	TARGO(1,5) - fifth two letters of the name of the 1th target organ.
The TARGO array of target organs is used in the tables of specific effective energy, committed dose, weighted committed dose and annual limit on intake. The name is one line and is restricted to ten characters. The ordering of the organs must be the same as the input for the SEE code.			
MAIN	1 card for each member of the chain		FORMAT(15)
		1-5	NTIME - number of time intervals (for ICRP, NTIME = 1).
			FORMAT(F4.0,A1,IX,3A4,F6.0,6X,3A1,3X,3F4.0,2X,F3.0,3F4.0)
		1-4	ANØ - mass number.
		5	EXM M or blank to indicate metastable state.
		7-18	ELEM - element name.
		19-24	ZNO - atomic number
		31	ICLASS(1) first inhalation class.
		32	ICLASS(2) - second inhalation class.
		33	ICLASS(3) - third inhalation class.
		37-40	F1(1) - f ₁ corresponding to first inhalation class.
		41-44	F1(2) - f ₁ corresponding to second inhalation class.
		45-48	F1(3) - f ₁ corresponding to third inhalation class.
		51-55	FRAC - percent decay (daughters only).
		56-59	F1(4) - f ₁ corresponding to first oral class.
		60-63	F1(5) - f ₁ corresponding to second oral class.
		64-67	F1(6) - f ₁ corresponding to third oral class.

Output may be grouped into two categories: (1) output to temporary data sets and (2) output to the line printer.

1. The MAIN routine creates three temporary data sets to be used by other subroutines within the code. Since they are used internal to the code, only a general description will be given. The first data set is &&SEEREM, which is written to unit 18 and contains a subset of the information in &&SEE. Only those SEE values for which there is a source organ in the metabolic model are contained in this data set. The second data set is &&STDØSE, which contains the committed dose equivalents broken down by source-target pairs and inhalation and oral class for each radionuclide in the chain. This data set is necessary to perform the 1% rule as described in Step I.7 of "Mode and Sequence of Computing Data for ICRP Tables." The third data set is &&CHAIN, which is written to unit 22 and contains the committed dose equivalents for each target organ for each radionuclide in the chain plus the total dose to all targets, all for each inhalation and oral class. This data set is used in computing the length of the chain of radionuclides. Consult Appendix C for correspondence between data set name and JCL.
2. The output to the line printer goes to two separate output units. Printout on unit 6 (primarily performed in MAIN) consists of the following:
 - a. The time interval of integration.
 - b. The cumulated activities (Bq-s) broken down by inhalation or oral class and within an inhalation class broken down by deposition in the various lung regions.
 - c. The committed dose equivalent values (Sv) for each inhalation and oral class. The fractions of dose resulting from deposition in the various regions of the lungs are given for each inhalation class.

Items a, b, and c are given for each radionuclide in a given chain.

 - d. The total committed dose equivalent values (Sv) for the entire chain of radionuclides.
 - e. Miscellaneous information for verifying results.

Printout on unit 15 consists of the following:

- a. Compressed SEE tables for each member of the chain produced by subroutine TAB0.
- b. Compressed "Number of Nuclear Transformations" table produced by TAB1.
- c. Committed dose equivalent table produced by TAB3.
- d. Weighted committed dose equivalent table produced by TAB5..
- e. Table of ALI and DAC produced by TAB6.

Printout is divided into two output units so that only unit 15 output is printed with reproduction quality ribbon, and unit 6 output is retained for checking purposes.

REFERENCES

1. Report of the International Commission on Radiological Protection by Committee 2, *Limits for Intake of Radionuclides by Workers*, ICRP Publication 30 (1979).
2. International Commission on Radiological Protection, *Recommendations of the International Commission on Radiological Protection*, ICRP Publication 26 (1977).
3. W. S. Snyder et al., *A Tabulation of Dose Equivalent Per Microcurie-Day for Source and Target Organs for an Adult for Various Radionuclides*, ORNL-5000 (November 1974).
4. W. S. Snyder et al., *A Tabulation of Dose Equivalent Per Microcurie-Day for Source and Target Organs of an Adult for Various Radionuclides*, ORNL-5000, Part 2 (November 1975).
5. L. T. Dillman, "Radionuclide Decay Schemes and Nuclear Parameters for use in Radiation-Dose Estimation," *J. Nucl. Med. Suppl.* 2:10,5 (March 1969) and *Suppl.* 4:11,5 (March 1970).
6. L. T. Dillman and F. C. Von Der lage, "Radionuclide Decay Schemes and Nuclear Parameters for use in Radiation-Dose Estimation," *J. Nucl. Med. Suppl.* 10: page 5 (September 1975).
7. L. T. Dillman, *EDISTR - A Computer Program to Obtain a Nuclear Decay Data Base from Radiation Dosimetry*, ORNL/TM-6689 (draft).
8. M. J. Berger, "Energy Deposition in Water by Photons from Point Isotropic Sources," *J. Nucl. Med. Suppl.* 1:15 (February 1968).
9. L. T. Dillman and T. D. Jones, "Internal Dosimetry of Spontaneously Fissioning Nuclides," *Health Phys.* 29: page 111 (1975).
10. M. R. Ford et al., "Maximum Permissible Concentration (MPC) Values for Spontaneously Fissioning Radionuclides," *Health Phys.* 33(1): 35-43 (July 1977).

11. S. B. Watson, W. S. Snyder and M. R. Ford, *TIMED: A Computer Program for Calculating Cumulated Activity of a Radionuclide in the Organs of the Human Body at a Given Time, t, After Deposition*, ORNL/CSD/TM-17 (December 1976).
12. U.S. Nuclear Regulatory Commission, *Reactor Safety Study - An Assessment of Accident Risks in the U.S. Commercial Nuclear Power Plants*, WASH-1400, NUREG-75/014 (1975).
13. M. R. Ford et al., *Internal Dosimetry Data and Methods of ICRP - Part 1*, ORNL/NUREG/TM 315 (June 1979).
14. ICRP Task Group on Lung Dynamics, "Deposition and Retention Models for Internal Dosimetry of the Human Respiratory Tract," *Health Phys.* 12:173 (1966).
15. International Commission on Radiological Protection, *The Metabolism of Compounds of Plutonium and the Other Actinides*, ICRP Publication 19 (1972).
16. I. S. Eve, "A Review of the Physiology of the Gastrointestinal Tract in Relation to Radiation Doses from Radioactive Materials," *Health Phys.* 12:131 (1966).
17. International Commission on Radiological Protection, *Report of the Task Group on Reference Man*, ICRP Publication 23 (1975).
18. A. C. Hindmarsh, *GEAR: Ordinary Differential Equation System Solver*, Lawrence Livermore Laboratory Report UCID-30001, Rev. 3 (December 1974).
19. C. W. Gear, *Numerical Initial Value Problems in Ordinary Differential Equations*, Prentice Hall, Englewood Cliffs, New Jersey (1971).
20. A. C. Hindmarsh, *Linear Multistep Methods for Ordinary Differential Equations: Method Formulations, Stability, and the Methods of Nordsiech and Gear*, Lawrence Livermore Laboratory Report UCRL-51186, Rev. 1 (March 1972).
21. A. Nordsiech, "On Numerical Integration of Ordinary Differential Equations," *Math. of Computations* 16:22 (1962).

22. D. E. Arnurius, Oak Ridge National Laboratory affiliation, private communication with S. B. Watson (1974).
23. N. Adams, B. W. Hunt, and J. A. Reissland, *Annual Limits of Intake of Radionuclides for Workers*, National Radiological Protection Board, Harwell, Didcot, NRPB-R82 (October 1978).

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APPENDIX A

PROGRAM LISTING OF SEE

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C      PROGRAM SEE
C      CALCULATES SPECIFIC EFFECTIVE ENERGIES FOR ORGAN PAIRS
C
C      CMCON/COMCNE/ CONTAINS THE FOLLOWING VARIABLES:
C      NSORS - NUMBER OF SOURCE ORGANS IN DATA SET
C      NTARG - NUMBER OF TARGET ORGANS IN DATA SET
C      SCRG(30,8)
C          SORG(I,J) - NAME OF ITH SOURCE ORGAN
C      TORG(40,10)
C          TORG(I,J) - NAME OF ITH TARGET ORGAN
C
C      CMNCH/COMSEV/ CONTAINS THE FOLLOWING VARIABLES:
C      AEO - MASS NUMBER
C      ZEO - ATOMIC NUMBER
C      LENE(3) - NAME OF THE ELEMENT
C      HLIFE - HALFLIFE OF THE RADIONUCLIDE
C      UNITS(2) - UNITS OF THE HALFLIFE
C      CHEMH - CHEMICAL SYMBOL OF THE ELEMENT
C      EXCH - SWITCH TO INDICATE METASTABLE STATE
C          M - METASTABLE
C          EIAK - NOT METASTABLE
C      NRAD - NUMBER OF RADS (RADIATIONS) FOR THIS RADIONUCLIDE
C      TY(3) - MASS NUMBER, CHEMICAL SYMBOL, AND ATOMIC NUMBER
C
C      CMNCH/COMNIN/ CONTAINS THE FOLLOWING VARIABLES:
C      GEFE(30,40)
C          GEFE(I,J) - GAMMA SEE VALUE FOR SOURCE ORGAN I,
C                      TARGET ORGAN J
C      BEFE(30,40)
C          BEFE(I,J) - BETA SEE VALUE FOR SOURCE ORGAN I, TARGET ORGAN J
C      AEFE(30,40)
C          AEFE(I,J) - ALPHA SEE VALUE FOR SOURCE ORGAN I, TARGET ORGAN J
C      REFE(30,40)
C          REFE(I,J) - ALPHA RECOIL SEE VALUE FOR SOURCE ORGAN I,
C                      TARGET ORGAN J
C      SPEFE(5,30,40)
C          SPEFE(K,I,J) - SPONTANEOUS FISSION SEE VALUE FOR SOURCE ORGAN
C                        I, TARGET ORGAN J
C                        K = 1 FISSION FRAGMENTS
C                        2 NEUTRONS
C                        3 SP GAMMA
C                        4 SP BETA
C                        5 SP TOTAL
C
C      VARIABLES RELATING TO THE DECAY DATA:
C      ICODE - STORES THE CODE NUMBER FOR TYPE OF RADIATION
C          1 = GAMMA RAYS
C          2 = X-RAYS
C          3 = ANNIHILATION QUANTA
C          4 = BETA PLUS
C          5 = BETA MINUS
C          6 = INTERNAL CONVERSION ELECTRONS
C          7 = AUGER ELECTRONS
C          8 = ALPHA PARTICLES
C          9 = SPONTANEOUS FISSION RADIATIONS
C
C      INDEX - STORES VARIOUS INDEXING INFORMATION
C              DEPENDING ON THE VALUE OF ICCDE - ARRAY NOT USED
C              IN THIS CODE
C
C      F - STORES PERCENT PER DECAY INTENSITY VALUE
C          FOR THE RADIATION
C
C      E - STORES IN MEV(AVERAGE ENERGY FOR BETA-PLUS
C          OR BETA-MINUS) EXCEPT FOR SPONTANEOUS FISSION
C          (ICCODE=9) IN WHICH CASE THE AVERAGE NUMBER OF NEUTRONS
C          PER SPONTANEOUS FISSION IS STORED
C
C      EM - IS USED ONLY WHEN ICODE=4 OR 5 IN WHICH CASE
C          IT IS THE VALUE OF THE BETA ENDPOINT ENERGY IN MEV,
C          OR WHEN ICODE=8 IN WHICH CASE IT IS THE VALUE OF THE
C          RECOIL NUCLEUS ENERGY IN MEV. WHEN IT IS NOT USED
C          EM IS ARBITRARILY SET EQUAL TO THE CORRESPONDING VALUE
C          IN THE E ARRAY.

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C
C CMNCH/MASS/ CONTAINS THE FOLLOWING VARIABLES:
C
C   TMASS(40)
C   TMASS(I) - MASS OF TARGET ORGAN USED IN GAMMA EXTRAPOLATION
C
C CMNCH/FRNTRX/ CONTAINS THE FOLLOWING VARIABLES:
C
C   NERS - NUMBER OF SOURCE ORGANS TO BE PRINTED
C
C   NPRT - NUMBER OF TARGET ORGANS TO BE PRINTED
C
C   IPRS(30) - ARRAY OF INDICES OF SOURCE ORGANS TO BE PRINTED
C
C   IPRT(40) - ARRAY OF INDICES OF TARGET ORGANS TO BE PRINTED
C
C   IGBAR(5) - ARRAY OF SWITCHES WHICH INDICATES MODES OF DECAY
C   0 = DECAY NOT PRESENT; 1 = DECAY PRESENT
C   IGEAR(1) - GAMMA DECAY
C   IGEAR(2) - BETA
C   IGEAR(3) - ALPHA
C   IGEAR(4) - RECOIL
C   IGEAR(5) - SPONTANEOUS FISSION
C
C CMNCH/SEER/ CONTAINS THE FOLLOWING VARIABLES:
C
C   IVOL = 1 RADIONUCLIDE IS VOLUME SOURCE
C   ISURF = 1 RADIONUCLIDE IS SURFACE SOURCE
C
C   INTEGER*2 SORG,TORG
C   REAL*4 LENE
C   COMMON /COMCNE/ NSORS,NTARG,SORG(30,8),TORG(40,10)
C   COMMON /COMSEV/ AHO,ZHO,LENE(3),HLIFE,UNITS(2),CHEMH,EXCH,NRAD,TY(
13)
C   COMMON /COMNIN/ GEFE(30,40),BEFE(30,40),AEFE(30,40),REFE(30,40),TE
1FE(30,40),SPEFE(5,30,40)
C   COMMON /MASS/ TMASS(40)
C   COMMON /FRNTRX/ NERS,NPRT,IPRS(30),IPRT(40),IGBAR(5)
C   COMMON /SEER/ IVOL,ISURF
C
C READ NAMES OF SOURCE AND TARGET ORGANS
C
C   REAL 150, NSORS,NTARG
C   DO 10 I=1,NSORS
C   READ 16C, (SCRG(I,J),J=1,8)
10 CONTINUE
C   DO 20 K=1,NTARG
C   READ 16C, (TORG(K,J),J=1,10)
20 CONTINUE
C
C READ GAMMA SPECIFIC ABSORBED FRACTION DATA
C
C   CALL INCAFR
C
C READ AND PRINT MASS OF TARGET ORGANS USED IN GAMMA EXTRAPOLATION
C
C   READ 170, (TMASS(K),K=1,NTARG)
C   PRINT 170, (TMASS(K),K=1,NTARG)
C
C READ BETA SPECIFIC ABSORBED FRACTION DATA
C
C   CALL INEEFR
C
C READ ALPHA SPECIFIC ABSORBED FRACTION DATA
C
C   CALL INALFR
C
C READ NEUTRON DOSE/NEUTRON FROM C252 SOURCE UNIFORMLY DISTRIBUTED
C IN EACH SOURCE ORGAN
C
C   CALL INCFAD
C
C
C READ INDICES WHICH IDENTIFY THE SOURCE AND TARGET
C ORGANS FOR WHICH SEE VALUES WILL BE PRINTED
C
C   READ (5,190) NERS,NPRT, (IPRS(I),I=1,NERS), (IPRT(I),I=1,NPRT)
C
C   SET TMASS TO RECIPROCAL OF TARGET ORGANS MASSES FOR
C GAMMA EXTREPOLATION
C
C   DO 30 K=1,NTARG
C   TMASS(K)=1./TMASS(K)
30 CONTINUE
C
C ZERO SPECIFIC EFFECTIVE ENERGY MATRICES
C
C   DO 50 I=1,NSORS
C   DO 50 K=1,NTARG
C   GEFE(I,K)=0.
C   BEFE(I,K)=0.
C   AEFE(I,K)=0.
C   REFE(I,K)=0.
C   DO 50 J=1,5

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      SPEFE(J,I,K)=0.
50 CONTINUE
C
C ZERO VECTOR OF DECAY TYPES
C
      DO 60 I=1,5
      IGEAR(I)=0
60 CONTINUE
C
C READ DECAY DATA
C
      READ (5,19C,END=150) IVOL,ISURF
      READ (5,20C,END=150) AHC,EXCH,LEBE,ZHC,HLIPE,UNITS,NRAD,TY,CHEMH
      DO 130 IRAD=1,NRAD
      READ 21C, ICODE,INDEX,P,E,EM
C
C FOR ALL FISSIONUCLIDES DETERMINE THE SEE VALUES
C FOR EACH SOURCE - TARGET PAIR
C
      KCDE=ICDDE
      DO 110 J=1,NPRS
      I=IPRS(J)
      DO 110 L=1,NPRT
      K=IPRT(L)
      IF (E.LE.0.) GO TO 110
C
C KCDE - 1,2,3 GAMMA
C 4,5,6,7 BETA
C 8 ALPHA
C 9 SPONTANEOUS FISSION
C
      GO TO (7C,70,7C,80,80,80,80,90,120),KODE
C
C GAMLIN - DETERMINES GAMMA SAF FOR SOURCE I - TARGET K
C
70 CONTINUE
      CALL GAMLIN (E,I,K,GAPR)
      IF (GAPR.LE.0.) GO TO 110
      IGEAR(1)=1
      GEFE(I,K)=GEFE(I,K)+P*E*GAPR*.01
      GO TO 110
C
C BETFRA - DETERMINES BETA SAF FOR SOURCE I - TARGET K
C
80 CONTINUE
      CALL BETFRA (E,EM,I,K,EAPR)
      IF (EAPR.LE.0.) GO TO 110
      IGEAR(2)=1
      BEFE(I,K)=BEFE(I,K)+P*E*BAPR*.01
      GO TO 110
C
C ALPFA - DETERMINES ALPHA SAF FOR SOURCE I - TARGET K
C
90 CONTINUE
      CALL ALPFA (I,K,ALPR)
      IF (ALPR.LE.0.) GO TO 110
      IGEAR(3)=1
      IGEAR(4)=1
      AEFE(I,K)=AEFE(I,K)+P*E*ALPR*.01
C
C CALCULATE RECOIL ENERGY
C
      CALL RECCIL (E,BRE)
C
      RECOIL ENERGY = 0 FOR GI TRACT
C
      IF (I.IT.2.OR.I.GT.5) GO TO 100
      ERE=C.C
100 CONTINUE
      RSAP=ALPR
C
C RECOIL SAF = 0 FOR ECNE DOSIMETRY
C
      IF ((I.EQ.15.OR.I.EQ.16).AND.(K.EQ.33.OR.K.EQ.19)) RSAP=0.
      REFE(I,K)=BEFE(I,K)+P*ERE*RSAP*.01
110 CONTINUE
      GO TO 130
C
C SPNFIS - CALCULATES SPONTANEOUS FISSION SEE VALUES
C
120 CONTINUE
      CALL SPNFIS (AHC,ZHC,P,E)
      IGEAR(5)=5
130 CONTINUE
C
C CALCULATE TOTAL SEE VALUES
C
      DO 140 J=1,NPRS
      I=IPRS(J)
      DO 140 L=1,NPRT
      K=IPRT(L)
      TEFE(I,K)=GEFE(I,K)+BEFE(I,K)+AEFE(I,K)+REFE(I,K)+SPEFE(5,I,K)
140 CONTINUE
C
C WRITE SEE TABLES
C

```

960
 965
 970
 975
 980
 985
 990
 995
 1000
 1005
 1010
 1015
 1020
 1025
 1030
 1035
 1040
 1045
 1050
 1055
 1060
 1065
 1070
 1075
 1080
 1085
 1090
 1095
 1100
 1105
 1110
 1115
 1120
 1125
 1130
 1135
 1140
 1145
 1150
 1155
 1160
 1165
 1170
 1175
 1180
 1185
 1190
 1195
 1200
 1205
 1210
 1215
 1220
 1225
 1230
 1235
 1240
 1245
 1250
 1255
 1260
 1265
 1270
 1275
 1280
 1285
 1290
 1295
 1300
 1305
 1310
 1315
 1320
 1325
 1330
 1335
 1340
 1345
 1350
 1355
 1360
 1365
 1370
 1375
 1380
 1385
 1390
 1395
 1400
 1405
 1410
 1415
 1420
 1425
 1430
 1435


```

      CALL CUTFUT (IFO)
      GO TO 40
150 CONTINUE
      PRINT 230
      STCE
C
160 FORMAT (10A2)
170 FCRMAT (8F15.2)
180 FCRMAT (2I2/(40I2))
190 FCRMAT (3I4)
200 FORMAT (F4.0,A1,1X,3A4,F4.0,E11.0,1X,2A4,I4,3(1X,A3),14X,A2)
210 FCRMAT (2I2,4E13.0)
220 FCRMAT (8E10.0)
230 FCRMAT ('1')
      END

```

1440
1445
1450
1455
1460
1465
1470
1475
1480
1485
1490
1495
1500
1505
1510-

```

      SUBROUTINE ALPFRA (ISO,ITA,APR)
C
C DETERMINE ALPHA SAF FOR SOURCE ORGAN I, TARGET ORGAN K
C
C ISO - SOURCE INDEX
C ITA - TARGET INDEX
C APR - ALPHA SPECIFIC ABSORBED FRACTION
C
      COMMON /FRAC/ GAMFR(30,12,40),BETFR(30,40,3),ALPFR(30,40,2),CFAD(3ALP
10,40)
      COMMON /SEEK/ IVOL,ISURF
      APR=ALPFR(ISC,ITA,1)
C
C FOR BONE ECCHIMETRY, SET APPROPRIATE SAF FOR VOLUME SEEKER
C OF SURFACE SEEKER
C
C ALPFR(ISC,ITA,1) - VOLUME SEEKER
C ALPFR(ISC,ITA,2) - SURFACE SEEKER
C
      IF ((ISC.EQ.15.OR.ISO.EQ.16).AND.(ITA.EQ.33.OR.ITA.EQ.19.OR.ITA.EQ
1.32).AND.ISURF.EQ.1) APR=ALPFR(ISO,ITA,2)
C
      RETURN
      END

```

ALP 5
ALP 10
ALP 15
ALP 20
ALP 25
ALP 30
ALP 35
ALP 40
ALP 45
ALP 50
ALP 55
ALP 60
ALP 65
ALP 70
ALP 75
ALP 80
ALP 85
ALP 90
ALP 95
ALP 100
ALP 105
ALP 110
ALP 115
ALP 120-

```

      SUBROUTINE BETFRA (ENERGY,ENMAX,ISO,ITA,APR)
C
C DETERMINE BETA SAF FOR SOURCE ORGAN I, TARGET ORGAN K
C
C ENERGY - MEAN ENERGY OF RADIATION
C ENMAX - INCIDENT ENERGY
C ISO - SOURCE INDEX
C ITA - TARGET INDEX
C APR - BETA SPECIFIC ABSORBED FRACTION
C
      COMMON /FRAC/ GAMFR(30,12,40),BETFR(30,40,3),ALPFR(30,40,2),CFAD(3BET
10,40)
      COMMON /SEEK/ IVOL,ISURF
      APR=BETFR(ISC,ITA,1)
C
C FOR BONE ECCHIMETRY, SET APPROPRIATE VALUES FOR VOLUME SEEKER
C OF SURFACE SEEKER
C
C
      IF ((ISC.EQ.15.OR.ISO.EQ.16).AND.(ITA.EQ.33.OR.ITA.EQ.19).AND.ISURF
1.EQ.1.AND.ENERGY.LT.0.2) APR=BETFR(ISO,ITA,2)
      IF ((ISC.EQ.15.OR.ISO.EQ.16).AND.(ITA.EQ.33.OR.ITA.EQ.19).AND.ISURF
1.EQ.1.AND.ENERGY.GE.0.2) APR=BETFR(ISO,ITA,3)
C
      RETURN
      END

```

BET 5
BET 10
BET 15
BET 20
BET 25
BET 30
BET 35
BET 40
BET 45
BET 50
BET 55
BET 60
BET 65
BET 70
BET 75
BET 80
BET 85
BET 90
BET 95
BET 100
BET 105
BET 110
BET 115
BET 120
BET 125
BET 130-

```

      SUBROUTINE GAMFR (E,ISC,ITA,APR)
C
C LINEAR INTERPOLATION SCHEME TO CALCULATE GAMMA SPECIFIC
C ABSORBED FRACTIONS WHICH ARE USED WITH GAMMA, X-RAYS, AND
C ANNIHILATION RADIATIONS. GAMMA SAF IS DEFINED FOR A
C GIVEN SOURCE - TARGET PAIR AND A GIVEN ENERGY.
C
C E - ENERGY OF THE RADIATION
C ISO - SOURCE INDEX
C ITA - TARGET INDEX
C APR - GAMMA SPECIFIC ABSORBED FRACTION
C
      COMMON /FRAC/ GAMFR(30,12,40),BETFR(30,40,3),ALPFR(30,40,2),CFAD(3GAM
10,40)
      COMMON /MASS/ IMASS(40)
      DIMENSION EK(12), MTARG(40)
      DATA EK/.01,.015,.02,.03,.05,.1,.2,.5,1.,1.5,2.,4./
      DATA MTARG/0,26,3,28,29,6,7,0,8,9,10,11,12,13,14,0,15,16,17,18,4*0
1,19,20,21,0,22,0,23,25/
C

```

GAM 5
GAM 10
GAM 15
GAM 20
GAM 25
GAM 30
GAM 35
GAM 40
GAM 45
GAM 50
GAM 55
GAM 60
GAM 65
GAM 70
GAM 75
GAM 80
GAM 85
GAM 90
GAM 95
GAM 100

[illegible]

```

      SUBROUTINE INALFR
C
C READS ALFPA SPECIFIC ABSORBED FRACTIONS
C
C ALPFR(30,40,2)
C   ALPFR(I,K,J) - ALFPA SPECIFIC ABSORBED FRACTION FOR SOURCE
C                   ORGAIN I, TARGET ORGAIN K. J = 1 FOR MOST
C                   SOURCE - TARGET PAIRS. HOWEVER FOR BONE DOSIMETRY
C                   J = 1 SAF FOR VOLUME SEEKER
C                   J = 2 SAF FOR SURFACE SEEKER
C
C   INTEGER*2 SOEG,TOEG
C   COMMON /CCMCNE/ NSCRS,NTARG,SCRG(30,8),TORG(40,10)
C   COMMON /FRAC/ GAMFR(30,12,40),BETFR(30,40,3),ALPFR(30,40,2),CFAD(30,40)
C
C   ZERC ALFFB AFRAY
C
C   DO 10 K=1,NTARG
C   DO 10 I=1,NSCRS
C   DO 10 J=1,2
C     ALPFR(I,K,J)=0.
C   10 CONTINUE
C
C   READ ALFPA SAF DATA SET
C
C   20 CONTINUE
C   READ 30, I,K,ALPFR(I,K,1),ALPFR(I,K,2)
C   IF (I.NE.30) GC TC 20
C
C   RETURN
C
C   30 FORMAT (2I5,2E10.0)
C   END
      INA 5
      INA 10
      INA 15
      INA 20
      INA 25
      INA 30
      INA 35
      INA 40
      INA 45
      INA 50
      INA 55
      INA 60
      INA 65
      INA 70
      INA 75
      INA 80
      INA 85
      INA 90
      INA 95
      INA 100
      INA 105
      INA 110
      INA 115
      INA 120
      INA 125
      INA 130
      INA 135
      INA 140
      INA 145
      INA 150
      INA 155
      INA 160
      INA 165
      INA 170-

      SUBROUTINE INBIFR
C
C READS BETA SPECIFIC ABSORBED FRACTIONS WHICH ARE USED WITH
C BETA PLUS, BETA MINUS, INTERNAL CONVERSION ELECTRON AND AUGER
C ELECTRON EMISSIONS
C
C BETFRA(30,40,3)
C   BETFRA(I,K,J) - BETA SPECIFIC ABSORBED FRACTION FOR SOURCE
C                   ORGAIN I, TARGET ORGAIN K. J = 1 FOR MOST SOURCE -
C                   TARGET PAIRS. HOWEVER FOR BONE DOSIMETRY
C                   J = 1 SAF FOR VOLUME SEEKER
C                   J = 2 SAF FOR SURFACE SEEKER, ENERGY LT 0.2 MEV
C                   J = 3 SAF FOR SURFACE SEEKER, ENERGY GE 0.2 MEV
C
C   INTEGER*2 SOEG,TCRG
C   COMMON /CCMCNE/ NSCRS,NTARG,SCRG(30,8),TORG(40,10)
C   COMMON /FRAC/ GAMFR(30,12,40),BETFR(30,40,3),ALPFR(30,40,2),CFAD(30,40)
C
C   ZERO BETFB AFRAY
C
C   DO 10 K=1,NTARG
C   DO 10 I=1,NSCRS
C   DO 10 J=1,3
C     BETFRA(I,K,J)=0.
C   10 CONTINUE
C
C   READ BETA SAF DATA SET
C
C   20 CONTINUE
C   READ 30, I,K,BETFR(I,K,1),BETFR(I,K,2),BETFR(I,K,3)
C   IF (I.NE.30) GC TO 20
C
C   RETURN
C
C   30 FORMAT (2I5,3E10.0)
C   END
      INB 5
      INB 10
      INB 15
      INB 20
      INB 25
      INB 30
      INB 35
      INB 40
      INB 45
      INB 50
      INB 55
      INB 60
      INB 65
      INB 70
      INB 75
      INB 80
      INB 85
      INB 90
      INB 95
      INB 100
      INB 105
      INB 110
      INB 115
      INB 120
      INB 125
      INB 130
      INB 135
      INB 140
      INB 145
      INB 150
      INB 155
      INB 160
      INB 165
      INB 170
      INB 175
      INB 180
      INB 185-

      SUBROUTINE INCFAL
C
C READS NEUTRON DOSES FOR A CF-252 SOURCE (PICORADS/NEUTRON)
C
C CFAD(30,40)
C   CFAD(I,K) - NEUTRON DOSES CALCULATED FOR CF-252
C               FOR SOURCE ORGAIN I, TARGET ORGAIN K
C
C   INTEGER*2 SOEG,TOEG
C   COMMON /CCMCNE/ NSCRS,NTARG,SCRG(30,8),TORG(40,10)
C   COMMON /FRAC/ GAMFR(30,12,40),BETFR(30,40,3),ALPFR(30,40,2),CFAD(30,40)
C
C   ZERC CFAL AFRAY
C
C   DO 10 K=1,NTARG
C   DO 10 I=1,NSCRS
C
      INC 5
      INC 10
      INC 15
      INC 20
      INC 25
      INC 30
      INC 35
      INC 40
      INC 45
      INC 50
      INC 55
      INC 60
      INC 65
      INC 70
      INC 75
      INC 80
      INC 85

```

```

      CFAD(I,K)=0.
10  CONTINUE
C
C  READ NEUTRON DOSE DATA SET
C
20  CONTINUE
    REAC 3C, K, (CFAD(I,K), I=1, NSORS)
    IF (K.NE.4C) GO TO 20
C
    RETURN
C
30  FORMAT (I2,8X,7F10.0/(10X,7F10.0))
    END

```

```

INC 50
INC 95
INC 100
INC 105
INC 110
INC 115
INC 120
INC 125
INC 130
INC 135
INC 140
INC 145
INC 150-

```

```

      SUBROUTINE INGAFR
C
C  INPUTS PHCTCN SPECIFIC ABSORBED FRACTIONS WHICH ARE USED WITH
C  GAMMAS, X-RAYS, AND ANNIHILATION RADIATIONS
C
C  GAMFR(30,12,40) - SPECIFIC ABSORBED FRACTION FOR SOURCE ORGAN I,
C  GAMFR(I,J,K) - SPECIFIC ABSORBED FRACTION FOR SOURCE ORGAN I,
C  TARGET ORGAN K, FOR THE JTH MONOENERGETIC PHOTON
C
C  G(12)
C  G(I) - SPECIFIC ABSORBED FRACTION FROM DISK FOR THE ITH.
C  MONOENERGETIC PHOTON
C
C  COMMON /FRAC/ GAMFR(30,12,40), BETFR(30,40,3), ALPFR(30,40,2), CFAD(30,
C  10,40)
C  INTEGER*2 SORG, TORG
C  COMMON /CONCNE/ NSCRS, NTARG, SCRG(30,8), TORG(40,10)
C  DIMENSION G(12)
C
C  READ SPECIFIC ABSORBED FRACTIONS FOR THE 12 MONOENERGETIC PHOTONS -
C  .01,.015,.02,.03,.05,.1,.2,.5,1.,1.5,2.,4.
C
C
C  DO 30 I=1, NSCRS
C  DO 30 K=1, NTARG
    READ 4C, (G(J), J=1,12)
    DO 20 J=1, 12
C..... 3.72001E-44 = EXP(-100)
    IF (G(J).GT.3.72001E-44) GO TO 10
    GAMFR(I,J,K)=3.72001E-44
    GC IC 20
    10 GAMFR(I,J,K)=G(J)
    20 CONTINUE
    30 CONTINUE
C
C  PRINT FIRST SAF FOR EACH SOURCE - TARGET PAIR TO VERIFY DATA SET
C
C  PRINT 50, ((GAMFR(I,1,K), I=1,12), K=1,33)
C  PRINT 50, ((GAMFR(I,1,K), I=13,24), K=1,33)
C  RETURN
C
40  FORMAT (7E10.0)
50  FORMAT (12E10.3)
    END

```

```

ING 5
ING 10
ING 15
ING 20
ING 25
ING 30
ING 35
ING 40
ING 45
ING 50
ING 55
ING 60
ING 65
ING 70
ING 75
ING 80
ING 85
ING 90
ING 95
ING 100
ING 105
ING 110
ING 115
ING 120
ING 125
ING 130
ING 135
ING 140
ING 145
ING 150
ING 155
ING 160
ING 165
ING 170
ING 175
ING 180
ING 185
ING 190
ING 195
ING 200
ING 205
ING 210
ING 215
ING 220
ING 225-

```

```

      SUBROUTINE OUTPUT (IPO)
C
C  WRITES OUTPUT TABLES CP SEE VALUES
C
C  INTEGER*2 SORG, TORG
C  REAL*8 TCDAY
C  DATA G/' G ', E/' E ', B/' B ', A/' A ', R/' R ', T/' T ' /
C  COMMON /CONCNE/ NSCRS, NTARG, SORG(30,8), TORG(40,10)
C  COMMON /CONCIN/ GEFE(30,40), BEFE(30,40), AEFE(30,40), REFE(30,40), TEFE(30,40),
C  1FE(30,40), SPEFE(5,30,40)
C  COMMON /EBNTRX/ NEFS, NEFT, IPRS(30), IPRT(40), IGBAR(5)
C  COMMON /SEEF/ IVOL, ISUBF
C  DIMENSION SF(5)
C  DATA SF/'SF-F', 'SF-N', 'SF-G', 'SF-B', 'SF-T' /
C
C  CALL ICAY (TCDAY)
C
C  FORM STR AND STR1 - DESCRIPTIVE INFO ABOUT RADIONUCLIDE
C
C  PUT TOGETHER CHARACTERS IN THE TITLE OF THE SEE TABLE
C
C  CALL TITLE
C
C  PRINT 100, TCDAY
C  IG=IGBAR(1)+IGBAR(2)+IGBAR(3)+IGBAR(4)+IGBAR(5)+1
C  IE=-10
C  NLINE=NEFS/11
C  IF (NEFS.II.11) GO TO 50

```

```

OUT 5
OUT 10
OUT 15
OUT 20
OUT 25
OUT 30
OUT 35
OUT 40
OUT 45
OUT 50
OUT 55
OUT 60
OUT 65
OUT 70
OUT 75
OUT 80
OUT 85
OUT 90
OUT 95
OUT 100
OUT 105
OUT 110
OUT 115
OUT 120
OUT 125
OUT 130
OUT 135
OUT 140
OUT 145
OUT 150

```



```

      SUBROUTINE PRDRT (TODAY,IPO)
C
C   WRITE SEE VALUES CN DISK (UNIT 14) AND ON TAPE (UNIT 15)
C   IPO = 1 WRITE CN DISK ONLY
C   IPO NE 1 WRITE ON DISK AND ON TAPE
C
      REAL*4 IFNE
      REAL*8 TCDA
      COMMON /COMCNE/ NSCRS,NTARG,X(160)
      COMMON /COMNIN/ GEFE(30,40),BEFE(30,40),AEFE(30,40),REFE(30,40),TEPRD
      1FE(30,40),SPEFE(5,30,40)
      COMMON /COMSEV/ AHO,ZHO,LEME(3),HLIFE,UNITS(2),CHEM,EXCH,NRAD,TY(3)
      1)
      COMMON /PRNTRX/ NPRS,NPRT,IPRS(30),IPRT(40),IGBAR(5)
C
C   WRITE SEE VALUES CN DISK FOR USE IN DOSE CODES
C
      WRITE (14) AHO,EXCH,LEME,ZHO,NSORS,NTARG,TODAY
      DC 10 K=1,NTARG
      10 WRITE (14) (GEFE(I,K),I=1,NSORS)
      DO 20 K=1,NTARG
      20 WRITE (14) (BEFE(I,K),I=1,NSORS)
      DC 30 K=1,NTARG
      30 WRITE (14) (AEFE(I,K),I=1,NSORS)
      DC 40 K=1,NTARG
      40 WRITE (14) (REFE(I,K),I=1,NSORS)
      DC 50 J=1,5
      DO 50 K=1,NTARG
      WRITE (14) (SPEFE(J,I,K),I=1,NSORS)
      50 CONTINUE
      DO 60 K=1,NTARG
      60 WRITE (14) (TEFE(I,K),I=1,NSORS)
C
C   WRITE S TAELE CN TAPE (UNIT 15)
C
      IF (IFC.EQ.1) GO TO 180
      IG-IGEAR(1)+IGDAR(2)+IGBAR(3)+ICBAR(4)+IGBAR(5)+1
      WRITE (15,190) AHC,EXCH,LEME,ZHO,HLIFE,UNITS,NPRS,NPRT,IG,TCDA
      WRITE (15,200) (IPRS(I),I=1,NPRS),(IPRT(I),I=1,NPRT)
      IF (IGEAR(1).EQ.0) GO TO 80
      DO 70 K=1,NPRT
      WRITE (15,210) (GEFE(IPRS(I),IPRT(K)),I=1,NPRS)
      70 CONTINUE
      80 CONTINUE
      IF (IGEAR(2).EQ.0) GO TO 100
      DO 90 K=1,NPRT
      WRITE (15,210) (BEFE(IPRS(I),IPRT(K)),I=1,NPRS)
      90 CONTINUE
      100 CONTINUE
      IF (IGEAR(3).EQ.0) GO TO 120
      DO 110 K=1,NPRT
      WRITE (15,210) (AEFE(IPRS(I),IPRT(K)),I=1,NPRS)
      110 CONTINUE
      120 CONTINUE
      IF (IGEAR(4).EQ.0) GO TO 140
      DO 130 K=1,NPRT
      WRITE (15,210) (REFE(IPRS(I),IPRT(K)),I=1,NPRS)
      130 CONTINUE
      140 CONTINUE
      IF (IGEAR(5).EQ.0) GO TO 160
      DO 150 J=1,5
      DO 150 K=1,NPRT
      WRITE (15,210) (SPEFE(J,IPRS(I),IPRT(K)),I=1,NPRS)
      150 CONTINUE
      160 CONTINUE
      DO 170 K=1,NPRT
      WRITE (15,210) (TEFE(IPRS(I),IPRT(K)),I=1,NPRS)
      170 CONTINUE
      180 CONTINUE
      RETURN
C
      190 FCNMT (15.0,A1,1X,3A4,P5.0,1PE11.4,1X,2A4,3I3,A6)
      200 FCNMT (6012)
      210 FCNMT (1PE12E11.3)
      END
C
      SUBROUTINE RECCII (ENERGY,ERE)
C
C   CALCULATE RECCII ENERGY
C
      COMMON /COMSEV/ AHO,ZY(13)
      ERE=(ENERGY*4.)/(AHO-4.)
      RETURN
      END
C
      SUBROUTINE SFNFIS (A,Z,P,NUBAR)
C
C   THIS SUBROUTINE CALCULATES SPONTANEOUS FISSION SEE VALUES
C   REFERENCE 'INTERNAL DOSIMETRY OF SPONTANEOUSLY FISSIONING NUCLIDES',
C   L. THOMAS CILLMAN AND TROYCE JONES
C

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C A - MASS NUMBER SFN 35
C Z - ATOMIC NUMBER SFN 40
C P - SPONTANEOUS FISSION YIELD SFN 45
NUFAR - AVERAGE NUMBER OF NEUTRONS PER SPONTANEOUS FISSION SFN 50
C SFN 55
REAL*4 KUEAR SFN 60
COMMON /PRNTRX/ NPBS,NPET,IPRS(30),IPRT(40),IGBAR(5) SFN 65
COMMON /CCMNIN/ GEPE(30,40),BEPE(30,40),AEPE(30,40),REPE(30,40),TESPN SFN 70
1FE(30,40),SPEPE(5,30,40) SFN 75
COMMON /FRAC/ GAMFR(30,12,40),BETFR(30,40,3),ALPFR(30,40,2),CPAD(3SFN 80
10,40) SFN 85
DIMENSION EIF(42), FIP(42), EID(28), FID(28) SFN 90
SFN 95
PROMPT GAMMA-RAYS IN THE FISSION OF U-236 SFN 100
SFN 105
DATA EIP/0.0148,0.0314,0.0453,0.0553,0.0753,0.0853,0.0953,0.11,0.1SFN 110
13,0.15,0.17,0.19,0.225,0.275,0.325,0.375,0.425,0.475,0.525,0.575,0SFN 115
2.645,C.749,C.849,C.949,1.049,1.149,1.25,1.35,1.45,1.73,2.23,2.73,3SFN 120
3.23,3.73,4.23,4.73,5.23,5.91,6.91,7.91,8.91,9.91/ SFN 125
DATA FIE/0.0947,0.247,0.00716,0.0102,0.0208,0.0295,0.0421,0.14,0.1SFN 130
14,0.14,0.14,0.14,0.351,0.351,0.351,0.351,0.351,0.351,0.351,0.351,0SFN 135
2.676,C.565,0.474,0.396,0.332,0.277,0.232,0.194,0.162,0.575,0.334,0SFN 140
3.193,0.112,0.0650,0.0377,0.0218,0.0127,0.0116,0.0039,0.0013,0.0004SFN 145
44,0.00015/ SFN 150
SFN 155
DELAYED GAMMA-RAYS IN THE FISSION OF U-236 SFN 160
SFN 165
DATA EID/0.03,0.05,0.07,0.09,0.11,0.13,0.15,0.17,0.19,0.225,0.275,SFN 170
10.325,0.375,0.44,0.54,0.64,0.74,0.84,1.10,1.56,2.00,2.40,2.80,3.25SFN 175
2.3,3.75,4.25,4.75,5.25/ SFN 180
DATA FID/9*0.11,4*0.27,0.76,0.59,0.46,0.36,0.28,1.18,0.77,0.78,0.7SFN 185
18,0.16,0.12,0.086,0.042,0.020,0.0095/ SFN 190
SFN 195
SF FRAGMENT SEE VALUES SFN 200
SFN 205
FEAR=C.139601*2**2/A**(1./3.)-21.975 SFN 210
DO 10 I=1,NPBS SFN 215
I=IPRS(I) SFN 220
DO 10 I=1,NPET SFN 225
K=IPRT(I) SFN 230
CALL AEFRA (I,K,BFR) SFN 235
SPEPE (I,I,K)=F*0.01*EBAR*AFR SFN 240
10 CONTINUE SFN 245
SFN 250
SF NEUTRON SEE VALUES SFN 255
SFN 260
FEAR=C.75+0.65*SQRT(NUFAR+1.0) SFN 265
DO 20 I=1,NPBS SFN 270
I=IPRS(I) SFN 275
DO 20 I=1,NPET SFN 280
K=IPRT(I) SFN 285
SPEPE (2,I,K)=3.1968E-3/51.15*NUBAR*EBAR*F*0.01*CPAD (I,K) *10.0/2.16SFN 290
14 SFN 295
IF (I.EQ.13.AND.K.EQ.27) SPEPE (2,I,K)=0. SFN 300
IF (I.EQ.21.AND.K.EQ.14) SPEPE (2,I,K)=0. SFN 305
IF (I.EQ.21.AND.K.EQ.30) SPEPE (2,I,K)=0. SFN 310
20 CONTINUE SFN 315
SFN 320
SF GAMMA SEE VALUES SFN 325
SFN 330
R=0.0279*(5.98+92.0/236.0*A-Z)**2 SFN 335
DO 50 I=1,NPBS SFN 340
I=IPRS(I) SFN 345
DO 50 I=1,NPET SFN 350
K=IPRT(I) SFN 355
GUM=0. SFN 360
DO 30 J=1,28 SFN 365
CALL GAMLIN (EID(J),I,K,GAPR) SFN 370
SUM=SUM+EID(J)*FID(J)*GAPR SFN 375
30 CONTINUE SFN 380
SUM=SUM+R SFN 385
DO 40 J=1,42 SFN 390
CALL GAMLIN (EIP(J),I,K,GAPR) SFN 395
SUM=SUM+EIP(J)*FIP(J)*CAPR SFN 400
40 CONTINUE SFN 405
SPEPE (2,I,K)=F*0.01*SUM SFN 410
50 CONTINUE SFN 415
SFN 420
SF BETA SEE VALUES SFN 425
SFN 430
FBETA=(5.98+92.0/236.0*A-Z)/2.0 SFN 435
FEAR=0.4116*FBETA SFN 440
SFN 445
BETA MINUS SFN 450
SFN 455
FEO=FEAR/0.37 SFN 460
DO 60 I=1,NPBS SFN 465
I=IPRS(I) SFN 470
DO 60 I=1,NPET SFN 475
K=IPRT(I) SFN 480
CALL EEFRA (FEAR,FEO,I,K,BAPR) SFN 485
SPEPE (4,I,K)=F*0.01*FBETA*EBAR*BAPR SFN 490
60 CONTINUE SFN 495
SFN 500
BETA PLUS SFN 505

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C      EEO=EBAE/0.44                      SFN 510
C      DC 70 E=1,NPRS                      SFN 515
C      I=IPRS (M)                          SFN 520
C      DC 7C I=1,NPRT                      SFN 525
C      K=IPRT (L)                          SFN 530
C      CALL EPTFPA (EPAE,EBO,I,K,BAPR)     SFN 535
C      SPEFE(4,I,K)=SPEFE(4,I,K)+F*0.01*FBETA*EBAR*BAPR SFN 540
C      70 CONTINUE                         SFN 545
C                                          SFN 550
C      TCTAL SF SEE VALUES                SFN 555
C                                          SFN 560
C      DO 80 E=1,NPRS                      SFN 565
C      I=IPRS (E)                          SFN 570
C      DC 80 I=1,NPFT                      SFN 575
C      K=IPFT (L)                          SFN 580
C      SPEFE(5,I,K)=SPEFE(1,I,K)+SPEFE(2,I,K)+SPEFE(3,I,K)+SPEFE(4,I,K) SFN 585
C      80 CONTINUE                         SFN 590
C                                          SFN 595
C      RETURN                              SFN 600
C      END                                 SFN 605
C                                          SFN 610-

```

```

C      SUPRCUTINE TITLE                    TIT 5
C                                          TIT 10
C      PUT TOGETHER CHARACTERS IN THE TITLE OF SEE TABLE TIT 15
C      AND CENTER OVER THE TABLE         TIT 20
C                                          TIT 25
C      REAL*4 LEME(3),UNITS(2)             TIT 30
C      COMMON /CONSEV/ AHC,ZHC,LEME(3),HLIFE,UNITS(2),CHENH,EXCH,NRAD,TY TIT 35
C      13)                                 TIT 40
C      COMMON /CORCBE/ HSCRS,WTARG,SORG(30,8),TORG(40,10) TIT 45
C      COMMON /FRNTEX/ NFRS,NERT,IPRS(30),IPRT(40),IGBAR(5) TIT 50
C      INTEGER*2 SORG,IOEG                 TIT 55
C      LCGICAL*1 STR(132),TEMP(12),BLANK/' '/,DASH/'-'/,ANO(4),ZERO,TR(6) TIT 60
C      1/' ','I','R','=' ,')',XHLIFE(9),TEMP1(4),TEMP2(8) TIT 65
C      LCGICAL*1 STR1(132),ZNO(4),PRNTR(67),PRNTR1(67) TIT 70
C      LCGICAL*1 CONT(11)/' ','C','O','N','T','I','N','U','E','D'/' TIT 75
C      LCGICAL*1 S/'S'/'N'/'M'/'D'/'D'/'F'/'C'/'R'/'/'/' TIT 80
C      EQUIVALENCE (LEME(1),TEMP(1)), (EXCH,TEMP1(1)), (UNITS(1),TEMP2(1)) TIT 85
C      1)                                 TIT 90
C      ZERO=.FALSE.                       TIT 95
C      IABC=AEC                             TIT 100
C      IZHC=ZEC                             TIT 105
C                                          TIT 110
C      IP=0                                TIT 115
C      IP1=0                                TIT 120
C      DO 10 I=1,132                       TIT 125
C      STR(I)=ZEREC                         TIT 130
C      10 CONTINUE                         TIT 135
C      DO 20 I=1,132                       TIT 140
C      STR1(I)=ZEREC                       TIT 145
C      20 CONTINUE                         TIT 150
C      DC 30 I=1,4                         TIT 155
C      IP=IP+1                             TIT 160
C      STR(IP)=FOF(I)                      TIT 165
C      30 CONTINUE                         TIT 170
C                                          TIT 175
C      PUT Z NUMEER IN STR                 TIT 180
C                                          TIT 185
C      CALL INTCPC (IZHC,ZNO)              TIT 190
C      DC 4C I=1,4                         TIT 195
C      IF (ZNC(I).EQ.ZERC) GO TO 50        TIT 200
C      IF (ZNC(I).EQ.ELANK) GO TO 40       TIT 205
C      IP=IP+1                             TIT 210
C      STR(IP)=ZNC(I)                     TIT 215
C      IP1=IP+1                             TIT 220
C      STR1(IP1)=ZNC(I)                   TIT 225
C      40 CONTINUE                         TIT 230
C      50 CONTINUE                         TIT 235
C                                          TIT 240
C      PUT DASH IN STR                     TIT 245
C                                          TIT 250
C      IP=IP+1                             TIT 255
C      STR(IP)=DASH                         TIT 260
C      IP1=IP+1                             TIT 265
C      STR1(IP1)=DASH                     TIT 270
C                                          TIT 275
C      PUT NAME OF RADIONUCLIDE IN STR     TIT 280
C                                          TIT 285
C      DC 60 I=1,12                       TIT 290
C      IF (TEMP(I).EQ.ELANK) GO TO 60      TIT 295
C      IP=IP+1                             TIT 300
C      STR(IP)=TEMP(I)                     TIT 305
C      IP1=IP+1                             TIT 310
C      STR1(IP1)=TEMP(I)                   TIT 315
C      60 CONTINUE                         TIT 320
C                                          TIT 325
C      PUT DASH IN STR                     TIT 330
C                                          TIT 335
C      IP=IP+1                             TIT 340
C      STR(IP)=DASH                         TIT 345
C      IP1=IP+1                             TIT 350
C                                          TIT 355

```



```

      STR1(IE1)=LASH
C
C PUT A NUMBER IN STR
C
      CALL INTCEC (IANC,ANO)
      DC 70 I=1,4
      IF (ANC(I).EQ.2ERC) GO TO 80
      IF (ANC(I).EQ.ELANK) GO TO 70
      IP=IP+1
      STR(IE)=ANC(I)
      IE1=IE1+1
      STR1(IE1)=ANC(I)
      70 CONTINUE
      80 CONTINUE
C
C PUT N, IF METASTABLE STATE
C
      IF (TEMP1(1).EQ.ELANK) GO TO 90
      IE=IE+1
      STR(IE)=TEMP1(1)
      IE1=IE1+1
      STR1(IE1)=TEMP1(1)
      90 CONTINUE
C
C PUT RADIOACTIVE HALFLIFE IN STR
C
      DO 100 I=1,5
      IE=IE+1
      STR(IE)=TR(I)
      100 CONTINUE
      CALL CORF (XHLIFE,9)
      WRITE (1,100) XHLIFE
      DC 110 I=1,9
      IE=IE+1
      STR(IE)=XHLIFE(I)
      110 CONTINUE
      IP=IP+1
      STR(IE)=ELANK
      KCUNT=5
      IF (TEMP2(1).EQ.S.CR.TEMP2(1).EQ.M) KCUNT=3
      IF (TEMP2(1).EQ.D) KCUNT=4
      DC 120 I=1,KCUNT
      IE=IE+1
      STR(IE)=TEMP2(I)
      120 CONTINUE
      IE=IE+1
      STR(IE)=TR(6)
C
C
C CENTER STR
C
      ICVER=(123-IE)/2
      DC 130 I=1,ICVER
      PRNTR(I)=FIANK
      130 CONTINUE
C
C
C CENTER STR1
C
      IF11=IE1+11
      IOVER1=(123-IP11)/2
      DC 140 J=1,IOVER1
      PRNTR1(J)=ELANK
      140 CONTINUE
C
      RETURN
C
      ENTEX FR(N,IE,IE)
      GC TC (150,160),N
      150 CONTINUE
      PRINT 190, (PRNTR(I),I=1,IOVER),(STR(I),I=1,IP)
      GC TC 170
      160 CONTINUE
      PRINT 200, (PRNTR1(I),I=1,IOVER1),(STR1(I),I=1,IP1),(CONT(I),I=1,11)
      170 CONTINUE
      PRINT 210
      PRINT 220, ((SORG(IPRS(I),J),J=1,4),I=IB,IE)
      PRINT 220, ((SCRG(IPRS(I),J),J=5,8),I=IB,IE)
      RETURN
C
      180 FORMAT (1P29.3)
      190 FORMAT (' ',132A1)
      200 FORMAT ('1',132A1)
      210 FORMAT ('0', ' TARGET ',41X,'S C U R C E O R G A N S',/, ' ', ' ORGTIT
      1ANS ')
      220 FORMAT (' ',13X,12(2X,4A2))
      END

```

TIT 360
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APPENDIX B

SAMPLE INPUT AND OUTPUT TO THE SEE PROGRAM

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APPENDIX B
SAMPLE INPUT AND OUTPUT TO THE SEE PROGRAM

The radionuclide ^{54}Mn is the example presented in Appendices B, E, and G. Following the examples in these three appendices will guide the user through a complete run of the ICRP Code.

For this Appendix the input (see Table 2.6) contains:

1. Names of source and target organs — This includes the full set of organs for which gamma specific absorbed fractions are available at Oak Ridge National Laboratory. *This ordering of source and target organs is used throughout the entire code.*
2. Gamma specific absorbed fractions — The blanks within the data set are for those source or target organs in the data base which are not of interest in the ICRP calculations. (Most of the gamma SAF data are omitted to save space).
3. Masses of target organs in extrapolation calculations for gamma specific absorbed fractions.
4. Beta specific absorbed fractions.
5. Alpha specific absorbed fractions.
6. Neutrons doses from ^{252}Cf source.
7. Indices of source and target organs to be printed.
8. Decay data for ^{54}Mn .

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Sample Input to the SEE Program

```

25 33
    BLAD CON
    S CCNT
    SI+CONT
    ULI CCNT
    LLI CONT
    KIDNEYS
    LIVER
    SAL GLND
    TB REG
    LUNG      (F REG)
RESP  LYM NCDE
      MUSCLE*
      OVARIES
      PANCREAS
      COR BONE
      CAN ECNE      (TRA BONE)
      P MARROW
      Y MARROW
      SKIN
      SPLEEN
      TESTES
      THYROID
      T ECDY
      CLOUD
      ADRENALS
      BLAD WALL
GI TRACT  S WALL
          SI+CONT
          ULI WALL
          LLI WALL
          KIDNEYS
          LIVER
          LUNGS
          SAL GLND
          TB REG
          P REG
RESP      LYM NODE
          MUSCLE*
          OVARIES
          PANCREAS
SKELETON  BONE
          COR BONE
          CAN BONE
          R MARROW
          Y MARROW
          T MARROW
          COR E CL
          CAN E CL
          T E CL
          SKIN
          SPLEEN
          TESTES
          THYMOS
          THYROID
          UTERUS
          T ECDY
          ADRENALS
          SURFACES
BONE      .8494-3 .1401-2 .1434-2 .9835-3 .4494-3 .2560-3 .2466-3 BLC1 BLW
          .2560-3 .2225-3 .2070-3 .1967-3 .1575-3
          .2833-17 .4250-17 .1203-10 .3283-7 .4532-6 .1052-5 .1016-5 BLC2 BLW
          .1102-5 .1857-5 .1304-5 .1833-5 .1532-5
          .1520-9 .2280-9 .1761-6 .5106-5 .1243-4 .1218-4 .1026-4 BLC1 STW
          .8970-5 .8840-5 .8166-5 .8423-5 .6654-5
          .1711-9 .2567-9 .1022-6 .3039-5 .8586-5 .8309-5 .8371-5 BLC2 STW
          .8184-5 .6186-5 .6153-5 .5799-5 .5292-5
          .3416-6 .5124-6 .7802-5 .3507-4 .4156-4 .3011-4 .2511-4 BLC1 SI
          .2438-4 .2093-4 .2165-4 .2023-4 .1361-4
          .1518-18 .2277-18 .3951-11 .2460-7 .4054-6 .9979-6 .1005-5 BLC2 SI
          .1333-5 .1168-5 .1690-5 .1258-5 .1370-5
          .2608-18 .3912-18 .2368-11 .2050-7 .2724-6 .5555-6 .7700-6 BLC1 KID
          .9761-6 .1019-5 .9601-6 .1193-5 .1044-5
          .4259-28 .6389-28 .5549-16 .7649-10 .1311-7 .8891-7 .9333-7 BLC2 KID
          .1655-6 .2829-6 .3071-6 .3312-6 .4606-6
          BLC1 LIV
          BLC2 LIV
          BLC1 LUN
          BLC2 LUN
          BLC1 SGL
          BLC2 SGL
          BLC1 T-B
          BLC2 T-B
          BLC1 PUL
          BLC2 PUL
          BLC1 LYM
          BLC2 LYM
          .2004-6 .2020-5 .5418-5 .9695-5 .9259-5 .6861-5 .6278-5 BLC1 MUS
          .6129-5 .5710-5 .5422-5 .5109-5 .4271-5
          .6235-8 .9353-8 .1624-5 .2781-4 .3585-4 .2821-4 .2723-4 BLC2 MUS
          .2170-4 .1352-4 .2314-4 .1657-4 .1482-4
          .3633-21 .5450-21 .2109-12 .6509-8 .2922-6 .7244-6 .1105-5 BLC1 OVS
          .8925-6 .1001-5 .7996-6 .1398-5 .8264-6
          BLC2 OVS
          BLC1 PAN
          BLC2 PAN
          BLC1 BON
          BLC2 BON
          BLC1 COB
          BLC2 COB
          BLC1 TRB
          BLC2 TRB

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.2836-7	.4255-7	.5673-7	.3883-5	.1231-4	.1000-4	.6101-5	BLC1R MA
.4329-5	.3723-5	.3475-5	.3361-5	.3067-5			BLC2R MA
							BLC1Y MA
							BLC2Y MA
							BLC1T MA
							BLC2T MA
							BLC1COEC
							BLC2COEC
							BLC1TREC
							BLC2TREC
							BLC1T EC
							BLC2T EC
.2659-7	.3988-7	.3752-6	.1702-5	.2261-5	.2122-5	.2006-5	BLC1 SKI
.2240-5	.2350-5	.2221-5	.2117-5	.1889-5			BLC2 SKI
.2629-21	.3943-21	.1520-12	.4777-8	.1956-6	.3866-6	.5293-6	BLC1 SPL
.7805-6	.8528-6	.6336-6	.1125-5	.4630-6			BLC2 SPL
.1791-8	.2686-8	.1386-5	.1541-4	.2754-4	.1882-4	.1595-4	BLC1 TES
.1755-4	.1568-4	.1285-4	.1404-4	.1208-4			BLC2 TES
.5913-36	.8869-36	.1318-19	.2050-11	.2065-8	.2670-7	.6220-7	BLC1 THM
.1098-6	.1540-6	.1781-6	.1938-6	.2096-6			BLC2 THM
.6205-24	.9308-24	.1241-23	.2859-13	.1555-9	.4046-8	.1333-7	BLC1 THR
.3269-7	.5682-7	.7326-7	.8550-7	.1049-6			BLC2 THR
.3985-5	.5827-5	.4278-4	.1094-3	.1019-3	.6213-4	.5509-4	BLC1 UT
.5110-4	.4687-4	.3977-4	.4038-4	.3303-4			BLC2 UT
							BLC1T BY
							BLC2T BY
.2677-24	.4015-24	.8921-14	.1560-8	.1199-6	.5067-6	.7042-6	BLC1 ADP
.7967-6	.8398-6	.8411-6	.8327-6	.7627-6			BLC2 ADP
.2557-10	.3836-10	.1604-7	.1160-5	.4305-5	.4065-5	.2701-5	BLC1BNSP
.2030-5	.1777-5	.1719-5	.1714-5	.1550-5			BLC2BNSP
.1608-17	.2412-17	.8640-11	.2822-7	.5321-6	.1174-5	.7911-6	STC1 BLW
.1578-5	.1655-5	.1476-5	.1028-5	.1437-5			STC2 BLW
.3206-3	.7609-3	.8998-3	.6868-3	.3277-3	.1084-3	.1784-3	STC1 STW
.1789-3	.1653-3	.1479-3	.1407-3	.1152-3			STC2 STW
.1993-6	.2990-6	.1232-5	.6724-5	.1216-4	.1084-4	.9274-5	STC1 SI
.9079-5	.8160-5	.7366-5	.7665-5	.6381-5			STC2 SI
.8087-6	.1213-5	.5675-5	.1623-4	.1897-4	.1396-4	.1260-4	STC1LLIW
.1133-4	.9619-5	.1166-4	.8404-5	.7907-5			STC2LLIW
.1709-8	.2564-8	.2798-6	.1832-5	.4776-5	.4438-5	.4651-5	STC1LLIW
.4355-5	.4535-5	.4507-5	.3982-5	.2762-5			STC2LLIW
.3829-9	.5744-9	.4173-6	.8185-5	.1654-4	.1365-4	.1262-4	STC1 KID
.1131-4	.1058-4	.9842-5	.8969-5	.7421-5			STC2 KID
.2144-6	.3216-6	.4288-6	.3992-5	.8269-5	.8059-5	.7003-5	STC1 LIV
.7020-5	.6345-5	.6152-5	.6196-5	.4895-5			STC2 LIV
.1763-6	.2645-6	.2596-5	.7908-5	.9611-5	.6922-5	.5971-5	STC1 LUN
.6405-5	.5721-5	.5514-5	.4913-5	.4284-5			STC2 LUN
							STC1 SGL
							STC2 SGL
							STC1 T-B
							STC2 T-B
							STC1 POL
							STC2 POL
							STC1 LYM
							STC2 LYM
.3982-7	.1152-5	.3918-5	.7643-5	.7311-5	.5369-5	.4963-5	STC1 MOS
.4839-5	.4603-5	.4379-5	.4103-5	.3451-5			STC2 MOS
.1987-13	.2980-13	.1053-0	.2007-0	.2360-9	.2135-5	.1530-5	STC1 QVS
.1699-5	.5086-5	.3023-5	.2860-5	.2422-5			STC2 QVS
.8300-5	.1245-4	.6954-4	.1398-3	.1119-3	.7103-4	.6368-4	STC1 PAN
.6721-4	.6235-4	.5064-4	.4402-4	.3390-4			STC2 PAN
							STC1 BON
							STC2 BON
							STC1 COB
							STC2 COB
							STC1 TRB
							STC2 TRB
.3998-7	.5957-7	.6673-6	.3652-5	.8533-5	.7120-5	.4643-5	STC1R MA
.3609-5	.3179-5	.2900-5	.2780-5	.7657-5			STC2R MA
							STC1Y MA
							STC2Y MA
							STC1T MA
							STC2T MA
							STC1COEC
							STC2COEC
							STC1TREC
							STC2TREC
							STC1T EC
							STC2T EC
.1381-7	.2071-7	.3621-6	.1526-5	.1940-5	.1659-5	.1673-5	STC1 SKI
.2042-5	.2671-5	.1965-5	.2093-5	.1697-5			STC2 SKI
.1125-6	.1688-6	.1059-4	.5186-4	.5984-4	.3956-4	.3561-4	STC1 SPL
.3265-4	.3038-4	.2804-4	.2489-4	.1845-4			STC2 SPL
.3449-25	.5129-25	.1887-14	.5202-9	.5499-7	.2786-6	.2414-6	STC1 TES
.8064-7	.5721-6	.5912-6	.5950-6	.5614-6			STC2 TES
.2195-17	.3293-17	.1183-10	.3413-7	.1577-5	.1072-5	.8914-6	STC1 THM
.7814-6	.2867-5	.2263-5	.1652-5	.1418-5			STC2 THM
.5674-25	.8511-25	.2271-14	.5700-9	.5823-7	.2589-6	.4346-6	STC1 THR
.5258-6	.5818-6	.5961-6	.6023-6	.5667-6			STC2 THR
.7513-15	.1127-14	.2810-9	.1901-6	.1446-5	.2896-5	.2966-5	STC1 UT
.3080-5	.3217-5	.3283-5	.2540-5	.4005-5			STC2 UT
							STC1T BY
							STC2T BY
.4322-10	.6483-10	.1047-6	.3445-5	.1207-4	.1155-4	.8528-5	STC1 ADP
.7283-5	.7019-5	.1149-4	.7786-5	.5165-5			STC2 ADP
.3860-7	.5790-7	.6314-6	.3046-5	.5516-5	.4003-5	.2586-5	STC1BNSP

.2084-5	.1889-5	.1789-5	.1733-5	.1614-5			SIC2BNSP
.4214-9	.6321-9	.1737-6	.5861-5	.1022-4	.1020-4	.9283-5	SI 1 BLW
.1177-4	.6792-5	.1072-4	.7971-5	.5560-5			SI 2 BLW
.5689-6	.1798-5	.8169-5	.1420-4	.1774-4	.1446-4	.1310-4	SI 1 STW
.1164-4	.1136-4	.1083-4	.9876-5	.7842-5			SI 2 STW
.7396-3	.6611-3	.5604-3	.3706-3	.1871-3	.1127-3	.1075-3	SI 1 SI
.1068-3	.9570-4	.9073-4	.8227-4	.6685-4			SI 2 SI
.4501-3	.4479-3	.3951-3	.2739-3	.1422-3	.8658-4	.8232-4	SI 10LIW
.7835-4	.7209-4	.6688-4	.6306-4	.4981-4			SI 20LIW
.2915-4	.5121-4	.6840-4	.6328-4	.4280-4	.2819-4	.2519-4	SI 1LLIW
.2319-4	.2188-4	.2028-4	.2048-4	.1629-4			SI 2LLIW
.4938-8	.7407-8	.8434-6	.6918-5	.1282-4	.1305-4	.1082-4	SI 1 KID
.1091-4	.1030-4	.8674-5	.8586-5	.6256-5			SI 2 KID
.7600-7	.3518-6	.1334-5	.4592-5	.7672-5	.7175-5	.6638-5	SI 1 LIV
.6196-5	.6108-5	.5666-5	.5479-5	.4389-5			SI 2 LIV
.4445-17	.6667-17	.9650-11	.6306-7	.4612-6	.7930-6	.9025-6	SI 1 LUN
.1157-5	.1169-5	.1066-5	.1167-5	.1131-5			SI 2 LUN
							SI 1 SGL
							SI 2 SGL
							SI 1 T-B
							SI 2 T-B
							SI 1 PUL
							SI 2 PUL
							SI 1 LYM
							SI 2 LYM
.6965-6	.2136-5	.4244-5	.7307-5	.7492-5	.5947-5	.5511-5	SI 1 MUS
.5335-5	.5003-5	.4733-5	.4430-5	.3775-5			SI 2 MUS
.1378-4	.2067-4	.4432-4	.6259-4	.6513-4	.4227-4	.3746-4	SI 1 OVS
.2996-4	.3386-4	.2313-4	.2134-4	.2813-4			SI 2 OVS
.2641-10	.3961-10	.4107-7	.2452-5	.7923-5	.8130-5	.7300-5	SI 1 PAN
.7171-5	.6551-5	.5079-5	.5741-5	.5212-5			SI 2 PAN
							SI 1 BON
							SI 2 BON
							SI 1 COB
							SI 2 COB
							SI 1 TRB
							SI 2 TRB
.9040-6	.2972-5	.7393-5	.2077-4	.3059-4	.1921-4	.1158-4	SI 1R MA
.8573-5	.7780-5	.7067-5	.6767-5	.5523-5			SI 2R MA
							SI 1Y MA
							SI 2Y MA
							SI 1T MA
							SI 2T MA
							SI 1COEC
							SI 2COEC
							SI 1TREC
							SI 2TREC
							SI 1T EC
							SI 2T EC
.5310-7	.7965-7	.1062-6	.7669-6	.1492-5	.1516-5	.1635-5	SI 1 SKI
.1830-5	.1933-5	.1969-5	.1752-5	.1543-5			SI 2 SKI
.2122-9	.3183-9	.6002-7	.2670-5	.5110-5	.5950-5	.5555-5	SI 1 SPL
.5408-5	.5053-5	.5282-5	.5008-5	.3595-5			SI 2 SPL
.2757-17	.4135-17	.1677-10	.4802-7	.4879-6	.1099-5	.1277-5	SI 1 TES
.1242-5	.1794-5	.1923-5	.2125-5	.1177-5			SI 2 TES
.1051-25	.1577-25	.1066-14	.4010-9	.4765-7	.2517-6	.3887-6	SI 1 THM
.4815-6	.5376-6	.5540-6	.5622-6	.5343-6			SI 2 THM
.4337-34	.6505-34	.1110-18	.5173-11	.3478-8	.3841-7	.8309-7	SI 1 THR
.1378-6	.1849-6	.2101-6	.2259-6	.2396-6			SI 2 THR
.1365-5	.2047-5	.1971-4	.5490-4	.5743-4	.3832-4	.3306-4	SI 1 UT
.2991-4	.2711-4	.2419-4	.2214-4	.1852-4			SI 2 UT
							SI 1T BY
							SI 2T BY
.2152-13	.3228-13	.1457-8	.4374-6	.2719-5	.2694-5	.5770-5	SI 1 ADR
.4261-5	.3859-5	.3699-5	.4331-5	.2937-5			SI 2 ADR
.2147-6	.7103-6	.1786-6	.5229-5	.8262-5	.5610-5	.3537-5	SI 1RNSP
.2695-5	.2533-5	.2343-5	.2265-5	.1946-5			SI 2RNSP
.3317-9	.4975-9	.1251-6	.3867-5	.7397-5	.8924-5	.7670-5	ULIC1 BLW
.6533-5	.7065-5	.4829-5	.7280-5	.4261-5			ULIC2 BLW
.2107-5	.3161-5	.1143-4	.2221-4	.2052-4	.1490-4	.1324-4	ULIC1 STW
.1243-4	.1158-4	.9482-5	.1010-4	.7762-5			ULIC2 STW
.5460-5	.5064-4	.1186-3	.1504-3	.1033-3	.6489-4	.5888-4	ULIC1 SI
.5609-4	.5051-4	.4538-4	.4207-4	.3293-4			ULIC2 SI
.3531-3	.8012-3	.8624-3	.5574-3	.2613-3	.1525-3	.1470-3	ULIC10LIW
.1468-3	.1392-3	.1244-3	.1180-3	.9327-4			ULIC20LIW
.2469-5	.3703-5	.1145-4	.1815-4	.1514-4	.1304-4	.1059-4	ULIC1LLIW
.1028-4	.1083-4	.8633-5	.8140-5	.5993-5			ULIC2LLIW
.3182-9	.4773-9	.3547-6	.5764-5	.1252-4	.1141-4	.9845-5	ULIC1 KID
.9318-5	.9405-5	.8589-5	.7308-5	.6253-5			ULIC2 KID
.1582-6	.2373-6	.1930-5	.7434-5	.1180-4	.1004-4	.9308-5	ULIC1 LIV
.8446-5	.8114-5	.7667-5	.7241-5	.6323-5			ULIC2 LIV
.3966-17	.5949-17	.1177-10	.7160-7	.6142-6	.9962-6	.9828-6	ULIC1 LUN
.1171-5	.1385-5	.1429-5	.1284-5	.1132-5			ULIC2 LUN
							ULIC1 SLG
							ULIC2 SLG
							ULIC1 T-B
							ULIC2 T-B
							ULIC1 PUL
							ULIC2 PUL
							ULIC1 LYM
							ULIC2 LYM
.7418-7	.8767-6	.3189-5	.6954-5	.7284-5	.5741-5	.5225-5	ULIC1 MUS
.5097-5	.4802-5	.4550-5	.4365-5	.3602-5			ULIC2 MUS
.2011-4	.5328-4	.5317-4	.7415-4	.5591-4	.4531-4	.4098-4	ULIC1 OVS
.4389-4	.2311-4	.1869-4	.3332-4	.2084-4			ULIC2 OVS

Majority of Data Set Omitted to Save Space.

							CLD1Y MA
							CLD2Y MA
							CLD1T MA
							CLD2T MA
							CLD1COEC
							CLD2COEC
							CLD1TREC
							CLD2TREC
							CLD1T EC
							CLD2T EC
0.259-3	0.126-3	0.648-4	0.271-4	0.123-4	0.784-5	0.736-5	CLD1 SKI
0.759-5	0.774-5	0.732-5	0.694-5	0.549-5			CLD2 SKI
0.297-6	0.744-6	0.110-5	0.389-5	0.523-5	0.409-5	0.508-5	CLD1 SPL
0.639-5	0.604-5	0.686-5	0.360-5	0.472-5			CLD2 SPL
0.101-6	0.927-5	0.183-4	0.158-4	0.788-5	0.638-5	0.807-5	CLD1 TES
0.688-5	0.549-5	0.454-5	0.291-5	0.306-5			CLD2 TES
0.172-9	0.701-7	0.963-6	0.610-5	0.579-5	0.354-5	0.513-5	CLD1 THM
0.391-5	0.409-5	0.565-5	0.534-5	0.854-5			CLD2 THM
0.576-6	0.569-7	0.490-5	0.121-4	0.888-5	0.830-5	0.598-5	CLD1 THR
0.262-5	0.449-5	0.601-5	0.558-5	0.880-5			CLD2 THR
0.114-19	0.106-8	0.122-7	0.149-5	0.153-5	0.279-5	0.378-5	CLD1 UT
0.420-5	0.423-5	0.402-5	0.474-5	0.391-5			CLD2 UT
							CLD1T BY
							CLD2T BY
0.164-8	0.140-6	0.700-5	0.434-5	0.488-5	0.510-5	0.467-5	CLD1 BNSP
0.546-5	0.573-5	0.424-5	0.449-5	0.404-5			CLD2 BNSP
0.210-5	0.778-5	0.126-4	0.178-4	0.174-4	0.124-4	0.953-5	CLD1BNSP
0.703-5	0.663-5	0.626-5	0.589-5	0.445-5			CLD2BNSP
0.502-24	0.9753-24	0.1295-13	0.1720-8	0.1244-6	0.5602-6	0.4317-6	ADR1 BLW
0.3683-6	0.6651-6	0.8444-6	0.9190-6	0.7643-6			ADR2 BLW
0.1400-9	0.2100-9	0.5086-6	0.5446-5	0.1204-4	0.1138-4	0.1046-4	ADR1 STW
0.1014-4	0.9669-5	0.8162-5	0.6868-5	0.6426-5			ADR2 STW
0.2152-13	0.3228-13	0.1457-8	0.3573-6	0.2164-5	0.3198-5	0.3044-5	ADR1 SI
0.3309-5	0.3108-5	0.3447-5	0.3144-5	0.2592-5			ADR2 SI
0.1149-13	0.1724-13	0.1381-7	0.4453-6	0.2721-5	0.3707-5	0.3288-5	ADR1ULIW
0.3603-5	0.3769-5	0.2881-5	0.3523-5	0.2669-5			ADR2ULIW
0.2012-16	0.3018-16	0.2424-10	0.3558-7	0.4237-6	0.8258-6	0.8171-6	ADR1LLIW
0.1232-5	0.8027-6	0.1298-5	0.1404-5	0.1109-5			ADR2LLIW
0.4226-5	0.3709-4	0.7530-4	0.9370-4	0.5908-4	0.4247-4	0.4124-4	ADR1 KID
0.3952-4	0.3586-4	0.3069-4	0.3141-4	0.2540-4			ADR2 KID
0.2727-6	0.4143-5	0.1280-4	0.2644-4	0.2555-4	0.1931-4	0.1762-4	ADR1 LIV
0.1684-4	0.1504-4	0.1449-4	0.1366-4	0.1080-4			ADR2 LIV
0.3191-6	0.4787-6	0.3074-5	0.1027-4	0.1203-4	0.9489-5	0.8914-5	ADR1 LUN
0.7985-5	0.7719-5	0.7416-5	0.6800-5	0.5523-5			ADR2 LUN
							ADR1 SLG
							ADR2 SLG
							ADR1 T-B
							ADR2 T-B
							ADR1 PUL
							ADR2 PUL
							ADR1 LYM
							ADR2 LYM
0.4014-5	0.9563-5	0.1217-4	0.1074-4	0.7094-5	0.5322-5	0.5175-5	ADR1 MUS
0.5264-5	0.4994-5	0.4707-5	0.4418-5	0.3684-5			ADR2 MUS
0.1981-19	0.2971-19	0.2374-11	0.2442-7	0.6424-6	0.2490-5	0.2105-5	ADR1 OVS
0.1078-5	0.1814-5	0.2814-6	0.1671-5	0.1453-5			ADR2 OVS
0.3025-7	0.4537-7	0.7506-5	0.3844-4	0.4749-4	0.3695-4	0.3033-4	ADR1 PAN
0.2985-4	0.2826-4	0.2595-4	0.2383-4	0.2018-4			ADR2 PAN
							ADR1 BON
							ADR2 BON
							ADR1 COD
							ADR2 COD
							ADR1 TRB
							ADR2 TRB
0.6600-6	0.9900-6	0.7433-5	0.2245-4	0.2783-4	0.1583-4	0.1034-4	ADR1R MA
0.8427-5	0.7713-5	0.7033-5	0.6787-5	0.5791-5			ADR2R MA
							ADR1Y MA
							ADR2Y MA
							ADR1T MA
							ADR2T MA
							ADR1COEC
							ADR2COEC
							ADR1TREC
							ADR2TREC
							ADR1T EC
							ADR2T EC
0.6518-7	0.5177-7	0.7853-6	0.2109-5	0.2145-5	0.1816-5	0.2088-5	ADR1 SKI
0.2344-5	0.2443-5	0.2431-5	0.2097-5	0.1830-5			ADR2 SKI
0.4174-6	0.6261-6	0.7292-5	0.3223-4	0.3481-4	0.2411-4	0.2375-4	ADR1 SPL
0.2216-4	0.1955-4	0.1693-4	0.1693-4	0.1315-4			ADR2 SPL
0.7087-32	0.1063-31	0.2079-17	0.2803-10	0.1065-7	0.8896-7	0.1675-6	ADR1 TES
0.2443-6	0.3019-6	0.3283-6	0.3430-6	0.3445-6			ADR2 TES
0.9753-18	0.1463-17	0.1403-10	0.5724-7	0.1245-5	0.1660-5	0.1358-5	ADR1 THM
0.3290-5	0.2023-5	0.2016-5	0.2202-5	0.1796-5			ADR2 THM
0.2120-25	0.3180-25	0.7745-14	0.9077-9	0.8812-7	0.4040-6	0.5855-6	ADR1 THP
0.6835-6	0.7338-6	0.8419-6	0.7395-6	0.6846-6			ADR2 THP
0.1956-20	0.2934-20	0.9114-12	0.1613-7	0.2616-6	0.8425-6	0.8656-6	ADR1 UT
0.1285-5	0.1713-5	0.1471-5	0.8536-6	0.1138-5			ADR2 UT
							ADR1T BY
							ADR2T BY
0.5219-1	0.3292-1	0.1895-1	0.7044-2	0.2233-2	0.1330-2	0.1451-2	ADR1 ADR
0.1574-2	0.1513-2	0.1349-2	0.1324-2	0.1012-2			ADR2 ADR
0.4405-6	0.6608-6	0.5024-5	0.1433-4	0.1614-4	0.8759-5	0.5639-5	ADR1BNSP
0.4701-5	0.4368-5	0.4013-5	0.3826-5	0.3233-5			ADR2BNSP
45.13	150.	1044.	209.2	160.1	284.2	1809.	999.2

85.0	999.2	999.2	999.2	4.848E4	8.268	60.27	1.047E4
1.047E4	1.047E4	1500.	1500.	3000.	1.047E4	1.047E4	1.047E4
2791.	173.6	37.08	24.8	19.63	65.4	6.988E4	15.5
1.047E4							
1	1	2.50E-3					
2	2	2.0E-3					
3	3	1.250E-3					
4	4	2.27273-3					
5	5	3.76370-3					
6	6	3.22581-3					
7	7	5.55556-4					
9	8	1.0E-3					
10	8	1.0E-3					
11	8	1.0E-3					
12	13	3.57143-5					
13	14	9.09091-2					
14	15	.010					
15	33	1.25-4	2.08333-3	1.25-4			
16	33	2.08333-4	2.08333-3	2.08333-4			
16	19	2.33333-4	3.33333-4	3.33333-4			
19	25	3.84615-4					
20	26	5.55556-3					
21	27	.2857-1					
22	29	.05					
23	1	1.42857-5					
23	2	1.42857-5					
23	3	1.42857-5					
23	4	1.42857-5					
23	5	1.42857-5					
23	6	1.42857-5					
23	7	1.42857-5					
23	8	1.42857-5					
23	13	1.42857-5					
23	14	1.42857-5					
23	15	1.42857-5					
23	19	1.42857-5					
23	25	1.42857-5					
23	26	1.42857-5					
23	27	1.42857-5					
23	28	1.42857-5					
23	29	1.42857-5					
23	30	1.42857-5					
23	32	1.42857-5					
23	33	1.42857-5					
25	32	7.14286-2					
30	40						

END BETA FRACTIONS

1	1	.0500					
2	2	4.0E-4					
3	3	2.5E-4					
4	4	4.45455-4					
5	5	7.40741-4					
6	6	6.45161-2					
7	7	1.11111-2					
9	8	.020					
10	8	.020					
11	8	.020					
12	13	7.14286-4					
13	14	1.8181818					
14	15	.20					
15	33	1.66667-3	4.16667-2				
16	33	4.16667-3	4.16667-2				
16	19	6.66667-4	6.66667-3				
17	19	1.33333-2					
19	25	7.69231-3					
20	26	1.11111-1					
21	27	5.71429-1					
22	29	1.0					
23	1	2.85714-4					
23	2	2.85714-4					
23	3	2.85714-4					
23	4	2.85714-4					
23	5	2.85714-4					
23	6	2.85714-4					
23	7	2.85714-4					
23	8	2.85714-4					
23	13	2.85714-4					
23	14	2.85714-4					
23	15	2.85714-4					
23	19	2.85714-4					
23	25	2.85714-4					
23	26	2.85714-4					
23	27	2.85714-4					
23	28	2.85714-4					
23	29	2.85714-4					
23	30	2.85714-4					
23	32	2.85714-4					
23	33	2.85714-4					
25	32	1.4285714					
30	40						

END ALPHA FRACTIONS

1	1	0.250E 02	0.977E-01	0.699E 00	0.829E 00	0.181E 01	0.104E 00	0.686E-01
1	2		0.104E-01	0.104E-01	0.104E-01	0.663E 00	0.195E 01	0.656E-01
1	3	0.135E 00	0.135E 00	0.330E 00		0.190E 00	0.555E-01	0.243E-01
1	4	0.879E-03	0.522E 00		0.399E-01			
2	1	0.101E 00	0.186E 02	0.999E 00	0.112E 01	0.490E 00	0.947E 00	0.574E 00
2	2		0.763E 00	0.763E 00	0.763E 00	0.626E 00	0.241E 00	0.509E 01

2 3	0.132E 00	0.132E 00	0.287E 00	.	0.207E 00	0.295E 01	0.252E-01
2 4	0.251E-01	0.563E 00		0.795E 00			
3 1	0.688E 00	0.901E 00	0.979E 01	0.669E 01	0.281E 01	0.861E 00	0.530E 00
3 2		0.687E-01	0.687E-01	0.687E-01	0.303E 00	0.323E 01	0.540E 00
3 3	0.127E 00	0.127E 00	0.731E 00		0.167E 00	0.428E 00	0.146E 00
3 4	0.479E-02	0.545E 00		0.298E 00			
4 1	0.578E 00	0.104E 01	0.737E 01	0.100E 02	0.130E 01	0.790E 00	0.730E 00
4 2		0.672E-01	0.672E-01	0.672E-01	0.400E 00	0.360E 01	0.551E 00
4 3	0.104E 00	0.104E 00	0.683E 00		0.172E 00	0.379E 00	0.131E 00
4 4	0.529E-02	0.565E 00		0.298E 00			
5 1	0.211E 01	0.350E 00	0.244E 01	0.999E 00	0.178E 02	0.225E 00	0.739E-01
5 2		0.268E-01	0.268E-01	0.268E-01	0.639E 00	0.506E 01	0.170E 00
5 3	0.225E 00	0.225E 00	0.100E 01		0.169E 00	0.200E 00	0.253E 01
5 4	0.159E-02	0.555E 00		0.843E-01			
6 1	0.102E 00	0.950E 00	0.861E 00	0.646E 00	0.275E 00	0.233E 02	0.118E 01
6 2		0.253E 00	0.253E 00	0.253E 00	0.408E 00	0.309E 00	0.189E 01
6 3	0.375E 00	0.375E 00	0.243E-01		0.215E 00	0.288E 01	0.299E-01
6 4	0.136E-01	0.512E 00		0.385E 01			
7 1	0.680E-01	0.561E 00	0.530E 00	0.570E 00	0.874E-01	0.118E 01	0.904E 01
7 2		0.221E 00	0.221E 00	0.221E 00	0.339E 00	0.166E 00	0.122E 01
7 3	0.185E 00	0.185E 00	0.298E 00		0.209E 00	0.292E 00	0.180E-01
7 4	0.304E-01	0.551E 00		0.151E 01			
8 1	0.103E-01	0.679E 00	0.687E-01	0.591E-01	0.332E-01	0.253E 00	0.222E 00
8 2		0.882E 01	0.882E 01	0.882E 01	0.514E 00	0.346E-01	0.505E 00
8 3	0.274E 00	0.274E 00	0.365E 00		0.212E 00	0.581E 00	0.292E-02
8 4	0.264E 00	0.567E 00		0.750E 00			
9 1							
9 2							
9 3							
9 4							
10 1							
10 2							
10 3							
10 4							
11 1							
11 2							
11 3							
11 4							
12 1							
12 2							
12 3							
12 4							
13 1	0.663E 00	0.626E 00	0.303E 00	0.400E 00	0.639E 00	0.408E 00	0.339E 00
13 2		0.514E 00	0.514E 00	0.514E 00	0.459E 00	0.570E 00	0.588E 00
13 3	0.415E 00	0.415E 00	0.329E 00		0.270E 00	0.392E 00	0.595E 00
13 4	0.468E 00	0.429E 00		0.461E 00			
14 1	0.189E 01	0.232E 00	0.323E 01	0.185E 01	0.593E 01	0.309E 00	0.166E 00
14 2		0.246E-01	0.246E-01	0.246E-01	0.570E 00	0.158E 03	0.168E 00
14 3	0.123E 00	0.123E 00	0.918E 00		0.157E 00	0.151E 00	0.383E 00
14 4	0.185E-02	0.580E 00		0.110E 00			
15 1	0.648E-01	0.551E 01	0.540E 00	0.485E 00	0.213E 00	0.189E 01	0.122E 01
15 2		0.585E 00	0.585E 00	0.585E 00	0.588E 00	0.168E 00	0.549E 02
15 3	0.204E 00	0.204E 00	0.529E 00		0.157E 00	0.631E 01	0.170E-01
15 4	0.308E-01	0.609E 00		0.260E 01			
16 1							
16 2							
16 3							
16 4							
17 1							
17 2							
17 3							
17 4							
18 1							
18 2							
18 3							
18 4							
19 1	0.325E 00	0.272E 00	0.731E 00	0.563E 00	0.103E 01	0.243E-01	0.298E 00
19 2		0.365E 00	0.365E 00	0.365E 00	0.329E 00	0.918E 00	0.529E 00
19 3	0.609E 00	0.609E 00	0.234E 01		0.276E 00	0.322E 00	0.214E 00
19 4	0.262E 00	0.431E 00		0.816E 00			
20 1							
20 2							
20 3							
20 4							
21 1							
21 2							
21 3							
21 4							
22 1							
22 2							
22 3							
22 4							
23 1							
23 2							
23 3							
23 4							
24 1							
24 2							
24 3							
24 4							
25 1	0.190E 00	0.192E 00	0.167E 00	0.178E 00	0.173E 00	0.215E 00	0.209E 00
25 2		0.212E 00	0.212E 00	0.212E 00	0.270E 00	0.157E 00	0.157E 00
25 3	0.286E 00	0.286E 00	0.276E 00		0.556E 00	0.205E 00	0.219E 00
25 4	0.266E 00	0.277E 00		0.224E 00			
26 1	0.549E-01	0.290E 01	0.428E 00	0.345E 00	0.252E 00	0.288E 01	0.292E 00

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26 2      0.581E 00 0.581E 00 0.581E 00 0.392E 00 0.151E 00 0.631E 01
26 3      0.192E 00 0.192E 00 0.322E 00      0.205E 00 0.413E 02 0.159E-01
26 4      0.232E-01 0.479E 00      0.201E 01
27 1      0.169E 01 0.242E-01 0.146E 00 0.607E 00 0.174E 01 0.299E-01 0.180E-01
27 2      0.292E-02 0.292E-02 0.292E-02 0.595E 00 0.383E 00 0.170E-01
27 3      0.372E 00 0.372E 00 0.214E 00      0.219E 00 0.159E-01 0.992E 02
27 4      0.264E-03 0.537E 00      0.116E-01
28 1      0.363E-02 0.109E 00 0.218E-01 0.202E-01 0.243E-01 0.610E-01 0.163E 00
28 2      0.105E 01 0.105E 01 0.105E 01 0.613E 00 0.795E-02 0.147E 00
28 3      0.207E 00 0.279E 00      0.222E 00 0.912E-01 0.103E-02
28 4      0.133E 01 0.549E 00      0.150E 00
29 1      0.874E-03 0.244E-01 0.479E-02 0.440E-02 0.193E-02 0.136E-01 0.304E-01
29 2      0.264E 00 0.264E 00 0.264E 00 0.468E 00 0.185E-02 0.308E-01
29 3      0.257E 00 0.257E 00 0.262E 00      0.266E 00 0.232E-01 0.264E-03
29 4      0.122E 03 0.430E 00      0.327E-01
30 1      0.520E 01 0.216E 00 0.266E 01 0.105E 01 0.175E 01 0.260E 00 0.148E 00
30 2      0.223E-01 0.223E-01 0.223E-01 0.610E 00 0.558E 01 0.154E 00
30 3      0.100E 00 0.100E 00 0.519E 00      0.163E 00 0.125E 00 0.527E 00
30 4      0.173E-02 0.606E 00      0.952E-01

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31 1

31 2

31 3

31 4

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32 1      0.394E-01 0.786E 00 0.298E 00 0.250E 00 0.102E 00 0.385E 01 0.151E 01
32 2      0.750E 00 0.750E 00 0.750E 00 0.461E 00 0.110E 00 0.260E 01
32 3      0.392E 00 0.392E 00 0.816E 00      0.224E 00 0.201E 01 0.116E-01
32 4      0.327E-01 0.514E 00      0.103E 03
33 1      0.126E 00 0.123E 00 0.127E 00 0.383E 00 0.173E 00 0.375E 00 0.185E 00
33 2      0.274E 00 0.274E 00 0.274E 00 0.415E 00 0.123E 00 0.204E 00
33 3      0.146E 01 0.146E 01 0.609E 00      0.286E 00 0.192E 00 0.372E 00
33 4      0.257E 00 0.513E 00      0.392E 00

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40 1

40 2

40 3

40 4

1

2220

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1 2 3 4 5 6 7 9 10 11 12 13 14 15 16 17 19 20 21 22 23 25 1 2 3 4 5 6 7 8 13 14 15 19 25 26 27 28 29 30

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3233

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1
54. HANGANESE 25. 3.125E+02 DAYS 34 EC 23-APR-78 54.MN25. 0
1 1 9.99760E+01 8.34827E-01 8.34827E-01 0.00000E-01 54.MN25. 1
6 1 2.23984E-02 8.28838E-01 8.28838E-01 0.00000E-01 54.MN25. 2
6 5 2.03982E-03 8.34132E-01 8.34132E-01 0.00000E-01 54.MN25. 3
6 6 1.88849E-05 8.34243E-01 8.34243E-01 0.00000E-01 54.MN25. 4
6 7 2.21216E-05 8.34253E-01 8.34253E-01 0.00000E-01 54.MN25. 5
2 1 1.50118E+01 5.41470E-03 5.41470E-03 0.00000E-01 54.MN25. 6
2 2 7.56597E+00 5.40550E-03 5.40550E-03 0.00000E-01 54.MN25. 7
2 3 4.54859E-06 5.29460E-03 5.29460E-03 0.00000E-01 54.MN25. 8
2 4 1.93653E+00 5.94670E-03 5.94670E-03 0.00000E-01 54.MN25. 9
2 6 9.78772E-01 5.94670E-03 5.94670E-03 0.00000E-01 54.MN25. 10
2 7 5.76455E-04 5.98690E-03 5.98690E-03 0.00000E-01 54.MN25. 11
2 9 8.59480E-02 5.72200E-04 5.72200E-04 2.00000E+00 54.MN25. 12
210 9.54022E-03 5.72200E-04 5.72200E-04 2.00000E+00 54.MN25. 13
212 3.62114E-02 5.81400E-04 5.81400E-04 2.00000E+00 54.MN25. 14
214 6.23031E-03 6.52100E-04 6.52100E-04 2.00000E+00 54.MN25. 15
215 3.30206E-03 6.52100E-04 6.52100E-04 2.00000E+00 54.MN25. 16
217 3.52387E-04 5.74500E-04 5.74500E-04 2.00000E+00 54.MN25. 17
225 1.52128E-04 5.00400E-04 5.00400E-04 0.00000E-01 54.MN25. 18
727 2.86829E+00 4.55700E-03 4.55700E-03 2.00000E+00 54.MN25. 19
728 1.09885E+01 4.65100E-03 4.65100E-03 2.00000E+00 54.MN25. 20
729 2.52514E+00 4.68700E-03 4.68700E-03 2.00000E+00 54.MN25. 21
730 3.26382E+00 4.75700E-03 4.75700E-03 2.00000E+00 54.MN25. 22
731 3.01759E+01 4.77800E-03 4.77800E-03 2.00000E+00 54.MN25. 23
732 2.89448E+00 4.79500E-03 4.79500E-03 2.00000E+00 54.MN25. 24
734 3.26840E+00 5.24752E-03 5.24752E-03 2.00000E+00 54.MN25. 25
735 2.84668E+00 5.35842E-03 5.35842E-03 2.00000E+00 54.MN25. 26
736 5.16619E+00 5.36763E-03 5.36763E-03 2.00000E+00 54.MN25. 27
738 9.11991E-01 5.89962E-03 5.89962E-03 0.00000E-01 54.MN25. 28
740 1.49896E+00 6.59910E-04 6.59910E-04 2.00000E+00 54.MN25. 29
743 2.46586E+01 5.49010E-04 5.49010E-04 2.00000E+00 54.MN25. 30
744 1.19982E+00 5.81400E-04 5.81400E-04 2.00000E+00 54.MN25. 31
746 1.18796E+02 5.39810E-04 5.39810E-04 2.00000E+00 54.MN25. 32
747 2.61772E+00 5.72200E-04 5.72200E-04 2.00000E+00 54.MN25. 33
753 3.09887E+02 1.86446E-05 1.86446E-05 0.00000E-01 54.MN25. 34

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Sample Output of SEE Program

The sample output is given for ^{54}Mn . The SEE values are broken down by beta and gamma contributions for the various source and target organs. Miscellaneous printed output for checking is omitted.

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SPECIFIC EFFECTIVE ENERGIES
FOR 25-MANGANESE-54 (TR=3.125E 02 DAYS)

TARGET ORGANS		S O U R C E O R G A N S										
		BLAD CON	S CONT	SI+CONT	ULI CGNT	LLI CONT	KIDNEYS	LIVER	TB REG	LUNG	RESP LYM NODE	MUSCLE*
BLAD WALL	G	1.96E-04	1.36E-06	7.04E-06	5.75E-05	1.44E-05	1.25E-06	6.57E-07	2.43E-07	2.43E-07	2.43E-07	4.93E-06
	B	1.06E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	2.06E-04	1.36E-06	7.04E-06	5.75E-06	1.44E-05	1.25E-06	6.57E-07	2.43E-07	2.43E-07	2.43E-07	4.88E-06
GI TRACT S WALL	G	1.34E-06	1.42E-04	9.56E-06	9.90E-06	4.50E-06	9.17E-06	5.39E-06	5.29E-06	5.29E-06	5.29E-06	3.91E-06
	B	0.0	8.44E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	1.34E-06	1.50E-04	9.56E-06	9.90E-06	4.50E-06	9.17E-06	5.39E-06	5.29E-06	5.29E-06	5.29E-06	3.91E-06
SI+CONT	G	7.41E-06	7.06E-06	8.35E-05	4.37E-05	2.44E-05	7.64E-06	4.38E-05	8.59E-07	8.69E-07	8.69E-07	4.27E-06
	B	0.0	0.0	5.28E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	7.41E-06	7.06E-06	8.88E-05	4.37E-05	2.44E-05	7.64E-06	4.38E-05	8.59E-07	8.69E-07	8.69E-07	4.27E-06
ULI WALL	G	5.71E-06	8.50E-06	6.22E-05	1.19E-04	1.10E-05	7.87E-06	6.75E-05	1.14E-06	1.14E-06	1.14E-06	4.09E-06
	B	0.0	0.0	0.0	9.59E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	5.71E-06	8.50E-06	6.22E-05	1.23E-04	1.10E-05	7.87E-06	6.75E-06	1.14E-06	1.14E-06	1.14E-06	4.09E-06
LLI WALL	G	1.84E-05	3.74E-06	1.86E-05	8.89E-05	1.40E-04	2.42E-06	8.06E-07	2.54E-07	2.54E-07	2.54E-07	4.67E-06
	B	0.0	0.0	0.0	0.0	1.56E-05	0.0	0.0	0.0	0.0	0.0	0.0
	T	1.84E-05	3.74E-06	1.86E-05	8.89E-06	1.55E-04	2.42E-06	8.06E-07	2.54E-07	2.54E-07	2.54E-07	4.57E-06
KIDNEYS	G	1.02E-06	9.03E-06	8.76E-06	7.83E-06	2.51E-06	2.01E-04	1.02E-05	2.79E-06	2.79E-06	2.79E-06	3.99E-06
	B	0.0	0.0	0.0	0.0	0.0	1.36E-05	0.0	0.0	0.0	0.0	0.0
	T	1.02E-06	9.03E-06	8.76E-06	7.83E-06	2.51E-06	2.14E-04	1.02E-05	2.79E-06	2.79E-06	2.79E-06	3.99E-06
LIVER	G	8.39E-07	5.48E-06	5.12E-06	6.86E-06	1.05E-06	1.06E-05	7.03E-05	6.57E-06	6.57E-06	6.57E-06	3.12E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	2.34E-06	0.0	0.0	0.0	0.0
	T	8.39E-07	5.48E-06	5.12E-06	6.86E-06	1.05E-06	1.06E-05	7.26E-05	6.57E-06	6.57E-06	6.57E-06	3.12E-06
LUNGS	G	2.04E-07	4.96E-06	9.72E-07	1.10E-06	4.03E-07	2.75E-06	6.68E-06	4.05E-05	4.05E-05	4.05E-05	3.69E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.22E-06	4.22E-06	4.22E-06	0.0
	T	2.04E-07	4.96E-06	9.72E-07	1.10E-06	4.03E-07	2.75E-06	6.68E-06	4.47E-05	4.47E-05	4.47E-05	3.69E-06
MUSCLE*	G	4.88E-06	3.91E-06	4.27E-06	4.09E-06	4.67E-06	3.99E-06	3.12E-06	3.69E-06	3.69E-06	3.69E-06	4.26E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.51E-07
	T	4.88E-06	3.91E-06	4.27E-06	4.09E-06	4.67E-06	3.99E-06	3.12E-06	3.69E-06	3.69E-06	3.69E-06	4.41E-06
OVARIES	G	1.35E-05	3.31E-06	2.72E-05	2.50E-05	4.57E-05	4.13E-06	1.57E-06	4.66E-07	4.66E-07	4.66E-07	5.47E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	1.35E-05	3.31E-06	2.72E-05	2.50E-05	4.57E-05	4.13E-06	1.57E-06	4.66E-07	4.66E-07	4.66E-07	5.47E-06
PANCREAS	G	8.06E-07	4.59E-05	5.64E-06	5.51E-06	2.07E-06	1.87E-05	1.21E-05	6.53E-06	6.63E-06	6.63E-06	4.90E-05
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	8.06E-07	4.59E-05	5.64E-06	5.51E-06	2.07E-06	1.87E-05	1.21E-05	6.53E-06	6.63E-06	6.63E-06	4.90E-06
R MARROW	G	3.27E-06	2.77E-06	6.71E-06	5.63E-06	8.36E-06	6.71E-06	2.82E-06	3.44E-06	3.44E-06	3.44E-06	3.69E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	3.27E-06	2.77E-06	6.71E-06	5.63E-06	8.36E-06	6.71E-06	2.82E-06	3.44E-06	3.44E-06	3.44E-06	3.69E-06

25-MANGANESE-54 CONTINUED

TARGET ORGANS		S O U R C E O R G A N S										
		BLAD CON	S CONT	SI+CONT	ILI CONT	LLI CONT	KIDNEYS	LIVER	TB EEG	LUNG	RESP LYM NODE	MUSCLE*
SKIN	G	1.93E-06	1.72E-06	1.58E-06	1.57E-06	1.70E-06	1.88E-06	1.74E-06	1.93E-06	1.93E-06	1.93E-06	2.63E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	1.93E-06	1.72E-06	1.58E-06	1.57E-06	1.70E-06	1.88E-06	1.74E-06	1.93E-06	1.93E-06	1.93E-06	2.63E-06
SPLEEN	G	6.95E-07	2.63E-06	4.32E-06	3.70E-06	2.39E-06	2.29E-05	3.08E-06	6.03E-06	6.03E-06	6.03E-06	4.08E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	6.95E-07	2.63E-06	4.32E-06	3.70E-06	2.88E-06	2.29E-05	3.08E-06	6.03E-06	6.03E-06	6.03E-06	4.08E-06
TESTES	G	1.36E-05	3.42E-07	1.35E-06	1.56E-06	4.69E-06	4.65E-07	5.98E-07	9.12E-08	9.12E-08	9.12E-08	3.46E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	1.36E-05	3.42E-07	1.35E-06	1.56E-06	4.69E-06	4.65E-07	5.98E-07	9.12E-08	9.12E-08	9.12E-08	3.46E-06
THYMUS	G	1.16E-07	1.82E-06	4.33E-07	4.70E-07	1.96E-07	5.41E-07	2.70E-06	1.11E-05	1.11E-05	1.11E-05	4.04E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	1.16E-07	1.82E-06	4.33E-07	4.70E-07	1.96E-07	5.41E-07	2.70E-06	1.11E-05	1.11E-05	1.11E-05	4.04E-06
THYROID	G	4.08E-08	4.70E-07	1.41E-07	1.50E-07	6.95E-08	3.06E-07	5.55E-07	3.75E-06	3.75E-06	3.75E-06	3.80E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	4.08E-08	4.70E-07	1.41E-07	1.50E-07	6.95E-08	3.06E-07	5.55E-07	3.75E-06	3.75E-06	3.75E-06	3.80E-06
UTERUS	G	4.03E-05	2.65E-05	2.34E-05	1.28E-05	1.53E-05	2.34E-06	1.13E-06	3.17E-07	3.17E-07	3.17E-07	6.79E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	4.03E-05	2.65E-05	2.34E-05	1.28E-05	1.53E-05	2.34E-06	1.13E-06	3.17E-07	3.17E-07	3.17E-07	6.79E-06
ADRENALS	G	6.88E-07	5.93E-06	3.33E-06	3.28E-06	1.38E-06	3.42E-05	1.34E-05	6.64E-06	6.64E-06	6.64E-06	4.25E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	6.88E-07	5.93E-06	3.33E-06	3.28E-06	1.38E-06	3.42E-05	1.34E-05	6.64E-06	6.64E-06	6.64E-06	4.25E-06
BONE SURFACES	G	1.55E-06	1.63E-06	2.16E-06	1.92E-06	2.80E-06	2.67E-06	1.98E-06	2.73E-06	2.73E-06	2.73E-06	3.10E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	T	1.55E-06	1.63E-06	2.16E-06	1.92E-06	2.80E-06	2.67E-06	1.98E-06	2.73E-06	2.73E-06	2.73E-06	3.10E-06

CONTINUED NEXT PAGE

25-MANGANESE-54 CONTINUED

TARGET
ORGANS

S O U R C E O R G A N S

		OVARIES	PANCREAS	COR BONE	CAN BONE	R MARROW	SKIN	SPLEEN	TESTES	THYROID	T BODY	ADRENALS
BLAD WALL	G	1.91E-05	4.13E-07	1.40E-06	1.40E-06	2.76E-06	2.08E-06	8.24E-07	1.45E-05	4.10E-08	5.53E-06	5.85E-07
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	1.91E-05	4.13E-07	1.40E-06	1.40E-06	2.76E-06	2.08E-06	8.24E-07	1.45E-05	4.10E-08	5.59E-06	5.85E-07
GI TRACT S WALL	G	2.19E-06	4.63E-05	1.54E-06	1.54E-06	3.17E-06	1.85E-06	2.57E-05	2.64E-07	3.81E-07	4.78E-06	8.20E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	2.19E-06	4.63E-05	1.54E-06	1.54E-06	3.17E-06	1.85E-06	2.57E-05	2.64E-07	3.81E-07	4.84E-06	8.20E-06
SI+CONT	G	3.12E-05	4.97E-06	2.32E-06	2.32E-06	7.25E-06	1.65E-06	3.87E-06	1.51E-06	8.38E-08	5.43E-06	2.65E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	3.12E-05	4.97E-06	2.32E-06	2.32E-06	7.25E-06	1.65E-06	3.87E-06	1.51E-06	8.38E-08	5.49E-06	2.65E-06
ULI WALL	G	2.93E-05	6.06E-06	2.12E-06	2.12E-06	5.35E-06	1.81E-06	3.89E-06	1.09E-06	9.46E-08	5.25E-06	3.10E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	2.93E-05	6.06E-06	2.12E-06	2.12E-06	5.35E-06	1.81E-06	3.89E-06	1.09E-06	9.46E-08	5.31E-06	3.10E-06
LLI WALL	G	3.72E-05	1.54E-06	2.90E-06	2.90E-06	8.31E-06	1.83E-06	1.82E-06	6.76E-06	5.96E-08	5.47E-06	7.88E-07
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	3.72E-05	1.54E-06	2.90E-06	2.90E-06	8.31E-06	1.83E-06	1.82E-06	6.76E-06	5.96E-08	5.53E-06	7.88E-07
KIDNEYS	G	3.11E-06	1.67E-05	3.11E-06	3.11E-06	6.55E-06	2.17E-06	2.25E-05	3.80E-07	2.77E-07	5.00E-06	3.09E-05
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	3.11E-06	1.67E-05	3.11E-06	3.11E-06	6.55E-06	2.17E-06	2.25E-05	3.80E-07	2.77E-07	5.06E-06	3.09E-05
LIVER	G	1.80E-06	1.11E-05	2.02E-06	2.02E-06	2.80E-06	1.90E-06	2.99E-06	2.51E-07	5.17E-07	4.98E-06	1.30E-05
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	1.80E-06	1.11E-05	2.02E-06	2.02E-06	2.80E-06	1.90E-06	2.99E-06	2.51E-07	5.17E-07	5.04E-06	1.30E-05
LUNGS	G	4.09E-07	6.42E-06	2.77E-06	2.77E-06	3.37E-06	1.97E-06	5.92E-06	6.99E-08	3.15E-06	4.06E-06	6.52E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	4.09E-07	6.42E-06	2.77E-06	2.77E-06	3.37E-06	1.97E-06	5.92E-06	6.99E-08	3.15E-06	4.12E-06	6.52E-06
MUSCLE*	G	5.47E-06	4.90E-06	3.10E-06	3.10E-06	3.65E-06	2.63E-06	4.08E-06	3.46E-06	3.80E-06	4.05E-06	4.25E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	5.47E-06	4.90E-06	3.10E-06	3.10E-06	3.65E-06	2.63E-06	4.08E-06	3.46E-06	3.80E-06	4.11E-06	4.25E-06
OVARIES	G	2.22E-03	2.31E-06	2.80E-06	2.80E-06	8.15E-06	1.46E-06	1.97E-06	2.84E-07	7.09E-08	3.98E-06	1.53E-06
	B	3.84E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	2.61E-03	2.31E-06	2.80E-06	2.80E-06	8.15E-06	1.46E-06	1.97E-06	2.84E-07	7.09E-08	4.04E-06	1.53E-06
PANCREAS	G	2.30E-06	5.99E-04	2.70E-06	2.70E-06	3.69E-06	1.47E-06	5.09E-05	2.37E-07	1.70E-07	4.62E-06	2.37E-05
	B	0.0	4.22E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	2.30E-06	6.41E-04	2.70E-06	2.70E-06	3.69E-06	1.47E-06	5.09E-05	2.37E-07	1.70E-07	4.68E-06	2.37E-05
R MARROW	G	8.15E-06	4.63E-06	8.62E-06	8.62E-06	2.06E-05	2.22E-06	3.11E-06	1.45E-06	2.23E-06	4.48E-06	6.63E-06
	B	0.0	0.0	0.0	1.41E-06	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	8.15E-06	4.63E-06	8.62E-06	1.00E-05	2.06E-05	2.22E-06	3.11E-06	1.45E-06	2.23E-06	4.54E-06	6.63E-06

25-MANGANESE-54 CONTINUED

TARGET
ORGANS

S O U R C E O R G A N S

		OVARIES	PANCREAS	COR BONE	CAN BONE	R MARROW	SKIN	SPLEEN	TESTES	THYROID	T BODY	ADRENALS
SKIN	G	1.56E-06	1.54E-06	2.43E-06	2.43E-06	2.11E-06	6.17E-06	1.81E-06	4.39E-06	2.54E-06	2.63E-06	2.01E-06
	B	0.0	0.0	0.0	0.0	0.0	1.62E-06	0.0	0.0	0.0	6.03E-08	0.0
	T	1.56E-06	1.54E-06	2.43E-06	2.43E-06	2.11E-06	7.79E-06	1.81E-06	4.39E-06	2.54E-06	2.69E-06	2.01E-06
SPLEEN	G	1.81E-06	5.05E-05	2.45E-06	2.45E-06	2.76E-06	2.12E-06	3.61E-04	2.44E-07	5.24E-07	4.93E-06	1.70E-05
	B	0.0	0.0	0.0	0.0	0.0	0.0	2.34E-05	0.0	0.0	6.03E-08	0.0
	T	1.81E-06	5.05E-05	2.45E-06	2.45E-06	2.76E-06	2.12E-06	3.84E-04	2.44E-07	5.24E-07	4.99E-06	1.70E-05
TESTES	G	2.84E-07	2.98E-07	1.80E-06	1.80E-06	1.23E-06	2.52E-06	3.08E-07	1.02E-03	1.70E-08	5.00E-06	2.36E-07
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.21E-04	0.0	6.03E-08	0.0
	T	2.84E-07	2.98E-07	1.80E-06	1.80E-06	1.23E-06	2.52E-06	3.08E-07	1.14E-03	1.70E-08	5.06E-06	2.36E-07
THYMUS	G	2.07E-07	1.49E-06	2.31E-06	2.31E-06	1.69E-06	2.18E-06	1.81E-06	4.65E-08	1.11E-05	3.75E-06	2.04E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	2.07E-07	1.49E-06	2.31E-06	2.31E-06	1.69E-06	2.18E-06	1.81E-06	4.65E-08	1.11E-05	3.82E-06	2.04E-06
THYROID	G	7.09E-08	2.30E-07	1.96E-06	1.96E-06	2.65E-06	2.14E-06	4.58E-07	1.70E-08	1.39E-03	4.31E-06	5.99E-07
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.11E-04	6.03E-08	0.0
	T	7.09E-08	2.30E-07	1.96E-06	1.96E-06	2.65E-06	2.14E-06	4.58E-07	1.70E-08	1.60E-03	4.37E-06	5.99E-07
UTERUS	G	4.68E-05	1.72E-06	2.31E-06	2.31E-06	4.70E-06	1.98E-06	1.62E-05	2.64E-07	6.76E-08	6.15E-06	1.31E-06
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	4.68E-05	1.72E-06	2.31E-06	2.31E-06	4.70E-06	1.98E-06	1.62E-05	2.64E-07	6.76E-08	6.21E-06	1.31E-06
ADRENALS	G	1.61E-06	1.99E-05	5.07E-06	5.07E-06	7.25E-06	2.18E-06	1.89E-05	2.36E-07	5.99E-07	5.40E-06	1.36E-03
	B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.03E-08	3.01E-04
	T	1.61E-06	1.99E-05	5.07E-06	5.07E-06	7.25E-06	2.18E-06	1.89E-05	2.36E-07	5.99E-07	5.46E-06	1.66E-03
BONE SURFACES	G	2.49E-06	2.47E-06	9.56E-06	9.56E-06	3.55E-06	2.40E-06	2.12E-05	1.83E-06	2.06E-06	4.06E-06	3.74E-06
	B	0.0	0.0	8.39E-06	8.41E-06	0.0	0.0	0.0	0.0	0.0	6.03E-08	0.0
	T	2.49E-06	2.47E-06	1.80E-05	1.80E-05	3.55E-06	2.40E-06	2.12E-05	1.83E-06	2.06E-06	4.13E-06	3.74E-06

*"MUSCLE" VALUES MAY BE USED FOR "SEPARABLE FAT" WITH ADJUSTMENT (SEE TEXT)
THIS RADIONUCLIDE IS A SURFACE SEEKER

APPENDIX C

JOB CONTROL LANGUAGE FOR THE ICRP CODE

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//SGBICRP JOB (13852),'BIN Q S.B. WATSON'
//*ROUTE PRINT LOCAL
//*CLASS CP091=5M,REGION=350K,LINES=50,IO=5
// EXEC PGM=IEBGENER
//SYSPRINT DD SYSOUT=A
//SYSIN DD DUMMY
//SYSUT2 DD UNIT=SYSDA,
// ICB=(RECFM=FB,LRECL=80,BLKSIZE=3200),
// SPACE=(TRK,(30,10),RLSE),DSN=88DECA1,
// DISP=(NEW,PASS)
//SYSUT1 DD *
1
2220
1 2 3 4 5 6 7 91011121314151617192021222325 1 2 3 4 5 6 7 813141519252627282930
3233

DECAY DATA

/*
//SEE EXEC PORTHCLG,PARN.PORT='XREP',
// PARN.GO='DUMP=I,EU=-1',REGION.GO=270K
//PORT.SYSIN DD *

SEE SOURCE DECK

/*
//GO.PT14P001 DD UNIT=SYSDA,
// DCB=(RECFM=VBS,BLKSIZE=1644,LRECL=164),
// SPACE=(1644,(100,100),RLSE),DSN=88ESEE,
// DISP=(NEW,PASS)
//GO.PT05P001 DD DISP=SHR,DSN=T.SGB03852.ICRP SAF'S
// DD DSN=88EDECAY,DISP=(OLD,PASS) DECAY DATA
//GO.PT15P001 DD DUMMY
//GO.SYSUDUMP DD SYSOUT=A
// EXEC ASHFC,PARN.ASM='LOAD'
//ASM.SYSIN DD *

AXPB SOURCE DECK

/*
// EXEC ASHFC,PARN.ASM='LOAD'
//ASM.SYSIN DD *

YPAY SOURCE DECK

/*
//TIMED EXEC PORTHCLG,,PARN.PORT='XREP',
// PARN.GO='SO=51,SI=50,EU=-1,DUMP=I',REGION.GO=350K
//PORT.SYSIN DD *

ICRP TIMED SOURCE DECK

/*
//GO.PT06P001 DD DUMMY SUPPRESS OUTPUT ON UNIT 6
//GO.PT07P001 DD DUMMY PUNCHED CARD OUTPUT
//GO.PT16P001 DD UNIT=SYSDA,DCB=(RECFM=VBS,LRECL=150,BLKSIZE=1504),
// SPACE=(1504,(100,100),RLSE),DSN=88UCIDAY,DISP=(NEW,PASS)
//GO.PT10P001 DD SYSOUT=A,DCB=(RECFM=FA,BLKSIZE=133)
//GO.PT05P001 DD *

INPUT TO ICRP TIMED

/*
//ICRP EXEC PORTHCLG,PARN.PORT='XREP',
// PARN.GO='EU=-1,DUMP=I',
// REGION.GO=350K
//PORT.SYSIN DD *

DOSE SOURCE DECK

/*
//GO.PT14P001 DD DSN=88ESEE,DISP=(OLD,DELETE)
//GO.PT16P001 DD DSN=88UCIDAY,DISP=(OLD,DELETE)
//GO.PT18P001 DD UNIT=SYSDA,DSN=88SEEREM,
// DCB=(RECFM=VBS,LRECL=204,BLKSIZE=7144),
// SPACE=(TRK,(50,10),RLSE),DISP=NEW
//GO.PT15P001 DD SYSOUT=(J,3101,5), SPECIAL PRINT
// DCB=(RECFM=FBA,LRECL=133,BLKSIZE=3458)
//GO.PT20P001 DD DISP=NEW,DSN=88STD0SE,UNIT=SYSDA,
// DCB=(RECFM=VBS,LRECL=164,BLKSIZE=6564),SPACE=(TRK,(12,6),RLSE)
//GO.PT22P001 DD DISP=NEW,DSN=88CHAIN,UNIT=SYSDA,
// DCB=(RECFM=VBS,LRECL=36,BLKSIZE=3604),SPACE=(3604,(5,1),RLSE)
//GO.PT05P001 DD *

INPUT TO DOSE

/*
//

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APPENDIX D

PROGRAM LISTING OF ICRP TIMED

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C      MAIN DRIVER
C
C      IMPLICIT REAL*8(A-H,O-Z)
COMMON /PRINT/ TPRL(10),DTPR(10),TPRINT,IPRT,NPR,NPRT,NARPRT(10)
COMMON /SC1235/ T,H,HMIN,HMAX,EPS1,HF1,KPLAG1,JSTART,N,NINV,NX0,YN
1AX(400),ERROR(400),PSAVE(800),YPRINT(400)
C *** NEED DIMENSION YMAX(NX0),ERROR(NX0),PSAVE(2*NX0)
COMMON /NSW/ NSW
COMMON /ICRP/ A,X0,LR,SWICRP,IDIAG,NBLK,NDSUBM,NDWAV
REAL*8 LR(15)
DIMENSION A(12001), X0(400), IDIAG(400), NBLK(15)
COMMON /CLASS/ ICLASS(15)
DATA NPRTA/10/
DATA MAXNO/400/
C *** MUST HAVE NO.LE.MAXNO
DATA NELY/2400/
DIMENSION Y(2400)
C *** DIMENSION Y(NELY)
C
C      NX0=MAXNO
C
C ***
C ***
C *** SET MF AND T1 INTERNALLY
C *** HAVE DEFAULT VALUES FOR H1 AND EPS
C ***
C ***
C *** DESIRE TO INTEGRATE FROM T1 TO TLAST
C
C *** MF=21 INDICATES A STIFF SYSTEM.
MF=21
C
C *** INTEGRATE Y'(T)=A*Y(T)+X0 FROM T=T1 TO T=TLAST WHERE Y(T1)=0.
C *** Y IS THE TIME INTEGRAL OF ACTIVITY
C *** A IS A CONSTANT LOWER TRIANGULAR MATRIX AND X0 IS A CONSTANT VECT.
C *** A,X0 ARE OBTAINED FROM SUBR.MATRIX BY A CALL IN SUBR.STIFF
T1=0.D0
C
C      10 CONTINUE
READ (5,140,END=130) NO,TLAST,H1,EPS,SWICRP
NSW=1
IF (EPS.EQ.0.D0) EPS=1.D-6
IF (H1.EQ.0.D0) H1=1.D-7
C
C *** SET INITIAL VALUES TO 0.
C
DO 20 I=1,NO
20 Y(I)=0.D0
C
C      READ (5,150) NPRT
NREAD=MNO(NPRT,NPRTA)
READ (5,160) (TPRL(I),DTPR(I),NARPRT(I),I=1,NREAD)
PRINT 170, NPRT,NREAD,(TPRL(I),DTPR(I),NARPRT(I),I=1,NREAD)
C
IF (NREAD.EQ.NPRT) GO TO 30
PRINT 180
GO TO 70
C
30 CONTINUE
TMAX=TPRL(NPRT)+NARPRT(NPRT)*DTPR(NPRT)
C
C *** EXPECT TMAX TO BE THE LARGEST T VALUE AT WHICH A 'CALL YOUT' IS
C *** DESIRED.
IF (DABS(TLAST-TMAX).LE.1.D-14*DABS(TLAST)) TLAST=TMAX
IF (TLAST.LE.TMAX) GO TO 40
C
PRINT 190, TLAST,TMAX
C
TLAST=TMAX
40 NT=NPRT-1
TO=T1
NC=0
IF (NT.LT.1) GO TO 60
DO 50 I=1,NT
IF (TPRL(I)+NARPRT(I)*DTPR(I).LT.TPRL(I+1)) GO TO 50
NC=NC+1
50 CONTINUE
IF (NC.GT.0) PRINT 200, NC,NT
C
60 CONTINUE
IF (TO.LE.TPRL(1)) GO TO 80
PRINT 210
70 CALL EXIT
C
80 IF (NC.GT.0) GO TO 70
TPRINT=TPRL(1)
IPRT=1
NPR=0
NCASE=0
HO=H1
WRITE (6,220) NO,HF,TO,TLAST,H0,EPS
C
C *** FOR STIFF PROCEDURE NEED 6*NO ELEMENTS IN 'VECTOR' Y. FOR ADAM'S
C *** (NONSTIFF) NEED 13*NO ELEMENTS.

```

```

C *** MF=10*METH*NITER, METH=1 FOR ADAM'S, =2 FOR STIFF PROCEDURE. 480
C 485
C IF (MF.GT.19) GO TO 90 490
C 495
C *** ADAM'S (NONSTIFF) 500
C 505
C IF (13*NO.LE.NELY) GO TO 100 510
C PRINT 230, NELY 515
C GO TO 70 520
C 525
C 90 IF (6*NO.LE.NELY) GO TO 100 530
C 535
C *** STIFF PROCEDURE. 540
C 545
C PRINT 240, NELY 550
C GO TO 70 555
C 560
C 100 IF (NO.LE.MAXNO) GO TO 110 565
C PRINT 250, NO, MAXNO 570
C GO TO 70 575
C 580
C 110 CONTINUE 585
C 590
C 595
C DO WE WANT TO SOLVE THE SAME SYSTEM WITH DIFFERENT 600
C INITIAL CCNDITIONS 605
C 610
C IF (SWICRQ.EQ.0.) GO TO 120 615
C READ (5,260) D3,D4,D5 620
C WRITE (10,270) D3,D4,D5 625
C CALL LONG (D3,D4,D5) 630
C CALL LONG1 (ICLASS,X0,NO) 635
C 120 CONTINUE 640
C CALL DRIVES (NO,TO,TLAST,Y,H0,EPS,MF,KFLAG) 645
C WRITE (6,280) KFLAG 650
C 655
C GO TO 10 660
C 130 STOP 665
C ----- LAST CARD OF MAIN DRIVER ----- 670
C 675
C 140 FORMAT (I5,7E10.2) 680
C 150 FORMAT (I5) 685
C 160 FORMAT (2E10.2,I5) 690
C 170 FORMAT ('1NO. PRINT INTERVALS DESIRED ='I2,3X,'NO. READ ='I2/' POI 695
C 1NLS SELECTED IN PRINT INTERVAL = T+Q*DT WHERE Q=0,1,...,H'/9X,'T'1 700
C 28X'DT'11X'H'/(1PE18.10,E19.10,I6)) 705
C 180 FORMAT (///'ONEED MORE STORAGE SPACE FOR INTERVALS IN MAIN.'//) 710
C 190 FORMAT (///'OVALUE OF TLAST HAS BEEN CHANGED FROM'1PE21.13,1X,'TO'E 715
C 121.13//) 720
C 200 FORMAT ('1'I2,1X'OF THE 'I2,1X'CONSECUTIVE INTERVAL PAIRS OVERLAP. 725
C 1'/' PROG. WILL CALL EXIT. SEE MAIN DRIVER.'//) 730
C 210 FORMAT ('1TPRL(1).LT.10. CALL EXIT. SEE MAIN DRIVER.') 735
C 220 FORMAT ('0NO='I4/' MF='I2/' TO='1PE22.15/' TLAST='E22.15/' H0='E22 740
C 1.15/' EPS='E10.4//) 745
C 230 FORMAT ('1NEED 13*NO ELEMENTS IN VECTOR Y IN MAIN. HAVE ONLY NELY= 750
C 1'I4) 755
C 240 FORMAT ('1NEED 6*NO ELEMENTS IN VECTOR Y IN MAIN. HAVE ONLY NELY=' 760
C 1'I4) 765
C 250 FORMAT ('1NO EXCEEDS MAX.NO'/' NO='I4/' MAXNO='I4/' INCREASE DIM. 770
C 1IN COMMON SC1235.') 775
C 260 FORMAT (10X,3F10.0) 780
C 270 FORMAT ('1PERCENT DEPOSITION'/' ',4X,'N-P',12X,'T-B',12X,'P'/' ',P 785
C 17.2,4(8X,P7.2),/) 790
C 280 FORMAT (9HOKFLAG = ,I6) 795
C END 800-

SUBROUTINE DRIVES (NO,TO,TLAST,Y,H0,EPS,MF,KFLAG) DRI 5
IMPLICIT REAL*8(A-H,O-Z) DRI 10
COMMON /SC1235/ T,H,HMIN,HMAX,EPS1,MF1,KFLAG1,ISTART,N,NINV,NXO,YMDRI 15
1AX(400),ERROR(400),PSAVE(800),YPRINT(400) DRI 20
C *** NEED DIMENSION YMAX(NX0),ERROR(NX0),PSAVE(2*NX0) DRI 25
COMMON /PRINT/ TPRL(10),DTPR(10),TPRINT,IPRT,NPR,NPRT,NABPRT(10) DRI 30
DIMENSION Y(H0,1) DRI 35
C***** DRI 40
C* DRIVES IS DRIVER SUBROUTINE FOR STIFF. SEE WRITUP FOR FULL DETAILS. DRI 45
C* DRI 50
C* THE INPUT PARAMETERS ARE.. DRI 55
C* NO = THE NUMBER OF DIFFERENTIAL EQUATIONS, INITIALLY. DRI 60
C* TO = THE INITIAL VALUE OF T, THE INDEPENDENT VARIABLE. DRI 65
C* TLAST = THE FINAL VALUE OF T. DRI 70
C* Y = AN NO BY LMAX ARRAY FOR THE COMPUTED SOLUTION, THE SAME DRI 75
C* AS IN STIFF. THE FIRST COLUMN SHOULD CONTAIN THE DRI 80
C* INITIAL VALUES OF THE DEPENDENT VARIABLE. DRI 85
C* CURRENTLY, LMAX IS 13 FOR THE ADAMS METHODS AND DRI 90
C* 6 FOR THE GEAR METHODS. TO CHANGE THIS, SEE DRI 95
C* SUBROUTINE TESOC. DRI 100
C* H0 = THE INITIAL VALUE OF H, THE STEP SIZE IN T. DRI 105
C* EPS = THE RELATIVE ERROR BOUND, THE SAME AS IN STIFF. DRI 110
C* MF = THE METHOD FLAG, THE SAME AS IN STIFF. DRI 115
C* ALLOWED VALUES ARE 10, 11, 12, 13, 20, 21, 22, 23. DRI 120
C* DRI 125
C* THE OUTPUT PARAMETERS ARE.. DRI 130
C* TO = VALUE OF T TO WHICH INTEGRATION HAS BEEN COMPLETED. DRI 135

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C* Y = NO BY LMAX ARRAY OF Y AND ITS SCALED DERIVATIVES. DRI 140
C* Y(I) FOR I .LE. N CONTAINS THE COMPUTED SOLUTION DRI 145
C* AT TIME T. DRI 150
C* H0 = THE VALUE OF THE STEP SIZE H USED LAST, BOTH IN THE DRI 155
C* INTEGRATION AND IN THE SCALING IN THE Y ARRAY. DRI 160
C* KFLAG = A COMPLETION FLAG WITH THE FOLLOWING VALUES AND MEANINGS.. DRI 165
C* 0 THE PROBLEM WAS COMPLETED SUCCESSFULLY. DRI 170
C* -1 THE INTEGRATION WAS HALTED AFTER FAILING TO PASS THE DRI 175
C* ERROR TEST EVEN AFTER REDUCING H BY A FACTOR OF DRI 180
C* 1.0D10 FROM ITS INITIAL VALUE. DRI 185
C* -2 AFTER SOME INITIAL SUCCESS, THE INTEGRATION WAS DRI 190
C* HALTED WHEN A REDUCTION IN H BY A FACTOR OF MORE DRI 195
C* THAN 1.0D4 WAS INDICATED IN ORDER TO PASS THE ERROR TEST. DRI 200
C* -3 THE INTEGRATION WAS HALTED AFTER FAILING TO ACHIEVE DRI 205
C* CORRECTOR CONVERGENCE EVEN AFTER REDUCING H BY A DRI 210
C* FACTOR OF 1.0D10 FROM ITS INITIAL VALUE. DRI 215
C* -4 IMMEDIATE HALT BECAUSE OF ILLEGAL VALUES OF INPUT DRI 220
C* PARAMETERS. SEE PRINTED MESSAGE. DRI 225
C* -5 H IS SUCH THAT T+H .EQ. T DRI 230
C* DRI 235
C* DRIVES CALLS SUBROUTINE YOUT FOR NORMAL OUTPUT AT STATEMENT 20, DRI 240
C* AND SUBROUTINE YOUTD FOR OUTPUT IN CASE OF FAILURE BELOW 150 AND 200. DRI 245
C* THE NAMES AND CALL SEQUENCES OF THESE CAN BE ALTERED AS DESIRED. DRI 250
C* DRI 255
C* IN THE FOLLOWING, SET.. DRI 260
C* NMN = THE MAXIMUM VALUE OF N FOR WHICH DRIVES IS TO BE USED. DRI 265
C* LOUT = THE LOGICAL UNIT NUMBER FOR THE OUTPUT OF MESSAGES DRI 270
C* DURING THE INTEGRATION. DRI 275
C* THE DIMENSION OF PW ABOVE CAN BE REDUCED IF MITER IS NOT 1 OR 2 DRI 280
C* (SEE DESCRIPTION OF PW IN STIFF). DRI 285
C* DRI 290
C* THE ORIGINAL VERSION OF THIS PROGRAM WAS WRITTEN AT LLL BY A. C. DRI 295
C* HINDMARSH FOR CDC COMPUTERS. THE CDC VERSION WAS MODIFIED FOR DRI 300
C* USE ON IBM COMPUTERS AT ARGONNE IN JUNE, 1973. DRI 305
C* DRI 310
C* LATEST REVISION SEPTEMBER, 1973 DRI 315
C* DRI 320
C***** DRI 325
C* DRI 330
C* DATA LOUT/6/ DRI 335
C* DRI 340
C***** DRI 345
C* DRI 350
C* IF (EPS.LE.0.0D0) GO TO 90 DRI 355
C* IF (N0.LE.0) GO TO 100 DRI 360
C* IF ((T0-TLAST)*H0.GE.0.0D0) GO TO 110 DRI 365
C* N=N0 DRI 370
C* T=T0 DRI 375
C* H=H0 DRI 380
C* NINV=0 DRI 385
C* HMIN=DABS(H0) DRI 390
C* HMAX=DABS(T0-TLAST)*.1D0 DRI 395
C* HMIN=DMIN1(HMIN,.1D0*HMAX) DRI 400
C* EPS1=EPS DRI 405
C* MF1=MF DRI 410
C* JSTART=0 DRI 415
C* KFLAG=0 DRI 420
C *** MAY WISH TO PRINT INITIAL VALUES THRU YOUT. DRI 425
C IF (T.EQ.TPRINT) CALL YOUT (N0,TLAST,Y,1) DRI 430
C 10 CALL STIFF (Y,N0) DRI 435
C NQ=JSTART DRI 440
C DRI 445
C KGO=1-KFLAG1 DRI 450
C GO TO (20,30,60,70,20,80),KGO DRI 455
C KFLAG1 = 0, -1, -2, -3, -5 DRI 460
C DRI 465
C 20 CONTINUE DRI 470
C IF (T.GE.TPRINT) CALL YOUT (N0,TLAST,Y,NQ) DRI 475
C IF ((T-TLAST)*H.LT.0.0D0) GO TO 10 DRI 480
C* THE PROBLEM IS FINISHED. HERE CALL YOUT AND/OR OTHER ROUTINES DRI 485
C* TO OUTPUT DESIRED FINAL RESULTS. DRI 490
C GO TO 120 DRI 495
C DRI 500
C 30 WRITE (LOUT,130) T DRI 505
C 40 IF (KFLAG.EQ.10) GO TO 50 DRI 510
C KFLAG=KFLAG+1 DRI 515
C HMIN=HMIN*.1D0 DRI 520
C H=H*.1D0 DRI 525
C WRITE (LOUT,140) H DRI 530
C JSTART=-1 DRI 535
C GO TO 10 DRI 540
C DRI 545
C 50 WRITE (LOUT,150) DRI 550
C***** DRI 555
C* HMIN HAS BEEN CUT BY 10 ORDERS OF MAGNITUDE WITH NO SUCCESS. DRI 560
C* AT THIS POINT, OUTPUT INFORMATION NEEDED FOR DEBUGGING. DRI 565
C***** DRI 570
C CALL YOUTD (Y,NQ) DRI 575
C GO TO 120 DRI 580
C DRI 585
C 60 WRITE (LOUT,160) T,H DRI 590
C* AT THIS POINT, OUTPUT INFORMATION NEEDED FOR DEBUGGING. DRI 595
C CALL YOUTD (Y,NQ) DRI 600
C GO TO 120 DRI 605
C DRI 610
C 70 WRITE (LOUT,170) T DRI 615

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      GO TO 40                                DRI 620
80  WRITE (LOUT,180) T,H                     DRI 625
      CALL YOUTD (Y,NQ)                      DRI 630
      GO TO 120                              DRI 635
C
90  WRITE (LOUT,190)                         DRI 640
      KFLAG=-4                              DRI 645
      RETURN                                DRI 650
C
100 WRITE (LOUT,200)                         DRI 655
      KFLAG=-4                              DRI 660
      RETURN                                DRI 665
C
110 WRITE (LOUT,210)                         DRI 670
      KFLAG=-4                              DRI 675
      RETURN                                DRI 680
C
120 KFLAG=KFLAG1                            DRI 685
      TO=T                                  DRI 690
      HO=H                                  DRI 695
      RETURN                                DRI 700
C
130 FORMAT (//30H KFLAG = -1 FROM STIFF AT T = ,D25.16/38H ERROR TESTDRI 705
1  FAILED WITH ABS(H) = HMIN/)              DRI 710
140 FORMAT (24H H HAS BEEN REDUCED TO ,D25.16,26H AND STEP WILL BE RDRI 715
1  TRIED//)                                DRI 720
150 FORMAT (//44H PROBLEM APPEARS UNSOLVABLE WITH GIVEN INPUT//) DRI 725
160 FORMAT (//30H KFLAG = -2 FROM STIFF AT T = ,D25.16,5H H = ,D25.16/DRI 730
1  52H THE REQUESTED ERROR IS SMALLER THAN CAN BE HANDLED//) DRI 735
170 FORMAT (//30H KFLAG = -3 FROM STIFF AT T = ,D25.16/45H CORRECTOR DRI 740
1  CONVERGENCE COULD NOT BE ACHIEVED//) DRI 745
180 FORMAT (//30H KFLAG = -5 FROM STIFF AT T = ,D25.16,5H H = ,D25.16/DRI 750
1  45H H IS SUCH THAT T+H .RO. T ON MACHINE. //) DRI 755
190 FORMAT (//28H ILLEGAL INPUT.. EPS .LE. 0.//) DRI 760
200 FORMAT (//25H ILLEGAL INPUT.. N .LE. 0.//) DRI 765
210 FORMAT (//38H ILLEGAL INPUT.. (TO-TLAST)*NO .GE. 0.//) DRI 770
      END                                    DRI 775

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      SUBROUTINE FAKE                                FAK 5
C
C  CALLED BY SUBROUTINE ORGAN TO AVOID A ZERO DIVIDE GENERATED FAK 10
C  BY THE OPT=2 VERSION OF THE H-LEVEL COMPILER FAK 15
C
C  COMMON /FAKE1/ SUM FAK 20
      REAL*8 SUM FAK 25
      RETURN FAK 30
      END FAK 35

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      SUBROUTINE GI (A,RINDEX,CINDEX,IROW,JCOL,ICOL1,IKOUNT,LAMB,P,K,J,NGI 5
1,NBRNCH,X0,NX0)                                GI 10
C
C  THIS SUBROUTINE DETERMINES THE ENTRIES OF THE COEFFICIENT GI 15
C  MATRIX CORRESPONDING TO THE COMPARTMENTS OF THE GI TRACT GI 20
C
C  GILAM(4) GI 25
C  GILAM(I) = LAMBDA FOR COMPARTMENT I OF GI TRACT GI 30
C
C  LAMAB(15,4) GI 35
C  LAMAB(I,1) = LAMBDA OF ABSORPTION IN S FOR DAUGHTER I GI 40
C  LAMAB(I,2) = LAMBDA OF ABSORPTION IN SI FOR DAUGHTER I GI 45
C  LAMAB(I,3) = LAMBDA OF ABSORPTION IN ULI FOR DAUGHTER I GI 50
C  LAMAB(I,4) = LAMBDA OF ABSORPTION IN LLI FOR DAUGHTER I GI 55
C
C  IMPLICIT REAL*8(A-H,O-Z) GI 60
      REAL*8 LANX(15,10),LAMR(1),LAMAB(15,4) GI 65
      INTEGER? RINDEX(1),CINDEX(1) GI 70
      DIMENSION A(1), GILAM(4), P(15,1), NBRNCH(1), X0(1), JCOL(1) GI 75
C
C  COMMON /TABLES/ LAMAB(15,4),LANX(15,10),ORGNR(10),TAG(15),ICOM(15,GI 80
110),IOPT,NCON(15),NIEQ,NORC GI 85
C
C  DATA GILAM/24,0.0,6.0,1.0461530460,1.00/ GI 90
C
C  SET INITIAL VALUES FOR ODE GI 95
C
C  IF (K.GT.1) GO TO 20 GI 100
C  IF (IOPT.EQ.0.OR.IOPT.EQ.2) GO TO 20 GI 105
      DO 10 I=1,NX0 GI 110
      X0(I)=0.00 GI 115
      IF (I.EQ.1) X0(I)=1.00 GI 120
10  CONTINUE GI 125
C
20  CONTINUE GI 130
C
C  GI TRACT GI 135
C  STONACH GI 140
C
C  IROW=IROW+1 GI 145
      J=J+1 GI 150

```

```

      IF (K.EQ.1) GO TO 40
      NBR=NBRRCH(K)
      DO 30 IBR=1,NBR
      ICOL=JCOL(IBR)+J
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMR(K)*P(K,IBR)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
30    CONTINUE
      IF (IOPT.EQ.0) ICOL=ICOL+2
      IF (IOPT.EQ.1) ICOL=ICOL+1
      GO TO 50
40    CONTINUE
      IF (IOPT.EQ.0) ICOL=2
      IF (IOPT.EQ.1) ICOL=1
50    CONTINUE
      IF (IOPT.EQ.1) GO TO 80
      DO 60 I=2,4,2
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMX(K,I)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      ICOL=ICOL+I
60    CONTINUE
      ICOL=ICOL+3
      DO 70 I=1,2
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMX(K,4)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      ICOL=ICOL+1
70    CONTINUE
80    CONTINUE
      IKOUNT=IKOUNT+1
      A(IKOUNT)=-GILAM(1)
      A(IKOUNT)=A(IKOUNT)-LAMAB(K,1)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
C
C    SI,ULI,LLI
C
      DO 120 I=1,3
      IROW=IROW+1
      J=J+1
      IF (K.EQ.1) GO TO 100
      NBR=NBRRCH(K)
      DO 90 IBR=1,NBR
      ICOL=JCOL(IBR)+J
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMR(K)*P(K,IBR)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
90    CONTINUE
      ICOL=ICOL+J-1
      GO TO 110
100   CONTINUE
      ICOL=J-1
110   CONTINUE
      IKOUNT=IKOUNT+1
      A(IKOUNT)=GILAM(I)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      ICOL=ICOL+1
      IKOUNT=IKOUNT+1
      A(IKOUNT)=-GILAM(I+1)
      A(IKOUNT)=A(IKOUNT)-LAMAB(K,I+1)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
120   CONTINUE
C
      RETURN
      END

```

GI 215
 GI 220
 GI 225
 GI 230
 GI 235
 GI 240
 GI 245
 GI 250
 GI 255
 GI 260
 GI 265
 GI 270
 GI 275
 GI 280
 GI 285
 GI 290
 GI 295
 GI 300
 GI 305
 GI 310
 GI 315
 GI 320
 GI 325
 GI 330
 GI 335
 GI 340
 GI 345
 GI 350
 GI 355
 GI 360
 GI 365
 GI 370
 GI 375
 GI 380
 GI 385
 GI 390
 GI 395
 GI 400
 GI 405
 GI 410
 GI 415
 GI 420
 GI 425
 GI 430
 GI 435
 GI 440
 GI 445
 GI 450
 GI 455
 GI 460
 GI 465
 GI 470
 GI 475
 GI 480
 GI 485
 GI 490
 GI 495
 GI 500
 GI 505
 GI 510
 GI 515
 GI 520
 GI 525
 GI 530
 GI 535
 GI 540
 GI 545
 GI 550
 GI 555
 GI 560
 GI 565
 GI 570-

```

      SUBROUTINE INDEX (K,NBRCH,IBRCH,JCOL,NCON,ICOL1)
C
C    DETERMINES FIRST COLUMNJ FOR THE DAUGHTERS
C
C    JCOL(IBR) - FIRST COLUMN FOR BRANCH IBRCH(K,IBR)
C    ICOL1 - FIRST COLUMN OF BLOCK ASSOCIATED WITH DECAY OF KTH
C             MEMBER OF CHAIN
C
      DIMENSION IBRCH(15,1), NCON(1), JCOL(1), NBRCH(1)
      NBR=NBRRCH(K)
      DO 10 IBR=1,NBR
      JCOL(IBR)=0
10    CONTINUE
      ICOL1=0
      KM1=K-1
      IF (K.EQ.1) GO TO 30
      DO 20 I=1,KM1
      ICOL1=ICOL1+NCON(I)
20    CONTINUE
30    CONTINUE

```

IND 5
 IND 10
 IND 15
 IND 20
 IND 25
 IND 30
 IND 35
 IND 40
 IND 45
 IND 50
 IND 55
 IND 60
 IND 65
 IND 70
 IND 75
 IND 80
 IND 85
 IND 90
 IND 95
 IND 100

```

DO 90 IBR=1,NBR                                IND 105
IF (NBR.EQ.0) GO TO 60                          IND 110
C BRANCHING IN CHAIN                            IND 115
C IND=IBRNCH(K,IBR)-1                           IND 120
C IF (IND.EQ.0) GO TO 50                         IND 125
DO 40 I=1,IND                                   IND 130
JCOL (IBR)=JCOL (IBR)+NCON (I)                  IND 135
40 CONTINUE                                     IND 140
50 CONTINUE                                     IND 145
GO TO 90                                         IND 150
C NO BRANCHING                                  IND 155
C IND=K-2                                       IND 160
C IF (IND.EQ.0) GO TO 80                         IND 165
DO 70 I=1,IND                                   IND 170
JCOL (IBR)=JCOL (IBR)+NCON (I)                  IND 175
70 CONTINUE                                     IND 180
80 CONTINUE                                     IND 185
90 CONTINUE                                     IND 190
RETURN                                           IND 195
END                                              IND 200
END                                              IND 205
END                                              IND 210
END                                              IND 215
END                                              IND 220
END                                              IND 225-

SUBROUTINE LUNG (D3,D4,D5)                      LUN 5
C THIS SUBROUTINE DETERMINES THE ENTRIES OF THE CORRESPONDENT LUN 10
C MATRIX CORRESPONDING TO THE LUNG COMPARTMENTS LUN 15
C AMNT(10) LUN 20
C AMNT(I) = LAMB(K)*PRAC(K,I) FOR PATHWAY I, DAUGHTER K LUN 25
C D(9) - REGIONAL DEPOSITION VALUES LUN 30
C D(1) = D3 D(5) = D5 LUN 35
C D(2) = D3 D(6) = D5 LUN 40
C D(3) = D4 D(7) = D5 LUN 45
C D(4) = D4 D(8) = D5 LUN 50
C P(9,3) LUN 55
C P(X,I) = REGIONAL FRACTION TO PATHWAY LUN 60
C X = A,B,C,...J LUN 65
C I = 1 CLASS D LUN 70
C 2 CLASS W LUN 75
C 3 CLASS Y LUN 80
C PRAC(15,9) LUN 85
C PRAC(I,J) = REGIONAL FRACTION IN PATHWAY J OF DAUGHTER I LUN 90
C IC(15) LUN 95
C IC(I) = CLASS INDEX FOR DAUGHTER I LUN 100
C 1 - CLASS D LUN 105
C 2 - CLASS W LUN 110
C 3 - CLASS Y LUN 115
C LAMBDA(2,0) LUN 120
C LAMBDA(J,X) = LN 2/(REMOVAL HALFLIFE FOR PATHWAY LUN 125
C X = A,B,C,...I) LUN 130
C J = 1 CLASS D LUN 135
C 2 CLASS W LUN 140
C 3 CLASS Y LUN 145
C IMPLICIT REAL*8(A-H,O-Z) LUN 150
C REAL*8 LAMB(1),LAMBDA(3,9),LAMX(15,10),LANAB(15,4) LUN 155
C INTEGER*2 RTINDEX(1),CINDEX(1) LUN 160
C DIMENSION A(1), PRAC(15,9), P(9,3), ICLASS(1), IC(15), D(9), P(15,LUN 165
C 11), IBRNCH(1), AMNT(15), X0(1), JCOL(1) LUN 170
C INTEGER DAY, WKK, YR LUN 175
C COMMON /TABLES/ LANAB(15,4),LAMX(15,10),ORGN(10),TAG(15),ICON(15,LUN 180
C 110),IOPT,NCON(15),NISO,NORG LUN 185
C DATA P/.5D0,.5D0,.95D0,.05D0,.8D0,0.0D0,0.0D0,.2D0,1.0D0,.1D0,.9D0,.5LUN 190
C 1D0,.5D0,.1D0,.4D0,.4D0,.05D0,1.0D0,.01D0,.99D0,.01D0,.99D0,.05D0,.LUN 195
C 24D0,.4D0,.15D0,.9D0/ LUN 200
C DATA LAMBDA/3*69.3147180559945D0,69.3147180559945D0,2*1.7328679513LUN 205
C 19986D0,3*69.3147180559945D0,3*3.465735902799725D0,1.38629436111989LUN 210
C 2D0,.0138629436111989D0,.00138629436111989D0,0.0D0,2*.69314718055994LUN 215
C 35D0,0.0D0,.0138629436111989D0,.00138629436111989D0,1.38629436111989LUN 220
C 4D0,.0138629436111989D0,.00138629436111989D0,1.38629436111989D0,.01LUN 225
C 538629436111989D0,.000693147180559945D0/ LUN 230
C DATA DAY/' D ',WKK/' W ',YEAR/' Y ' / LUN 235
C ASSIGN REGIONAL DEPOSITION FOR EACH PATHWAY LUN 240
C D(1)=D3 LUN 245
C D(2)=D3 LUN 250
C D(3)=D4 LUN 255
C D(4)=D4 LUN 260

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D(5)=D5                                LUN 340
D(6)=D5                                LUN 345
D(7)=D5                                LUN 350
D(8)=D5                                LUN 355
RETURN                                  LUN 360
C                                       LUN 365
C   ENTRY LUNG1(ICLASS,X0,NX0)          LUN 370
C                                       LUN 375
C   CHECK CLASS                        LUN 380
C                                       LUN 385
C   DO 80 I=1,NISO                     LUN 390
C   IF (ICLASS(I).NE.DAY) GO TO 10     LUN 395
C   IC(I)=1                            LUN 400
C   GO TO 40                           LUN 405
10  CONTINUE                           LUN 410
C   IF (ICLASS(I).NE.WEEK) GO TO 20    LUN 415
C   IC(I)=2                            LUN 420
C   GO TO 40                           LUN 425
20  CONTINUE                           LUN 430
C   IF (ICLASS(I).NE.YEAR) GO TO 30    LUN 435
C   IC(I)=3                            LUN 440
C   GO TO 40                           LUN 445
30  CONTINUE                           LUN 450
C   WRITE (10,230)                     LUN 455
C   CALL ERROR                          LUN 460
40  CONTINUE                           LUN 465
C                                       LUN 470
C   SET LAMX AND FRAC                  LUN 475
C                                       LUN 480
C   DO 50 J=1,9                        LUN 485
C   LAMX(I,J)=LAMBDA(IC(I),J)          LUN 490
C   FRAC(I,J)=F(J,IC(I))              LUN 495
50  CONTINUE                           LUN 500
C   LAMX(I,10)=0.D0                   LUN 505
C                                       LUN 510
C   IF PARENT IS CLASS Y AND DAUGHTER IS CLASS D OR W LUN 515
C   SET LAMX(I,10) TO LAMX(I,9)       LUN 520
C                                       LUN 525
C   IF (I.EQ.1) GO TO 60               LUN 530
C   IF (IC(I-1).EQ.3.AND.(IC(I).EQ.1.OR.IC(2).EQ.2)) LUN 535
C   1,9)                               LUN 540
60  CONTINUE                           LUN 545
C   IF (I.GT.1) GO TO 80               LUN 550
C                                       LUN 555
C   SET INITIAL VALUES FOR ODE       LUN 560
C                                       LUN 565
C   DO 70 K=1,NX0                     LUN 570
C   X0(K)=0.D0                         LUN 575
C   IF (K.LE.8) X0(K)=D(K)*PRAC(1,K)   LUN 580
70  CONTINUE                           LUN 585
80  CONTINUE                           LUN 590
C                                       LUN 595
C   RETURN                             LUN 600
C                                       LUN 605
C   ENTRY LUNG2(A,RINDEX,CINDEX,IROW,JCOL,ICOL1,IKOUNT,LAMR,P,K,J,N,NBLUN LUN 610
C   1,RNCH)                             LUN 615
C   IF (K.EQ.1) ICOL=0                 LUN 620
C                                       LUN 625
C   LUNG COMPARTMENTS                  LUN 630
C   PATHWAYS A-H                       LUN 635
C                                       LUN 640
C   IF (K.EQ.1) GO TO 100              LUN 645
C   DO 90 I=1,10                       LUN 650
C   AMNT(I)=LAMR(K)                    LUN 655
90  CONTINUE                           LUN 660
100 CONTINUE                           LUN 665
C   J=J+1                              LUN 670
C   IROW=IROW+1                        LUN 675
C   IF (K.EQ.1) GO TO 120               LUN 680
C   NBR=NBRRCH(K)                      LUN 685
C   DO 110 IBR=1,NBR                   LUN 690
C   IKOUNT=IKOUNT+1                    LUN 695
C   ICOL=JCOL(IBR)+J                  LUN 700
C   A(IKOUNT)=AMNT(J)*P(K,IBR)         LUN 705
C   RINDEX(IKOUNT)=IROW                LUN 710
C   CINDEX(IKOUNT)=ICOL                LUN 715
110 CONTINUE                           LUN 720
C   ICOL=ICOL+J                        LUN 725
C   GO TO 130                           LUN 730
120 CONTINUE                           LUN 735
C   ICOL=ICOL+1                        LUN 740
130 CONTINUE                           LUN 745
C   IKOUNT=IKOUNT+1                    LUN 750
C   A(IKOUNT)=-LAMX(K,J)                LUN 755
C   RINDEX(IKOUNT)=IROW                 LUN 760
C   CINDEX(IKOUNT)=ICOL                 LUN 765
C   IF (J.EQ.8) GO TO 140               LUN 770
C   GO TO 100                           LUN 775
140 CONTINUE                           LUN 780
C                                       LUN 785
C   PATHWAYS I AND J                   LUN 790
C                                       LUN 795
C   IROW=IROW+1                        LUN 800
C   J=J+1                              LUN 805
C   IF (K.EQ.1) GO TO 160               LUN 810
C   NPB=NBRRCH(K)                      LUN 815

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      DO 150 IER=1,NBR
      ICOL=JCOL(IBR)+J
      IKOUNT=IKOUNT+1
      A(IKOUNT)=AMHT(J)*P(K,IBR)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
150  CONTINUE
      ICOL=ICOL+8
      GO TO 170
160  CONTINUE
      ICOL=8
170  CONTINUE
      IKOUNT=IKOUNT+1
      IF (J.EQ.9) A(IKOUNT)=LAMX(K,8)*FRAC(K,9)
      IF (J.EQ.10) A(IKOUNT)=LAMX(K,8)*(1.00-FRAC(K,9))
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      II=1
      IF (J.EQ.10) II=2
      ICOL=ICOL+II
      IKOUNT=IKOUNT+1
      IF (J.EQ.9) A(IKOUNT)=-LAMX(K,J)
      IF (J.EQ.10) A(IKOUNT)=0.00
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      IF (J.EQ.10) GO TO 180
      GO TO 140
180  CONTINUE
C
C   PATHWAYS K AND L
C
      DO 220 I=1,2
      IROW=IROW+1
      J=J+1
      IF (K.EQ.1) GO TO 200
      DO 190 IER=1,NBR
      ICOL=JCOL(IBR)+J
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMR(K)*P(K,IBR)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
190  CONTINUE
      ICOL=ICOL+5+I
      GO TO 210
200  CONTINUE
      ICOL=5+I
210  CONTINUE
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMX(K,5+I)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      IKOUNT=IKOUNT+1
      ICOL=ICOL+5
      A(IKOUNT)=-LAMX(K,4)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
220  CONTINUE
      *****
C
230  FORMAT ('0',11X,' ERROR. CLASS DOES NOT COMPARE')
      END

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      SUBROUTINE MATRIX (A,NWRDA,INDXA,IDIAG,XO,NXO,N,LR,NBLK,NLR,NDSUBMMAT 5
1)
C   A(NWRDA)
C   CONTAINS NON-ZERO ENTRIES OF THE COEFFICIENT MATRIX
C   A(IDIAG(I)) = DIAGONAL ELEMENT OF ITH ROW OF THE COEFFICIENT MATRIX
C   CINDEX(12001)
C   CINDEX(I) = COLUMN INDEX OF A(I)
C   ICLASS(15)
C   ICLASS(I) = CLASS OF THE ITH MEMBER OF CHAIN
C   ICON(15,10)
C   ICON(I,J) = NO. OF COMPARTMENT FOR DAUGHTER I, ORGAN J
C   INDXA( )
C   INDXA(2,2*I-1) = -1*(NO. OF NON-ZERO ELEMENTS IN
C   ROW I OF A
C   INDXA(2,2*I) = 8*(NO. OF NON-ZERO ELEMENTS IN
C   ROW I OF A
C   INDXA(1,1) = 8*(J-1) IF A(I) BELONGS IN COLUMN
C   J OF THE MATRIX A
C   ISORS(20)
C   ISORS(I) = INDEX OF THE ITH SOURCE ORGAN (INDICES FROM SEE CODE)
C   LAMAB(15,4)
C   LAMAB(I,1) = LAMBDA OF ABSORPTION IN S FOR DAUGHTER I
C   LAMAB(I,2) = LAMBDA OF ABSORPTION IN SI FOR DAUGHTER I
C   LAMAB(I,3) = LAMBDA OF ABSORPTION IN ULI FOR DAUGHTER I

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C      LAMAB(I,4) = LAMBDA OF ABSORPTION IN LLI FOR DAUGHTER I      MAT 160
C      LAMR(15)                                                    MAT 165
C      LAMR(I) = LN 2/(HALFLIFE OF DAUGHTER I)                      MAT 170
C      LAMX(15,10)                                                  MAT 175
C      LAMX(I,J) = LN 2/(HALFLIFE OF DAUGHTER I IN COMPARTMENT J)  MAT 180
C      LR(K) = LAMR(K)                                              MAT 185
C      NBLK(NDSDUM)                                                 MAT 190
C      NBLK(I) = ORDER OF SQUARE DIAGONAL SUBMATRIX I OF A      MAT 195
C      NBLK(I) = NCOM(I)                                           MAT 200
C      NCOM(15)                                                     MAT 205
C      NCOM(I) = NO. OF COMPARTMENTS FOR DAUGHTER I              MAT 210
C      ORGNM(10)                                                    MAT 215
C      ORGNM(I) = NAME OF THE ITH ORGAN                          MAT 220
C      PRNT(1000)                                                  MAT 225
C      PRNT(I) = ITH ENTRY OF A GIVEN ROW OF THE COEFFICIENT MATRIX MAT 230
C      RINDEX(12001)                                               MAT 235
C      RINDEX(I) = ROW INDEX OF A(I)                              MAT 240
C      TAG(15)                                                      MAT 245
C      TAG(I) - ATOMIC SYMBOL AND MASS NUMBER FOR DAUGHTER I      MAT 250
C      TR(15)                                                       MAT 255
C      TP(I) = HALFLIFE OF DAUGHTER I                             MAT 260
C      XO(NX0) - VECTOR OF INITIAL VALUES                       MAT 265
C      P(15,5)                                                      MAT 270
C      P(I,J) - BRANCHING RATIO TO RADIONUCLIDE I                MAT 275
C      NBRNCH(15)                                                   MAT 280
C      NBRNCH(I) - NUMBER OF RADIONUCLIDES THAT BRANCH TO MEMBER  MAT 285
C      I OF THE CHAIN                                             MAT 290
C      IBRNCH(15,5)                                                 MAT 295
C      IBRNCH(I,J) - INDEX OF RADIONUCLIDE BRANCHING TO NUCLIDE I MAT 300
C      JCOL(15)                                                     MAT 305
C      JCOL(J) - FIRST COLUMNS OF MATRIX CORRESPONDING          MAT 310
C      TO IBRNCH(I,J)                                             MAT 315
C      IMPLICIT REAL*8(A-H,O-Z)                                    MAT 320
C      REAL*8 LR(1),LAMX(15,10),LAMR(15),LAMAB(15,4)             MAT 325
C      INTEGER*2 RINDEX(12001),CINDEX(12001),SUM1               MAT 330
C      DIMENSION A(1), XO(1), INDXA(2,1), IDIAG(1), ICLASS(15), TR(15), PRNT  MAT 335
C      1RNT(400), NBLK(1), ISORS(20), P(15,5), NBRNCH(15), IBRNCH(15,5), JHAT  MAT 340
C      2COM(15)                                                    MAT 345
C      COMMON /TABLES/ LAMAB(15,4),LAMX(15,10),ORGNM(10),TAG(15),ICOM(15,  MAT 350
C      110),IOPT,NCOM(15),NISO,NORG                                MAT 355
C      COMMON /SWTCH/ ISWTCH                                       MAT 360
C      COMMON /CLASS/ ICLASS(15)                                   MAT 365
C      DATA PLN2/.693147180559945D0/                             MAT 370
C      DATA ISORS/8,9,10,11,2,3,4,5/                             MAT 375
C      ZERO RINDEX AND CINDEX                                     MAT 380
C      DO 10 I=1,12001                                             MAT 385
C      RINDEX(I)=0                                                 MAT 390
C      CINDEX(I)=0                                                 MAT 395
C      10 CONTINUE                                                MAT 400
C      READ NISO = NO. OF RADIONUCLIDES IN CHAIN                 MAT 405
C      D3,D4,D5 = REGIONAL DEPOSITION VALUES                   MAT 410
C      NORG = NO. OF ORGANS (EXCLUDING LUNG AND GI)             MAT 415
C      IOPT = 0 INTAKE BY INHALATION                             MAT 420
C      1 INTAKE BY INGESTION                                     MAT 425
C      2 INTAKE BY INJECTION                                     MAT 430
C      READ (50,140) NISO,D3,D4,D5,NORG,IOPT,NORAL             MAT 435
C      WRITE (10,150)                                             MAT 440
C      IF (IOPT.EQ.0) WRITE (10,160) D3,D4,D5                   MAT 445
C      WRITE (16) NISO,NORG,IOPT                                 MAT 450
C      WRITE (7,170) NISO,NORG,IOPT                             MAT 455
C      WRITE (16) NORAL                                           MAT 460
C      WRITE (7,170) NORAL                                         MAT 465
C      ASSIGN REGIONAL DEPOSITION FOR EACH PATHWAY              MAT 470
C      IF (IOPT.EQ.0) CALL LUNG(D3,D4,D5)                       MAT 475
C      FOR EACH RADIONUCLIDE READ                                MAT 480
C      TAG = MASS NO. AND SYMBOL                                 MAT 485
C      TR = HALFLIFE                                              MAT 490
C      ICLASS = CLASS                                             MAT 495

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      III=III-1
      INDXA(2,2*I-1)=-14*III
      INDXA(2,2*I)=8*III
      IDIAG(I)=II
      WRITE (51,260) (PRNT(J),J=1,SUM1)
      GO TO 110
100 CONTINUE
      PRNT(CINDEX(II))=A(II)
      INDXA(1,II)=8*(CINDEX(II)-1)
      GO TO 90
110 CONTINUE
C
      DO 120 I=1,NISO
      LR(I)=-LAHR(I)
      NBLK(I)=NCOM(I)
120 CONTINUE
      NDSUBM=NISO
      N=SUM1
      NELA=IDIAG(N)
C
C PRINT NON-ZERO ELEMENTS OF THE COEFFICIENT MATRIX AND
C THE ROW AND COLUMN IN WHICH EACH ONE APPEARS
C
      WRITE (6,270)
      DO 130 I=1,NELA
      WRITE (51,280) A(I),RINDEX(I),CINDEX(I)
130 CONTINUE
C
      RETURN
C
140 FORMAT (I10,3F10.3,3I10)
150 FORMAT ('1')
160 FORMAT (' PERCENT DEPOSITION'/' ',4X,'N-P',12X,'T-B',12X,'P'/' ',F
17.2,4(8X,F7.2),/)
170 FORMAT (16I5)
180 FORMAT (' ISOTOPE',4X,'HALFLIFE',4X,'CLASS',3X,'LANAB',3X,' IBRNCH
1 '7X,'BR. RATIOS')
190 FORMAT (3F10.0)
200 FORMAT (' ',A8,1PE12.3,4X,A4,E10.3,5I3,0P5P7.4)
210 FORMAT (' ',21X,'LANAB-S',1PE10.3,/' ',19X,'LANAB-ULI',E10.3,/' ',
119X,'LANAB-LLI',E10.3)
220 FORMAT (A8,2X,F10.0,8X,A2,F10.0,6I2,5F5.0,I3)
230 FORMAT (10A8)
240 FORMAT ('1MATRIX A PRINTED BY ROWS')
250 FORMAT ('0')
260 FORMAT (' ',8D15.6)
270 FORMAT ('1',3X,'ENTRIES OF A',2X,'ROW',2X,'COL')
280 FORMAT (' ',D15.6,2I5)
      END

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      SUBROUTINE ORGAN (A,RINDEX,CINDEX,IROW,JCOL,ICOL1,IKOUNT,LAHR,P,K,ORG
      1J,N,NBRNCH,ISORS,X0,NX0)
C
C THIS SUBROUTINE DETERMINES THE ENTRIES OF THE COEFFICIENT
C MATRIX CORRESPONDING TO THE COMPARTMENTS OF OTHER ORGANS OF
C THE BODY
C
C
C
C ICOM(15,10)
C ICOM(I,J) = NO. OF COMPARTMENT FOR DAUGHTER I,
C ORGAN J
C
C AS(10,10), TBS(10,10)
C AS(I,J) = COEF. OF EXPONENTIAL OF COMPARTMENT I, ORGAN J
C TBS(I,J) = POWER OF E, COMPARTMENT I ORGAN J
C
C
C
C IMPLICIT REAL*8(A-H,O-Z)
C REAL*8 LANX(15,10),LAHR(1),LANAB(15,4)
C INTEGER*2 RINDEX(1),CINDEX(1)
C DIMENSION A(1), AS(10,10), TBS(10,10), ISORS(1), P(15,1), NBRNCH(10
1), X0(1), JCOL(1)
C
C
C COMMON /TABLES/ LANAB(15,4),LANX(15,10),ORGNN(10),TAG(15),ICOM(15,
110),IOPT,NCOM(15),NISO,NORG
C COMMON /PAKE1/ SUM
C
C
C IO=-1
C IF (NORG.EQ.0) GO TO 150
C WRITE (10,160)
C READ (50,170) TRANS
C WRITE (10,180) TAG(K)
C
C
C SET INITIAL VALUES FOR ODE'S
C
C
C IF (K.GT.1) GO TO 20
C IF (IOPT.EQ.0.OR.IOPT.EQ.1) GO TO 20
C X0(1)=1.D0
C DO 10 I=2,NX0
C X0(I)=0.D0
10 CONTINUE
C
C
C 20 CONTINUE

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C TRANSFER COMPARTMENT
C
      IROW=IROW+1
      J=J+1
      IF (K.EQ.1) GO TO 40
      NBR=NBRRCH(K)
      DO 30 IBR=1,NBR
      ICOL=JCOL(IBR)+J
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMR(K)*P(K,IBR)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
30 CONTINUE
      ICOL=ICOL+1
      GO TO 50
40 CONTINUE
      ICOL=1
50 CONTINUE
      IF (IOPT.EQ.1) GO TO 70
      IF (IOPT.EQ.2) GO TO 90
      DO 60 JJ=1,5,2
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMX(K,JJ)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      ICOL=ICOL+2
60 CONTINUE
      ICOL=ICOL+2
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMX(K,9)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      ICOL=ICOL+4
70 CONTINUE
      DO 80 JJ=1,4
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMAB(K,JJ)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      ICOL=ICOL+1
80 CONTINUE
90 CONTINUE
      IKOUNT=IKOUNT+1
      A(IKOUNT)=-TRANS
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
C
C OTHER ORGANS
C
      IO=0
      DO 140 I=1,NORG
      READ (50,190) ISORS(I+8),ORGNH(I),ICOM(K,I)
      ICOMKI=ICOM(K,I)
      READ (50,200) (AS(JJ,I),JJ=1,ICOMKI), (TBS(JJ,I),JJ=1,ICOMKI)
      WRITE (10,210) ORGNH(I), (AS(JJ,I),JJ=1,ICOMKI), (TBS(JJ,I),JJ=1,ICOMKI)
1 MKI
      DO 130 MM=1,ICOMKI
      IO=IO+1
      IROW=IROW+1
      J=J+1
      IF (K.EQ.1) GO TO 110
      NBR=NBRRCH(K)
      DO 100 IBR=1,NBR
      ICOL=JCOL(IBR)+J
      IKOUNT=IKOUNT+1
      A(IKOUNT)=LAMR(K)*P(K,IBR)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
100 CONTINUE
      IF (IOPT.EQ.0) ICOL=ICOL+17
      IF (IOPT.EQ.1) ICOL=ICOL+5
      IF (IOPT.EQ.2) ICOL=ICOL+1
      GO TO 120
110 CONTINUE
      IF (IOPT.EQ.0) ICOL=17
      IF (IOPT.EQ.1) ICOL=5
      IF (IOPT.EQ.2) ICOL=1
120 CONTINUE
      IKOUNT=IKOUNT+1
      A(IKOUNT)=AS(MM,I)*TRANS
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
      ICOL=ICOL+IO
      IKOUNT=IKOUNT+1
      A(IKOUNT)=-TBS(MM,I)
      RINDEX(IKOUNT)=IROW
      CINDEX(IKOUNT)=ICOL
130 CONTINUE
140 CONTINUE
150 CONTINUE
      IF (IOPT.EQ.0) NCOM(K)=IO+17
      IF (IOPT.EQ.1) NCOM(K)=IO+5
      IF (IOPT.EQ.2) NCOM(K)=IO+1
      RETURN
C
160 FORMAT ('0',////,' ISOTOPE',4X,'ORGAN',5X,'A''S AND TB''S')

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170 FORMAT (F10.0)                                ORG 700
190 FORMAT (' ',A8)                                ORG 705
190 FORMAT (I2,A8,I2)                              ORG 710
200 FORMAT (8F10.0)                                ORG 715
210 FORMAT (' ',10X,A8,2X,1P8E12.3,/,(' ',20X,8E12.3)) ORG 720
END                                                  ORG 725-

SUBROUTINE OTHER (X)                                OTH 5
C                                                    OTH 10
C PRINTS OTHER TISSUES INFORMATION                  OTH 15
C                                                    OTH 20
REAL*8 TAG,LAMX,X(15,1),ORGNM,LAMAB               OTH 25
COMMON /TAELES/ LAMAB(15,4),LAMX(15,10),ORGNM(10),TAG(15),ICOM(15, OTH 30
110),IOPT,NCOM(15),NISO,NORG                       OTH 35
DIMENSION IOTHER(10)                               OTH 40
NORGM1=NCRG-1                                       OTH 45
READ (50,10) NOTOP,(IOTHER(I),I=1,NORGM1)         OTH 50
WRITE (16) NOTOP,(IOTHER(I),I=1,NORGM1)           OTH 55
WRITE (7,10) NOTOP,(IOTHER(I),I=1,NORGM1)         OTH 60
RETURN                                              OTH 65
C                                                    OTH 70
10 FORMAT (40I2)                                    OTH 75
END                                                  OTH 80-

SUBROUTINE STIFF (Y,N0)                             STI 5
IMPLICIT REAL*8 (A-H,O-Z)                         STI 10
COMMON /NSW/ NSW                                    STI 15
COMMON /SC1235/ T,H,HMIN,HMAX,EPS,MF,KPLAG,JSTART,N,NINV,NX0,YMAX( STI 20
1400),ERROR(400),PSAVE(800),YPRINT(400)          STI 25
COMMON /ICRP/ A,X0,LR,SWICRP,IDIAG,NBLK,NDSUBM,NDAV STI 30
C *** NEED DIMENSION YMAX(NX0),ERROR(NX0),PSAVE(2*NX0) STI 35
DIMENSION Y(N0,13),EL(13),TQ(4)                  STI 40
C*****STIFF PERFORMS ONE STEP OF THE INTEGRATION OF AN INITIAL VALUE STI 45
C* STIFF PERFORMS ONE STEP OF THE INTEGRATION OF AN INITIAL VALUE STI 50
C* PROBLEM FOR A SYSTEM OF ORDINARY DIFFERENTIAL EQUATIONS. STI 55
C* COMMUNICATION WITH STIFF IS DONE WITH THE FOLLOWING VARIABLES.. STI 60
C* STI 65
C* Y AN N0 BY LMAX ARRAY CONTAINING THE DEPENDENT VARIABLES STI 70
C* AND THEIR SCALED DERIVATIVES. LMAX IS CURRENTLY 13 FOR STI 75
C* THE ADAMS METHODS AND 6 FOR THE GEAR METHODS. LMAX - 1 STI 80
C* IS MAXDER, THE MAXIMUM ORDER USED. SEE SUBROUTINE TESOC. STI 85
C* Y(I,J+1) CONTAINS THE J-TH DERIVATIVE OF Y(I), SCALED BY STI 90
C* H**J/FACTORIAL(J). ONLY Y(I), 1 .LE. I .LE. N, NEED BE STI 95
C* SET BY THE CALLING PROGRAM ON THE FIRST ENTRY. STI 100
C* IF IT IS DESIRED TO INTERPOLATE TO NON-MESH POINTS, STI 105
C* THE Y ARRAY CAN BE USED. IF THE CURRENT STEP SIZE STI 110
C* IS H AND THE VALUE AT T + E IS NEEDED, FORM STI 115
C* S = E/H, AND THEN COMPUTE STI 120
C* NO STI 125
C* Y(I)(T+E) = SUM NO Y(I,J+1)*S**J. STI 130
C* J=0 STI 135
C* THE Y ARRAY SHOULD NOT BE ALTERED BY THE CALLING PROGRAM. STI 140
C* WHEN REFERENCING Y AS A 2-DIMENSIONAL ARRAY, USE A STI 145
C* COLUMN LENGTH OF N0, AS THIS IS THE VALUE USED IN STIFF. STI 150
C* N THE NUMBER OF FIRST ORDER DIFFERENTIAL EQUATIONS. N STI 155
C* MAY BE DECREASED ON LATER CALLS IF THE NUMBER OF STI 160
C* ACTIVE EQUATIONS REDUCES, BUT IT MUST NOT BE STI 165
C* INCREASED WITHOUT CALLING WITH JSTART = 0. STI 170
C* NO A CONSTANT INTEGER .GE. N, USED FOR DIMENSIONING PURPOSES. STI 175
C* NO MUST NOT BE CHANGED WITHOUT SETTING JSTART = 0. STI 180
C* T THE INDEPENDENT VARIABLE. T IS UPDATED ON EACH STEP TAKEN. STI 185
C* H THE STEP SIZE TO BE ATTEMPTED ON THE NEXT STEP. STI 190
C* H MAY BE ADJUSTED UP OR DOWN BY THE ROUTINE STI 195
C* IN ORDER TO ACHIEVE AN ECONOMICAL INTEGRATION. STI 200
C* HOWEVER, IF THE H PROVIDED BY THE USER DOES STI 205
C* NOT CAUSE A LARGER ERROR THAN REQUESTED, IT STI 210
C* WILL BE USED. TO SAVE COMPUTER TIME, THE USER IS STI 215
C* ADVISED TO USE A FAIRLY SMALL STEP FOR THE FIRST STI 220
C* CALL. IT WILL BE AUTOMATICALLY INCREASED LATER. STI 225
C* H CAN BE EITHER POSITIVE OR NEGATIVE, BUT ITS SIGN STI 230
C* MUST REMAIN CONSTANT THROUGHOUT THE PROBLEM. STI 235
C* HMIN THE MINIMUM ABSOLUTE VALUE OF THE STEP SIZE THAT WILL BE STI 240
C* USED FOR THE PROBLEM. ON STARTING THIS MUST BE MUCH STI 245
C* SMALLER THAN THE AVERAGE ABS(H) EXPECTED, SINCE STI 250
C* A FIRST ORDER METHOD IS USED INITIALLY. STI 255
C* HMAX THE MAXIMUM ABSOLUTE VALUE OF THE STEP SIZE THAT WILL STI 260
C* BE USED FOR THE PROBLEM. STI 265
C* EPS THE RELATIVE ERROR TEST CONSTANT. SINGLE STEP ERROR STI 270
C* ESTIMATES DIVIDED BY YMAX(I) MUST BE LESS THAN THIS STI 275
C* IN THE EUCLIDEAN NORM. THE STEP AND/OR ORDER IS STI 280
C* ADJUSTED TO ACHIEVE THIS. STI 285
C* MF THE METHOD FLAG. MF IS A POSITIVE INTEGER WITH STI 290
C* TWO DECIMAL DIGITS--METH AND NITER (MF=10*METH+NITER). STI 295
C* METH IS THE BASIC METHOD INDICATOR.. STI 300
C* METH = 1 MEANS THE ADAMS METHODS. STI 305
C* METH = 2 MEANS THE STIFF SYSTEM METHODS OF GEAR. STI 310
C* NITER IS THE ITERATION METHOD INDICATOR.. STI 315
C* NITER = 0 MEANS FUNCTIONAL ITERATION ( NO PARTIAL STI 320
C* DERIVATIVES NEEDED). STI 325
C* NITER = 1 MEANS CHORD METHOD WITH ANALYTIC JACOBIAN. STI 330

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C*          FOR THIS USER SUPPLIES SUBROUTINE          STI 335
C*          PEDERV(N,T,Y,PD,NO). PD IS AN N BY N ARRAY, STI 340
C*          STORED AS AN NO BY NO ARRAY. PD(I,J) IS    STI 345
C*          TO BE SET TO THE PARTIAL DERIVATIVE OF     STI 350
C*          YDOT(I) WITH RESPECT TO Y(J).              STI 355
C*          MITER = 2 MEANS CHORD METHOD WITH JACOBIAN   STI 360
C*          CALCULATED IN STIFF BY FINITE DIFFERENCES. STI 365
C*          PEDERV IS NOT CALLED AND A DUMMY CAN BE USED. STI 370
C*          MITER = 3 MEANS CHORD METHOD WITH JACOBIAN REPLACED STI 375
C*          BY A DIAGONAL APPROXIMATION BASED ON A      STI 380
C*          DIRECTIONAL DERIVATIVE.                    STI 385
C*          YMAX    AN ARRAY OF N LOCATIONS WHICH CONTAINS THE MAXIMUM STI 390
C*          ABSOLUTE VALUE OF EACH Y SEEN SO FAR.       STI 395
C*          ERROR    AN ARRAY OF N ELEMENTS PROPORTIONAL TO THE ESTIMATED STI 400
C*          ONE STEP ERROR IN EACH COMPONENT.           STI 405
C*          KFLAG    A COMPLETION CODE WITH THE FOLLOWING MEANINGS.. STI 410
C*          0 THE STEP WAS SUCCESSFUL.                  STI 415
C*          -1 THE REQUESTED ERROR COULD NOT BE ACHIEVED STI 420
C*          WITH ABS(H) = HMIN.                         STI 425
C*          -2 THE REQUESTED ERROR IS SMALLER THAN CAN   STI 430
C*          BE HANDLED FOR THIS PROBLEM.                STI 435
C*          -3 CORRECTOR CONVERGENCE COULD NOT BE       STI 440
C*          ACHIEVED FOR ABS(H) .GT. HMIN.              STI 445
C*          -5. H WAS SUCH THAT T+H .EQ. T ON MACHINE.. STI 450
C*          ON A RETURN WITH KFLAG NEGATIVE, THE VALUES OF T AND STI 455
C*          THE Y ARRAY ARE AS OF THE BEGINNING OF THE LAST STI 460
C*          STEP, AND H IS THE LAST STEP SIZE ATTEMPTED. STI 465
C*          JSTART   AN INTEGER USED ON INPUT AND OUTPUT. STI 470
C*          ON INPUT, IT HAS THE FOLLOWING VALUES AND MEANINGS.. STI 475
C*          0 PERFORM THE FIRST STEP. THIS VALUE ENABLES STI 480
C*          THE SUBROUTINE TO INITIALIZE ITSELF.         STI 485
C*          .GT.0 TAKE A NEW STEP CONTINUING FROM THE LAST. STI 490
C*          ASSUMES THE LAST STEP WAS SUCCESSFUL AND     STI 495
C*          USER HAS NOT CHANGED ANY PARAMETERS.       STI 500
C*          .LT.0 REPEAT THE LAST STEP WITH A NEW VALUE OF STI 505
C*          H AND/OR EPS AND/OR MP. THIS MAY BE         STI 510
C*          EITHER IN REDOING A STEP THAT FAILED, OR    STI 515
C*          IN CONTINUING FROM A SUCCESSFUL STEP.       STI 520
C*          ON EXIT, JSTART IS SET TO NQ, THE CURRENT ORDER OF THE STI 525
C*          METHOD. THIS IS ALSO THE ORDER OF THE MAXIMUM DERIVATIVE STI 530
C*          AVAILABLE IN THE Y ARRAY. AFTER A SUCCESSFUL STEP, STI 535
C*          JSTART NEED NOT BE RESET FOR THE NEXT CALL. STI 540
C*          PW       A BLOCK OF LOCATIONS USED FOR PARTIAL DERIVATIVES IF STI 545
C*          MITER IS NOT 0. IF MITER IS 1 OR 2, ITS LENGTH MUST STI 550
C*          BE AT LEAST NO*(NO+1), FOR THE JACOBIAN AND PIVOT STI 555
C*          INFORMATION. IF MITER = 3, ITS LENGTH MUST ONLY BE STI 560
C*          AT LEAST N.                                  STI 565
C*          PSAVE    A BLOCK OF AT LEAST 2*NO LOCATIONS FOR TEMPORARY STORAGE. STI 570
C*          STI 575
C*          THE PARAMETERS WHICH MUST BE INPUT BY THE USER ARE.. STI 580
C*          N, NO, T, Y, H, HMIN, HMAX, EPS, MP, JSTART. STI 585
C*          STI 590
C*          ADDITIONAL SUBROUTINES REQUIRED ARE..         STI 595
C*          TESOC(METH,NQ,PL,TQ,MAXDER) SETS METHOD COEFFICIENTS. STI 600
C*          IT IS PROVIDED IN THE PACKAGE.              STI 605
C*          DTPPN(N,T,Y,XDOT) COMPUTES DY/DT GIVEN T AND I. STI 610
C*          PEDERV(N,T,Y,PD,NO) COMPUTES PARTIAL DERIVATIVES. IT IS USED STI 615
C*          ONLY IF MITER = 1. (SEE MP DESCRIPTION.)     STI 620
C*          PHOCED(NO,N,A,IPS,S,IER,NINW) AND EVLOS(NO,N,A,B,X,IPS) ARE USED STI 625
C*          FOR THE SOLUTION OF SYSTEMS OF LINEAR ALGEBRAIC EQUATIONS. STI 630
C*          THEY ARE PROVIDED IN THE PACKAGE, AND USED IF MITER = 1 OR 2. STI 635
C*          STI 640
C*          THE CALLING PROGRAM MUST CONTAIN THE COMMON DECLARATIONS GIVEN STI 645
C*          ABOVE, IN WHICH THE LENGTHS ARE AS GIVEN BY THE DESCRIPTIONS STI 650
C*          OF THE VARIABLES ABOVE. THE OPTIONAL ROUTINE DRIVES MAY BE STI 655
C*          USED FOR THIS PURPOSE. THE CONSTANT ANOISE IN THE DATA STATEMENT STI 660
C*          BELOW SHOULD BE SET TO THE NOISE LEVEL OF THE MACHINE. STI 665
C*          STI 670
C*          THE ORIGINAL VERSION OF THIS PROGRAM WAS WRITTEN AT LLL BY A. C. STI 675
C*          HINDMARSH FOR CDC COMPUTERS. THE CDC VERSION WAS MODIFIED FOR STI 680
C*          USE ON IBM COMPUTERS AT ARGONNE IN JUNE, 1973. STI 685
C*          STI 690
C*          LATEST REVISION SEPTEMBER, 1973             STI 695
C*          STI 700
C*          *****Q***** STI 705
C*          DATA ANOISE/5.D-16/ STI 710
C*          STI 715
C*          ***** STI 720
C*          DIMENSION A(12001), IDIAG(400), X0(400), PW(6000) STI 725
C*          DIMENSION NBLK(015) STI 730
C*          REAL*8 LR(15) STI 735
C*          EQUIVALENCE (A(1),IND(1)) STI 740
C*          DIMENSION IND(1) STI 745
C*          DATA NLK/15/ STI 750
C*          DATA NWDAA/12001/ STI 755
C*          DATA NWDPR/6000/ STI 760
C*          *** NWDPR = NO. WORDS IN VECTOR PW. REQUIRE NWDPR.GE.NWLEA STI 765
C*          *** NWDAA = NO. WORDS IN ARRAY A. SHOULD BE ODD STI 770
C*          *** NX0 = NO. ELE. IN X0 VECTOR = NO. ELE. IN IDIAG VECTOR. STI 775
C*          *** NLR = NO. WORDS IN ARRAY LR. STI 780
C*          IF (NSW.EQ.0) GO TO 100 STI 785
C*          STI 790
C*          *** NL=1 STI 795
C*          STI 800
C*          *** NSW=0 STI 805
C*          NWDAA=NWDAA/2 STI 810

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      INDXA=NWDAY+1
C *** WANT A(1) AND A(INDXA) .TO BE LOCATED IN DIFFERENT MEMORY BOXES.
C *** ON THE IBM 360/91.
      IF (16*(NWDAY/16).EQ.NWDAY) INDXA=INDXA+1
C *** X0 AND IDIAG WILL EACH HAVE N ELEMENTS IN THEM ON RETURN FROM
C *** MATRIX
      IF (N.LE.NX0) GO TO 20
      PRINT 580, N,NX0
      10 CALL EXIT
      20 CONTINUE
C *** MATRIX RETURNS THE DIAGONAL OF A SPLIT INTO A PART IN THE DIAG.
C *** ELEMENTS IN VECTOR A AND INTO THE LR ARRAY THAT EXPANDS TO
C *** DIAG(LR(1)*I(1),...,LR(NDSUBM)*I(NDSUBM)) WHERE I(J) IS A VECTOR
C *** OF 1'S OF DIMENSION NBLK(J).
C *** THIS SPLIT IS FOR ANOTHER PROGRAM TO CALC. APPROX.EIGENVECTORS.
C *** THE NO. OF NONZERO OFF-DIAGONAL ELEMENTS IN MATRIX A + N
C *** (N= NUMBER OF DIAG. ENTRIES IN MATRIX A) MUST BE .LE.NWDAY WHERE
C *** NWDAY=MAX. NO. WORDS AVAILABLE FOR THE VECTOR A.
C *** EXPECT SUBR.MATRIX TO CHECK THAT AVAILABLE STORAGE IS SUFFICIENT
C *** FOR CURRENT PROBLEM
      IF (SWICBP.EQ.1.) GO TO 30
      CALL MATRIX (A,NWDAY,A(INDXA),IDIAG,X0,NX0,N,LR,NBLK,NLR,NDSUBM)
C *** DIMENSION IDIAG(NX0),X0(NX0),LR(NLR),NBLK(NLR)
C *** NDSUBM=NO. OF DIAG. SUBMATRICES IN ARRAY A.
      30 CONTINUE
      IF (NDSUBM.LE.NLR) GO TO 40
      PRINT 590, NDSUBM,NLR
      GO TO 10
      40 CONTINUE
      NELEA=IDIAG(N)
      IF (NELEA.LE.NWDPW) GO TO 50
      PRINT 600, NELEA,NWDPW
      GO TO 10
      50 CONTINUE
      NB=0
      NB=INDXA+INDXA
      DO 60 I=1,N
      NB=MIN0(NB,IND(NB))
      60 NB=NB+4
      NB=NB/(-14)
      IF (NB.LE.052) GO TO 70
      PRINT 610, NB
      GO TO 10
      70 CONTINUE
      ICUT=0
      INBLK=0
      DO 90 I=1,N
      IF (I.LE.ICUT) GO TO 80
      INBLK=INBLK+1
      ICUT=ICUT+NBLK(INBLK)
      RLR=LR(INBLK)
      80 CONTINUE
      ID=IDIAG(I)
      IF (SWICRP.EQ.1.) GO TO 90
      A(ID)=A(ID)+RLR
      90 CONTINUE
C *** BASIC DIFFERENTIAL EQ. IS  $Y' = A*Y + X0$ ,  $Y(0) = 0$ 
C *** INITIAL CONDITIONS SET IN MAIN PROGRAM.
      RJAC=0.
      100 CONTINUE
C*
      KFLAG=0
      TOLD=T
C* TEST FOR SMALL H ADDED AT ARGONNE IN AUGUST, 1973.
      IF (T+H.EQ.T) GO TO 550
      IF (JSTART.GT.0) GO TO 190
      IF (JSTART.EQ.0) GO TO 120
C*****
C* ON THE FIRST CALL, THE ORDER IS SET TO 1 AND THE INITIAL
C* DERIVATIVES ARE CALCULATED. YMAX IS INITIALIZED USING THE INITIAL
C* Y AND YDOT. IF BOTH ARE INITIALLY ZERO IN ANY COMPONENT, THE DEFAULT
C* VALUE IS 1. RMAX IS THE MAXIMUM RATIO BY WHICH H CAN BE INCREASED
C* IN A SINGLE STEP. IT IS INITIALLY 1.E4 TO COMPENSATE FOR THE SMALL
C* INITIAL H, BUT THEN IS NORMALLY EQUAL TO 10. IF A FAILURE
C* OCCURS (IN CORRECTOR CONVERGENCE OR ERROR TEST), RMAX IS SET AT 2
C* FOR THE NEXT INCREASE. EPSJ IS USED AS THE RELATIVE INCREMENT
C* TO Y WHEN GETTING PARTIALS BY FINITE DIFFERENCING.
C*****
      NSQ=N0*N0
      NSQ1=NSQ+1
      N1=N0+1
      CALL YPAY (PSAVE,A,Y,X0,A(INDXA),N)
      DO 110 I=1,N
      Y(I,2)=PSAVE(I)*H
      AYI=DABS(Y(I,1))
      IF (AYI.EQ.0.D0) AYI=DABS(Y(I,2))
      IF (AYI.EQ.0.D0) AYI=1.D0
      YMAX(I)=AYI
      110 CONTINUE
      NQ=1
      L=2
      RMAX=1.0D4
      EPSJ=DSQRT(ANOISE)
      CHATE=1.0D0
      OLDLO=1.0D0
      RC=0.0D0

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STI 815
 STI 820
 STI 825
 STI 830
 STI 835
 STI 840
 STI 845
 STI 850
 STI 855
 STI 860
 STI 865
 STI 870
 STI 875
 STI 880
 STI 885
 STI 890
 STI 895
 STI 900
 STI 905
 STI 910
 STI 915
 STI 920
 STI 925
 STI 930
 STI 935
 STI 940
 STI 945
 STI 950
 STI 955
 STI 960
 STI 965
 STI 970
 STI 975
 STI 980
 STI 985
 STI 990
 STI 995
 STI 1000
 STI 1005
 STI 1010
 STI 1015
 STI 1020
 STI 1025
 STI 1030
 STI 1035
 STI 1040
 STI 1045
 STI 1050
 STI 1055
 STI 1060
 STI 1065
 STI 1070
 STI 1075
 STI 1080
 STI 1085
 STI 1090
 STI 1095
 STI 1100
 STI 1105
 STI 1110
 STI 1115
 STI 1120
 STI 1125
 STI 1130
 STI 1135
 STI 1140
 STI 1145
 STI 1150
 STI 1155
 STI 1160
 STI 1165
 STI 1170
 STI 1175
 STI 1180
 STI 1185
 STI 1190
 STI 1195
 STI 1200
 STI 1205
 STI 1210
 STI 1215
 STI 1220
 STI 1225
 STI 1230
 STI 1235
 STI 1240
 STI 1245
 STI 1250
 STI 1255
 STI 1260
 STI 1265
 STI 1270
 STI 1275
 STI 1280
 STI 1285
 STI 1290


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MFOLD=0
METH=0
HOLD=H
C* THIS INITIALIZES MITER SO STIFF WILL FUNCTION CORRECTLY WHEN
C* GIVEN THE SAME MITER AS WAS GIVEN IN A PREVIOUS PROBLEM.
MITER=4
C* ADDED AT ARGONNE IN JULY, 1973.
C*****
C* IF THE CALLER HAS CHANGED METH, OR IF JSTART = 0, TESOC IS CALLED
C* TO SET THE COEFFICIENTS OF THE METHOD. IF THE CALLER HAS CHANGED
C* EPS OR METH, THE CONSTANTS E, EDN, EUP, AND BND MUST BE RESET.
C* E IS A COMPARISON FOR ERRORS OF THE CURRENT ORDER NQ. EUP IS
C* TO TEST FOR INCREASING THE ORDER, EDN FOR DECREASING THE ORDER.
C* BND IS USED TO TEST FOR CONVERGENCE OF THE CORRECTOR ITERATES.
C* IF THE CALLER HAS CHANGED H, Y MUST BE RESCALED.
C* IF H OR METH HAS BEEN CHANGED, IDOUB IS RESET TO L + 1 TO PREVENT
C* FURTHER CHANGES IN H FOR THAT MANY STEPS. ALSO, RC IS RESET.
C* RC IS THE RATIO OF NEW TO OLD VALUES OF THE COEFFICIENT L(0)*H.
C* WHEN RC DIFFERS FROM 1 BY MORE THAN 30 PERCENT, OR THE CALLER HAS
C* CHANGED MITER, IWEVAL IS SET TO MITER TO FORCE THE PARTIALS TO BE
C* UPDATED, IF PARTIALS ARE USED.
C*****
120 IF (MF.EQ.MFOLD) GO TO 150
    NEO=METH
    MIO=MITER
    METH=MF/10
    MITER=MF-10*METH
    MFOLD=MF
    IF (MITER.NE.MIO) IWEVAL=MITER
    IF (METH.EQ.MEO) GO TO 150
    IDOUB=L+1
    IRET=1
130 CALL TESOC (METH,NQ,DL,TO,MAXDER)
    RC=RC*EL(1)/OLDLO
    OLDLO=EL(1)
140 EDN=(TQ(1)*EPS)**2
    E=(TQ(2)*EPS)**2
    EUP=(TQ(3)*EPS)**2
    BND=(TQ(4)*EPS)**2
    GO TO (160,170,190),IRET
150 IF (EPS.EQ.EPSOLD) GO TO 160
    IRET=1
    GO TO 140
160 LMAX=MAXDER+1
    EPSOLD=EPS
    IF (H.EQ.HOLD) GO TO 190
    RH=H/HOLD
    H=HOLD
170 RH=DMAX1(RH,HMIN/DABS(H))
    RH=DMIN1(RH,HMAX/DABS(H),RMAX)
    R1=1.0D0
C
    DO 180 J=2,L
        R1=R1*RH
C
    DO 180 I=NL,N
        Y(I,N)=Y(I,N)*R1
180 CONTINUE
C
    H=H*RH
    RC=RC*RH
    IDOUB=L+1
    IF (T.NE.TOLD) GO TO 560
C*****
C* THIS SECTION COMPUTES THE PREDICTED VALUES BY EFFECTIVELY
C* MULTIPLYING THE Y ARRAY BY THE PASCAL TRIANGLE MATRIX.
C*****
190 IF (DABS(RC-1.0D0).GT.0.3D0) IWEVAL=MITER
    Y=Y+H
C
    DO 200 J1=1,NQ
C
    DO 200 J2=J1,NQ
        J=NQ-J2+J1
C
    DO 200 I=NL,N
        Y(I,J)=Y(I,J)+Y(I,J+1)
200 CONTINUE
C*****
C* UP TO 3 CORRECTOR ITERATIONS ARE TAKEN. CONVERGENCE IS TESTED
C* BY REQUIRING CHANGES TO BE LESS THAN BND, WHICH IS DEPENDENT ON
C* EPS, IN EUCLIDEAN NORM. THE SUM OF THE CORRECTIONS IS ACCUMULATED
C* IN THE VECTOR ERROR(I). IT IS APPROXIMATELY EQUAL TO THE L-TH
C* DERIVATIVE OF Y MULTIPLIED BY H**L/(FACTORIAL(L-1)*EL(L)), AND IS
C* THUS PROPORTIONAL TO THE ACTUAL ERRORS TO THE LOWEST POWER OF
C* H PRESENT (H**L).
C* THE Y ARRAY IS NOT ALTERED IN THE CORRECTION LOOP. THE UPDATED
C* Y VECTOR IS STORED TEMPORARILY IN PSAVE. THE NORM OF THE
C* ITERATE DIFFERENCE IS STORED IN D.
C*****
210 DO 220 I=NL,N
    220 ERROR(I)=0.0D0
C
    H=0
    CALL YPAY (PSAVE(N1),A,Y,X0,A(INDXA),N)
C*****

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C* IF NECESSARY, THE PARTIALS ARE REEVALUATED PRIOR TO STARTING THE STI1775
C* CORRECTOR ITERATION. IWEVAL IS THEN SET TO 0 AS AN INDICATOR STI1780
C* THAT THIS HAS BEEN DONE. STI1785
C* IF NITER = 1 OR 2, THE MATRIX P = I - L(0)*H*JACOBIAN IS STORED STI1790
C* IN PW AND SUBJECTED TO LU DECOMPOSITION, WITH THE RESULTS ALSO STI1795
C* STORED IN PW. IF NITER = 3, THE MATRIX USED IS P = I - L(0)*H*D, STI1800
C* WHERE D IS A DIAGONAL MATRIX. STI1805
C***** STI1810
IF (H.EQ.HJAC) GO TO 250 STI1815
HJAC=H STI1820
R=-EL(1)*H STI1825
C *** NELEA=NO. NONZERO ELE. IN MATRIX A STI1830
DO 230 I=1,NELEA STI1835
230 PW(I)=R*A(I) STI1840
DO 240 I=1,N STI1845
K=IDIAG(I) STI1850
240 PW(K)=1.D0+PW(K) STI1855
IWEVAL=0 STI1860
RC=1.0D0 STI1865
250 DC 260 I=NL,N STI1870
260 FSAVE(I+N0)=FSAVE(I+N0)*H-Y(I,2)-ERROR(I) STI1875
CALL AXEB (PW,FSAVE,FSAVE(N1),A(INDXA),N) STI1880
D=0.0D0 STI1885
C STI1890
DO 270 I=NL,N STI1895
ERROR(I)=ERROR(I)+FSAVE(I) STI1900
D=D+(FSAVE(I)/YMAX(I))*2 STI1905
FSAVE(I)=Y(I,1)+EL(1)*ERROR(I) STI1910
270 CONTINUE STI1915
IF (M.NE.0) CRATE=DHAX1(.9D0*CRATE,D/D1) STI1920
IF ((D*DHIN1(1.0D0,2.0D0*CRATE)).LE.BND) GO TO 310 STI1925
D1=D STI1930
M=M+1 STI1935
IF (M.EQ.3) GO TO 280 STI1940
CALL YPAY (FSAVE(N1),A,FSAVE,X0,A(INDXA),N) STI1945
GO TO 250 STI1950
C***** STI1955
C* THE CORRECTOR ITERATION FAILED TO CONVERGE IN 3 TRIES. IF PARTIALS STI1960
C* ARE INVOLVED BUT ARE NOT UP TO DATE, THEY ARE REEVALUATED FOR THE STI1965
C* NEXT TRY. OTHERWISE THE Y ARRAY IS RETRACTED TO ITS VALUES STI1970
C* BEFORE PREDICTION, AND H IS REDUCED, IF POSSIBLE. IF NOT, A STI1975
C* NO-CONVERGENCE EXIT IS TAKEN. STI1980
C***** STI1985
280 IF (IWEVAL.EQ.-1) GO TO 300 STI1990
T=TOLD STI1995
RMAX=2.0D0 STI2000
C STI2005
DO 290 J1=1,NQ STI2010
C STI2015
DO 290 J2=J1,NQ STI2020
J=NQ-J2+J1 STI2025
C STI2030
DO 290 I=NL,N STI2035
Y(I,J)=Y(I,J)-Y(I,J+1) STI2040
290 CONTINUE STI2045
C STI2050
IF (DABS(H).LE.(HMN*1.00001D0)) GO TO 540 STI2055
RH=.25D0 STI2060
GO TO 170 STI2065
300 IWEVAL=NITER STI2070
GO TO 210 STI2075
C***** STI2080
C* THE CORRECTOR HAS CONVERGED. IWEVAL IS SET TO -1 IF PARTIAL STI2085
C* DERIVATIVES WERE USED, TO SIGNAL THAT THEY MAY NEED UPDATING ON STI2090
C* SUBSEQUENT STEPS. THE ERROR TEST IS MADE AND CONTROL PASSES TO STI2095
C* STATEMENT 500 IF IT FAILS. STI2100
C***** STI2105
310 D=0.0D0 STI2110
C STI2115
DO 320 I=NL,N STI2120
320 D=D+(ERROR(I)/YMAX(I))*2 STI2125
C STI2130
IF (NITER.NE.0) IWEVAL=-1 STI2135
IF (D.GT.E) GO TO 360 STI2140
C***** STI2145
C* AFTER A SUCCESSFUL STEP, UPDATE THE Y ARRAY AND YMAX. STI2150
C* CONSIDER CHANGING H IF IDOUB = 1. OTHERWISE DECREASE IDOUB BY 1. STI2155
C* IF IDOUB IS THEN 1 AND NQ .LT. MAXDER, THEN ERROR IS SAVED FOR STI2160
C* USE IN A POSSIBLE ORDER INCREASE ON THE NEXT STEP. STI2165
C* IF A CHANGE IN H IS CONSIDERED, AN INCREASE OR DECREASE IN ORDER STI2170
C* BY ONE IS CONSIDERED ALSO. A CHANGE IN H IS MADE ONLY IF IT IS BY A STI2175
C* FACTOR OF AT LEAST 1.1. IF NOT, IDOUB IS SET TO 10 TO PREVENT STI2180
C* TESTING FOR THAT MANY STEPS. STI2185
C***** STI2190
KFLAG=0 STI2195
C STI2200
DO 330 J=1,L STI2205
C STI2210
DO 330 I=NL,N STI2215
Y(I,J)=Y(I,J)+EL(J)*ERROR(I) STI2220
330 CONTINUE STI2225
C STI2230
DO 340 I=NL,N STI2235
340 YMAX(I)=DHAX1(YMAX(I),DABS(Y(I,1))) STI2240
C STI2245
IF (IDOUB.EQ.1) GO TO 380 STI2250

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      IDOUB=IDOUB-1
      IF (IDOUB.GT.1) GO TO 570
      IF (NQ.EQ.MAXDER) GO TO 570
C
      DO 350 I=NL,N
      350 Y(I,LMAX)=ERROR(I)
C
      GO TO 570
C*****
C* THE ERROR TEST FAILED. KFLAG KEEPS TRACK OF MULTIPLE FAILURES.
C* RESTORE T AND THE Y ARRAY TO THEIR PREVIOUS VALUES, AND PREPARE
C* TO TRY THE STEP AGAIN. COMPUTE THE OPTIMUM STEP SIZE FOR THIS OR
C* ONE LOWER ORDER.
C*****
      360 KFLAG=KFLAG-1
      T=TOLD
C
      DO 370 J1=1,NQ
C
      DO 370 J2=J1,NQ
      J=NQ-J2+J1
C
      DO 370 I=NL,N
      Y(I,J)=Y(I,J)-Y(I,J+1)
      370 CONTINUE
C
      H=H*1.0001
      IF (DAES(H).LE.(HMIN*1.00001D0)) GO TO 520
      IF (KFLAG.EQ.-2) GO TO 500
      PR3=1.0D20
      GO TO 400
C*****
C* REGARDLESS OF THE SUCCESS OR FAILURE OF THE STEP, FACTORS
C* PR1, PR2, AND PR3 ARE COMPUTED, BY WHICH H COULD BE DIVIDED
C* AT ORDER NQ - 1, ORDER NQ, OR ORDER NQ + 1, RESPECTIVELY.
C* IN THE CASE OF FAILURE, PR3 = 1.0D20 TO AVOID AN ORDER INCREASE.
C* THE SMALLEST OF THESE IS DETERMINED AND THE NEW ORDER CHOSEN
C* ACCORDINGLY. IF THE ORDER IS TO BE INCREASED, WE COMPUTE ONE
C* ADDITIONAL SCALED DERIVATIVE.
C*****
      380 PR3=1.0D20
      IF (NQ.EQ.MAXDER) GO TO 400
      D1=0.0D0
C
      DO 390 I=NL,N
      390 D1=D1+((ERROR(I)-Y(I,LMAX))/YMAX(I))**2
C
      ENQ3=0.5D0/DFLOAT(L+1)
      PR3=((D1/ENQ3)**ENQ3)*1.4D0+1.4D-06
      400 ENQ2=0.5D0/DFLOAT(L)
      PR2=((D1/ENQ2)**ENQ2)*1.2D0+1.2D-06
      PR1=1.0D20
      IF (NQ.EQ.1) GO TO 420
      D=0.0D0
C
      DO 410 T=NL,N
      410 D=D+((Y(T,1)-YMAX(I))/YMAX(I))**2
C
      ENQ1=0.5D0/DFLOAT(NQ)
      PR1=((D/ENQ1)**ENQ1)*1.3D0+1.3D-06
      420 IF (PR2.LE.PR3) GO TO 430
      IF (PR3.LT.PR1) GO TO 450
      430 IF (PR2.GT.PR1) GO TO 440
      NEWQ=NQ
      RH=1.0D0/PR2
      GO TO 480
      440 NEWQ=NQ-1
      IVEVAL=NITER
      RH=1.0D0/PR1
      GO TO 480
      450 NEWQ=L
      RH=1.0D0/PR3
      IF (RH.LT.1.1D0) GO TO 470
C
      DO 460 I=NL,N
      460 Y(I,NEWQ+1)=ERROR(I)*EL(L)/DFLOAT(L)
C
      GO TO 490
      470 IDOUB=10
      GO TO 570
      480 IF ((KFLAG.EQ.0).AND.(RH.LT.1.1D0)) GO TO 470
C*****
C* IF THERE IS A CHANGE OF ORDER, RESET NQ, L, AND THE COEFFICIENTS.
C* IN ANY CASE H IS RESET ACCORDING TO RH AND THE Y ARRAY IS RESCALED.
C* THEN EXIT FROM 690 IF THE STEP WAS OK, OR REDO THE STEP OTHERWISE.
C*****
      IF (NEWQ.EQ.NQ) GO TO 170
      490 NQ=NEWQ
      L=NQ+1
      IRET=2
      GO TO 130
C*****
C* CONTROL REACHES THIS SECTION IF 3 OR MORE FAILURES HAVE OCCURED.
C* IT IS ASSUMED THAT THE DERIVATIVES THAT HAVE ACCUMULATED IN THE
C* Y ARRAY HAVE ERRORS OF THE WRONG ORDER. HENCE THE FIRST
C* DERIVATIVE IS RECOMPUTED, AND THE ORDER IS SET TO 1. THEN

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TES 225
TES 230
TES 240
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      EL(11)=1.5156525573192240D-06      TES 705
      EL(12)=2.5052108385441719D-08      TES 710
      GO TO 200                            TES 715
140  EL(1)=2.7426554003159906D-01        TES 720
      EL(3)=1.5099386724386724D+00        TES 725
      EL(4)=1.2602711640211640D+00        TES 730
      EL(5)=6.5923418209876543D-01        TES 735
      EL(6)=2.3045800264550265D-01        TES 740
      EL(7)=5.5697246105232216D-02        TES 745
      EL(8)=9.4394841269841270D-03        TES 750
      EL(9)=1.1192749669312169D-03        TES 755
      EL(10)=9.0939153439153439D-05       TES 760
      EL(11)=4.8225308641975309D-06       TES 765
      EL(12)=1.5031265031265031D-07       TES 770
      EL(13)=2.0876756987868099D-09       TES 775
      GO TO 200                            TES 780
150  EL(1)=1.0D+00                        TES 785
      GO TO 200                            TES 790
160  EL(1)=6.6666666666666667D-01        TES 795
      EL(3)=3.3333333333333333D-01        TES 800
      GO TO 200                            TES 805
170  EL(1)=5.4545454545454545D-01        TES 810
      EL(3)=EL(1)                          TES 815
      EL(4)=9.0909090909090909D-02        TES 820
      GO TO 200                            TES 825
180  EL(1)=0.48D+00                       TES 830
      EL(3)=0.7D+00                        TES 835
      EL(4)=0.2D+00                        TES 840
      EL(5)=0.02D+00                       TES 845
      GO TO 200                            TES 850
190  EL(1)=4.3795620437956204D-01        TES 855
      EL(3)=8.2116788321167883D-01        TES 860
      EL(4)=3.1021897810218978D-01        TES 865
      EL(5)=5.4744525547445255D-02        TES 870
      EL(6)=3.6496350364963504D-03        TES 875
C*                                          TES 880
200  DO 210 K=1,3                         TES 885
210  TQ(K)=PERTST(NQ,METH,K)              TES 890
C*                                          TES 895
      TQ(4)=0.5D0*TQ(2)/DFLOAT(NQ+2)      TES 900
      RETURN                                TES 905
C*****LAST CARD OF TESOC*****          TES 910
      END                                  TES 915-

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      SUBROUTINE YNA (Y,N)                  YNA 5
      IMPLICIT REAL*8(A-H,O-Z)             YNA 10
C                                          YNA 15
C THIS SUBROUTINE PRINTS MICROCURIE-DAYS FOR EACH YNA 20
C TIME INTERVAL                           YNA 25
C                                          YNA 30
C NORG - NUMBER OF ORGANS (EXCLUDING LUNG AND GI) YNA 35
C ICOM(I,J) - NO. OF COMPARTMENTS FOR DAUGHTER I, ORGAN J YNA 40
C NCOM(I) - NO. OF COMPARTMENTS FOR DAUGHTER I YNA 45
C NISO - NUMBER OF ELEMENTS IN THE CHAIN YNA 50
C LANX(I,J) - LN2/(HALFTIME OF DAUGHTER I IN COMPARTMENT J) YNA 55
C ORGNM(I) - NAME OF ORGAN I YNA 60
C TAG(I) - ATOMIC SYMBOL AND ATOMIC NUMBER FOR YNA 65
C DAUGHTER I YNA 70
C                                          YNA 75
      REAL*8 TAG,LANX,X(15,22),ORGNM,LANAB YNA 80
      COMMON /TABLES/ LANAB(15,4),LANX(15,10),ORGNM(10),TAG(15),ICOM(15, YNA 85
      110),IOPT,NCOM(15),NISO,NORG YNA 90
      COMMON /PRINT/ TPR(10),DTPR(10),TPRINT YNA 95
      DIMENSION Y(1) YNA 100
C                                          YNA 105
C PRINT SOLUTION VECTOR Y YNA 110
C                                          YNA 115
      PRINT 150, TPRINT, (Y(I),I=1,N) YNA 120
      K=0 YNA 125
C                                          YNA 130
C X(I,1) - NP REGION FOR DAUGHTER I YNA 135
C X(I,2) - TB REGION FOR DAUGHTER I YNA 140
C X(I,3) - P REGION FOR DAUGHTER I YNA 145
C X(I,4) - LYMPH FOR DAUGHTER I YNA 150
C X(I,5) - STCNACH FOR DAUGHTER I YNA 155
C X(I,6) - EI FOR DAUGHTER I YNA 160
C X(I,7) - ULI FOR DAUGHTER I YNA 165
C X(I,8) - LLI FOR DAUGHTER I YNA 170
C X(I,J) - COMPARTMENT J (J=9,10,...18) FOR DAUGHTER I YNA 175
C X(I,19) - MICROCURIES ENTERING BLOOD FROM LUNGS FOR DAUGHTER I YNA 180
C X(I,20) - MICROCURIES ENTERING GI FROM LUNGS FOR DAUGHTER I YNA 185
C X(I,21) - MICROCURIES ENTERING BLOOD FROM GI FOR DAUGHTER I YNA 190
C X(I,22) - TRANSFER COMPARTMENT FOR DAUGHTER I YNA 195
C                                          YNA 200
      DO 80 I=1,NISO YNA 205
      IF (IOPT.EQ.1.OR.IOPT.EQ.2) GO TO 10 YNA 210
      X(I,1)=Y(1+K)+Y(2+K) YNA 215
      X(I,2)=Y(3+K)+Y(4+K)+Y(11+K)+Y(12+K) YNA 220
      X(I,3)=Y(5+K)+Y(6+K)+Y(7+K)+Y(8+K) YNA 225
      X(I,4)=Y(9+K)+Y(10+K) YNA 230
      GO TO 20 YNA 235
10  CONTINUE YNA 240
      X(I,1)=0. YNA 245

```

c

	SUBROUTINE YOUT (N0,TLAST,Y,NQ)	YOU	5
	IMPLICIT REAL*8 (A-H,O-Z)	YOU	10
	DIMENSION Y(N0,13)	YOU	15
	COMMON /SC1235/ T,H,HMIN,HMAX,EPS1,NF1,KFLAG1,JSTART,N,NINV,NX0,YMYOU	YOU	20
	1AX(400),ERROR(400),PSAVE(800),YPRINT(400)	YOU	25
C ***	NEED DIMENSION YMAX(NX0),BERROR(NX0),PSAVE(2*NX0)	YOU	30
	COMMON /PRINT/ TPRL(10),DTPR(10),TPRINT,IPRT,NPR,NPRT,NARPRT(10)	YOU	35
10	CONTINUE	YOU	40
	S=(TPRINT-T)/H	YOU	45
	DO 20 I=1,N	YOU	50
20	YPRINT(I)=Y(I,1)	YOU	55
	R=1.000	YOU	60
	L=NQ+1	YOU	65
	DO 40 J=2,L	YOU	70
	R=R*S	YOU	75
	DC 30 I=1,N	YOU	80
30	YPRINT(I)=YPRINT(I)+Y(I,J)*R	YOU	85
40	CONTINUE	YOU	90
	CALL YNA (YPRINT,N)	YOU	95
	NPR=NPR+1	YOU	100
	IF (NPR.LE.NARPRT(IPRT)) GO TO 50	YOU	105
	IPRT=IPRT+1	YOU	110
	NPR=0	YOU	115
50	TPRINT=TPRL(IPRT)+NPR*DTPR(IPRT)	YOU	120
	IF (TPRINT.LE.T) GO TO 10	YOU	125
	RETURN	YOU	130
	END	YOU	135-

	SUBROUTINE YOUTD	YOU	5
	PRINT 10	YOU	10
	RETURN	YOU	15
C		YOU	20
	10 FORMAT ('0CALLED YOUTD. SHOULD WE PRINT.')	YOU	25
	END	YOU	30-

AXEB	TITLE	'SOLVE AX=B WHERE A IS A COMPACTED LOWER TRI.MATRIX'	AXEB	10
AXEB	START	0	AXEB	20
* CALL AXEB(A,X,B,INDXA,N)			AXEB	30
* A IS AN N BY N LOWER TRIANGULAR MATRIX. THE VECTOR A CONSISTS			AXEB	40
* OF THE NONZERO ENTRIES IN A STORED SEQUENTIALLY BY ROWS.			AXEB	50
* SOLVE LINEAR SYSTEM OF EQUATIONS.			AXEB	60
***** IT IS ASSUMED THAT THE MAX. NO. OF NONZERO ENTRIES IN A ROW OF A			AXEB	70
***** IS .LE. 52. MOREOVER, THE DIAG. ENTRIES ARE NONZERO.			AXEB	80
***** AT MOST 51 SUMMANDS IN SUML			AXEB	90
A	EQU	1	AXEB	100
X	EQU	2	AXEB	110
B	EQU	3	AXEB	120
INDXA	EQU	4	AXEB	130
IND14	EQU	5	AXEB	140
IINC	EQU	6	AXEB	150
I	EQU	8	AXEB	160
J	EQU	9	AXEB	170
BADDR	EQU	10	AXEB	180
USING AXEB,15			AXEB	190
STM	14,12,12(13)		AXEB	200
LM	1,5,0(1)		AXEB	210
LA	IINC,8		AXEB	220
L	7,0(5) N		AXEB	230
LA	0,16		AXEB	240
SLA	7,3 UN		AXEB	250
SR	7,IINC 8(N-1)		AXEB	260
SR	I,I		AXEB	270
LR	5,4		AXEB	280
LA	BADDR,POINT+14		AXEB	290
SR	A,IINC A=ADD(A(K-1,K-1),K=1,...,N		AXEB	300
SDR	0,0 FORM SUML=SUM (J=1,...,I-1) A(I,J)*X(J)		AXEB	310
LOOP			AXEB	320
*	FOR I=1,...,N.		AXEB	330
	L	11,4(IND14)	AXEB	340
	B	0(BADDR,11)	AXEB	350
**			AXEB	360
**			AXEB	370
L	J,400(INDXA)	AT LEAST 51	AXEB	380
LD	6,408(A)		AXEB	390
MD	6,0(X,J)		AXEB	400
SDR	0,6		AXEB	410
L	J,392(INDXA)	AT LEAST 50	AXEB	420
LD	4,400(A)		AXEB	430
MD	4,0(X,J)		AXEB	440
SDR	0,4		AXEB	450
L	J,384(INDXA)	AT LEAST 49	AXEB	460
LD	2,392(A)		AXEB	470
MD	2,0(X,J)		AXEB	480
SDR	0,2		AXEB	490
L	J,376(INDXA)	AT LEAST 48	AXEB	500
LD	6,384(A)		AXEB	510
MD	6,0(X,J)		AXEB	520
SDR	0,6		AXEB	530
L	J,368(INDXA)	AT LEAST 47	AXEB	540
LD	4,376(A)		AXEB	550

MD	4,0 (X,J)		AXEB 550
SDR	0,4		AXEB 560
L	J,360 (INDXA)	AT LEAST 46	AXEB 570
LD	2,368 (A)		AXEB 580
MD	2,0 (X,J)		AXEB 590
SDR	0,2		AXEB 600
L	J,352 (INDXA)	AT LEAST 45	AXEB 610
LD	6,360 (A)		AXEB 620
MD	6,0 (X,J)		AXEB 630
SDR	0,6		AXEB 640
L	J,344 (INDXA)	AT LEAST 44	AXEB 650
LD	4,352 (A)		AXEB 660
MD	4,0 (X,J)		AXEB 670
SDR	0,4		AXEB 680
L	J,336 (INDXA)	AT LEAST 43	AXEB 690
LD	2,344 (A)		AXEB 700
MD	2,0 (X,J)		AXEB 710
SDR	0,2		AXEB 720
L	J,328 (INDXA)	AT LEAST 42	AXEB 730
LD	6,336 (A)		AXEB 740
MD	6,0 (X,J)		AXEB 750
SDR	0,6		AXEB 760
L	J,320 (INDXA)	AT LEAST 41	AXEB 770
LD	4,328 (A)		AXEB 780
MD	4,0 (X,J)		AXEB 790
SDR	0,4		AXEB 800
L	J,312 (INDXA)	AT LEAST 40	AXEB 810
LD	2,320 (A)		AXEB 820
MD	2,0 (X,J)		AXEB 830
SDR	0,2		AXEB 840
L	J,304 (INDXA)	AT LEAST 39	AXEB 850
LD	6,312 (A)		AXEB 860
MD	6,0 (X,J)		AXEB 870
SDR	0,6		AXEB 880
L	J,296 (INDXA)	AT LEAST 38	AXEB 890
LD	4,304 (A)		AXEB 900
MD	4,0 (X,J)		AXEB 910
SDR	0,4		AXEB 920
L	J,288 (INDXA)	AT LEAST 37	AXEB 930
LD	2,296 (A)		AXEB 940
MD	2,0 (X,J)		AXEB 950
SDR	0,2		AXEB 960
L	J,280 (INDXA)	AT LEAST 36	AXEB 970
LD	6,288 (A)		AXEB 980
MD	6,0 (X,J)		AXEB 990
SDR	0,6		AXE 1000
L	J,272 (INDXA)	AT LEAST 35	AXE 1010
LD	4,280 (A)		AXE 1020
MD	4,0 (X,J)		AXE 1030
SDR	0,4		AXE 1040
L	J,264 (INDXA)	AT LEAST 34	AXE 1050
LD	2,272 (A)		AXE 1060
MD	2,0 (X,J)		AXE 1070
SDR	0,2		AXE 1080
L	J,256 (INDXA)	AT LEAST 33	AXE 1090
LD	6,264 (A)		AXE 1100
MD	6,0 (X,J)		AXE 1110
SDR	0,6		AXE 1120
L	J,248 (INDXA)	AT LEAST 32	AXE 1130
LD	4,256 (A)		AXE 1140
MD	4,0 (X,J)		AXE 1150
SDR	0,4		AXE 1160
L	J,240 (INDXA)	AT LEAST 31	AXE 1170
LD	2,248 (A)		AXE 1180
MD	2,0 (X,J)		AXE 1190
SDR	0,2		AXE 1200
L	J,232 (INDXA)	AT LEAST 30	AXE 1210
LD	6,240 (A)		AXE 1220
MD	6,0 (X,J)		AXE 1230
SDR	0,6		AXE 1240
L	J,224 (INDXA)	AT LEAST 29	AXE 1250
LD	4,232 (A)		AXE 1260
MD	4,0 (X,J)		AXE 1270
SDR	0,4		AXE 1280
L	J,216 (INDXA)	AT LEAST 28	AXE 1290
LD	2,224 (A)		AXE 1300
MD	2,0 (X,J)		AXE 1310
SDR	0,2		AXE 1320
L	J,208 (INDXA)	AT LEAST 27	AXE 1330
LD	6,216 (A)		AXE 1340
MD	6,0 (X,J)		AXE 1350
SDR	0,6		AXE 1360
L	J,200 (INDXA)	AT LEAST 26	AXE 1370
LD	4,208 (A)		AXE 1380
MD	4,0 (X,J)		AXE 1390
SDR	0,4		AXE 1400
L	J,192 (INDXA)	AT LEAST 25	AXE 1410
LD	2,200 (A)		AXE 1420
MD	2,0 (X,J)		AXE 1430
SDR	0,2		AXE 1440
L	J,184 (INDXA)	AT LEAST 24	AXE 1450
LD	6,192 (A)		AXE 1460
MD	6,0 (X,J)		AXE 1470
SDR	0,6		AXE 1480
L	J,176 (INDXA)	AT LEAST 23	AXE 1490
LD	4,184 (A)		AXE 1500

MD	4,0 (X,J)		AXE	1510
SDR	0,4		AXE	1520
L	J,168 (INDXA)	AT LEAST 22	AXE	1530
LD	2,176 (A)		AXE	1540
MD	2,0 (X,J)		AXE	1550
SDR	0,2		AXE	1560
L	J,160 (INDXA)	AT LEAST 21	AXE	1570
LD	6,168 (A)		AXE	1580
MD	6,0 (X,J)		AXE	1590
SDR	0,6		AXE	1600
L	J,152 (INDXA)	AT LEAST 20	AXE	1610
LD	4,160 (A)		AXE	1620
MD	4,0 (X,J)		AXE	1630
SDR	0,4		AXE	1640
L	J,144 (INDXA)	AT LEAST 19	AXE	1650
LD	2,152 (A)		AXE	1660
MD	2,0 (X,J)		AXE	1670
SDR	0,2		AXE	1680
L	J,136 (INDXA)	AT LEAST 18	AXE	1690
LD	6,144 (A)		AXE	1700
MD	6,0 (X,J)		AXE	1710
SDR	0,6		AXE	1720
L	J,128 (INDXA)	AT LEAST 17 NONZERO OFF-DIAG. ENTRIES	AXE	1730
LD	4,136 (A)		AXE	1740
MD	4,0 (X,J)		AXE	1750
SDR	0,4		AXE	1760
L	J,120 (INDXA)	AT LEAST 16 NONZERO OFF-DIAG. ENTRIES	AXE	1770
LD	2,128 (A)		AXE	1780
MD	2,0 (X,J)		AXE	1790
SDR	0,2		AXE	1800
L	J,112 (INDXA)	AT LEAST 15 NONZERO OFF-DIAG. ENTRIES	AXE	1810
LD	6,120 (A)		AXE	1820
MD	6,0 (X,J)		AXE	1830
SDR	0,6		AXE	1840
L	J,104 (INDXA)	AT LEAST 14 NONZERO OFF-DIAG. ENTRIES	AXE	1850
LD	4,112 (A)		AXE	1860
MD	4,0 (X,J)		AXE	1870
SDR	0,4		AXE	1880
L	J,096 (INDXA)	AT LEAST 13 NONZERO OFF-DIAG. ENTRIES	AXE	1890
LD	2,104 (A)		AXE	1900
MD	2,0 (X,J)		AXE	1910
SDR	0,2		AXE	1920
L	J,088 (INDXA)	AT LEAST 12 NONZERO OFF-DIAG. ENTRIES	AXE	1930
LD	6,096 (A)		AXE	1940
MD	6,0 (X,J)		AXE	1950
SDR	0,6		AXE	1960
L	J,080 (INDXA)	AT LEAST 11 NONZERO OFF-DIAG. ENTRIES	AXE	1970
LD	4,088 (A)		AXE	1980
MD	4,0 (X,J)		AXE	1990
SDR	0,4		AXE	2000
L	J,072 (INDXA)	AT LEAST 10 NONZERO OFF-DIAG. ENTRIES	AXE	2010
LD	2,080 (A)		AXE	2020
MD	2,0 (X,J)		AXE	2030
SDR	0,2		AXE	2040
L	J,64 (INDXA)		AXE	2050
LD	6,72 (A)		AXE	2060
MD	6,0 (X,J)		AXE	2070
SDR	0,6		AXE	2080
L	J,56 (INDXA)		AXE	2090
LD	4,64 (A)		AXE	2100
MD	4,0 (X,J)		AXE	2110
SDR	0,4		AXE	2120
L	J,48 (INDXA)		AXE	2130
LD	2,56 (A)		AXE	2140
MD	2,0 (X,J)		AXE	2150
SDR	0,2		AXE	2160
L	J,40 (INDXA)		AXE	2170
LD	6,48 (A)		AXE	2180
MD	6,0 (X,J)		AXE	2190
SDR	0,6		AXE	2200
L	J,32 (INDXA)		AXE	2210
LD	4,40 (A)		AXE	2220
MD	4,0 (X,J)		AXE	2230
SDR	0,4		AXE	2240
L	J,24 (INDXA)		AXE	2250
LD	2,32 (A)		AXE	2260
MD	2,0 (X,J)		AXE	2270
SDR	0,2		AXE	2280
L	J,16 (INDXA)		AXE	2290
LD	6,24 (A)		AXE	2300
MD	6,0 (X,J)		AXE	2310
SDR	0,6		AXE	2320
L	J,8 (INDXA)		AXE	2330
LD	4,16 (A)		AXE	2340
MD	4,0 (X,J)		AXE	2350
SDR	0,4		AXE	2360
L	J,0 (INDXA)		AXE	2370
LD	2,8 (A)		AXE	2380
MD	2,0 (X,J)		AXE	2390
SDR	0,2		AXE	2400
** PCINT	L	11,12 (IND14)	8*(NO. NONZERO ENTRIES IN ROW I OF A)	AXE 2410
	AR	A,11		AXE 2420
	AR	INDXA,11		AXE 2430
	AR	IND14,0		AXE 2440
	AD	0,0 (B,I)	COULD CHECK FOR LOSS OF LEADING FIGURES.	AXE 2450
				AXE 2460

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DD      0,0(A)          A(I,I)
STD     0,0(X,I)
BKLE   1,IINC,LOOP
LM      14,12,12(13)
BR      14
END

AXE 2470
AXE 2480
AXE 2490
AXE 2500
AXE 2510
AXE 2520

YPAY    TITLE 'FORM YDOT = A*Y + X0'
YPAY    START 0
* CALL YPAY(YDOT,A,Y,X0,INDXA,N)
* FORM YDOT=A*Y+X0
* WHERE A IS AN N BY N MATRIX. HOWEVER, ONLY THE NONZERO ENTRIES IN A
* ARE STORED IN THE VECTOR, A. STORAGE IN A IS BY ROWS
* VIEW INDXA AS AN INTEGER*4 VECTOR.
* THE NONZERO ENTRY A(I) BELONGS IN COLUMN (INDXA(2I-1)+8)/8
* INDXA(4I-2) = -14*(NO. NONZERO ENTRIES IN ROW I OF MATRIX A).
* INDXA(4I) = 8*(
* Y AND X0 ARE FULL VECTORS WITH N ELEMENTS
* A ZERO ROW IN A IS OKAY.
*****
* SET FOR AT MOST 52 NONZERO ENTRIES IN A ROW OF THE MATRIX A.
** IT IS ASSUMED THAT THE MAXIMUM NO. OF NONZERO ENTRIES IN A ROW OF
** A IS .LE. 52.
*****
***** PROBABLY A REGULAR LOOP WOULD BE BETTER.
YDOT    EQU 1
A        EQU 2
Y        EQU 3
X0       EQU 4
INDXA    EQU 5
IND14    EQU 6
I        EQU 7
IINC     EQU 8
J        EQU 10
        USING YPAY,15
        STM 14,12,12(13)
        LM 1,6,0(1)
        LA IINC,8
        SR I,I          I=0
        L 9,0(6)        N
        SLA 9,3         8N
        LA 00,16
        SR 9,8          8(N-1)
        LR 6,5          USE 6 TO REFERENCE (4I) AND (4I-2)
        LA 11,X0ADD
        LD 0,0(X0,I)    FORM YDOT(I) IN 0. =X0(I)
        L 12,4(IND14)   -14*(NO. NONZERO ELE. IN ROW I OF A)
        B 0(11,12)
*
*
L        J,408(INDXA)   AT LEAST 52
LD        2,408(A)
MD        2,0(J,Y)
ADR        0,2
L        J,400(INDXA)   AT LEAST 51
LD        6,400(A)
MD        6,0(J,Y)
ADR        0,6
L        J,392(INDXA)   AT LEAST 50
LD        4,392(A)
MD        4,0(J,Y)
ADR        0,4
L        J,384(INDXA)   AT LEAST 49
LD        2,384(A)
MD        2,0(J,Y)
ADR        0,2
L        J,376(INDXA)   AT LEAST 48
LD        6,376(A)
MD        6,0(J,Y)
ADR        0,6
L        J,368(INDXA)   AT LEAST 47
LD        4,368(A)
MD        4,0(J,Y)
ADR        0,4
L        J,360(INDXA)   AT LEAST 46
LD        2,360(A)
MD        2,0(J,Y)
ADR        0,2
L        J,352(INDXA)   AT LEAST 45
LD        6,352(A)
MD        6,0(J,Y)
ADR        0,6
L        J,344(INDXA)   AT LEAST 44
LD        4,344(A)
MD        4,0(J,Y)
ADR        0,4
L        J,336(INDXA)   AT LEAST 43
LD        2,336(A)
MD        2,0(J,Y)
ADR        0,2
L        J,328(INDXA)   AT LEAST 42
LD        6,328(A)
MD        6,0(J,Y)

```

```

YPAY 10
YPAY 20
YPAY 30
YPAY 40
YPAY 50
YPAY 60
YPAY 70
YPAY 80
YPAY 90
YPAY 100
YPAY 110
YPAY 120
YPAY 130
YPAY 140
YPAY 150
YPAY 160
YPAY 170
YPAY 180
YPAY 190
YPAY 200
YPAY 210
YPAY 220
YPAY 230
YPAY 240
YPAY 250
YPAY 260
YPAY 270
YPAY 280
YPAY 290
YPAY 300
YPAY 310
YPAY 320
YPAY 330
YPAY 340
YPAY 350
YPAY 360
YPAY 370
YPAY 380
YPAY 390
YPAY 400
YPAY 410
YPAY 420
YPAY 430
YPAY 440
YPAY 450
YPAY 460
YPAY 470
YPAY 480
YPAY 490
YPAY 500
YPAY 510
YPAY 520
YPAY 530
YPAY 540
YPAY 550
YPAY 560
YPAY 570
YPAY 580
YPAY 590
YPAY 600
YPAY 610
YPAY 620
YPAY 630
YPAY 640
YPAY 650
YPAY 660
YPAY 670
YPAY 680
YPAY 690
YPAY 700
YPAY 710
YPAY 720
YPAY 730
YPAY 740
YPAY 750
YPAY 760
YPAY 770
YPAY 780
YPAY 790
YPAY 800
YPAY 810
YPAY 820
YPAY 830
YPAY 840
YPAY 850
YPAY 860

```

ADR	0,6		YPAY	870
L	J,320 (INDXA)	AT LEAST 41	YPAY	880
LD	4,320 (A)		YPAY	890
MD	4,0 (J,Y)		YPAY	900
ADR	0,4		YPAY	910
L	J,312 (INDXA)	AT LEAST 40	YPAY	920
LD	2,312 (A)		YPAY	930
MD	2,0 (J,Y)		YPAY	940
ADR	0,2		YPAY	950
L	J,304 (INDXA)	AT LEAST 39	YPAY	960
LD	6,304 (A)		YPAY	970
MD	6,0 (J,Y)		YPAY	980
ADR	0,6		YPAY	990
L	J,296 (INDXA)	AT LEAST 38	YPA	1000
LD	4,296 (A)		YPA	1010
MD	4,0 (J,Y)		YPA	1020
ADR	0,4		YPA	1030
L	J,288 (INDXA)	AT LEAST 37	YPA	1040
LD	2,288 (A)		YPA	1050
MD	2,0 (J,Y)		YPA	1060
ADR	0,2		YPA	1070
L	J,280 (INDXA)	AT LEAST 36	YPA	1080
LD	6,280 (A)		YPA	1090
MD	6,0 (J,Y)		YPA	1100
ADR	0,6		YPA	1110
L	J,272 (INDXA)	AT LEAST 35	YPA	1120
LD	4,272 (A)		YPA	1130
MD	4,0 (J,Y)		YPA	1140
ADR	0,4		YPA	1150
L	J,264 (INDXA)	AT LEAST 34	YPA	1160
LD	2,264 (A)		YPA	1170
MD	2,0 (J,Y)		YPA	1180
ADR	0,2		YPA	1190
L	J,256 (INDXA)	AT LEAST 33	YPA	1200
LD	6,256 (A)		YPA	1210
MD	6,0 (J,Y)		YPA	1220
ADR	0,6		YPA	1230
L	J,248 (INDXA)	AT LEAST 32	YPA	1240
LD	4,248 (A)		YPA	1250
MD	4,0 (J,Y)		YPA	1260
ADR	0,4		YPA	1270
L	J,240 (INDXA)	AT LEAST 31	YPA	1280
LD	2,240 (A)		YPA	1290
MD	2,0 (J,Y)		YPA	1300
ADR	0,2		YPA	1310
L	J,232 (INDXA)	AT LEAST 30	YPA	1320
LD	6,232 (A)		YPA	1330
MD	6,0 (J,Y)		YPA	1340
ADR	0,6		YPA	1350
L	J,224 (INDXA)	AT LEAST 29	YPA	1360
LD	4,224 (A)		YPA	1370
MD	4,0 (J,Y)		YPA	1380
ADR	0,4		YPA	1390
L	J,216 (INDXA)	AT LEAST 28	YPA	1400
LD	2,216 (A)		YPA	1410
MD	2,0 (J,Y)		YPA	1420
ADR	0,2		YPA	1430
L	J,208 (INDXA)	AT LEAST 27	YPA	1440
LD	6,208 (A)		YPA	1450
MD	6,0 (J,Y)		YPA	1460
ADR	0,6		YPA	1470
L	J,200 (INDXA)	AT LEAST 26	YPA	1480
LD	4,200 (A)		YPA	1490
MD	4,0 (J,Y)		YPA	1500
ADR	0,4		YPA	1510
L	J,192 (INDXA)	AT LEAST 25	YPA	1520
LD	2,192 (A)		YPA	1530
MD	2,0 (J,Y)		YPA	1540
ADR	0,2		YPA	1550
L	J,184 (INDXA)	AT LEAST 24	YPA	1560
LD	6,184 (A)		YPA	1570
MD	6,0 (J,Y)		YPA	1580
ADR	0,6		YPA	1590
L	J,176 (INDXA)	AT LEAST 23	YPA	1600
LD	4,176 (A)		YPA	1610
MD	4,0 (J,Y)		YPA	1620
ADR	0,4		YPA	1630
L	J,168 (INDXA)	AT LEAST 22	YPA	1640
LD	2,168 (A)		YPA	1650
MD	2,0 (J,Y)		YPA	1660
ADR	0,2		YPA	1670
L	J,160 (INDXA)	AT LEAST 21	YPA	1680
LD	6,160 (A)		YPA	1690
MD	6,0 (J,Y)		YPA	1700
ADR	0,6		YPA	1710
L	J,152 (INDXA)	AT LEAST 20	YPA	1720
LD	4,152 (A)		YPA	1730
MD	4,0 (J,Y)		YPA	1740
ADR	0,4		YPA	1750
L	J,144 (INDXA)	AT LEAST 19	YPA	1760
LD	2,144 (A)		YPA	1770
MD	2,0 (J,Y)		YPA	1780
ADR	0,2		YPA	1790
L	J,136 (INDXA)	AT LEAST 18	YPA	1800
LD	6,136 (A)		YPA	1810
MD	6,0 (Y,J)		YPA	1820

ADR	0,6		YPA	1830	
L	J,128 (INDXA)	AT LEAST 17	YPA	1840	
LD	4,128 (A)		YPA	1850	
MD	4,0 (Y,J)		YPA	1860	
ADR	0,4		YPA	1870	
L	J,120 (INDXA)	AT LEAST 16	YPA	1880	
LD	2,120 (A)		YPA	1890	
MD	2,0 (Y,J)		YPA	1900	
ADR	0,2		YPA	1910	
L	J,112 (INDXA)	AT LEAST 15	YPA	1920	
LD	6,112 (A)		YPA	1930	
MD	6,0 (Y,J)		YPA	1940	
ADR	0,6		YPA	1950	
L	J,104 (INDXA)	AT LEAST 14	YPA	1960	
LD	4,104 (A)		YPA	1970	
MD	4,0 (Y,J)		YPA	1980	
ADR	0,4		YPA	1990	
L	J,96 (INDXA)	AT LEAST 13	YPA	2000	
LD	2,96 (A)		YPA	2010	
MD	2,0 (Y,J)		YPA	2020	
ADR	0,2		YPA	2030	
L	J,88 (INDXA)	AT LEAST 12	YPA	2040	
LD	6,88 (A)		YPA	2050	
MD	6,0 (Y,J)		YPA	2060	
ADR	0,6		YPA	2070	
L	J,80 (INDXA)	AT LEAST 11	YPA	2080	
LD	4,80 (A)		YPA	2090	
MD	4,0 (Y,J)		YPA	2100	
ADR	0,4		YPA	2110	
L	J,72 (INDXA)	AT LEAST 10 NONZERO ENTRIES IN ROW I	YPA	2120	
LD	2,72 (A)		YPA	2130	
MD	2,0 (Y,J)		YPA	2140	
ADR	0,2		YPA	2150	
L	J,64 (INDXA)	9	YPA	2160	
LD	6,64 (A)		YPA	2170	
MD	6,0 (Y,J)		YPA	2180	
ADR	0,6		YPA	2190	
L	J,56 (INDXA)	8	YPA	2200	
LD	4,56 (A)		YPA	2210	
MD	4,0 (Y,J)		YPA	2220	
ADR	0,4		YPA	2230	
L	J,48 (INDXA)	7	YPA	2240	
LD	2,48 (A)		YPA	2250	
MD	2,0 (Y,J)		YPA	2260	
ADR	0,2		YPA	2270	
L	J,40 (INDXA)		YPA	2280	
LD	6,40 (A)		YPA	2290	
MD	6,0 (Y,J)		YPA	2300	
ADR	0,6		YPA	2310	
L	J,32 (INDXA)	5	YPA	2320	
LD	4,32 (A)		YPA	2330	
MD	4,0 (Y,J)		YPA	2340	
ADR	0,4		YPA	2350	
L	J,24 (INDXA)	4	YPA	2360	
LD	2,24 (A)		YPA	2370	
MD	2,0 (Y,J)		YPA	2380	
ADR	0,2		YPA	2390	
L	J,16 (INDXA)	3	YPA	2400	
LD	6,16 (A)		YPA	2410	
MD	6,0 (Y,J)		YPA	2420	
ADR	0,6		YPA	2430	
L	J,8 (INDXA)	2	YPA	2440	
LD	4,8 (A)		YPA	2450	
MD	4,0 (Y,J)		YPA	2460	
ADR	0,4		YPA	2470	
L	J,00 (INDXA)	AT LEAST 1 NONZERO ENTRY IN ROW I	YPA	2480	
LD	2,00 (A)		YPA	2490	
MD	2,00 (Y,J)		YPA	2500	
ADR	0,2		YPA	2510	
* X0ADD	L	12,12 (IND14)	8* (NO. NONZERO ENTRIES IN ROW I OF A)	YPA	2520
	AR	A,12		YPA	2530
	AR	INDXA,12		YPA	2540
	AR	IND14,0		YPA	2550
	STD	0,0 (YDOT,I)		YPA	2560
	BALD	1,1INC,LOUP		YPA	2570
	LM	14,12,12 (13)		YPA	2580
	DR	14		YPA	2590
	END			YPA	2600
				YPA	2610

IHC002I STOP 0

APPENDIX E

SAMPLE INPUT AND OUTPUT TO THE ICRP TIMED PROGRAM

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APPENDIX E

SAMPLE INPUT AND OUTPUT TO THE ICRP TIMED PROGRAM

Appendix E contains the sample input and output to ICRP TIMED for ^{54}Mn . The metabolic model for manganese (ref. 1) contains the following source organs:

Lungs

GI tract

$$\text{Cortical Bone: } R(t) = 0.175 \exp\left(\frac{-0.693}{40}\right)t$$

$$\text{Trabecular Bone: } R(t) = 0.175 \exp\left(\frac{-0.693}{40}\right)t$$

$$\text{Liver: } R(t) = 0.1 \exp\left(\frac{-0.693}{4}\right)t + 0.15 \exp\left(\frac{-0.693}{40}\right)t$$

$$\text{Other tissues: } R(t) = 0.2 \exp\left(\frac{-0.693}{4}\right)t + 0.2 \exp\left(\frac{-0.693}{40}\right)t$$

The oxides, hydroxides, halides, and nitrates of manganese are assigned to inhalation class W for lung clearance and other compounds of the element to inhalation class D. The f_1 for both classes is 0.1.

Manganese is classified for bone dosimetry as a surface seeker.

The technique for running ICRP TIMED is summarized as follows:

For each inhalation class solve the differential equations three times assuming the initial conditions

- (1) deposition in N-P region only,
- (2) deposition in T-B region only,
- (3) deposition in P region only.

Then solve the differential equations for the injection case(s). See Table 3.2 for complete description of card input.

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Sample Input to ICRP TIMED

```

23 18262.5
1
18262.5
1 .3
MN-54 3.125E2 D .6666667 4 0 2
2.772
15COR BONE 1
.175 1.7325-2
16TRA BONE 1
.175 1.7325-2
7LIVER 2
.1 .15 1.7325-1 1.7325-2
230TH TISS 2
.2 .2 1.7325-1 1.7325-2
11516 7
23 18262.5 1.
1
18262.5
.08
11516 7
23 18262.5 1.
1
18262.5
.25
11516 7
23 18262.5
1
18262.5
.3
MN-54 3.125E2 W .6666667 4 0 2
2.772
15COR BONE 1
.175 1.7325-2
16TRA BONE 1
.175 1.7325-2
7LIVER 2
.1 .15 1.7325-1 1.7325-2
230TH TISS 2
.2 .2 1.7325-1 1.7325-2
11516 7
23 18262.5 1.
1
18262.5
.08
11516 7
23 18262.5 1.
1
18262.5
.25
11516 7
11 18262.5
1
18262.5
.3
MN-54 3.125E2 .6666667 4 1 1
2.772
15COR BONE 1
.175 1.7325-2
16TRA BONE 1
.175 1.7325-2
7LIVER 2
.1 .15 1.7325-1 1.7325-2
230TH TISS 2
.2 .2 1.7325-1 1.7325-2
11516 7

```

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Sample Output from the ICRP TIMED Program

The printed output from the ICRP TIMED for ^{54}Mn is broken down into two parts: (1) output to unit 6 and (2) output to unit 10.

Output to unit 6 contains:

1. Summary information for the differential equations for the given inhalation or oral class.
2. The coefficient matrix for the differential equations.
3. Entries of the coefficient matrix and the associated row and column indices.
4. Solution of the differential equation by compartment for each of the three sets of initial conditions.

Steps 1, 2, 3, and 4 are included for inhalation classes D and W and also for the ingestion case. Note there is only one set of initial conditions in the ingestion case.

Output to unit 10 contains:

1. Descriptive information about ^{54}Mn for the inhalation or oral class and the retention functions, $R(t)$, for each organ.
2. Cumulated activity for each source organ and microcuries entering blood corresponding to each of the three sets of initial conditions for the differential equations.

Steps 1 and 2 are included for inhalation classes D and W and also for the ingestion case for which there is only one set of initial conditions.

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Output to Unit 6 From ICRP TIMED

NO. PRINT INTERVALS DESIRED = 1 NO. READ = 1
POINTS SELECTED IN PRINT INTERVAL = $T + Q \cdot \Delta T$ WHERE $Q=0,1,\dots,M$
T DT N
1.9262500000 04 0.0 9

```

N0= 23
MF=21
T0= 0.2
TLAST= 1.826250000000000D 04
H0= 1.000000000000000D-07
EPS=1.0000D-06

```

MATRIX A PRINTED BY ROWS

[illegible]

0.693147D 02	0.0	0.693147D 02	0.0	0.138629D 01	0.0	0.0	0.0
0.138629D 01	0.0	0.0	0.0	0.0	0.666667D 00	0.0	0.0
-0.277200D 01	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.485100D 00	-0.173250D-01	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.485100D 00	0.0	-0.173250D-01	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.277200D 00	0.0	0.0	-0.173250D 00	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.415800D 00	0.0	0.0	0.0	-0.173250D-01	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.554400D 00	0.0	0.0	0.0	0.0	-0.173250D 00	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.554400D 00	0.0	0.0	0.0	0.0	0.0	-0.173250D-01	0.0

ENTRIES OF A	ROW	COL
-0.693147D 02	1	1
-0.693147D 02	2	2
-0.693147D 02	3	3
-0.346574D 01	4	4
-0.138629D 01	5	5
0.0	6	6
0.0	7	7
-0.138629D 01	8	8
0.138629D 01	9	8
-0.138629D 01	9	9
0.0	10	8
0.0	10	10
0.0	11	6
-0.346574D 01	11	11
0.0	12	7
-0.346574D 01	12	12
0.693147D 02	13	2
0.346574D 01	13	4
0.346574D 01	13	11
0.346574D 01	13	12
-0.240000D 02	13	13
0.240000D 02	14	13
-0.666667D 01	14	14
0.666667D 01	15	14
-0.184615D 01	15	15
0.184615D 01	16	15
-0.100000D 01	16	16
0.693147D 02	17	1
0.693147D 02	17	3
0.138629D 01	17	5
0.138629D 01	17	9
0.0	17	13
0.666667D 00	17	14
0.0	17	15
0.0	17	16
-0.277200D 01	17	17
0.485100D 00	18	17
-0.173250D-01	18	18
0.485100D 00	19	17
-0.173250D-01	19	19
0.277200D 00	20	17
-0.173250D 00	20	20
0.415800D 00	21	17
-0.173250D-01	21	21
0.554400D 00	22	17
-0.173250D 00	22	22
0.554400D 00	23	17
-0.173250D-01	23	23

KFLAG = -1 FROM STIFF AT T = 0.0
 ERROR TECT FAILED WITH AD3 (H) = MMIN

H HAS BEEN REDUCED TO 0.999999999999998D-08 AND STEP WILL BE RETRIED

2. 1.826250000D 04	Y FOLLOWS				
2. 1639733142D-03		0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0
6. 2492224556D-33	2. 2489718159D-02	7. 3003873146D-02	1. 3447809921D-01	5. 9472017744D-02	1. 4762201826D-00
1. 4762201826D 00	3. 3952381486D-02	1. 2653315851D 00	1. 8790476497D-01	1. 6871087801D 00	

```
KFLAG = 0
```

NO. PRINT INTERVALS DESIRED = 1 NO. READ = 1
POINTS SELECTED IN PRINT INTERVAL = $T + Q \cdot DT$ WHERE $Q = 0, 1, \dots, M$

T	DT	M
1.8262500000D 04	0.0	0

NO = 23

५९=२१

$T0 = 0.0$

TLAST= 1.826250000000000D 04

H0= 1.000000000000000000D-07

EPS=1.0000D-06

```
KFLAG = -1 FROM STIFF AT T' = 0.0
ERROR TEST FAILED WITH ABS(H) = HMIN
```

H HAS BEEN REDUCED TO 0.999999999999998D-08. AND STEP WILL BE RETRIED

T= 1.826250000D 04	Y FOLLOWS				
0.0	0.0	1.0964131459D-03	1.1534178453D-03	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0
1.6654467623D-04	5.9936141749D-04	1.9455870715D-03	3.5839037020D-03	2.7538261384D-02	6.8355739038D-01
6.8355739038D-01	4.3504245606D-02	5.8590633461D-01	8.7608491211D-02	7.8120844615D-01	

KFLAG = 0

NC. PRINT INTERVALS DESIRED = 1 NO. READ = 1
POINTS SELECTED IN PRINT INTERVAL = $T + Q * DT$ WHERE $Q = 0, 1, \dots, M$

T	DT	M
1.8262500000D 04	0.0	0

NO= 23

MF=21

TC= 0.0

```
TLAST= .1.8262500000000000D 04
```

H0= 1.00000C000000000D-07

EP S= 1.00C0D-C6

```

      = 1.826250000D 04      Y FOLLOWS      .
      0.0      0.0      0.0      0.0      1.4403904162D-01      0.0
      0.0      3.6009760406D-02      3.5952236827D-02      0.0      0.0
      0.0      0.0      0.0      0.0      8.9942783148D-02      2.2325684717D 00
      2.2325684717D 00      1.4208932343D-01      1.9136301186D 00      2.8417864686D-01      2.5515068248D 00

```

KPLAG = 0

NO. PRINT INTERVALS DESIRED = 1 NO. READ = 1
POINTS SELECTED IN PRINT INTERVAL = $T + Q \cdot DT$ WHERE $Q = 0, 1, \dots, M$

T	DT	M
1.8262500000p 04	0.0	0

NO= 23

MF=21

$$T_0 = 0.0$$

```
TLAST= 1.8262500000000000D 04
```

H0= 1.20000000000000000000p-07

ΣPS=1.0000D-06

MATRIX A PRINTED BY ROWS

-0.693147D 02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	-0.173287D 01	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	-0.693147D 02	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

0.0	0.0	0.0	-0.346574D 01	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[illegible]

ENTRIES OF A	ROW	COL
-0.693147D 02	1	1
-0.173287D 01	2	2
-0.693147D 02	3	3
-0.346574D 01	4	4
-0.138629D-01	5	5
-0.693147D 00	6	6
-0.138629D-01	7	7
-0.138629D-01	8	8
0.138629D-01	9	8
-0.138629D-01	9	9
0.0	10	8
0.0	10	10
0.693147D 00	11	6
-0.346574D 01	11	11
0.138629D-01	12	7
-0.346574D 01	12	12
0.173287D 01	13	2
0.346574D 01	13	4
0.346574D 01	13	11
0.346574D 01	13	12
-0.240000D 02	13	13
0.240000D 02	14	13
-0.666667D 01	14	14
0.600000D 01	15	14
-0.184615D 01	15	15
0.184615D 01	16	15
-0.100000D 01	16	16
0.693147D 02	17	1
0.693147D 02	17	3
0.138629D-01	17	5
0.138629D-01	17	9
0.0	17	13
0.666667D 00	17	14
0.0	17	15
0.0	17	16
-0.277200D 01	17	17
0.485100D 00	18	17
-0.173250D-01	18	18
0.485100D 00	19	17
-0.173250D-01	19	19
0.277200D 00	20	17
-0.173250D 00	20	20
0.415800D 00	21	17
-0.173250D-01	21	21
0.554400D 00	22	17
-0.173250D 00	22	22
0.554400D 00	23	17
-0.173250D-01	23	23

KFLAG = -1 FROM STIFF AT T = 0.0
 ERROR TEST FAILED WITH ABS(H) = HMIN

H HAS BEEN REDUCED TO 0.999999999999998D-08 AND STEP WILL BE RETRIED

T= 1.826250000D 04	Y FOLLOWS					
4.3279466284D-04	1.5561188121D-01	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.1234580113D-02	4.0431036368D-02	1.3124318541D-01	2.4175887316D-01	2.0529411952D-02	5.0958305116D-01	
5.0958305116D-01	3.2431843362D-02	4.3678547242D-01	6.4863686725D-02	5.8238062989D-01		

KFLAG = 0

NO. PRINT INTERVALS DESIRED = 1 NO. READ = 1
 POINTS SELECTED IN PRINT INTERVAL = T+Q*DT WHERE Q=0,1,...,M

T	DT	M
1.826250000D 04	0.0	0

NO= 23

MF=21

T0= 0.0

TLAST= 1.826250000000000D 04

H0= 1.000000000000000D-07

EPS=1.0000D-06

KFLAG = -1 FROM STIFF AT T = 0.0
 ERROR TEST FAILED WITH ABS(H) = HMIN

H HAS BEEN REDUCED TO 0.999999999999998D-08 AND STEP WILL BE RETRIED

T= 1.826250000D 04 Y FOLLOWS
 0.0 0.0 5.7705955045D-04 1.1534178453D-02 0.0 0.0
 0.0 0.0 0.0 0.0 0.0 0.0
 1.6654467623D-03 5.9936141749D-03 1.9455870715D-02 3.5839037020D-02 1.5858329049D-02 3.9363697909D-01
 3.9363697909D-01 2.5052585282D-02 3.3740312493D-01 5.0105170564D-02 4.4987083324D-01

KPLAG = 0

NO. PRINT INTERVALS DESIRED = 1 NO. READ = 1
 POINTS SELECTED IN PRINT INTERVAL = $T+Q*DT$ WHERE $Q=0,1,\dots,M$
 $\begin{matrix} T & DT & M \\ 1.826250000D 04 & 0.0 & 0 \end{matrix}$

NO= 23
 MF=21
 TO= 0.0
 TLAST= 1.826250000000000D 04
 HQ= 1.000000000000000D-07
 EPS=1.0000D-06

T= 1.826250000D 04 Y FOLLOWS
 0.0 0.0 0.0 0.0 2.3319424152D 00 1.4380931428D-01
 6.2185131073D 00 7.7731413841D-01 6.7009439518D-01 0.0 2.8743487038D-02 2.4858143217D-02
 7.7396607497D-03 2.7853511400D-02 9.0415282154D-02 1.6655109873D-01 2.1694808938D-02 5.3851064797D-01
 5.3851064797D-01 3.4272907909D-02 4.6158055541D-01 6.8545815817D-02 6.1544074054D-01

KPLAG = 0

NO. PRINT INTERVALS DESIRED = 1 NO. READ = 1
 POINTS SELECTED IN PRINT INTERVAL = $T+Q*DT$ WHERE $Q=0,1,\dots,M$
 $\begin{matrix} T & DT & M \\ 1.826250000000D 04 & 0.0 & 0 \end{matrix}$

NO= 11
 MF=21
 TO= 0.0
 TLAST= 1.826250000000000D 04
 HQ= 1.000000000000000D-07
 EPS=1.0000D-06

MATRIX A PRINTED BY ROWS

-0.240000D 02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0					
0.240000D 02	-0.666667D 01	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0					
0.0	0.600000D 01	-0.184615D 01	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0					
0.0	0.0	0.184615D 01	-0.184615D 01	0.0	0.0	0.0	0.0
0.0	0.0	0.0					
0.0	0.666667D 00	0.0	0.0	-0.277200D 01	0.0	0.0	0.0
0.0	0.0	0.0					
0.0	0.0	0.0	0.0	0.485100D 00	-0.173250D-01	0.0	0.0
0.0	0.0	0.0					
0.0	0.0	0.0	0.0	0.485100D 00	0.0	-0.173250D-01	0.0
0.0	0.0	0.0					
0.0	0.0	0.0	0.0	0.277200D 00	0.0	0.0	-0.173250D 00
0.0	0.0	0.0					
0.0	0.0	0.0	0.0	0.415400D 00	0.0	0.0	0.0
-0.173250D-01	0.0	0.0					
0.0	0.0	0.0	0.0	0.554400D 00	0.0	0.0	0.0
0.0	-0.173250D 00	0.0					
0.0	0.0	0.0	0.0	0.554400D 00	0.0	0.0	0.0
0.0	0.0	0.0					
0.0	0.0	0.0	0.0	0.554400D 00	0.0	0.0	0.0
0.0	0.0	0.0					
0.0	0.0	0.0	0.0	-0.173250D-01			

ENTRIES OF A	ROW	COL
-0.240000D 02	1	1
0.240000D 02	2	1
-0.666667D 01	2	2
0.500000D 01	3	2
-0.184615D 01	3	3
0.184615D 01	4	3
-0.100000D 01	4	4
0.0	5	1
0.666667D 00	5	2
0.0	5	3
0.0	5	4
-0.277200D 01	5	5
0.485100D 00	5	5
-0.173250D-01	6	6
0.485100D 00	7	5
-0.173250D-01	7	7
0.277200D 00	8	5
-0.173250D 00	8	8
0.415800D 00	9	5
-0.173250D-01	9	9
0.554400D 00	10	5
-0.173250D 00	10	10
0.554400D 00	11	5
-0.173250D-01	11	11

KFLAG = -1 FROM STIFF AT T = 0.0
 ERROR TEST FAILED WITH ABS(H) = HMIN

H HAS BEEN REDUCED TO 0.999999999999998D-08 AND STEP WILL BE RETRIED

T= 1.826250000D 04 Y FOLLOWS
 4.1662816205D-02 1.4993625220D-01 4.8670806180D-01 8.9654935008D-01 3.6030875694D-02 8.9436188505D-01
 8.9436188505D-01 5.6920661901D-02 7.6659590147D-01 1.1384132380D-01 1.0221278686D 00

KFLAG = 0

IHC002I STOP 0

Output to Unit 10 From ICRP TIMED

PERCENT DEPOSITION

	N-P	T-B	P															
	0.30	0.0	0.0															
ISOTOPE	HALFLIFE	CLASS	LAMAB	IBRNCH								BR. RATIOS						
MN-54	3.125D 02	D	6.667D-01	0	0	0	0	0	0	0	0	1.0000 0.0	0.0	0.0	0.0			

ISOTOPE ORGAN A'S AND TB'S

ISOTOPE	ORGAN	A'S	TB'S				
MN-54							
	COR BONE	1.750D-01	1.733D-02				
	TRA BONE	1.750D-01	1.733D-02				
	LIVER	1.000D-01	1.500D-01	1.733D-01	1.733D-02		
	OTH TISS	2.000D-01	2.000D-01	1.733D-01	1.733D-02		

T = 1.8263D 04

MICROCURIES-DAYS FROM INHALATION OF MN-54

LUNGS

ISOTOPE	N-P	T-B	P	LYMPH	MICROCURIES ENTERING BLOOD GI	
MN-54	4.3279D-03	0.0	0.0	0.0	1.5000D-01	1.5000D-01

GI TRACT

ISOTOPE	STOMACH	S.I.	U.L.I.	L.I.I.	MICROCURIES ENTERING BLOOD
MN-54	6.2492D-03	2.2490D-02	7.3004D-02	1.3448D-01	1.4993D-02

TRANSFER COMPARTMENT

ISOTOPE	
MN-54	5.9472D-02

OTHER ORGANS

ISOTOPE	COR BONE	TRA BONE	LIVER	OTH TISS
MN-54	1.4762D 00	1.4762D 00	1.3593D 00	1.8750D 00

PERCENT DEPOSITION

N-P	T-B	P
0.0	0.08	0.0

T = 1.8263D 04

MICROCURIES-DAYS FROM INHALATION OF MN-54

LUNGS

ISOTOPE	N-P	T-B	P	LYMPH
MN-54	0.0	2.2498D-03	0.0	0.0

MICROCURIES ENTERING
BLOOD GI

7.5998D-02 3.9974D-03

GI TRACT

ISOTOPE	STOMACH	S.I.	U.L.I.	L.L.I.
MN-54	1.6654D-04	5.9936D-04	1.9456D-03	3.5839D-03

MICROCURIES ENTERING
BLOOD

3.9957D-04

TRANSFER COMPARTMENT

ISOTOPE	
MN-54	2.7538D-02

OTHER ORGANS

ISOTOPE	COR BONE	TRA BONE	LIVER	OTH TISS
MN-54	6.8356D-01	6.8356D-01	6.2941D-01	8.6822D-01

PERCENT DEPOSITION

N-P	T-B	P
0.0	0.0	0.25

T = 1.8263D 04

MICROCURIES-DAYS FROM INHALATION OF MN-54

LUNGS

ISOTOPE	N-P	T-B	P	LYMPH
MN-54	0.0	0.0	1.8005D-01	3.5952D-02

MICROCURIES ENTERING
BLOOD GI

2.4952D-01 0.0

GI TRACT

ISOTOPE	STOMACH	S.I.	U.L.I.	L.L.I.
MN-54	0.0	0.0	0.0	0.0

MICROCURIES ENTERING
BLOOD

0.0

TRANSFER COMPARTMENT

ISOTOPE	
MN-54	8.9943D-02

OTHER ORGANS

ISOTOPE	COR BONE	TRA BONE	LIVER	OTH TISS
MN-54	2.2326D 00	2.2326D 00	2.0557D 00	2.8357D 00

PERCENT DEPOSITION

	N-P	T-B	P										
	0.30	0.0	0.0										
ISOTOPE	HALFLIFE	CLASS	LAMAB	IBRNCH	BR. RATIOS								
MN-54	3.125D 02	W	6.667D-01	0 0 0 0 0	1.0000 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ISOTOPE ORGAN A'S AND TB'S

ISOTOPE	ORGAN	A'S	TB'S				
MN-54	COR BONE	1.750D-01	1.733D-02				
	TRA BONE	1.750D-01	1.733D-02				
	LIVER	1.000D-01	1.500D-01	1.733D-01	1.733D-02		
	OTH TISS	2.000D-01	2.000D-01	1.733D-01	1.733D-02		

T = 1.8263D 04

MICROCURIES-DAYS FROM INHALATION OF MN-54

LUNGS

ISOTOPE	N-P	T-B	P	LYMPH	MICROCURIES ENTERING BLOOD	GI
MN-54	1.5604D-01	0.0	0.0	0.0	2.9999D-02	2.6965D-01

GI TRACT

ISOTOPE	STOMACH	S.I.	U.L.I.	L.L.I.	MICROCURIES ENTERING BLOOD
MN-54	1.1235D-02	4.0431D-02	1.3124D-01	2.4176D-01	2.6954D-02

TRANSFER COMPARTMENT

ISOTOPE	
MN-54	2.0529D-02

OTHER ORGANS

ISOTOPE	COR BONE	TRA BONE	LIVER	OTH TISS
MN-54	5.0958D-01	5.0958D-01	4.6922D-01	6.4724D-01

PERCENT DEPOSITION

N-P	T-B	P
0.0	0.08	0.0

T = 1.8263D 04

MICROCURIES-DAYS FROM INHALATION OF MN-54

LUNGS

ISOTOPE	N-P	T-B	P	LYMPH
MN-54	0.0	1.2111D-02	0.0	0.0

MICROCURIES ENTERING
BLOOD GI

3.9999D-02 3.9974D-02

GI TRACT

ISOTOPE	STOMACH	S.I.	U.L.I.	L.L.I.
MN-54	1.6654D-03	5.9936D-03	1.9456D-02	3.5839D-02

MICROCURIES ENTERING
BLOOD

3.9957D-03

TRANSFER COMPARTMENT

ISOTOPE	
MN-54	1.5858D-02

OTHER ORGANS

ISOTOPE	COR BONE	TRA BONE	LIVER	OTH TISS
MN-54	3.9364D-01	3.9364D-01	3.6246D-01	4.9998D-01

PERCENT DEPOSITION

N-P	T-B	P
0.0	0.0	0.25

T = 1.8263D 04

MICROCURIES-DAYS FROM INHALATION OF MN-54

LUNGS

ISOTOPE	N-P	T-B	P	LYMPH
MN-54	0.0	5.3602D-02	9.4716D 00	6.7010D-01

MICROCURIES ENTERING
BLOOD GI

4.1617D-02 1.8577D-01

GI TRACT

ISOTOPE	STOMACH	S.I.	U.L.I.	L.L.I.
MN-54	7.7397D-03	2.7854D-02	9.0415D-02	1.6655D-01

MICROCURIES ENTERING
BLOOD

1.8569D-02

TRANSFER COMPARTMENT

ISOTOPE	
MN-54	2.1695D-02

OTHER ORGANS

ISOTOPE	COR BONE	TRA BONE	LIVER	OTH TISS
MN-54	5.3851D-01	5.3051D-01	4.9585D-01	6.8399D-01

ISOTOPE	HALFLIFE	CLASS	LAMAB	IBRNCH	BR. RATIOS				
MN-54	3.125D 02		6.667D-01	0 0 0 0 0	1.0000 0.0	0.0	0.0	0.0	0.0

ISOTOPE	ORGAN	A'S AND TB'S				
MN-54						
	COR BONE	1.750D-01	1.733D-02			
	TRA BONE	1.750D-01	1.733D-02			
	LIVER	1.000D-01	1.500D-01	1.733D-01	1.733D-02	
	OTH TISS	2.000D-01	2.000D-01	1.733D-01	1.733D-02	

T = 1.8263D 04

MICROCURIIE-DAYS FROM INGESTION OF MN-54

GI TRACT

ISOTOPE	STOMACH	S.I.	U.L.I.	L.L.I.
MN-54	4.1663D-02	1.4994D-01	4.8671D-01	8.9655D-01

MICROCURIIES ENTERING BLOOD

9.9958D-02

TRANSFER COMPARTMENT

ISOTOPE	
MN-54	3.6031D-02

OTHER ORGANS

ISOTOPE	COR BONE	TRA BONE	LIVER	OTH TISS
MN-54	0.7436D-01	8.9436D-01	8.2352D-01	1.1360D 00

APPENDIX F

PROGRAM LISTING OF DØSE

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C THIS JOB STEP CALCULATES DOSE (SV/BQ) 5
C 10
C UCI(4,3,15,20,1) 15
C UCI(I,J,K,L,M) - CUMULATED ACTIVITY 20
C   I - 1 INHALATION CLASS D 25
C       2 INHALATION CLASS W 30
C       3 INHALATION CLASS Y 35
C       4 INGESTION 40
C   J - 1 D3, FOR INHALATION (I = 1,2,3) 45
C       2 D4, FOR INHALATION (I = 1,2,3) 50
C       3 D5, FOR INHALATION (I = 1,2,3) 55
C   OR 60
C       1 1ST ORAL, FOR INGESTION (I = 4) 65
C       2 2ND ORAL, FOR INGESTION (I = 4) 70
C       3 3RD ORAL, FOR INGESTION (I = 4) 75
C   K - INDICATES KTH DAUGHTER IN THE CHAIN 80
C   I - SOURCE ORGAN 85
C   M - TIME INTERVAL 90
C 95
C DOSE(4,3,15,33) 100
C DOSE(I,J,K,L) - DOSE VALUES 105
C   I - 1 INHALATION CLASS D 110
C       2 INHALATION CLASS W 115
C       3 INHALATION CLASS Y 120
C       4 INGESTION 125
C   J - 1 D3, FOR INHALATION (I = 1,2,3) 130
C       2 D4, FOR INHALATION (I = 1,2,3) 135
C       3 D5, FOR INHALATION (I = 1,2,3) 140
C   CR 145
C       1 1ST ORAL, FOR INGESTION (I = 4) 150
C       2 2ND ORAL, FOR INGESTION (I = 4) 155
C       3 3RD ORAL, FOR INGESTION (I = 4) 160
C   K - INDICATES KTH DAUGHTER IN THE CHAIN 165
C   I - TARGET ORGAN 170
C 175
C SEEREN(25,33) 180
C SEEREN(I,J) - SPECIFIC EFFECTIVE ENERGIES 185
C   I - SOURCE ORGAN 190
C   J - TARGET ORGAN 195
C 200
C TAG(15) 205
C TAG(I) - ATOMIC SYMBOL AND MASS NUMBER FOR DAUGHTER I 210
C 215
C TIME(15) 220
C TIME(I) - LENGTH OF TIME INTERVAL I 225
C 230
C ISORS(20) 235
C ISORS(I) - TABLE NUMBER OF SOURCE ORGAN 240
C 245
C ITARG(33) 250
C ITARG(I) - TABLE NUMBER OF TARGET ORGAN 255
C 260
C SUMTOT(33,3,3) 265
C SUMTOT(I,J,K) - WEIGHTED PERCENTAGE FOR ORGAN I, 270
C   CLASS J, SUBCLASS K 275
C 280
C PD3(34,3), PD4(34,3), PD5(34,3) 285
C PD3(I,J), PD4(I,J), PD5(I,J) - PERCENTAGE FOR 290
C   ORGAN I, CLASS J FOR D3, D4, AND D5 295
C   COMPARTMENTS, RESPECTIVELY 300
C 305
C CSUM(33,3) 310
C CSUM(I,J) - SUM OF DOSES FROM D3, D4, AND D5 315
C   FOR ORGAN I, CLASS J 320
C 325
C TOTI(34,3) 330
C TOTI(I,J) - TOTAL INHALATION DOSE FOR ORGAN I, 335
C   CLASS J 340
C 345
C TOTO(34,3) 350
C TOTO(I,J) - TOTAL ORAL DOSE FOR ORGAN I, 355
C   INTAKE J 360
C 365
C STDOSE(20,33,6) 370
C STDOSE(I,J,K) - DOSE FROM SOURCE ORGAN I TO TARGET 375
C   ORGAN J 380
C   I - SOURCE ORGAN 385
C   J - TARGET ORGAN 390
C   K - 1 1ST ORAL 395
C       2 2ND ORAL 400
C       3 3RD ORAL 405
C       4 1ST INHALATION 410
C       5 2ND INHALATION 415
C       6 3RD INHALATION 420
C 425
C SEEOTH(33,15) 430
C SEEOTH(I,J) - OTHER TISSUES SEE VALUE FOR TARGET ORGAN I 435
C   RADIONUCLIDE J 440
C 445
C NISO - NUMBER OF RADIONUCLIDES IN THE CHAIN 450
C NORG - NUMBER OF SOURCE ORGANS (EXCLUDING GI AND LUNG) 455
C HTIME - NUMBER OF TIME INTERVALS 460
C 465
C 470
C DIMENSION UCI(4,3,15,20,1), DOSE(4,3,15,33), SEEREN(25,33), TIME(1 475

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15), ISORS(20)
DIMENSION SUNTOT(33,3,3), PD3(34,3), PD4(34,3), PD5(34,3), CSUM(33
1,3), TCTI(34,3), TOTO(34,3)
DIMENSION STDOS(20,33,6)
LOGICAL*1 ICLASS(15,3)
REAL*8 VECTOR(20),TAG(15),TOD,SORG(25),TARG(34),P(3)
REAL*8 TRNSP
REAL*4 LENE(3),ELEM(3),F1(15,6),PRAC(15)
INTEGER*2 SORG0(25,10),TARG0(34,5)
REAL*4 SORG1(25,3)
DIMENSION IOTHER(25), SEEO(33,15)
COMMON /OTHTIS/ NOTOP,SMASH
REAL*4 THASS(25)/200.,250.,400.,220.,135.,310.,1800.,85.,0.,1000.,
10.,28000.,11.,100.,4000.,1000.,1500.,1500.,2600.,180.,35.,20.,7000
20.,0.,14./
DATA SORG/'BLAD CON','S CONT','ST+CONT','ULI CONT','LLI CONT','
1KIDNEYS','LIVER','SAL GLND','TB REG','LUNGS','RESP LYM','
2MUSCLE','OVARIES','PANCREAS','COR BONE','CAN BONE','R MARROW','
3Y MARROW','SKIN','SPLEEN','TESTES','THYROID','OTH TISS','
4CLOUD','ADRENALS'/
DATA TARG/'BLAD WALL','S WALL','SI+CONT','ULI WALL','LLI WALL','
1KIDNEYS','LIVER','LUNGS','SAL GLND','TB REG','P REG','
2LYM NODE','MUSCLE','OVARIES','PANCREAS','BONE','COR BONE','
3CAN BONE','R MARROW','Y MARROW','T MARROW','COR E CL','CAN E CL','
4T E CL','SKIN','SPLEEN','TESTES','THYMUS','THYROID','
5UTERUS','T BODY','ADRENALS','BON SURF','REMAINDR'/
C
C READ LIST OF SOURCE AND TARGET ORGANS FOR ICRP TABLES
C
DO 10 I=1,25
READ (5,400) (SORG0(I,J),J=1,10)
10 CONTINUE
DO 20 I=1,25
READ (5,410) (SORG1(I,J),J=1,3)
20 CONTINUE
DO 30 I=1,34
READ (5,400) (TARG0(I,J),J=1,5)
30 CONTINUE
C
C 40 CONTINUE
C READ (5,420,END=390) NTIME
C
C READ NISO, NORG, IOFT, TAG, ISORS, AND UCI FROM UNIT 16
C
DO 50 IC=1,4
DO 50 IPART=1,3
DO 50 ID=1,15
DO 50 ISO=1,20
DO 50 ITN=1,1
UCI(IC,IPART,ID,ISO,ITN)=0.
50 CONTINUE
IC=0
IORAL=0
60 CONTINUE
IC=IC+1
INRAL=0
READ (16) NISO,NORG,TUP1
IF (IOFT.EQ.0) READ (16) NINHAL
IF (IOFT.EQ.1) READ (16) NORAL
READ (16) (TAG(ID),ID=1,NISO)
IF (IOFT.EQ.0) NORGP8=NORG+8
IF (IOFT.EQ.1) NORGP8=NORG+8
IF (IOFT.EQ.2) NORGP8=NORG
READ (16) (ISORS(ISO),ISO=1,NORGP8)
70 CONTINUE
IF (IOFT.EQ.0) INHAL=INHAL+1
IF (IUP1.EQ.1) IORAL=IORAL+1
NORGM1=NORG-1
DO 140 ITN=1,NTIME
READ (16) NOTOP,(IOther(I),I=1,NORGM1)
READ (16) TIME(ITN)
SMASH=0.
IF (NOTOP.EQ.0) GO TO 90
DO 80 I=1,NORGM1
SMASH=SMASH+THASS(IOTHER(I))
80 CONTINUE
90 CONTINUE
DO 140 ID=1,NISO
READ (16) (VECTOR(ISO),ISO=1,NORGP8),TRNSP
IF (IOFT.EQ.0) READ (16) (P(I),I=1,3)
C
C CONVERT MICROCURIE-DAYS PER MICROCURIE INTAKE
C TO BQ-S BY MULTIPLYING BY 3600*24
C
DO 130 ISO=1,NORGP8
DO 100 I=1,NORGM1
IF (ISCRS(ISO).NE.IOTHER(I)) GO TO 100
VECTOR(ISO)=VECTOR(ISO)+TRNSP*THASS(ISORS(ISO))/THASS(23)
GO TO 110
100 CONTINUE
110 CONTINUE
IF (NOTOP.EQ.0) GO TO 120
IF (ISORS(ISO).EQ.23) VECTOR(ISO)=VECTOR(ISO)+TRNSP*(THASS(23)-SMA
1SS)/THASS(23)
120 CONTINUE

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VECTOR(ISC)=VECTOR(ISO)*3600.*24.
130 CONTINUE
C
DO 140 ISO=1,NORGP8
IF (IOFT.EQ.0) UCI(IC,INHAL,ID,ISO,ITN)=VECTOR(ISO)
IF (IOFT.EQ.1) UCI(4,IOAL,ID,ISO,ITN)=VECTOR(ISO)
140 CONTINUE
IF (IOFT.EQ.0.AND.INHAL.LT.3) GO TO 70
IF (IOFT.EQ.0.AND.INHAL.EQ.3) GO TO 60
IF (IOFT.EQ.1.AND.IOAL.LT.NORAL) GO TO 60
C
C
C DETERMINE RADIONUCLIDE AND FORM MATRIX OF SEE VALUES
C
REWIND 18
DO 210 ID=1,NISO
READ (5,430) ANO,EXM,ELEM,ZNO,(ICLASS(ID,IC),IC=1,3),(P1(ID,IC),IC=1,3),FRAC(ID),(P1(ID,IC),IC=4,6)
REWIND 14
150 CONTINUE
READ (14) AHO,EXCH,LENE,ZHO,NSORS,NTARG,TOD
DO 160 IDEC=1,10
DO 160 ITO=1,NTARG
READ (14) (SEEREN(ISO,ITO),ISO=1,NSORS)
160 CONTINUE
IF (ANC.NE.AHO) GO TO 150
IF (EXM.NE.EXCH) GO TO 150
IF (ZNC.NE.ZHO) GO TO 150
C
C WRITE SEE VALUES ON UNIT 18
C
DO 170 ITO=1,NTARG
WRITE (18) (SEEREN(ISO,ITO),ISO=1,NORGP8)
170 CONTINUE
C
C PERFORM OTHER TISSUES TRANSFORMATION
C
IF (NOTOF.EQ.0) GO TO 200
DO 190 ITO=1,NTARG
SEEOH(ITO,ID)=THASS(23)/(THASS(23)-SHASS)*SEEREN(23,ITO)
DO 180 I=1,NORGH1
SEEOH(ITO,ID)=SEEOH(ITO,ID)-THASS(IOTHER(I))/(THASS(23)-SHASS)*S
18EREN(1CTHER(I),ITO)
180 CONTINUE
190 CONTINUE
200 CONTINUE
C
210 CONTINUE
C
C CALCULATE DOSE FOR EACH MEMBER OF THE CHAIN
C
DO 380 ITN=1,NTINE
DO 220 ICL=1,4
DO 220 IPART=1,3
DO 220 ID=1,NISO
DO 220 ITO=1,NTARG
DOSE(ICL,IPART,ID,ITO)=0.
220 CONTINUE
REWIND 18
C
C READ SEE VALUES FROM 18
C
DO 230 ITO=1,NTARG
DO 230 IPART=1,3
TOTI(ITO,IPART)=0.
TOTC(ITO,IPART)=0.
DO 230 ICL=1,3
SUNTOT(ITO,ICL,IPART)=0.
230 CONTINUE
C
REWIND 20
REWIND 22
DO 340 ID=1,NISO
C
C ZERO DOSE VALUES
C
DO 240 ISO=1,NORGP8
DO 240 ITO=1,NTARG
DO 240 ICL=1,6
STD0SE(ISO,ITO,ICL)=0.
240 CONTINUE
DO 250 ITO=1,NTARG
READ (18) (SEEREN(ISO,ITO),ISO=1,NORGP8)
IF (NOTOF.EQ.0) GO TO 250
SEEREN(23,ITO)=SEEOH(ITO,ID)
250 CONTINUE
C
C CALCULATE MATRIX DOSE
C
DO 270 ICL=1,4
DO 270 IPART=1,3
DO 270 ITO=1,NTARG
PD3(ITO,IPART)=0.
PD4(ITO,IPART)=0.
PD5(ITO,IPART)=0.
SUMREN=0.
CSUM(ITO,IPART)=0.

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360 CONTINUE                                     1920
C 370 CONTINUE                                     1925
      CALL TAP4 (ICLASS,TAG,IORAL,F1,NISO,TARGO,TOTI,TOTO,NTARG,PD3,PD4,
      1PD5,ISORS,NORGP8,SORG0,NINHAL,UCI,ITH,STDOSE,SORG1,53EREM) 1930
C 380 CONTINUE                                     1935
C 390 CONTINUE                                     1940
      GO TO 40                                     1945
      STOP                                         1950
C 400 FORMAT (10A2)                               1955
410 FORMAT (3A4)                                   1960
420 FORMAT (15)                                    1965
430 FORMAT (F4.0,A1,1X,3A4,F6.0,6X,3A1,3X,3P4.0,2X,F5.0,3P4.0) 1970
440 FORMAT ('1TIME INTERVAL = ',F7.1,' DAYS',30X,A8) 1975
450 FORMAT ('OBECQUEREL-SECONDS FOR ',A8//)        1980
460 FORMAT ('OBECQUEREL-SECONDS FOR ',A8,'(DECAY TO ',A8,'IS ',F6.2,'%
      1)'//)                                         1985
470 FORMAT (' SOURCE',12X,3('CLASS ',A1,24X),'ORAL'/' ORGAN',6X,3('D
      13',8X,'D4',8X,'D5',8X),' 1',7X,'2',7X,'3'//) 1990
480 FORMAT (' ',A8,1P9E10.3,3X,3E10.3)            1995
490 FORMAT ('0'// INTAKE OF 1 BECQUEREL ',A8,5X,'DOSE (SIEVERT) ', 'PR
      10M ',9A8,'/' ',55X,6A8)                    2000
500 FORMAT (' ',46X,'I N H A L A T I O N',43X,'O R A L',/,',', TARGET
      1',42(' ',7X,8(' ',',',/,',', ORGAN',6X,3('CLASS ',A1,4
      2X,'(D3,D4,D5)',7X),5X,'1',9X,'2',9X,'3'//) 2005
510 FORMAT (' ',A8,1X,3(1P9E10.2,' ('OPP4.0,',',P4.0,',',P4.0,')',1X),
      11X,1P3E10.2)                                2010
      END                                           2015
                                                    2020
SUBROUTINE CHNLEN (ISTOI,ISTOO,INDI,INDO,IORAL,NINHAL,NISO) CHN 5
C  THIS SUBROUTINE DETERMINES THE LENGTH OF THE CHAIN OF RADIONUCLIDES. CHN 10
C  THE CRITERION FOR THE LENGTH IS THAT, STARTING FROM THE END OF CHN 15
C  THE CHAIN, THE FIRST RADIONUCLIDE THAT CONTRIBUTES .1% TO THE DOSE CHN 20
C  FOR SOME ORGAN IS INCLUDED IN THE CHAIN. CHN 25
C  CHN 30
C  CHN 35
C  CHN 40
C  CHN 45
      TDSEI(16,20,3) - DOSE FOR RADIONUCLIDE I, ORGAN J, INHALATION CHN 50
C  TDSEI(I,J,K) - DOSE FOR RADIONUCLIDE I, ORGAN J, INHALATION CHN 55
C  CLASS K CHN 60
C  CHN 65
      TDSEO(16,20,3) - DOSE FOR RADIONUCLIDE I, ORGAN J, ORAL CHN 70
C  TDSEO(I,J,K) - DOSE FOR RADIONUCLIDE I, ORGAN J, ORAL CHN 75
C  CLASS K CHN 80
C  CHN 85
      XMAXI(3) CHN 90
C  XMAXI(I) - MAXIMUM FRACTION OF TOTAL DOSE (FOR CHAIN) CHN 95
C  FOR INHALATION CLASS I CHN 100
C  CHN 105
      NI(3) CHN 110
C  NI(I) - ORGAN ASSOCIATED WITH MAXIMUM FRACTION OF TOTAL DOSE CHN 115
C  FOR INHALATION CLASS I CHN 120
C  CHN 125
      XMAXO(3) - MAXIMUM FRACTION OF TOTAL DOSE (FOR CHAIN) FOR CHN 130
C  ORAL CLASS I CHN 135
C  CHN 140
      NO(3) CHN 145
C  NO(I) - ORGAN ASSOCIATED WITH MAXIMUM FRACTION OF TOTAL DOSE CHN 150
C  FOR ORAL CLASS I CHN 155
C  CHN 160
      DIMENSION ISTOI(1), ISTOO(1), INDI(20,1), INDO(20,1), TDSEI(16,20,3) CHN 165
      1,3), TDSEO(16,20,3), INDEX(20), XMAXI(3), XMAXO(3), NO(3), NI(3) CHN 170
C  CHN 175
      READ DOSES FROM UNIT 22 CHN 180
C  CHN 185
      REWIND 22 CHN 190
      NTARG=20 CHN 195
      NISOP1=NISO+1 CHN 200
      DO 10 ID=1,NISOP1 CHN 205
      DO 10 ITO=1,NTARG CHN 210
      READ (22) INDEX(ITO), (TDSEI(ID,ITO,ICL),ICL=1,NINHAL), (TDSEO(ID, CHN 215
      1ITO,ICL),ICL=1,IORAL) CHN 220
      10 CONTINUE CHN 225
C  CHN 230
      COMPARE INDIVIDUAL DOSES WITH TOTAL DOSE STARTING AT THE CHN 235
C  END OF THE CHAIN CHN 240
C  CHN 245
      NISONW=NISO CHN 250
      DO 100 ID=1,NISO CHN 255
      ID1=NISO-ID+1 CHN 260
      DO 40 ICL=1,IORAL CHN 265
      XMAXO(ICL)=0. CHN 270
      IEND=ISTOO(ICL) CHN 275
      DO 40 ITO=1,IEND CHN 280
      DO 20 I=1,NTARG CHN 285
      IEND=I CHN 290
      IF (INDEX(I).EQ.INDO(ITO,ICL)) GO TO 30 CHN 295
20 CONTINUE CHN 300
30 CONTINUE CHN 305

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X=TDSE0(ID1,IND,ICL)/TDSE0(NISOP1,IND,ICL)
IF (X.IE.XMAXO(ICL)) GO TO 40
XMAXO(ICL)=X
NO(ICL)=INDEX(IND)
40 CONTINUE
DO 70 ICL=1,NINHAL
XMAXI(ICL)=0.
IEND=ISTOI(ICL)
DO 70 ITO=1,IEND
DO 50 I=1,NTARG
IND=I
IF (INDEX(I).EQ.INDI(I"O,ICL)) GO TO 60
50 CONTINUE
60 CONTINUE
X=TDSEI(IC1,IND,IC1)/TDSEI(NISOP1,IND,ICL)
IF (X.IE.XMAXI(ICL)) GO TO 70
XMAXI(ICL)=X
NI(ICL)=INDEX(IND)
70 CONTINUE
C
C WRITE MAXIMUM VALUES
C
WRITE (6,120) ID1
WRITE (6,130) (NI(ICL),ICL=1,NINHAL),(NO(ICL),ICL=1,IORAL)
WRITE (6,140) (XMAXI(ICL),ICL=1,NINHAL),(XMAXO(ICL),ICL=1,IORAL)
C
C TEST TO SEE IF HEMODE CONTINUITES . IS IN TOTAL DOSE
G
DO 80 ICL=1,IORAL
IF (XMAXO(ICL).GT.0.001) GO TO 110
80 CONTINUE
DO 90 ICL=1,NINHAL
IF (XMAXI(ICL).GT.0.001) GO TO 110
90 CONTINUE
NISONW=NISONW-1
100 CONTINUE
110 CONTINUE
NISO=NISONW
WRITE (6,150) NISO
RETURN
C
120 FORMAT ('0','CONTRIBUTION FOR RADIONUCLIDE',I4)
130 FORMAT (' ',6I10)
140 FORMAT (' ',6F10.6)
150 FORMAT (' ',LENGTH OF CHAIN',I4)
END
C
SUBROUTINE FOOTNT (INDI,INDO,IORAL,ISORS,NORGP8,NINHAL,IMAXI,IMAXOP00
1,ISTOI,ISTOU)
C
C DETERMINE THOSE VALUES CORRESPONDING TO THE LARGEST H50-WT
C (A FOOTNOTE) AND VALUES RESULTING SOLELY FROM IRRADIATION
C FROM NEARBY ORGANS (A FOOTNOTE)
C
COMMON /FTNT/ FN
DIMENSION INDI(20,3), INDO(20,3), ISORS(20)
DIMENSION IMAXI(3), IMAXO(3), ISTOI(3), ISTOU(3)
INTEGER*2 FN(11,6),SNA/'a','/BLANK/' '/,SMB/'b' '/',SMB/'ab'/'
INTEGER*4 INDEX(34)/1,2,3,4,5,6,7,10,8,9,10,11,12,13,14,0,15,16,17
1,18,4*0,19,20,21,0,22,0,23,25,0,0/
C
C BLANK OUT FN
C
DO 10 I=1,11
DO 10 J=1,6
FN(I,J)=BLANK
10 CONTINUE
C
C AT THIS TIME (7/20/78) NO FOOTNOTES ARE TO BE PRINTED.
C BUT ROUTINE IS KEPT IN CASE OF CHANGE
C
GO TO 110
C
C SET ARRAY FN FOR INDICATION OF LARGEST H50-WT
C
DO 20 IC=1,NINHAL
IND=ISTOI(IC)
DO 20 ITO=1,IND
IF (INDI(ITO,IC).EQ.IMAXI(IC)) FN(ITO,IC+3)=SNA
20 CONTINUE
DO 30 IC=1,IORAL
IND=ISTOU(IC)
DO 30 ITO=1,IND
IF (INDO(ITO,IC).EQ.IMAXO(IC)) FN(ITO,IC)=SNA
30 CONTINUE
C
C IF OTHER TISSUES IS A SOURCE ORGAN, THERE ARE NO B FOOTNOTES
C
DO 40 ISO=1,NORGP8
IF (ISORS(ISO).EQ.23) GO TO 110
40 CONTINUE
C
C CHECK TO SEE IF A TARGET ORGAN IS ALSO A

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C SOURCE ORGAN                                F00 235
C THE TARGET ORGAN NUMBER POINTS TO THE SOURCE F00 240
C ORGAN NUMBER BY WAY OF THE ARRAY INDEX      F00 245
C                                              F00 250
C      DO 70 J=1,NINHAL                        F00 255
C      IND=ISTOI(J)                            F00 260
C      DO 70 I=1,IND                          F00 265
C                                              F00 270
C CHECK EACH ELEMENT IN INDO TO SEE IF        F00 275
C THERE IS A CORRESPONDING SOURCE ORGAN IN ISORS F00 280
C                                              F00 285
C      DO 50 K=1,NORGP8                       F00 290
C      IF (ISCRS(K).EQ.8) GO TO 50             F00 295
C      IF (ISCRS(K).EQ.INDEX(INDI(I,J))) GO TO 60 F00 300
C 50 CONTINUE                                F00 305
C                                              F00 310
C THE TARGET ORGAN IS NOT A SOURCE ORGAN      F00 315
C                                              F00 320
C      IF (FN(I,J+3).NE.BLANK) FN(I,J+3)=SNAB F00 325
C      IF (FN(I,J+3).EQ.BLANK) FN(I,J+3)=SHB   F00 330
C 60 CONTINUE                                F00 335
C 70 CONTINUE                                F00 340
C                                              F00 345
C      DO 100 J=1,IORAL                       F00 350
C      IND=ISTOC(J)                           F00 355
C      DO 100 I=1,IND                         F00 360
C                                              F00 365
C CHECK EACH ELEMENT CP INDO TO SEE IF THERE F00 370
C IS A CORRESPONDING SOURCE ORGAN IN ISORS    F00 375
C                                              F00 380
C      DO 80 K=1,NORGP8                       F00 385
C      IF (ISORS(K).EQ.8) GO TO 80             F00 390
C      IF (ISCRS(K).EQ.INDEX(INDO(I,J))) GO TO 90 F00 395
C 80 CONTINUE                                F00 400
C                                              F00 405
C TARGET ORGAN IS NOT A SOURCE ORGAN          F00 410
C                                              F00 415
C      IF (FN(I,J).NE.BLANK) FN(I,J)=SMAB     F00 420
C      IF (FN(I,J).EQ.BLANK) FN(I,J)=SHB       F00 425
C 90 CONTINUE                                F00 430
C 100 CONTINUE                               F00 435
C                                              F00 440
C 110 CONTINUE                               F00 445
C      RETURN                                  F00 450
C      END                                    F00 455-

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SUBROUTINE MAXTAB (ISTOI,ISTOO,INDI,INDO,IORAL,NINHAL,NTO,ITARG) MAX 5
C FIND MAXIMUM LENGTH OF TABLE FOR SEE VALUES (NTO) AND MAX 10
C A CUMULATIVE LIST OF TARGET ORGANS (ITARG) MAX 15
C MAX 20
C MAX 25
C DIMENSION ISTOI(3), ISTOO(3), INDI(20,3), INDO(20,3), ITARG(33) MAX 30
C MAX 35
C IE=ISTOI(1) MAX 40
C NTO=IE MAX 45
C DO 10 J=1,IE MAX 50
C ITARG(J)=INDI(J,1) MAX 55
C 10 CONTINUE MAX 60
C IF (NINHAL.EQ.1) GO TO 40 MAX 65
C DO 30 I=2,NINHAL MAX 70
C IE=ISTOI(I) MAX 75
C DO 30 J=1,IE MAX 80
C DO 20 K=1,NTO MAX 85
C IF (INDI(J,I).EQ.ITARG(K)) GO TO 30 MAX 90
C 20 CONTINUE MAX 95
C NTO=NIC+1 MAX 100
C ITARG(NTO)=INDI(J,I) MAX 105
C 30 CONTINUE MAX 110
C 40 CONTINUE MAX 115
C DO 60 I=1,IORAL MAX 120
C IE=ISTOC(I) MAX 125
C DO 60 J=1,IE MAX 130
C DO 50 K=1,NTO MAX 135
C IF (INDO(J,I).EQ.ITARG(K)) GO TO 60 MAX 140
C 50 CONTINUE MAX 145
C NTO=NTO+1 MAX 150
C ITARG(NTO)=INDO(J,I) MAX 155
C 60 CONTINUE MAX 160
C RETURN MAX 165
C END MAX 170-

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SUBROUTINE ORGTBL (TABL,NINHAL,IORAL,ISTOI,ISTOO,INDI,INDO,TARGO,IORG 5
1MAX) ORG 10
C FIND THE MAXIMUM LENGTH OF THE H50-T AND H50-WT TABLES ORG 15
C AND PLACE TARGET ORGANS IN ARRAY TABL ORG 20
C ORG 25
C DIMENSION ISTOI(3), ISTOO(3), INDI(20,3), INDO(20,3) ORG 30
C INTEGER*2 TARGO(34,5),TABL(11,6,5),BLANK2/' ' ORG 35
C ORG 40

```

C	BLANK OUT TABL	ORG 45
C	DO 10 I=1,11	ORG 50
C	DO 10 J=1,6	ORG 55
C	DO 10 K=1,5	ORG 60
C	TABL(I,J,K)=BLANK2	ORG 65
C	10 CONTINUE	ORG 70
C		ORG 75
C	FIND MAXIMUM LENGTH OF TABLE	ORG 80
C	INAX=0	ORG 85
C	DO 20 I=1,NINHAL	ORG 90
C	IF (ISTOI(I).GT.INAX) INAX=ISTOI(I)	ORG 95
C	20 CONTINUE	ORG 100
C	DO 30 I=1,IORAL	ORG 105
C	IF (ISTOO(I).GT.INAX) INAX=ISTOO(I)	ORG 110
C	30 CONTINUE	ORG 115
C		ORG 120
C	FILL OUT TABLE OF ORGAN NAMES	ORG 125
C	DO 40 I=1,NINHAL	ORG 130
C	IE=ISTOI(I)	ORG 135
C	DO 40 J=1,IE	ORG 140
C	DO 40 K=1,5	ORG 145
C	TABL(I,I+3,K)=TARGO(INDT(I,T),K)	ORG 150
C	40 CONTINUE	ORG 155
C	DO 50 I=1,IORAL	ORG 160
C	IE=ISTOO(I)	ORG 165
C	DO 50 J=1,IE	ORG 170
C	DO 50 K=1,5	ORG 175
C	TABL(J,I,K)=TARGO(INDO(J,I),K)	ORG 180
C	50 CONTINUE	ORG 185
C		ORG 190
C	RETURN	ORG 195
C	END	ORG 200
		ORG 205
		ORG 210
		ORG 215
		ORG 220-
	SUBROUTINE RESORT (INDEX,ITA,IC,KNT)	RES 5
	DIMENSION INDEX(20,3)	RES 10
C		RES 15
C	SORT INDEX ARRAY SO THAT THERE ONLY 5 ORGANS OTHER THAN	RES 20
C	THE RISK ORGANS	RES 25
C		RES 30
C	ITEMP=INDEX(ITA,IC)	RES 35
C	KNTM1=KNT-1	RES 40
C	DO 10 I=1,ITA,KNTM1	RES 45
C	INDEX(I,IC)=INDEX(I+1,IC)	RES 50
C	10 CONTINUE	RES 55
C	INDEX(KNT,IC)=ITEMP	RES 60
C		RES 65
C	RETURN	RES 70
C	END	RES 75-
	SUBROUTINE SORT (ARRAY,NTARG,ICLASS,INDEX)	SOR 5
	DIMENSION ARRAY(34,3), INDEX(20,3)	SOR 10
C		SOR 15
C	THIS ROUTINE SORTS ARRAY IN DESCENDING ORDER	SOR 20
C		SOR 25
C	DO 20 ICL=1,ICLASS	SOR 30
C	NTARM1=NTARG-1	SOR 35
C	DO 20 ITA=1,NTARM1	SOR 40
C	IF (ARRAY(ITA,ICL).GT.ARRAY(ITA+1,ICL)) GO TO 20	SOR 45
C		SOR 50
C	INTERCHANGE	SOR 55
C		SOR 60
C	TEMP=ARRAY(ITA,ICL)	SOR 65
C	ARRAY(ITA,ICL)=ARRAY(ITA+1,ICL)	SOR 70
C	ARRAY(ITA+1,ICL)=TEMP	SOR 75
C	ITEMP=INDEX(ITA,ICL)	SOR 80
C	INDEX(ITA,ICL)=INDEX(ITA+1,ICL)	SOR 85
C	INDEX(ITA+1,ICL)=ITEMP	SOR 90
C	IF (ITA.EQ.1) GO TO 20	SOR 95
C		SOR 100
C	RUN INDEX BACKWARD FROM ITA TO 2	SOR 105
C		SOR 110
C	ITAM1=ITA-1	SOR 115
C	DO 10 J=1,ITAM1	SOR 120
C	IND=ITA-(J-1)	SOR 125
C	IF (ARRAY(IND,ICL).LE.ARRAY(IND-1,ICL)) GO TO 20	SOR 130
C		SOR 135
C	INTERCHANGE	SOR 140
C		SOR 145
C	TEMP=ARRAY(IND,ICL)	SOR 150
C	ARRAY(IND,ICL)=ARRAY(IND-1,ICL)	SOR 155
C	ARRAY(IND-1,ICL)=TEMP	SOR 160
C	ITEMP=INDEX(IND,ICL)	SOR 165
C	INDEX(IND,ICL)=INDEX(IND-1,ICL)	SOR 170
C	INDEX(IND-1,ICL)=ITEMP	SOR 175
C	10 CONTINUE	SOR 180
C	20 CONTINUE	SOR 185

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C          RETURN                                SOR 190
C          END                                  SOR 195
C                                              SOR 200-

SUBROUTINE SORT01 (ARRAY2,ARRAY,IC,KTOT)
C                                              SOR 5
C          SORT ARRAY SO THAT ALL 1'S ARE AT THE END SOR 10
C                                              SOR 15
C          INTEGER*4 ARRAY2(20,3),ARRAY(11,3) SOR 20
C                                              SOR 25
C          KNT1=1 SOR 30
C                                              SOR 35
C          HUNT FOR A 1 SOR 40
C                                              SOR 45
C          10 CONTINUE SOR 50
C              IF (ARRAY(KNT1,IC).EQ.1) GO TO 20 SOR 55
C              KNT1=KNT1+1 SOR 60
C              GO TO 10 SOR 65
C          HUNT FOR THE NEXT 0 SOR 70
C          20 CONTINUE SOR 75
C              KNT0=KNT1+1 SOR 80
C          30 CONTINUE SOR 85
C              IF (KNT0.GT.KTOT) GO TO 50 SOR 90
C              IF (ARRAY(KNT0,IC).EQ.0) GO TO 40 SOR 95
C              KNT0=KNT0+1 SOR 100
C              GO TO 30 SOR 105
C          REARRANGE ARRAYS SOR 110
C          40 CONTINUE SOR 115
C              ITEMF=ARRAY(KNT1,IC) SOR 120
C              ARRAY(KNT1,IC)=ARRAY(KNT0,IC) SOR 125
C              ARRAY(KNT0,IC)=ITEMF SOR 130
C              ITEMF=ARRAY2(KNT1,IC) SOR 135
C              ARRAY2(KNT1,IC)=ARRAY2(KNT0,IC) SOR 140
C              ARRAY2(KNT0,IC)=ITEMF SOR 145
C              KNT1=KNT1+1 SOR 150
C              GO TO 10 SOR 155
C          50 CONTINUE SOR 160
C              RETURN SOR 165
C              END SOR 170
C              SOR 175
C              SOR 180
C              SOR 185
C              SOR 190
C              SOR 195-

SUBROUTINE TAB0 (ISWSEE,ISORS,NORGP8,TAG,SORGO,NISO,NTARG,ITARG,NTTB0 5
10,TORGO,ITEMP,IKOUNT,IW,SEEREM) TBO 10
C          TBO 15
C          WRITE SEP TABLES TBO 20
C          TBO 25
C          REAL*8 TAG(15) TBO 30
C          INTEGER*2 SORGO(25,10),TORGO(34,5) TBO 35
C          DIMENSION ISWSEE(20), ISORS(20), ITEMF(20), ITARG(33), SEEREM(25,3) TBO 40
C          13) TBO 45
C          DIMENSION IW(20), ITT(20) TBO 50
C          LOGICAL*1 TITL1(132),TITL2(132),HALFLP(80) TBO 55
C          INTEGER*4 IS(20)/21,12,17,10,22,2,3,4,5,6,7,14,15,16,19,20,25,1,23 TBO 60
C          1/ TBO 65
C          IF (IW(1).EQ.27) IS(1)=21 TBO 70
C          IF (IW(1).EQ.14) IS(1)=13 TBO 75
C          COUNT THE NUMBER OF SOURCE ORGANS - IKOUNT TBO 80
C          DETERMINE REDUCED LIST OF SOURCE ORGANS - ITEMF TBO 85
C          TBO 90
C          TBO 95
C          IKOUNT=0 TBO 100
C          DO 10 I=1,NORGP8 TBO 105
C          ELIMINATE TB REG AND LYMPH FROM LIST OF SOURCE ORGANS TBO 110
C          IF (ISORS(I).EQ.9.OR.ISORS(I).EQ.11) GO TO 10 TBO 115
C          IF (ISWSEE(I).EQ.0) GO TO 10 TBO 120
C          IKOUNT=IKOUNT+1 TBO 125
C          ITEMF(IKOUNT)=ISORS(I) TBO 130
C          10 CONTINUE TBO 135
C          TBO 140
C          SORT SOURCE ORGANS ITEMF ACCORDING TO THE PRBSET SCHEME TBO 145
C          TBO 150
C          KNTB=0 TBO 155
C          DO 30 ITO=1,19 TBO 160
C          DO 20 I=1,IKOUNT TBO 165
C          IF (ITEMF(I).NE.IS(ITO)) GO TO 20 TBO 170
C          KNTB=KNTB+1 TBO 175
C          ITT(KNTB)=ITEMF(I) TBO 180
C          20 CONTINUE TBO 185
C          30 CONTINUE TBO 190
C          TBO 195
C          REPLACE ITEMF TBO 200
C          TBO 205
C          DO 40 ITO=1,IKOUNT TBO 210
C          ITEMF(ITO)=ITT(ITO) TBO 215
C          40 CONTINUE TBO 220
C          WRITE (6,150) IKOUNT TBO 225
C          WRITE (6,160) (ITEMF(ITO),ITO=1,IKOUNT) TBO 230

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C		TBO 235
C	SORT TARGET TARGET ORGANS ITARG ACCORDING TO THE PRESET SCHEME	TBO 240
C		TBO 245
	KNTR=0	TBO 250
	DO 60 ITO=1,19	TBO 255
	DO 50 I=1,NTO	TBO 260
	IF (ITARG(I).NE.IW(ITO)) GO TO 50	TBO 265
	KNTR=KNTR+1	TBO 270
	ITT(KNTR)=ITARG(I)	TBO 275
	50 CONTINUE	TBO 280
	60 CONTINUE	TBO 285
C		TBO 290
C	REPLACE ITARG	TBO 295
C		TBO 300
	DO 70 ITC=1,NTC	TBO 305
	ITARG(ITO)=ITT(ITO)	TBO 310
	70 CONTINUE	TBO 315
	WRITE (6,150) NTO	TBO 320
	WRITE (6,160) (ITARG(ITO),ITO=1,NTO)	TBO 325
C		TBO 330
C	WRITE TABLES FOR EACH MEMBER OF THE CHAIN	TBO 335
C		TBO 340
	REWIND 18	TBO 345
	IWID=10	TBO 350
	DO 140 I=1,NISO	TBO 355
C		TBO 360
C	READ SEE VALUES FROM UNIT 18	TBU 365
C		TBO 370
	DO 80 ITO=1,NTARG	TBO 375
	READ (18) (SEEREN(ISORS(ISO),ITO),ISO=1,NORGP8)	TBO 380
	80 CONTINUE	TBO 385
C		TBO 390
C	DETERMINE NUMBER OF TABLES TO BE WRITTEN	TBO 395
C	MAXIMUM NUMBER OF SOURCE ORGANS IN EACH TABLE - IWID	TBO 400
C		TBO 405
	NTABL=IKCUNT/IWID	TBO 410
	IF (IKCUNT.LE.IWID) GO TO 110	TBO 415
C		TBO 420
C	CENTER TITLES OVER TABLE AND WRITE	TBO 425
C		TBO 430
	CALL TITLE (IWID,TAG,TITL1,TITL2,I)	TBO 435
C		TBO 440
	DO 100 ITABL=1,NTABL	TBO 445
	WRITE (15,170) TITL1	TBO 450
	WRITE (15,180) TITL2	TBO 455
	IB=IWID*(ITABL-1)+1	TBO 460
	IE=IB+(IWID-1)	TBO 465
C		TBO 470
C	WRITE SOURCE ORGANS	TBO 475
C		TBO 480
	WRITE (15,190) ((SORGO(ITEMP(J),K),K=1,5),J=IB,IE)	TBO 485
	WRITE (15,200) ((SORGO(ITEMP(J),K),K=6,10),J=IB,IE)	TBO 490
C		TBO 495
C	WRITE SEE VALUES	TBO 500
C		TBO 505
	DO 90 ITO=1,NTO	TBO 510
	WRITE (15,210) (TORGO(ITARG(ITO),K),K=1,5), (SEEREN(ITEMP(J),ITARG	TBO 515
	(ITO)),J=IB,IE)	TBO 520
	90 CONTINUE	TBO 525
	100 CONTINUE	TBO 530
	IB=IWID*NTABL+1	TBO 535
	IF=IKCUNT	TBO 540
	GO TO 120	TBO 545
C		TBO 550
	110 CONTINUE	TBO 555
	CALL TITLE (IKCUNT,TAG,TITL1,TITL2,I)	TBO 560
	IB=1	TBO 565
	IE=IKCUNT	TBO 570
	120 CONTINUE	TBO 575
	WRITE (15,170) TITL1	TBO 580
	WRITE (15,180) TITL2	TBO 585
	WRITE (15,190) ((SORGO(ITEMP(J),K),K=1,5),J=IB,IE)	TBO 590
	WRITE (15,200) ((SORGO(ITEMP(J),K),K=6,10),J=IB,IE)	TBO 595
C		TBO 600
	DO 130 ITO=1,NTO	TBO 605
	WRITE (15,210) (TORGO(ITARG(ITO),K),K=1,5), (SEEREN(ITEMP(J),ITARG	TBO 610
	(ITO)),J=IB,IE)	TBO 615
	130 CONTINUE	TBO 620
	140 CONTINUE	TBO 625
C		TBO 630
	RETURN	TBO 635
C		TBO 640
	150 FORMAT ('0',I3)	TBO 645
	160 FORMAT (' ',20I3)	TBO 650
	170 FORMAT ('1',132A1)	TBO 655
	180 FORMAT ('0',117A1)	TBO 660
	190 FORMAT ('0','TARGETS',3X,10(5A2))	TBO 665
	200 FORMAT (' ',10X,10(5A2))	TBO 670
	210 FORMAT ('0',5A2,1PE8.1,9(2X,E8.1))	TBO 675
	END	TBO 680

SUBROUTINE TAB1 (ICLASS,TAG,UCI,NISO,P1,IORAL,ITH,ISORS,SORG1,ITEHTB1 5
 1 P,IKCUNT,NORGP8,NINHAL) TBI 10

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        DIMENSION UCI(4,3,15,20,1), F1(15,6), SUM(6), ISORS(20)          TB1 15
        LOGICAL*1 ICLASS(15,3)                                           TB1 20
        REAL*8 TAG(15)                                                    TB1 25
        REAL*4 SORG1(25,3)                                                TB1 30
        DIMENSION ITEMP(20)                                              TB1 35
        COMMON /CTHTIS/, NOTOP, SNAISS                                  TB1 40
C
C   TIME INTEGRAL OF ACTIVITY TABLE
C
C
C   TITLE LINE
C
        IF ((IORAL.EQ.1).AND.(NINHAL.EQ.1.OR.NINHAL.EQ.2)) WRITE (15,230) TB1 75
        1TAG(1)                                                            TB1 80
        IF (IORAL.EQ.1.AND.NINHAL.EQ.3) WRITE (15,240) TAG(1)           TB1 85
        IF (IORAL.EQ.2.AND.NINHAL.EQ.1) WRITE (15,230) TAG(1)           TB1 90
        IF (IORAL.EQ.2.AND.NINHAL.EQ.2) WRITE (15,240) TAG(1)           TB1 95
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.EQ.1) WRITE (15,250) TAG(1TB1 100
        1)                                                                TB1 105
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.GT.1) WRITE (15,260) TAG(1TB1 110
        1)                                                                TB1 115
C
C   ORAL AND INHALATION LINE
C
        IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,270)    TB1 135
        IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,280)    TB1 140
        IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.EQ.1) WRITE (15,290)    TB1 145
        IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.GT.1) WRITE (15,300)    TB1 150
        IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.EQ.1) WRITE (15,310)    TB1 155
        IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.GT.1) WRITE (15,320)    TB1 160
        IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,330)    TB1 165
        IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,340)    TB1 170
        IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.EQ.1) WRITE (15,350)    TB1 175
        IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.GT.1) WRITE (15,360)    TB1 180
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.EQ.1) WRITE (15,370)    TB1 185
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.GT.1) WRITE (15,380)    TB1 190
C
C   CLASS LINE
C
        IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,390) (ICLATB1 210
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 215
        IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,400) (ICLATB1 220
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 225
        IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.EQ.1) WRITE (15,410) (ICLATB1 230
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 235
        IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.GT.1) WRITE (15,420) (ICLATB1 240
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 245
        IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.EQ.1) WRITE (15,430) (ICLATB1 250
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 255
        IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.GT.1) WRITE (15,440) (ICLATB1 260
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 265
        IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,450) (ICLATB1 270
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 275
        IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,460) (ICLATB1 280
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 285
        IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.EQ.1) WRITE (15,470) (ICLATB1 290
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 295
        IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.GT.1) WRITE (15,480) (ICLATB1 300
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 305
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.EQ.1) WRITE (15,490) (ICLATB1 310
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 315
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.GT.1) WRITE (15,500) (ICLATB1 320
        1SS(1,ICL),ICL=1,NINHAL)                                         TB1 325
        DO 10 ID=1,NISO                                                    TB1 330
C
C   F1 LINE
C
        IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,510) F1(IDTB1 350
        1,4),F1(ID,1)                                                     TB1 355
        IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,520) TAG(ITB1 360
        1D),F1(ID,4),F1(ID,1)                                             TB1 365
        IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.EQ.1) WRITE (15,530) F1(IDTB1 370
        1,4), (F1(ID,IC),IC=1,NINHAL)                                     TB1 375
        IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.GT.1) WRITE (15,540) TAG(ITB1 380
        1D),F1(ID,4), (F1(ID,IC),IC=1,NINHAL)                             TB1 385
        IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.EQ.1) WRITE (15,550) F1(IDTB1 390
        1,4), (F1(ID,IC),IC=1,NINHAL)                                     TB1 395
        IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.GT.1) WRITE (15,560) TAG(ITB1 400
        1D),F1(ID,4), (F1(ID,IC),IC=1,NINHAL)                             TB1 405
        IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,570) (F1(ITB1 410
        1D,IC+3),IC=1,IOBAL), (F1(ID,IC),IC=1,NINHAL)                   TB1 415
        IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,540) TAG(ITB1 420
        1C), (F1(ID,IC+3),IC=1,IOBAL), (F1(ID,IC),IC=1,NINHAL)           TB1 425
        IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.EQ.1) WRITE (15,550) (F1(ITB1 430
        1D,IC+3),IC=1,IOBAL), (F1(ID,IC),IC=1,NINHAL)                   TB1 435
        IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.GT.1) WRITE (15,560) TAG(ITB1 440
        1D), (F1(ID,IC+3),IC=1,IOBAL), (F1(ID,IC),IC=1,NINHAL)           TB1 445
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.EQ.1) WRITE (15,580) (F1(ITB1 450
        1D,IC+3),IC=1,IOBAL), (F1(ID,IC),IC=1,NINHAL)                   TB1 455
        IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.GT.1) WRITE (15,590) TAG(ITB1 460
        1D), (F1(ID,IC+3),IC=1,IOBAL), (F1(ID,IC),IC=1,NINHAL)           TB1 465
        10 CONTINUE                                                         TB1 470
C
C   WRITE VALUES
C
        ITEMP(J) - INDEX OF SOURCE ORGAN J                               TB1 475
        IKOUNT - TOTAL NUMBER OF SOURCE ORGANS                           TB1 480
C

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C
DO 220 ISO=1,IKOUNT
DO 200 ID=1,NISO
DO 20 I=1,6
SUN(I)=0.
20 CONTINUE
DO 30 I=1,NORGP8
K=I
IF (ITEMP(ISO).EQ.ISORS(K)) GO TO 40
30 CONTINUE
GO TO 220
40 CONTINUE
IF (ID.EQ.1) WRITE (15,600)
DO 50 IC=1,NINHAL
DO 50 IPART=1,3
SUN(IC)=SUN(IC)+UCI(IC,IPART,ID,K,ITM)
IF (K.EQ.3) SUN(IC)=SUN(IC)+UCI(IC,IPART,ID,2,ITM)+UCI(IC,IPART,IDTB1
1,4,ITM)
50 CONTINUE
DO 60 IC=1,IORAL
SUN(IC+3)=UCI(4,IC,ID,K,ITM)
60 CONTINUE
IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.EQ.1) GO TO 70
IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.GT.1) GO TO 80
IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.EQ.1) GO TO 90
IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.GT.1) GO TO 100
IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.EQ.1) GO TO 110
IF (IORAL.EQ.1.AND.NINHAL.EQ.3.AND.NISO.GT.1) GO TO 120
IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.EQ.1) GO TO 130
IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.GT.1) GO TO 140
IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.EQ.1) GO TO 150
IF (IORAL.EQ.2.AND.NINHAL.EQ.2.AND.NISO.GT.1) GO TO 160
IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.EQ.1) GO TO 170
IF (IORAL.EQ.2.AND.NINHAL.EQ.3.AND.NISO.GT.1) GO TO 180
70 CONTINUE
IF (K.NE.3) WRITE (15,610) (SORG1(ISORS(K),J),J=1,3),SUN(4),(SUN(ITB1
1C),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,620) (SORG1(ISORS(K),J),J=1,3),(SUN(IC),IC=1TB1
1,NINHAL)
GO TO 190
80 CONTINUE
IF (K.NE.3) WRITE (15,630) (SORG1(ISORS(K),J),J=1,3),TAG(ID),SUN(4TB1
1),(SUN(IC),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,640) (SORG1(ISORS(K),J),J=1,3),TAG(ID),(SUN(TB1
1C),IC=1,NINHAL)
GO TO 190
90 CONTINUE
IF (K.NE.3) WRITE (15,650) (SORG1(ISORS(K),J),J=1,3),SUN(4),(SUN(ITB1
1C),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,660) (SORG1(ISORS(K),J),J=1,3),(SUN(IC),IC=1TB1
1,NINHAL)
GO TO 190
100 CONTINUE
IF (K.NE.3) WRITE (15,670) (SORG1(ISORS(K),J),J=1,3),TAG(ID),SUN(4TB1
1),(SUN(IC),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,680) (SORG1(ISORS(K),J),J=1,3),TAG(ID),(SUN(TB1
1C),IC=1,NINHAL)
GO TO 190
110 CONTINUE
IF (K.NE.3) WRITE (15,690) (SORG1(ISORS(K),J),J=1,3),SUN(4),(SUN(ITB1
1C),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,700) (SORG1(ISORS(K),J),J=1,3),(SUN(IC),IC=1TB1
1,NINHAL)
GO TO 190
120 CONTINUE
IF (K.NE.3) WRITE (15,710) (SORG1(ISORS(K),J),J=1,3),TAG(ID),SUN(4TB1
1),(SUN(IC),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,720) (SORG1(ISORS(K),J),J=1,3),TAG(ID),(SUN(TB1
1C),IC=1,NINHAL)
GO TO 190
130 CONTINUE
IF (K.NE.3) WRITE (15,730) (SORG1(ISORS(K),J),J=1,3),(SUN(IC+3),ICTB1
1=1,IORAL),(SUN(IC),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,740) (SORG1(ISORS(K),J),J=1,3),(SUN(IC),IC=1TB1
1,NINHAL)
GO TO 190
140 CONTINUE
IF (K.NE.3) WRITE (15,670) (SORG1(ISORS(K),J),J=1,3),TAG(ID),(SUN(TB1
1C+3),IC=1,IORAL),(SUN(IC),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,750) (SORG1(ISORS(K),J),J=1,3),TAG(ID),(SUN(TB1
1C),IC=1,NINHAL)
GO TO 190
150 CONTINUE
IF (K.NE.3) WRITE (15,690) (SORG1(ISORS(K),J),J=1,3),(SUN(IC+3),ICTB1
1=1,IORAL),(SUN(IC),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,760) (SORG1(ISORS(K),J),J=1,3),(SUN(IC),IC=1TB1
1,NINHAL)
GO TO 190
160 CONTINUE
IF (K.NE.3) WRITE (15,710) (SORG1(ISORS(K),J),J=1,3),TAG(ID),(SUN(TB1
1C+3),IC=1,IORAL),(SUN(IC),IC=1,NINHAL)
IF (K.EQ.3) WRITE (15,770) (SORG1(ISORS(K),J),J=1,3),TAG(ID),(SUN(TB1
1C),IC=1,NINHAL)
GO TO 190
170 CONTINUE
IF (K.NE.3) WRITE (15,780) (SORG1(ISORS(K),J),J=1,3),(SUN(IC+3),ICTB1

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1=1, IORAL), (SUM(IC), IC=1, NINHAL)
IF (K.EQ.3) WRITE (15,790) (SORG1 (ISORS(K), J), J=1,3), (SUM(IC), IC=1, NINHAL)
1, NINHAL)
GO TO 190
180 CONTINUE
IF (K.NE.3) WRITE (15,800) (SORG1 (ISORS(K), J), J=1,3), TAG (ID), (SUM (TB11000
1IC+3), IC=1, IORAL), (SUM (IC), IC=1, NINHAL)
IF (K.EQ.3) WRITE (15,810) (SORG1 (ISORS(K), J), J=1,3), TAG (ID), (SUM (TB11010
1IC), IC=1, NINHAL)
190 CONTINUE
C
200 CONTINUE
C
C
C WRITE MASS OF OTHER TISSUES
C
IF (ISCKS(K).NE.23) GO TO 210
IOTHMS=70000.-SMASS
IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,820) IOTHMTB11060
1S
IF (IORAL.EQ.1.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,830) IOTHMTB11070
1S
IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.EQ.1) WRITE (15,840) IOTHMTB11080
1S
IF (IORAL.EQ.1.AND.NINHAL.EQ.2.AND.NISO.GT.1) WRITE (15,850) IOTHMTB11090
1S
IF (IORAL.EQ.1.AND.NINHAL.EQ.3) WRITE (15,860) IOTHMS
IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.EQ.1) WRITE (15,840) IOTHMTB11105
1S
IF (IORAL.EQ.2.AND.NINHAL.EQ.1.AND.NISO.GT.1) WRITE (15,850) IOTHMTB11115
1S
IF (IORAL.EQ.2.AND.NINHAL.EQ.2) WRITE (15,860) IOTHMS
IF (IORAL.EQ.2.AND.NINHAL.EQ.3) WRITE (15,860) IOTHMS
210 CONTINUE
220 CONTINUE
C
RETURN
C
230 FORMAT ('1',6X,'NUMBER OF NUCLEAR TRANSFORMATIONS OVER 50', ' YEARS', TB11160
1'/' ,3X,'IN SOURCE ORGANS OR TISSUES PER UNIT', ' INTAKE OF ACTIVITB11165
2TY'/' ,16X,'(TRANSFORMATIONS/Bq) OF ',A8) TB11170
240 FORMAT ('1',7X,'NUMBER OF NUCLEAR TRANSFORMATIONS OVER 50', ' YEARS', TB11175
1'/' ,4X,'IN SOURCE ORGANS OR TISSUES PER UNIT', ' INTAKE OF ACTIVITB11180
2TY'/' ,17X,'(TRANSFORMATIONS/Bq) OF ',A8) TB11185
250 FORMAT ('1',8X,'NUMBER OF NUCLEAR TRANSFORMATIONS OVER 50', ' YEARS', TB11190
1'/' ,5X,'IN SOURCE ORGANS OR TISSUES PER UNIT', ' INTAKE OF ACTIVITB11195
2TY'/' ,18X,'(TRANSFORMATIONS/Bq) OF ',A8) TB11200
260 FORMAT ('1',13X,'NUMBER OF NUCLEAR TRANSFORMATIONS OVER 50', ' YEARS', TB11205
1S'/' ,10X,'IN SOURCE ORGANS OR TISSUES PER UNIT', ' INTAKE OF ACTIVITB11210
2VTY'/' ,23X,'(TRANSFORMATIONS/Bq) OF ',A8) TB11215
270 FORMAT ('0',27X,'ORAL',7X,'INHALATION'/'+' ,27X,4 ('_'),7X,10 ('_') TB11220
280 FORMAT ('0',31X,'ORAL',7X,'INHALATION'/'+' ,31X,4 ('_'),7X,10 ('_') TB11225
290 FORMAT ('0',20X,'ORAL',14X,'INHALATION'/'+' ,20X,4 ('_'),14X,10 ('_') TB11230
1) TB11235
300 FORMAT ('0',25X,'ORAL',14X,'INHALATION'/'+' ,25X,4 ('_'),14X,10 ('_') TB11240
1) TB11245
310 FORMAT ('0',15X,'ORAL',21X,'INHALATION'/'+' ,15X,4 ('_'),21X,10 ('_') TB11250
1) TB11255
320 FORMAT ('0',24X,'ORAL',15X,'INHALATION'/'+' ,24X,4 ('_'),15X,10 ('_') TB11260
1) TB11265
330 FORMAT ('0',28X,'ORAL',13X,'INHALATION'/'+' ,28X,4 ('_'),13X,10 ('_') TB11270
1) TB11275
340 FORMAT ('0',33X,'ORAL',13X,'INHALATION'/'+' ,33X,4 ('_'),13X,10 ('_') TB11280
1) TB11285
350 FORMAT ('0',23X,'ORAL',20X,'INHALATION'/'+' ,23X,4 ('_'),20X,10 ('_') TB11290
1) TB11295
360 FORMAT ('0',30X,'ORAL',15X,'INHALATION'/'+' ,30X,4 ('_'),15X,10 ('_') TB11300
1) TB11305
370 FORMAT ('0',21X,'ORAL',20X,'INHALATION'/'+' ,21X,4 ('_'),20X,10 ('_') TB11310
1) TB11315
380 FORMAT ('0',30X,'ORAL',20X,'INHALATION'/'+' ,30X,4 ('_'),20X,10 ('_') TB11320
1) TB11325
390 FORMAT ('0',12X,'ORGAN',23X,'CLASS ',A1) TB11330
400 FORMAT ('0',7X,'ORGAN',9X,'ISOTOPE',16X,'CLASS ',A1) TB11335
410 FORMAT ('0',5X,'ORGAN',23X,2 ('CLASS ',A1,7X)) TB11340
420 FORMAT ('0',1X,'ORGAN',9X,'ISOTOPE',16X,2 ('CLASS ',A1,7X)) TB11345
430 FORMAT ('0', 'ORGAN',23X,3 ('CLASS ',A1,7X)) TB11350
440 FORMAT ('0', 'ORGAN',9X,'ISOTOPE',13X,3 ('CLASS ',A1,4X)) TB11355
450 FORMAT ('0',5X,'ORGAN',37X,'CLASS ',A1) TB11360
460 FORMAT ('0',1X,'ORGAN',9X,'ISOTOPE',30X,'CLASS ',A1) TB11365
470 FORMAT ('0', 'ORGAN',37X,2 ('CLASS ',A1,7X)) TB11370
480 FORMAT ('0', 'ORGAN',9X,'ISOTOPE',24X,2 ('CLASS ',A1,4X)) TB11375
490 FORMAT ('0', 'ORGAN',31X,3 ('CLASS ',A1,4X)) TB11380
500 FORMAT ('0', 'ORGAN',9X,'ISOTOPE',24X,3 ('CLASS ',A1,4X)) TB11385
510 FORMAT (' ',25X,2 ('F1=',1PE6.0,5X)) TB11390
520 FORMAT (' ',21X,A8,2 ('F1=',1PE6.0,5X)) TB11395
530 FORMAT (' ',18X,3 ('F1=',1PE6.0,5X)) TB11400
540 FORMAT (' ',15X,A8,3 ('F1=',1PE6.0,5X)) TB11405
550 FORMAT (' ',13X,4 ('F1=',1PE6.0,5X)) TB11410
560 FORMAT (' ',14X,A8,4 ('F1=',1PE6.0,2X)) TB11415
570 FORMAT (' ',18X,3 ('F1=',1PE6.0,5X)) TB11420
580 FORMAT (' ',12X,5 ('F1=',1PE6.0,2X)) TB11425
590 FORMAT (' ',14X,A8,5 ('F1=',1PE6.0,2X)) TB11430
600 FORMAT (' ') TB11435
610 FORMAT (' ',12X,3A4,2X,2 (1PE7.1,7X)) TB11440
620 FORMAT (' ',12X,3A4,16X,1PE7.1) TB11445
630 FORMAT (' ',7X,3A4,2X,A8,1X,2 (1PE7.1,7X)) TB11450

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640 FORMAT (' ',7X,3A4,2X,A8,15X,1PE7.1) TB11455
650 FORMAT (' ',5X,3A4,2X,3(1PE7.1,7X)) TB11460
660 FORMAT (' ',5X,3A4,16X,2(1PE7.1,7X)) TB11465
670 FORMAT (' ',1X,3A4,2X,A8,1X,3(1PE7.1,7X)) TB11470
680 FORMAT (' ',1X,3A4,2X,A8,15X,2(1PE7.1,7X)) TB11475
690 FORMAT (' ',3A4,2X,4(1PE7.1,7X)) TB11480
700 FORMAT (' ',3A4,16X,3(1PE7.1,7X)) TB11485
710 FORMAT (' ',3A4,2X,A8,1X,4(1PE7.1,4X)) TB11490
720 FORMAT (' ',3A4,2X,A8,12X,3(1PE7.1,4X)) TB11495
730 FORMAT (' ',5X,3A4,2X,3(1PE7.1,7X)) TB11500
740 FORMAT (' ',5X,3A4,30X,1PE7.1) TB11505
750 FORMAT (' ',1X,3A4,2X,A8,29X,1PE7.1) TB11510
760 FORMAT (' ',3A4,30X,2(1PE7.1,7X)) TB11515
770 FORMAT (' ',3A4,2X,A8,23X,2(1PE7.1,4X)) TB11520
780 FORMAT (' ',3A4,2X,5(1PE7.1,4X)) TB11525
790 FORMAT (' ',3A4,24X,3(1PE7.1,4X)) TB11530
800 FORMAT (' ',3A4,2X,A8,1X,5(1PE7.1,4X)) TB11535
810 FORMAT (' ',3A4,2X,A8,23X,3(1PE7.1,4X)) TB11540
820 FORMAT (' ',12X,'(','I5','g')') TB11545
830 FORMAT (' ',7X,'(','I5','g')') TB11550
840 FORMAT (' ',5X,'(','I5','g')') TB11555
850 FORMAT (' ',1X,'(','I5','g')') TB11560
860 FORMAT (' ',('','I5','g')') TB11565
      END TB11570-

SUBROUTINE TAD3 (ICLASS, IAG, IORAL, F1, IMAX, PD3, PD4, PD5, TABL, TOTI, TOTB3  5
1 TO, INDI, INDO, NINHAI, WT) TB3 10
DIMENSION PD3(34,3), PD4(34,3), PD5(34,3), IPD3(3), IPD4(3), IPD5(TB3 15
DIMENSION INDI(20,3), INDO(20,3) TB3 25
LOGICAL*1 ICLASS(15,3) TB3 30
REAL*8 TAG(15) TB3 35
REAL*8 WT(11,6) TB3 40
INTEGER*2 TABL(11,6,5), BLANK2/' ' TB3 45
LOGICAL*1 LINE1(132), LINE2(132), BLANK1/' ' TB3 50
LOGICAL*1 LINE3(132) TB3 55
INTEGER*2 FN(11,6) TB3 60
COMMON /FTNT/ FN TB3 65
C TB3 70
C TB3 75
C TB3 80
C TB3 85
C TB3 90
C TB3 95
C TB3 100
C TB3 105
C TB3 110
C TB3 115
C TB3 120
C TB3 125
C TB3 130
C TB3 135
C TB3 140
C TB3 145
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C TB3 295
C TB3 300
C TB3 305
C TB3 310
C TB3 315
C TB3 320
C TB3 325
C TB3 330
C TB3 335
C TB3 340
C TB3 345

      IF (IORAL.EQ.1) WRITE (15,650) TAG(1)
      IF (IORAL.EQ.2.AND.(NINHAI.EQ.1.OR.NINHAI.EQ.2)) WRITE (15,650) TAG(1)
      IF (1)
      IF (IORAL.EQ.2.AND.NINHAI.EQ.3) WRITE (15,660) TAG(1)

      ORAL OR INHALATION LINE

      IF (IORAL.EQ.1.AND.NINHAI.EQ.1) WRITE (15,670)
      IF (IORAL.EQ.1.AND.NINHAI.EQ.2) WRITE (15,680)
      IF (IORAL.EQ.1.AND.NINHAI.EQ.3) WRITE (15,690)
      IF (IORAL.EQ.2.AND.NINHAI.EQ.1) WRITE (15,700)
      IF (IORAL.EQ.2.AND.NINHAI.EQ.2) WRITE (15,710)
      IF (IORAL.EQ.2.AND.NINHAI.EQ.3) WRITE (15,720)

      CLASS LINE

      IF (IORAL.EQ.1.AND.NINHAI.EQ.1) WRITE (15,730) (ICLASS(1,IC), IC=1, TB3 180
1 NINHAI) TB3 185
      IF (IORAL.EQ.1.AND.NINHAI.EQ.2) WRITE (15,740) (ICLASS(1,IC), IC=1, TB3 190
1 NINHAI) TB3 195
      IF (IORAL.EQ.1.AND.NINHAI.EQ.3) WRITE (15,750) (ICLASS(1,IC), IC=1, TB3 200
1 NINHAI) TB3 205
      IF (IORAL.EQ.2.AND.NINHAI.EQ.1) WRITE (15,760) (ICLASS(1,IC), IC=1, TB3 210
1 NINHAI) TB3 215
      IF (IORAL.EQ.2.AND.NINHAI.EQ.2) WRITE (15,770) (ICLASS(1,IC), IC=1, TB3 220
1 NINHAI) TB3 225
      IF (IORAL.EQ.2.AND.NINHAI.EQ.3) WRITE (15,780) (ICLASS(1,IC), IC=1, TB3 230
1 NINHAI) TB3 235

      F1 LINE

      IF (IORAL.EQ.1.AND.NINHAI.EQ.1) WRITE (15,790) F1(1,4), F1(1,1) TB3 260
      IF (IORAL.EQ.1.AND.NINHAI.EQ.2) WRITE (15,800) F1(1,4), (F1(1,IC), I=1, TB3 265
1 NINHAI) TB3 270
      IF (IORAL.EQ.1.AND.NINHAI.EQ.3) WRITE (15,810) F1(1,4), (F1(1,IC), I=1, TB3 275
1 NINHAI) TB3 280
      IF (IORAL.EQ.2.AND.NINHAI.EQ.1) WRITE (15,800) F1(1,4), F1(1,5), F1(1, TB3 285
1,1) TB3 290
      IF (IORAL.EQ.2.AND.NINHAI.EQ.2) WRITE (15,810) F1(1,4), F1(1,5), (F1(1, TB3 295
1,IC), IC=1, NINHAI) TB3 300
      IF (IORAL.EQ.2.AND.NINHAI.EQ.3) WRITE (15,820) F1(1,4), F1(1,5), (F1(1, TB3 305
1,IC), IC=1, NINHAI) TB3 310
      WRITE (15,830) TB3 315
      DO 640 ITO=1, IMAX TB3 320
      I=ITO TB3 325
      DO 10 IC=1,3 TB3 330
      IPD3(IC)=PD3(INDI(ITO,IC),IC)+.5 TB3 335
      TB3 340
      TB3 345

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IPD4(IC)=PD4(INDI(ITO,IC),IC)+.5
IPD5(IC)=PD5(INDI(ITO,IC),IC)+.5
10 CONTINUE
IT1=IPD3(1)+IPD4(1)+IPD5(1)
IT2=IPD3(2)+IPD4(2)+IPD5(2)
IT3=IPD3(3)+IPD4(3)+IPD5(3)
IF (IT1.NE.100) GO TO 40
20 CONTINUE
IF (IT2.NE.100) GO TO 50
30 CONTINUE
IF (IT3.NE.100) GO TO 60
GO TO 70
40 CONTINUE
MTEMP=MAX0(IPD3(1),IPD4(1),IPD5(1))
IF (MTEMP.EQ.IP3(1)) IP3(1)=IP3(1)+(100-IT1)
IF (MTEMP.EQ.IP4(1)) IP4(1)=IP4(1)+(100-IT1)
IF (MTEMP.EQ.IP5(1)) IP5(1)=IP5(1)+(100-IT1)
GO TO 20
50 CONTINUE
MTEMP=MAX0(IPD3(2),IPD4(2),IPD5(2))
IF (MTEMP.EQ.IP3(2)) IP3(2)=IP3(2)+(100-IT2)
IF (MTEMP.EQ.IP4(2)) IP4(2)=IP4(2)+(100-IT2)
IF (MTEMP.EQ.IP5(2)) IP5(2)=IP5(2)+(100-IT2)
GO TO 30
60 CONTINUE
MTEMP=MAX0(IPD3(3),IPD4(3),IPD5(3))
IF (MTEMP.EQ.IP3(3)) IP3(3)=IP3(3)+(100-IT3)
IF (MTEMP.EQ.IP4(3)) IP4(3)=IP4(3)+(100-IT3)
IF (MTEMP.EQ.IP5(3)) IP5(3)=IP5(3)+(100-IT3)
70 CONTINUE
C
C WRITE ORGAN NAMES
C
IF (IORAL.EQ.1.AND.NINHAL.EQ.1) WRITE (15,840) (TABL(I,1,K),K=1,5)
1, (TABL(I,4,K),K=1,5)
IF (IORAL.EQ.1.AND.NINHAL.EQ.2) WRITE (15,850) (TABL(I,1,K),K=1,5)
1, ((TABL(I,IC+3,K),K=1,5),IC=1,NINHAL)
IF (IORAL.EQ.1.AND.NINHAL.EQ.3) WRITE (15,860) (TABL(I,1,K),K=1,5)
1, ((TABL(I,IC+3,K),K=1,5),IC=1,NINHAL)
IF (IORAL.EQ.2.AND.NINHAL.EQ.1) WRITE (15,850) ((TABL(I,IC,K),K=1,5),
15),IC=1,IOBAL),(TABL(I,4,K),K=1,5)
IF (IORAL.EQ.2.AND.NINHAL.EQ.2) WRITE (15,860) ((TABL(I,IC,K),K=1,5),
15),IC=1,IOBAL),(TABL(I,IC+3,K),K=1,5),IC=1,NINHAL)
IF (IORAL.EQ.2.AND.NINHAL.EQ.3) WRITE (15,870) ((TABL(I,IC,K),K=1,5),
15),IC=1,IOBAL),(TABL(I,IC+3,K),K=1,5),IC=1,NINHAL)
DO 80 IN=1,132
LINE1(IN)=BLANK1
LINE2(IN)=BLANK1
LINE3(IN)=BLANK1
80 CONTINUE
ICODE=IOBAL+NINHAL-1
GO TO (90,150,290,490),ICODE
C
C 1 ORAL AND 1 INHALATION
C
90 CONTINUE
CALL CORE (LINE1,132)
WRITE (15,880) (TOTO(INDO(ITO,IC),IC),FN(ITO,IC),IC=1,IOBAL),(TOTO(
1(INDI(ITO,IC),IC),FN(ITO,IC+3),IC=1,NINHAL)
CALL CCRE (LINE2,132)
WRITE (15,890) WT(ITO,1),(IPD3(IC),IPD4(IC),IPD5(IC),IC=1,NINHAL)
CALL CCRE (LINE3,132)
WRITE (15,900) WI(ITO,4)
C
IF (TABL(I,1,1).NE.BLANK2) GO TO 110
DO 100 IN=70,29
LINE1(IN)=BLANK1
100 CONTINUE
110 CONTINUE
C
IF (TABL(I,4,1).NE.BLANK2) GO TO 140
DO 120 IN=34,43
LINE1(IN)=BLANK1
120 CONTINUE
DO 130 IN=31,43
LINE2(IN)=BLANK1
130 CONTINUE
140 CONTINUE
GO TO 630
C
C 1 ORAL AND 2 INHALATIONS OR 2 ORALS AND 1 INHALATION
C
150 CONTINUE
CALL CCRE (LINE1,132)
WRITE (15,910) (TOTO(INDO(ITO,IC),IC),FN(ITO,IC),IC=1,IOBAL),(TOTO(
1(INDI(ITO,IC),IC),FN(ITO,IC+3),IC=1,NINHAL)
CALL CCRE (LINE2,132)
IF (IORAL.EQ.1) WRITE (15,920) WT(ITO,1),(IPD3(IC),IPD4(IC),IPD5(IC),
1C),IC=1,NINHAL)
IF (IORAL.EQ.2) WRITE (15,930) (WT(ITO,IC),IC=1,IOBAL),(IPD3(IC),IPD4(IC),
IPD4(IC),IPD5(IC),IC=1,NINHAL)
CALL CCRE (LINE3,132)
IF (IORAL.EQ.1) WRITE (15,940) (WT(ITO,IC+3),IC=1,NINHAL)
IF (IORAL.EQ.2) WRITE (15,950) (WT(ITO,IC+3),IC=1,NINHAL)
IF (TABL(I,1,1).NE.BLANK2) GO TO 170
DO 160 IN=13,22

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LINE1(IN)=BLANK1
160 CONTINUE
170 CONTINUE
C
  IF (IORAL.EQ.1.AND.NINHAL.EQ.2) GO TO 190
  IF (TABL(I,2,1).NE.BLANK2) GO TO 190
  DO 180 IN=27,36
  LINE1(IN)=BLANK1
180 CONTINUE
190 CONTINUE
C
  IF (IORAL.EQ.2.AND.NINHAL.EQ.1) GO TO 220
  IF (TABL(I,4,1).NE.BLANK2) GO TO 220
  DO 200 IN=27,36
  LINE1(IN)=BLANK1
200 CONTINUE
  DO 210 IN=24,36
  LINE2(IN)=BLANK1
210 CONTINUE
220 CONTINUE
C
C
  IF (IORAL.EQ.1.AND.NINHAL.EQ.2) GO TO 250
  IF (TABL(I,4,1).NE.BLANK2) GO TO 250
  DO 230 IN=41,50
  LINE1(IN)=BLANK1
230 CONTINUE
  DO 240 IN=38,50
  LINE2(IN)=BLANK1
240 CONTINUE
250 CONTINUE
C
  IF (IORAL.EQ.2.AND.NINHAL.EQ.1) GO TO 280
  IF (TABL(I,5,1).NE.BLANK2) GO TO 280
  DO 260 IN=41,50
  LINE1(IN)=BLANK1
260 CONTINUE
  DO 270 IN=38,50
  LINE2(IN)=BLANK1
270 CONTINUE
280 CONTINUE
  GO TO 630
C
C 1 ORAL AND 3 INHALATIONS OR 2 ORALS AND 2 INHALATIONS
C
290 CONTINUE
  CALL CORE (LINE1,132)
  WRITE (15,960) (IOTO(INDO(ITO,IC),IC),FN(ITO,IC),IC=1,IORAL),(TOTITR31065
1 (INDI(ITO,IC),IC),FN(ITO,IC+3),IC=1,NINHAL)
  CALL CORE (LINE2,132)
  IF (IORAL.EQ.1) WRITE (15,970) WT(ITO,1),(IPD3(IC),IPD4(IC),IPD5(ITB31080
1C),IC=1,NINHAL)
  IF (IORAL.EQ.2) WRITE (15,980) (WT(ITO,IC),IC=1,IORAL),(IPD3(IC),ITB31090
1PD4(IC),IPD5(IC),IC=1,NINHAL)
  CALL CORE (LINE3,132)
  IF (IORAL.EQ.1) WRITE (15,990) (WT(ITO,IC+2),IC=1,NINHAL)
  IF (IORAL.EQ.2) WRITE (15,1000) (WT(ITO,IC+3),IC=1,NINHAL)
C
  IF (TABL(I,1,1).NE.BLANK2) GO TO 310
  DO 300 IN=6,15
  LINE1(IN)=BLANK1
300 CONTINUE
310 CONTINUE
C
  IF (IORAL.EQ.1.AND.NINHAL.EQ.3) GO TO 330
  IF (TABL(I,2,1).NE.BLANK2) GO TO 330
  DO 320 IN=20,29
  LINE1(IN)=BLANK1
320 CONTINUE
330 CONTINUE
C
  IF (IORAL.EQ.2.AND.NINHAL.EQ.2) GO TO 360
  IF (TABL(I,4,1).NE.BLANK2) GO TO 360
  DO 340 IN=20,29
  LINE1(IN)=BLANK1
340 CONTINUE
  DO 350 IN=17,29
  LINE2(IN)=BLANK1
350 CONTINUE
360 CONTINUE
C
  IF (IORAL.EQ.1.AND.NINHAL.EQ.3) GO TO 390
  IF (TABL(I,4,1).NE.BLANK2) GO TO 390
  DO 370 IN=34,43
  LINE1(IN)=BLANK1
370 CONTINUE
  DO 380 IN=31,43
  LINE2(IN)=BLANK1
380 CONTINUE
390 CONTINUE
C
  IF (IORAL.EQ.2.AND.NINHAL.EQ.2) GO TO 420
  IF (TABL(I,5,1).NE.BLANK2) GO TO 420
  DO 400 IN=34,43
  LINE1(IN)=BLANK1
400 CONTINUE

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TB3 830
TB3 835
TB3 840
TB3 845
TB3 850
TB3 855
TB3 860
TB3 865
TB3 870
TB3 875
TB3 880
TB3 885
TB3 890
TB3 895
TB3 900
TB3 905
TB3 910
TB3 915
TB3 920
TB3 925
TB3 930
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TB3 940
TB3 945
TB3 950
TB3 955
TB3 960
TB3 965
TB3 970
TB3 975
TB3 980
TB3 985
TB3 990
TB3 995
TB31000
TB31005
TB31010
TB31015
TB31020
TB31025
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TB31085
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TB31105
TB31110
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TB31120
TB31125
TB31130
TB31135
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TB31145
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TB31170
TB31175
TB31180
TB31185
TB31190
TB31195
TB31200
TB31205
TB31210
TB31215
TB31220
TB31225
TB31230
TB31235
TB31240
TB31245
TB31250
TB31255
TB31260
TB31265
TB31270
TB31275
TB31280
TB31285
TB31290
TB31295
TB31300
TB31305

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	DO 410 IN=31,43	
	LINE2(IN)=BLANK1	TB31315
410	CONTINUE	TB31320
420	CONTINUE	TB31325
C		TB31330
	IF (IORAL.EQ.1.AND.NINHAL.EQ.3) GO TO 450	TB31335
	IF (TAE1(I,5,1).NE.BLANK2) GO TO 450	TB31340
	DO 430 IN=48,57	TB31345
	LINE1(IN)=BLANK1	TB31350
430	CONTINUE	TB31355
	DO 440 IN=45,57	TB31360
	LINE2(IN)=BLANK1	TB31365
440	CONTINUE	TB31370
450	CONTINUE	TB31375
C		TB31380
	IF (IORAL.EQ.2.AND.NINHAL.EQ.2) GO TO 480	TB31385
	IF (TAE1(I,6,1).NE.BLANK2) GO TO 480	TB31390
	DO 460 IN=48,57	TB31395
	LINE1(IN)=BLANK1	TB31400
460	CONTINUE	TB31405
	DO 470 IN=45,57	TB31410
	LINE2(IN)=BLANK1	TB31415
470	CONTINUE	TB31420
480	CONTINUE	TB31425
	GO TO 630	TB31430
C		TB31435
	2 ORALS AND 3 INHALATIONS	TB31440
C		TB31445
490	CONTINUE	TB31450
	CALL CCR6 (LINE1,132)	TB31455
	WRITE (15,1010) (TOT0(IND0(ITO,IC),IC),FN(ITO,IC),IC=1,IORAL),(TOT1(IND1(ITO,IC),IC),FN(ITO,IC+3),IC=1,NINHAL)	TB31460
	CALL CCR6 (LINE2,132)	TB31465
	WRITE (15,1020) (WT(ITO,IC),IC=1,IORAL),(IPD3(IC),IPD4(IC),IPD5(IC	TB31470
	1),IC=1,NINHAL)	TB31475
	CALL CCR6 (LINE3,132)	TB31480
	WRITE (15,1030) (WT(ITO,IC+3),IC=1,NINHAL)	TB31485
C		TB31490
	IF (TAE1(I,1,1).NE.BLANK2) GO TO 510	TB31495
	DO 500 IN=2,11	TB31500
	LINE1(IN)=BLANK1	TB31505
500	CONTINUE	TB31510
510	CONTINUE	TB31515
C		TB31520
	IF (TAE1(I,2,1).NE.BLANK2) GO TO 530	TB31525
	DO 520 IN=16,25	TB31530
	LINE1(IN)=BLANK1	TB31535
520	CONTINUE	TB31540
530	CONTINUE	TB31545
C		TB31550
	IF (TAE1(I,4,1).NE.BLANK2) GO TO 560	TB31555
	DO 540 IN=30,39	TB31560
	LINE1(IN)=BLANK1	TB31565
540	CONTINUE	TB31570
	DO 550 IN=27,39	TB31575
	LINE2(IN)=BLANK1	TB31580
550	CONTINUE	TB31585
560	CONTINUE	TB31590
C		TB31595
	IF (TAE1(I,5,1).NE.BLANK2) GO TO 590	TB31600
	DO 570 IN=44,53	TB31605
	LINE1(IN)=BLANK1	TB31610
570	CONTINUE	TB31615
	DO 580 IN=41,53	TB31620
	LINE2(IN)=BLANK1	TB31625
580	CONTINUE	TB31630
590	CONTINUE	TB31635
C		TB31640
	IF (TAE1(I,6,1).NE.BLANK2) GO TO 620	TB31645
	DO 600 IN=58,67	TB31650
	LINE1(IN)=BLANK1	TB31655
600	CONTINUE	TB31660
	DO 610 IN=55,67	TB31665
	LINE2(IN)=BLANK1	TB31670
610	CONTINUE	TB31675
620	CONTINUE	TB31680
C		TB31685
	IF (TAE1(I,7,1).NE.BLANK2) GO TO 650	TB31690
	DO 630 IN=62,71	TB31695
	LINE1(IN)=BLANK1	TB31700
630	CONTINUE	TB31705
	DO 640 IN=59,71	TB31710
	LINE2(IN)=BLANK1	TB31715
640	CONTINUE	TB31720
C		TB31725
	RETURN	TB31730
C		TB31735
650	FORMAT ('1',4X,'COMMITTED DOSE EQUIVALENT IN TARGET ORGANS',' OR	TB31740
	1 ISSUES',' ',8X,'PER INTAKE OF UNIT ACTIVITY',' (Sv/Bq) OF ',A8)	TB31745
660	FORMAT ('1',7X,'COMMITTED DOSE EQUIVALENT IN TARGET ORGANS',' OR	TB31750
	1 ISSUES',' ',11X,'PER INTAKE OF UNIT ACTIVITY',' (Sv/Bq) OF ',A8)	TB31755
670	FORMAT ('0',20X,'ORAL',7X,'INHALATION','+',20X,4(' '),7X,10(' '))	TB31760
680	FORMAT ('0',13X,'ORAL',14X,'INHALATION','+',13X,4(' '),14X,10(' '))	TB31765
	1)	TB31770
690	FORMAT ('0',6X,'ORAL',21X,'INHALATION','+',6X,4(' '),21X,10(' '))	TB31775
700	FORMAT ('0',21X,'ORAL',13X,'INHALATION','+',21X,4(' '),13X,10(' '))	TB31780
	1)	TB31785

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710 FORMAT ('0',14X,'ORAL',20X,'INHALATION'/'+' ,14X,4(' '),20X,10(' ') TB31790
1) TB31795
720 FORMAT ('0',10X,'ORAL',27X,'INHALATION'/'+' ,10X,4(' '),27X,10(' ') TB31800
1) TB31805
730 FORMAT ('0',33X,'CLASS ',A1) TB31810
740 FORMAT ('0',26X,'CLASS ',A1,7X,'CLASS ',A1) TB31815
750 FORMAT ('0',19X,3('CLASS ',A1,7X)) TB31820
760 FORMAT ('0',40X,'CLASS ',A1) TB31825
770 FORMAT ('0',33X,'CLASS ',A1,7X,'CLASS ',A1) TB31830
780 FORMAT ('0',29X,3('CLASS ',A1,7X)) TB31835
790 FORMAT (' ',18X,'F1=' ,1PE6.0,5X,'F1=' ,E6.0) TB31840
800 FORMAT (' ',11X,'F1=' ,1PE6.0,5X,'F1=' ,E6.0,5X,'F1=' ,E6.0) TB31845
810 FORMAT (' ',4X,4('F1=' ,1PE6.0,5X)) TB31850
820 FORMAT (' ',5('F1=' ,1PE6.0,5X)) TB31855
830 FORMAT (' ') TB31860
840 FORMAT (' ',19X,5A2,4X,5A2) TB31865
850 FORMAT (' ',12X,3(5A2,4X)) TB31870
860 FORMAT (' ',5X,4(5A2,4X)) TB31875
870 FORMAT (' ',1X,5(5A2,4X)) TB31880
880 FORMAT (19X,1PE7.1,1X,A2,4X,E7.1,1X,A2) TB31885
890 FORMAT (20X,A8,3X,(' ',I2,' ',I3,' ',I3,' ') TB31890
900 FORMAT (34X,A8) TB31895
910 FORMAT (12X,3(1PE7.1,1X,A2,4X)) TB31900
920 FORMAT (13X,A8,3X,2(' ',I2,' ',I3,' ',I3,' '),2X)) TB31905
930 FORMAT (13X,A8,6X,A8,3X,1(' ',I2,' ',I3,' ',I3,' '),2X)) TB31910
940 FORMAT (27X,A8,6X,A8) TB31915
950 FORMAT (41X,A8) TB31920
960 FORMAT (5X,4(1PE7.1,1X,A2,4X)) TB31925
970 FORMAT (6X,A8,3X,3(' ',I2,' ',I3,' ',I3,' '),2X)) TB31930
980 FORMAT (6X,A8,6X,A8,3X,2(' ',I2,' ',I3,' ',I3,' '),2X)) TB31935
990 FORMAT (20X,3(A8,6X)) TB31940
1000 FORMAT (34X,2(A8,6X)) TB31945
1010 FORMAT (1X,5(1PE7.1,1X,A2,4X)) TB31950
1020 FORMAT (2X,A8,6X,A8,3X,3(' ',I2,' ',I3,' ',I3,' '),2X)) TB31955
1030 FORMAT (30X,3(A8,6X)) TB31960
1040 FORMAT (' ',132A1) TB31965
1050 FORMAT (' ',132A1) TB31970
END TB31975-

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SUBROUTINE TAB4 (ICLASS,TAG,IORAL,F1,NISO,TARG0,TOTI,TOTO,NTARG,PDTB4 5
13,PD4,PD5,ISORS,NORGP8,SORGO,NINHAL,UCI,ITH,STDOSE,SORG1,SEEREN) TB4 10
DIMENSION ITARG(33), TOTI(34,3), TOTO(34,3), F1(15,6), WCEI(34,3), TB4 15
1 WCEO(34,3), INDI(20,3), INDO(20,3), ISTOI(3), ISTUO(3), DACI(3) TB4 20
DIMENSION PD3(34,3), PD4(34,3), PD5(34,3), ISORS(20), ISWSEE(20) TB4 25
DIMENSION UCI(4,3,15,20,1), STDOSE(20,33,6), ITENF(20) TB4 30
DIMENSION INDOTH(11,3), INDITH(11,3), INAXI(3), INAXO(3), IHENO(11) TB4 35
1,3), IHENI(11,3), KRENO(3), KRENI(3) TB4 40
DIMENSION SEEREN(25,33) TB4 45
DIMENSION CORDOS(20,33,6) TB4 50
INTEGER*4 IN(20)/27,13,19,8,29,33,2,3,4,5,6,7,15,25,26,28,30,32,1/ TB4 55
REAL*4 XW(20)/0.25,0.15,0.12,0.12,0.03,0.03,14*0.06/ TB4 60
INTEGER*4 IT(25)/1,2,3,4,5,6,7,9,10,8,12,13,14,15,17,18,19,20,25,2/ TB4 65
16,27,29,31,0,32/ TB4 70
LOGICAL*1 ICLASS(15,3) TB4 75
REAL*8 TAG(15) TB4 80
REAL*8 WT(11,6) TB4 85
INTEGER*2 TARGO(34,5), SORGO(25,10), TABL(11,6,5) TB4 90
REAL*4 SORG1(25,3) TB4 95
C TB4 100
C TB4 105
C ICLASS(10,3) TB4 110
C ICLASS(I,J) - INHALATION CLASS FOR THE ITH RADIONUCLIDE TB4 115
C IN THE CHAIN, JTH INHALATION CLASS TB4 120
C TB4 125
C TAG(10) TB4 130
C TAG(I) - ATOMIC SYMBOL AND MASS NUMBER OF THE ITH TB4 135
C MEMBER OF THE CHAIN TB4 140
C TB4 145
C IORAL - NUMBER OF ORAL CASES TB4 150
C TB4 155
C F1(10,6) TB4 160
C F1(I,J) - THE F1 FOR THE ITH MEMBER OF THE CHAIN TB4 165
C FOR THE INHALATION (J=1,2,3) AND ORAL (J=4,5,6) CASES TB4 170
C TB4 175
C NTO - NUMBER OF TARGET ORGANS TO BE PRINTED IN TB4 180
C THE ICRP TABLES TB4 185
C TB4 190
C NISO - NUMBER OF RADIONUCLIDES IN THE CHAIN TB4 195
C TB4 200
C TORG(34) TB4 205
C TORG(I) - NAME OF THE ITH TARGET ORGAN TB4 210
C TB4 215
C ITARG(33) TB4 220
C ITARG(I) - INDEX OF THE ITH TARGET ORGAN TO BE TB4 225
C PRINTED IN THE ICRP TABLES TB4 230
C TB4 235
C TOTI(34,3) TB4 240
C TOTI(I,J) - TOTAL INHALATION DOSE FOR THE ITH ORGAN, TB4 245
C JTH INHALATION CLASS TB4 250
C TB4 255
C TOTO(34,3) TB4 260
C TOTO(I,J) - TOTAL ORAL DOSE FOR THE ITH ORGAN, TB4 265
C JTH ORAL CASE TB4 270
C

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C	NTARG - TOTAL NUMBER OF TARGET ORGANS	TR4 275
C		TB4 280
C		TB4 285
C	WCEI(34,3)	TB4 290
C	WCEI(I,J) - WEIGHTED EFFECTANCE FOR ORGAN I AND	TB4 295
C	THE JTH INHALATION CLASS. ORGANS ARE ORDERED	TB4 300
C	AS FOLLOWS: I=1 GONADS (14 OR 27)	TB4 305
C	2 MUSCLE (13)	TB4 310
C	3 RED MARROW (19)	TB4 315
C	4 LUNG (8)	TB4 320
C	5 THYROID (29)	TB4 325
C	6 BONE SURFACE (33)	TB4 330
C	7-20 INDICES OF OTHER ORGANS	TB4 335
C		TB4 340
C	WCEO(34,3)	TB4 345
C	WCEO(I,J) - WEIGHTED EFFECTANCE FOR ORGAN I,	TB4 350
C	JTH ORAL CASE. I DESCRIBED ABOVE IN WCEI.	TB4 355
C		TB4 360
C	INDI(20,3)	TB4 365
C	INDI(I,J) - INDEX OF ORGAN I FOR THE JTH	TB4 370
C	INHALATION CLASS. I DESCRIBED ABOVE IN WCEI.	TB4 375
C		TB4 380
C	INDO(20,3)	TB4 385
C	INDO(I,J) - INDEX ORGAN I FOR THE JTH ORAL CASE,	TB4 390
C	I DESCRIBED ABOVE IN WCEI.	TB4 395
C		TB4 400
C	IW(20)	TB4 405
C	IW(I) - INDEX OF THE ITH ORGAN AS ORDERED BY ICRP	TB4 410
C	SEE WCEI ABOVE.	TB4 415
C		TB4 420
C	XW(20)	TB4 425
C	XW(I) - WEIGHT OF THE ITH ORGAN CORRESPONDING TO	TB4 430
C	THE IW INDICES.	TB4 435
C		TB4 440
C	ISTOO(3), ISTOI(3)	TB4 445
C	ISTOO(I) - INDICATES FOR THE ITH ORAL CASE HOW	TB4 450
C	MANY ORGANS USED IN CALCULATING ALI	TB4 455
C	ISTOI(I) - INDICATES FOR THE ITH INHALATION CLASS	TB4 460
C	HOW MANY ORGANS USED IN CALCULATING ALI	TB4 465
C		TB4 470
C	ISWSEE(20)	TB4 475
C	ISWSEE(I) = 1 SOURCE ORGAN ISORS(I) CONTRIBUTES	TB4 480
C	AT LEAST 1% TO DOSE	TB4 485
C	ISWSEE(I) = 1 SOURCE ORGAN ISORS(I) DOES NOT	TB4 490
C	CONTRIBUTE AT LEAST 1% TO DOSE	TB4 495
C		TB4 500
C	INDOTH(11,3)	TB4 505
C	INDOTH(I,J) - TEMPORARY VALUES OF INDO FOR ORGAN I,	TB4 510
C	ORAL CLASS J. USED WHEN SORTING INDO INTO ICRP	TB4 515
C	SEQUENCE. (SEE IW).	TB4 520
C		TB4 525
C	INDITH(11,3)	TB4 530
C	INDITH(I,J) - TEMPORARY VALUES OF INDI FOR ORGAN I,	TB4 535
C	INHALATION CLASS J. USED WHEN SORTING INDI INTO ICRP	TB4 540
C	SEQUENCE. (SEE IW).	TB4 545
C		TB4 550
C	IMAXO(3)	TB4 555
C	IMAXO(I) - INDEX OF MAXIMUM WEIGHTED H50-T VALUE FOR	TB4 560
C	ORAL CLASS I.	TB4 565
C		TB4 570
C	IMAXI(3)	TB4 575
C	IMAXI(I) - INDEX OF MAXIMUM WEIGHTED H50-T VALUE FOR	TB4 580
C	INHALATION CLASS I.	TB4 585
C		TB4 590
C	IREMO(11,3)	TB4 595
C	IREMO(I,J) - SWITCH THAT TELLS IF ORGAN I FOR	TB4 600
C	ORAL CLASS J IS PART OF THE REMAINDER ORGAN	TB4 605
C		TB4 610
C	IREMI(11,3)	TB4 615
C	IREMI(I,J) - SWITCH THAT TELLS IF ORGAN I FOR	TB4 620
C	INHALATION CLASS J IS PART OF THE REMAINDER ORGAN.	TB4 625
C		TB4 630
C	KREMO(3)	TB4 635
C	KREMO(I) - CONTAINS THE NUMBER OF ORGANS THAT CONTRIBUTE	TB4 640
C	TO THE REMAINDER FOR ORAL CLASS I.	TB4 645
C		TB4 650
C	KREMI(3)	TB4 655
C	KREMI(I) - CONTAINS THE NUMBER OF ORGANS THAT CONTRIBUTE	TB4 660
C	TO THE REMAINDER FOR INHALATION CLASS I.	TB4 665
C		TB4 670
C		TB4 675
C	TARGET ORGANS IN THE ICRP MODEL AND THEIR INDICES	TB4 680
C	(STARS INDICATE RISK ORGANS)	TB4 685
C	1 BLAD WALL 15 PANCREAS	TB4 690
C	2 S WALL 19 R MARROW *	TB4 695
C	3 SI 25 SKIN	TB4 700
C	4 ULI WALL 26 SPLEEN	TB4 705
C	5 ILI WALL 27 TESTES *	TB4 710
C	6 KIDNEYS 28 THYMUS	TB4 715
C	7 LIVER 29 THYROID *	TB4 720
C	8 LUNGS * 30 UTERUS	TB4 725
C	13 MUSCLE * 32 ADRENALS	TB4 730
C	14 OVARIES * 33 BONE SURFACES	TB4 735
C		TB4 740
C	FORM THE WEIGHTED DOSE VALUES, WCEO AND WCEI, AND	TB4 745
C	THEIR CORRESPONDING INDEX VECTORS, INDO AND INDI	TB4 750

```

C
C      IW(1)=27
C
C      IF OVARIES HIGHER THAN TESTES FOR 1ST INHALATION CLASS,
C      USE OVARIES FOR ALL CASES
C
C      IF (TOTI(14,1).GT.TOTI(27,1)) IW(1)=14
C      DO 10 I=1,6
C      DO 10 IC=1,3
C      INDO(I,IC)=IW(I)
C      INDI(I,IC)=IW(I)
C      10 CONTINUE
C
C      MULTIPLY GONADS, MUSCLE, RED MARROW, LUNGS, THYROID, AND
C      BONE SURFACES BY APPROPRIATE WEIGHTING FACTORS
C
C      DO 20 I=1,6
C      DO 20 IC=1,3
C      WCEO(I,IC)=XW(I)*TOTO(IW(I),IC)
C      WCEI(I,IC)=XW(I)*TOTI(IW(I),IC)
C      20 CONTINUE
C
C      PLACE REMAINING WEIGHTED DOSE VALUES IN WCEO AND
C      WCEI AND FILL INDC AND INDI
C
C      DO 40 IC=1,3
C      KNT=0
C      DO 40 ITA=1,NTARG
C      IF (ITA.EQ.27.OR.ITA.EQ.14.OR.ITA.EQ.12.OR.ITA.EQ.19.OR.ITA.EQ.19.OR.ITA.EQ.0.OTD4
C      1R.ITA.EQ.29.OR.ITA.EQ.33) GO TO 30
C
C      ALSO ELIMINATE THE FOLLOWING ORGANS:
C      9  SAL CLND      17  COR BONE      22  COR E CL
C      10  TB REG       18  CAN BONE      23  CAN E CL
C      11  P REG        20  Y MARROW      24  T E CL
C      12  LYMEH        21  T MARROW      31  T BODY
C      16  BONE
C
C      IF ((ITA.GE.9.AND.ITA.LE.12).OR.(ITA.GE.16.AND.ITA.LE.18).OR.(ITA
C      1GE.20.AND.ITA.LE.24).OR.ITA.EQ.31) GO TO 30
C      KNT=KNT+1
C      WCEO(KNT+6,IC)=XW(KNT+6)*TOTO(ITA,IC)
C      INDO(KNT+6,IC)=ITA
C      WCEI(KNT+6,IC)=XW(KNT+6)*TOTI(ITA,IC)
C      INDI(KNT+6,IC)=ITA
C      30 CONTINUE
C      40 CONTINUE
C      KNT=KNT+6
C
C      SORT THE WEIGHTED H50-T VALUES FROM MAXIMUM TO MINIMUM
C
C      CALL SORT (WCEO,KNT,IOBAL,INDO)
C      CALL SORT (WCEI,KNT,NINHAL,INDI)
C      DO 50 IC=1,NINHAL
C      WRITE (6,530) (INDI(ITO,IC),ITO=1,KNT)
C      50 CONTINUE
C      DO 60 IC=1,IOBAL
C      WRITE (6,530) (INDO(ITO,IC),ITO=1,KNT)
C      60 CONTINUE
C
C      ELIMINATE ALL WEIGHTED VALUES WHICH ARE NOT 10% OF THE
C      MAXIMUM WEIGHTED H50-T
C
C      DO 80 IC=1,3
C      ISTOO(IC)=1
C      ISTOI(IC)=1
C      IMAXO(IC)=INDO(1,IC)
C      IMAXI(IC)=INDI(1,IC)
C      DO 70 I=2,KNT
C      IF (WCEO(I,IC).LT.0.1*WCEO(1,IC)) GO TO 70
C      ISTOO(IC)=I
C      70 CONTINUE
C      IF (WCEI(I,IC).LT.0.1*WCEI(1,IC)) GO TO 80
C      ISTOI(IC)=I
C      80 CONTINUE
C      WRITE (6,530) (ISTOI(IC),IC=1,NINHAL)
C      WRITE (6,530) (ISTOO(IC),IC=1,IOBAL)
C
C      THERE CAN BE ONLY 5 ORGANS OTHER THAN THE 6 RISK ORGANS
C
C      DO 110 IC=1,IOBAL
C      KNTR=0
C      ITA=1
C      90 CONTINUE
C      IF (INDO(ITA,IC).EQ.27.OR.INDO(ITA,IC).EQ.14.OR.INDO(ITA,IC).EQ.13
C      1.OR.INDO(ITA,IC).EQ.19.OR.INDO(ITA,IC).EQ.8.OR.INDO(ITA,IC).EQ.29
C      2.OR.INDO(ITA,IC).EQ.33) GO TO 100
C      KNTR=KNTR+1
C      IF (KNTR.LE.5) GO TO 100
C      CALL RESORT (INDO,ITA,IC,KNTR)
C      ISTOO(IC)=ISTOO(IC)-1
C      ITA=ITA-1
C      100 CONTINUE
C      ITA=ITA+1
C      IF (ITA.GT.ISTOO(IC)) GO TO 110
C      GO TO 90

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110 CONTINUE                                TB4 1235
    DO 140 IC=1,NINHAL                      TB4 1240
        KNTR=0                              TB4 1245
        ITA=1                              TB4 1250
120 CONTINUE                                TB4 1255
    IF (INDI(ITA,IC).EQ.27.OR.INDI(ITA,IC).EQ.14.OR.INDI(ITA,IC).EQ.13)TB4 1260
    1.OR.INCI(ITA,IC).EQ.19.OR.INDI(ITA,IC).EQ.8.OR.INDI(ITA,IC).EQ.29.TB4 1265
    2OR.INDI(ITA,IC).EQ.33) GO TO 130        TB4 1270
    KNTR=KNTR+1                             TB4 1275
    IF (KNTR.LE.5) GO TO 130                TB4 1280
    CALL RESORT (INDI,ITA,IC,KNT)           TB4 1285
    ISTOI(IC)=ISTOI(IC)-1                  TB4 1290
    ITA=ITA-1                              TB4 1295
130 CONTINUE                                TB4 1300
    ITA=ITA+1                              TB4 1305
    IF (ITA.GT.ISTOI(IC)) GO TO 140        TB4 1310
    GO TO 120                              TB4 1315
140 CONTINUE                                TB4 1320
    WRITE (6,530) (ISTOI(IC),IC=1,NINHAL)   TB4 1325
    WRITE (6,530) (ISTOO(IC),IC=1,IOBAL)    TB4 1330
C                                            TB4 1335
C NOW ELIMINATE SOURCE ORGANS WHICH DO NOT CONTRIBUTE TB4 1340
C AT LEAST 1% TO THE DOSE                  TB4 1345
C ISWSEE AND ISORS ARE IN 1 TO 1 CORRESPONDENCE TB4 1350
C IE. IF ISWSEE=1, ISORS(I) CONTRIBUTES AT LEAST 1% TB4 1355
C TO THE DOSE; OTHERWISE ISWSEE(I)=0      TB4 1360
C                                           TB4 1365
    DO 150 ISO=1,NORGP8                    TB4 1370
        ISWSEE(ISO)=0                      TB4 1375
150 CONTINUE                                TB4 1380
    DO 160 ISO=1,NORGP8                    TB4 1385
    DO 160 ITO=1,NTARG                     TB4 1390
    DO 160 ICL=1,6                         TB4 1395
        SUMDOS(ISO,ITO,ICL)=0.            TB4 1400
160 CONTINUE                                TB4 1405
    REWIND 20                              TB4 1410
    DO 190 ID=1,NISO                       TB4 1415
C                                           TB4 1420
C READ STDSE FROM DISK FOR EACH RADIONUCLIDE TB4 1425
C                                           TB4 1430
    DO 180 ICL=1,6                         TB4 1435
    DO 180 ITO=1,NTARG                     TB4 1440
        READ (20) (STDSE(ISO,ITO,ICL),ISO=1,NORGP8) TB4 1445
    DO 170 ISO=1,NORGP8                   TB4 1450
        SUMDOS(ISO,ITO,ICL)=SUMDOS(ISO,ITO,ICL)+STDSE(ISO,ITO,ICL) TB4 1455
170 CONTINUE                                TB4 1460
180 CONTINUE                                TB4 1465
190 CONTINUE                                TB4 1470
C                                           TB4 1475
    DO 210 IC=1,IOBAL                      TB4 1480
        INDEX=ISTOO(IC)                   TB4 1485
    DO 200 ITO=1,INDEX                     TB4 1490
    DO 200 ISO=5,NORGP8                    TB4 1495
        IF (ISORS(ISO).EQ.8) GO TO 200    TB4 1500
        IF (ISWSEE(ISO).EQ.1) GO TO 200  TB4 1505
        IF (SUMDOS(ISO,INDO(ITO,IC),IC).GE.0.01*TOTO(INDO(ITO,IC),IC)) ISWBTB4 1510
        1SEE(ISO)=1                      TB4 1515
        WRITE (6,540) ISO,INDO(ITO,IC),SUMDOS(ISO,INDO(ITO,IC),IC),TOTO(INTB4 1520
        1DO(ITO,IC),IC)                 TB4 1525
200 CONTINUE                                TB4 1530
210 CONTINUE                                TB4 1535
    DO 230 IC=1,NINHAL                      TB4 1540
        INDEX=ISTOI(IC)                   TB4 1545
    DO 220 ITO=1,INDEX                     TB4 1550
    DO 220 ISO=1,NORGP8                    TB4 1555
        IF (ISUMS(ISO).EQ.8) GO TO 220    TB4 1560
        IF (ISWSEE(ISO).EQ.1) GO TO 220  TB4 1565
        IF (SUMDOS(ISO,INDI(ITO,IC),IC+3).GE.0.01*TOTI(INDI(ITO,IC),IC)) ITB4 1570
        1SWSEE(ISO)=1                      TB4 1575
        WRITE (6,540) ISO,INDI(ITO,IC),SUMDOS(ISO,INDI(ITO,IC),IC+3),TOTI(TB4 1580
        1INDI(ITO,IC),IC)                 TB4 1585
220 CONTINUE                                TB4 1590
230 CONTINUE                                TB4 1595
        IF (ISWSEE(3).EQ.1) ISWSEE(2)=1  TB4 1600
        IF (ISWSEE(3).EQ.1) ISWSEE(4)=1  TB4 1605
        WRITE (6,530) (ISWSEE(ISO),ISO=1,NORGP8) TB4 1610
C                                           TB4 1615
C SORT ORGAN SO THAT THE ORDER IS:        TB4 1620
C 27 OR 14 GONADS 6 KIDNEYS              TB4 1625
C 13 MUSCLE 7 LIVER                      TB4 1630
C 19 B MARROW 15 PANCREAS                 TB4 1635
C 8 LUNGS 25 SKIN                        TB4 1640
C 29 THYROID 26 SPLEEN                   TB4 1645
C 33 BONE SURF 28 THYMUS                  TB4 1650
C 2 S WALL 30 UTERUS                     TB4 1655
C 3 SI 32 ADRENALS                       TB4 1660
C 4 OLI WALL 1 BLAD WALL                  TB4 1665
C 5 LLI WALL                             TB4 1670
C                                           TB4 1675
C ALSO RECALCULATE DOSE VALUES AND WEIGHTED DOSE VALUES TB4 1680
C                                           TB4 1685
C ZERO TOTO,TOTI,WCEO,WCEI BEFORE RECALCULATION OF DOSE TB4 1690
C AND WEIGHTED DOSE VALUES              TB4 1695
    DO 240 ITO=1,34                       TB4 1700
    DO 240 IC=1,3                          TB4 1705
        TOTO(ITO,IC)=0.                  TB4 1710

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      TOTI(ITC,IC)=0.
      WCEC(ITC,IC)=0.
      WCEI(ITO,IC)=0.
240  CONTINUE
C
      REWIND 20
      DO 340 ID=1,NISO
C
      DO 250 ICL=1,6
      DO 250 ITO=1,NTARG
      READ (20) (STDCSE(ISO,ITO,ICL),ISO=1,NORGP8)
250  CONTINUE
C
      DO 290 IC=1,IORAL
      INDEX=ISTOO(IC)
      KNTR=0
      DO 280 ITO=1,KNT
      DO 270 I=1,INDEX
      IF (INDO(I,IC).NE.IW(ITO)) GO TO 270
C  FORN DOSE VALUES AND WEIGHTED DOSE VALUES
      KNTR=KNTR+1
      INDOTH(KNTR,IC)=INDO(I,IC)
      SUM=0.
      SUMW=0.
      DO 260 ISO=1,NORGP8
      IF (ISCRS(ISO).EQ.8) GO TO 260
      IF (ISWSEE(ISO).EQ.0) GO TO 260
      SUM=SUM+STDSE(ISO,INDO(I,IC),IC)
      SUMW=SUMW+STDSE(ISO,INDO(I,IC),IC)*XW(ITO)
260  CONTINUE
      TOTO(INDCTN(KNTR,IC),IC)=TOTO(INDOTH(KNTR,IC),IC)+SUM
      WCEO(INDCTN(KNTR,IC),IC)=WCEO(INDOTH(KNTR,IC),IC)+SUMW
270  CONTINUE
280  CONTINUE
290  CONTINUE
      DO 330 IC=1,NINHAL
      INDEX=ISTOI(IC)
      KNTR=0
      DO 320 ITO=1,KNT
      DO 310 I=1,INDEX
      IF (INDI(I,IC).NE.IW(ITO)) GO TO 310
C  FORN DOSE VALUES AND WEIGHTED DOSE VALUES
      KNTR=KNTR+1
      INDITH(KNTR,IC)=INDI(I,IC)
      SUM=0.
      SUMW=0.
      DO 300 ISO=1,NORGP8
      IF (ISCRS(ISO).EQ.8) GO TO 300
      IF (ISWSEE(ISO).EQ.0) GO TO 300
      SUM=SUM+STDSE(ISO,INDI(I,IC),IC+3)
      SUMW=SUMW+STDSE(ISO,INDI(I,IC),IC+3)*XW(ITO)
300  CONTINUE
      TOTI(INDITH(KNTR,IC),IC)=TOTI(INDITH(KNTR,IC),IC)+SUM
      WCEI(INDITH(KNTR,IC),IC)=WCEI(INDITH(KNTR,IC),IC)+SUMW
310  CONTINUE
320  CONTINUE
330  CONTINUE
340  CONTINUE
C
C  REPLACE INDO AND INDI WITH INDOTH AND INDITH
C
      DO 350 IC=1,IORAL
      INDEX=ISTOO(IC)
      WRITE (6,550) INDEX
      DO 350 ITO=1,INDEX
      INDO(ITO,IC)=INDOTH(ITO,IC)
      WRITE (6,560) TOTO(INDO(ITO,IC),IC),WCEO(INDO(ITO,IC),IC)
      WRITE (6,530) ITO,INDO(ITO,IC)
350  CONTINUE
      DO 360 IC=1,NINHAL
      INDEX=ISTOI(IC)
      WRITE (6,550) INDEX
      DO 360 ITO=1,INDEX
      INDI(ITO,IC)=INDITH(ITO,IC)
      WRITE (6,530) ITO,INDI(ITO,IC)
      WRITE (6,560) TOTI(INDI(ITO,IC),IC),WCEI(INDI(ITO,IC),IC)
360  CONTINUE
C
C  FIND LENGTH OF TABLE FOR SEE VALUES - NTO
C  AND THE CUMULATIVE LIST OF TARGET ORGANS - ITARG
C
      CALL MAXTAB (ISTOI,ISTOO,INDI,INDO,IORAL,NINHAL,NTO,ITARG)
      WRITE (6,550) NTO
      WRITE (6,530) (ITARG(ITO),ITO=1,NTO)
C
C  DETERMINE THE NUMBER OF RADIONUCLIDES IN THE CHAIN
C
      IF (NISO.EQ.1) GO TO 370
      CALL CHNLEN (ISTOI,ISTOO,INDI,INDO,IORAL,NINHAL,NISO)
370  CONTINUE
C
C  WRITE SEE TABLE
C
      CALL TABO (ISWSEE,ISCRS,NORGP8,TAG,SORGO,NISO,NTARG,ITARG,NTO,TARG,
10,ITENF,IKOUNT,IW,SEEREN)

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TB4 1715
 TB4 1720
 TB4 1725
 TB4 1730
 TB4 1735
 TB4 1740
 TB4 1745
 TB4 1750
 TB4 1755
 TB4 1760
 TB4 1765
 TB4 1770
 TB4 1775
 TB4 1780
 TB4 1785
 TB4 1790
 TB4 1795
 TB4 1800
 TB4 1805
 TB4 1810
 TB4 1815
 TB4 1820
 TB4 1825
 TB4 1830
 TB4 1835
 TB4 1840
 TB4 1845
 TB4 1850
 TB4 1855
 TB4 1860
 TB4 1865
 TB4 1870
 TB4 1875
 TB4 1880
 TB4 1885
 TB4 1890
 TB4 1895
 TB4 1900
 TB4 1905
 TB4 1910
 TB4 1915
 TB4 1920
 TB4 1925
 TB4 1930
 TB4 1935
 TB4 1940
 TB4 1945
 TB4 1950
 TB4 1955
 TB4 1960
 TB4 1965
 TB4 1970
 TB4 1975
 TB4 1980
 TB4 1985
 TB4 1990
 TB4 1995
 TB4 2000
 TB4 2005
 TB4 2010
 TB4 2015
 TB4 2020
 TB4 2025
 TB4 2030
 TB4 2035
 TB4 2040
 TB4 2045
 TB4 2050
 TB4 2055
 TB4 2060
 TB4 2065
 TB4 2070
 TB4 2075
 TB4 2080
 TB4 2085
 TB4 2090
 TB4 2095
 TB4 2100
 TB4 2105
 TB4 2110
 TB4 2115
 TB4 2120
 TB4 2125
 TB4 2130
 TB4 2135
 TB4 2140
 TB4 2145
 TB4 2150
 TB4 2155
 TB4 2160
 TB4 2165
 TB4 2170
 TB4 2175
 TB4 2180
 TB4 2185
 TB4 2190

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C                                     TB42195
C WRITE NUMBER OF NUCLEAR TRANSFORMATIONS TABLE ) TB42200
C                                     TB42205
C CALL TAB1 (ICLASS,TAG,UCI,NISO,F1,IOBAL,ITN,ISORS,SORG1,ITENP,IKOUTB42210
C 1NT,NORGP8,NINHAL) TB42215
C                                     TB42220
C DETERMINE REMAINDER ORGAN TB42225
C FORM MATRIX OF SWITCHES WHICH TELL IF VALUE IS PART TB42230
C OF THE REMAINDER ORGAN TB42235
C IREMC(ITO,IC) OR IREMI(ITO,IC)=1 ORGAN IS PART OF TB42240
C REMAINDER ORGAN TB42245
C =0 ORGAN IS NOT PART TB42250
C OF THE REMAINDER TB42255
C AN ORGAN IS NOT PART OF THE REMAINDER IF IT IS TB42260
C (1) A RISK ORGAN TB42265
C (2) PART OF THE METABOLIC MODEL TB42270
C                                     TB42275
C DO 380 ITO=1,11 TB42280
C DO 380 IC=1,3 TB42285
C IREMI(ITO,IC)=1 TB42290
C IREMO(ITO,IC)=1 TB42295
C 380 CONTINUE TB42300
C DO 420 IC=1,NINHAL TB42305
C INDEX=ISTOI(IC) TB42310
C KREMI(IC)=0 TB42315
C DO 420 ITO=1,INDEX TB42320
C DO 390 I=1,6 TB42325
C IF (INDI(ITO,IC).EQ.IW(I)) GO TO 410 TB42330
C 390 CONTINUE TB42335
C DO 400 I=1,NORGP8 TB42340
C IF (INDI(ITO,IC).EQ.IT(ISORS(I))) GO TO 410 TB42345
C 400 CONTINUE TB42350
C KREMI(IC)=KREMI(IC)+1 TB42355
C GO TO 420 TB42360
C 410 CONTINUE TB42365
C IREMI(ITO,IC)=0 TB42370
C 420 CONTINUE TB42375
C DO 460 IC=1,IOBAL TB42380
C INDEX=ISTOO(IC) TB42385
C KREMO(IC)=0 TB42390
C DO 460 ITO=1,INDEX TB42395
C DO 430 I=1,6 TB42400
C IF (INDO(ITO,IC).EQ.IW(I)) GO TO 450 TB42405
C 430 CONTINUE TB42410
C DO 440 I=1,NORGP8 TB42415
C IF (INDO(ITO,IC).EQ.IT(ISORS(I))) GO TO 450 TB42420
C 440 CONTINUE TB42425
C KREMO(IC)=KREMO(IC)+1 TB42430
C GO TO 460 TB42435
C 450 CONTINUE TB42440
C IREMO(ITO,IC)=0 TB42445
C 460 CONTINUE TB42450
C                                     TB42455
C DETERMINE REMAINDER VALUE AND WEIGHTED REMAINDER VALUE TB42460
C ASSIGN AN ORGAN INDEX OF 34 TO THE REMAINDER TB42465
C                                     TB42470
C SORT TOTI, INDI, AND IREMI ARRAYS SO THAT ALL THE 1'S TB42475
C ARE AT THE BOTTOM OF THE IREMI ARRAY TB42480
C                                     TB42485
C DO 490 IC=1,NINHAL TB42490
C INDEX=ISTOI(IC) TB42495
C IF (KREMI(IC).EQ.0) GO TO 490 TB42500
C CALL SCRT01 (INDI,IREMI,IC,ISTOI(IC)) TB42505
C                                     TB42510
C FIND THE MAXIMUM REMAINDER TB42515
C                                     TB42520
C KNT=INDEX-KREMI(IC)+1 TB42525
C IKT=KNT TB42530
C XMAX=TOTI(INDI(KNT,IC),IC) TB42535
C IF (KNT.EQ.ISTOI(IC)) GO TO 480 TB42540
C KNT=KNT+1 TB42545
C DO 470 K=KNT,INDEX TB42550
C IF (TOTI(INDI(K,IC),IC).LE.XMAX) GO TO 470 TB42555
C XMAX=TOTI(INDI(K,IC),IC) TB42560
C IKT=K TB42565
C 470 CONTINUE TB42570
C KNT=KNT-1 TB42575
C 480 CONTINUE TB42580
C TOTI(34,IC)=XMAX TB42585
C WCEI(34,IC)=XMAX*0.06*KREMI(IC) TB42590
C ISTOI(IC)=KNT TB42595
C PD3(34,IC)=PD3(INDI(IKT,IC),IC) TB42600
C PD4(34,IC)=PD4(INDI(IKT,IC),IC) TB42605
C PD5(34,IC)=PD5(INDI(IKT,IC),IC) TB42610
C INDI(KNT,IC)=34 TB42615
C 490 CONTINUE TB42620
C                                     TB42625
C SORT TOTO, INDO, AND IRENO ARRAYS SO THAT ALL THE 1'S TB42630
C ARE AT THE BOTTOM OF THE IRENO ARRAY TB42635
C                                     TB42640
C DO 520 IC=1,IOBAL TB42645
C INDEX=ISTOO(IC) TB42650
C IF (KREMO(IC).EQ.0) GO TO 520 TB42655
C CALL SCRT01 (TND0,IRENO,IC,ISTOO(IC)) TB42660
C                                     TB42665
C FIND THE MAXIMUM REMAINDER TB42670

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C      KNT=INDEX-KREMO(IC)+1
      XMAX=TCO(INDO(KNT,IC),IC)
      IF (KNT.EQ.ISTOO(IC)) GO TO 510
      KNT=KNT+1
      DO 500 K=KNT,INDEX
      IF (TOTO(INDO(K,IC),IC).GT.XMAX) XMAX=TOTO(INDO(K,IC),IC)
500  CONTINUE
      KNT=KNT-1
510  CONTINUE
      INDO(KNT,IC)=34
      TOTO(34,IC)=XMAX
      WCEO(34,IC)=XMAX*0.06*KREMO(IC)
      ISTOO(IC)=KNT
520  CONTINUE

C      WRITE DOSE TABLE AND WEIGHTED DOSE TABL
C      DETERMINE ARRANGEMENT OF FOOTNOTES IN H50-T AND
C      H50-WT TABLES
C      CALL FOOTNT (INDI,INDO,IORAL,ISORS,NORGP8,NINHAL,INAXI,INAXO,ISTOIT
1,ISTOO)
C      DETERMINE MATRIX OF WT VALUES
C      CALL WEIGHT (WT,ISTOI,ISTOO,KRENI,KRENO,IORAL,NINHAL)
C      FIND THE MAXIMUM LENGTH OF THE H50-W AND H50 WT TABLES
C      CALL ORGTBL (TABL,NINHAL,IORAL,ISTOI,ISTOO,INDI,INDO,TARGO,INAX)
C      WRITE H50-T TABLE (DOSE COMMITMENT)
C      CALL TAB3 (ICLASS,TAG,IORAL,F1,IMAX,PD3,PD4,PD5,TABL,TOTI,TOTO,INDT
1I,INDO,NINHAL,WT)
C      WRITE WEIGHTED H50-T TABLE
C      CALL TAB5 (WCEI,WCEO,ICLASS,IORAL,TAG,F1,TABL,INAX,NINHAL,INDI,INDT
1O)
C      CALCULATE ALI AND WRITE
C      CALL TAB6 (IORAL,NINHAL,ISTOO,ISTOI,TOTO,TOTI,INDO,INDI,WCEO,WCEI,
1TARGO,TAG,ICLASS,F1)
C      RETURN
530  FORMAT (' ',20I3)
540  FORMAT (' ',2I3,1P2E9.2)
550  FORMAT ('O',13)
560  FORMAT (' ',1P2E11.3)
      END

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      SUBROUTINE TAB5 (WCEI,WCEO,ICLASS,IORAL,TAG,F1,TABL,INAX,NINHAL,INTB5 5
1DI,INDO)
      TB5 10
C      WRITE TABLE OF WEIGHTED DOSE COMMITMENT
C      DIMENSION F1(15,6), WCEI(34,3), WCEO(34,3)
      TB5 15
      DIMENSION INDO(20,3), INDI(20,3)
      TB5 20
      REAL*8 TAG(15)
      TB5 25
      INTEGER*2 TABL(11,6,5), BLANK1/' '/
      TB5 30
      INTEGER*2 FN(11,6)
      TB5 35
      LOGICAL*1 ICLASS(15,3), LINE1(132)
      TB5 40
      COMMON /FTNT/ FN
      TB5 45
      LOGICAL*1 BLANK1/' '/
      TB5 50
      IF (IORAL.EQ.1) WRITE (15,450) TAG(1)
      TB5 55
      IF (IORAL.EQ.2.AND.(NINHAL.EQ.1.OR.NINHAL.EQ.2)) WRITE (15,450) TATB5 60
1G(1)
      TB5 65
      IF (IORAL.EQ.2.AND.NINHAL.EQ.3) WRITE (15,460) TAG(1)
      TB5 70
C      ORAL OR INHALATION LINK
C      IF (IORAL.EQ.1.AND.NINHAL.EQ.1) WRITE (15,470)
      TB5 75
      IF (IORAL.EQ.1.AND.NINHAL.EQ.2) WRITE (15,480)
      TB5 80
      IF (IORAL.EQ.1.AND.NINHAL.EQ.3) WRITE (15,490)
      TB5 85
      IF (IORAL.EQ.2.AND.NINHAL.EQ.1) WRITE (15,500)
      TB5 90
      IF (IORAL.EQ.2.AND.NINHAL.EQ.2) WRITE (15,510)
      TB5 95
      IF (IORAL.EQ.2.AND.NINHAL.EQ.3) WRITE (15,520)
      TB5 100
C      CLASS LINK
C      IF (IORAL.EQ.1.AND.NINHAL.EQ.1) WRITE (15,530) (ICLASS(1,IC),IC=1,TB5 105
1NINHAL)
      TB5 110
      IF (IORAL.EQ.1.AND.NINHAL.EQ.2) WRITE (15,540) (ICLASS(1,IC),IC=1,TB5 115
1NINHAL)
      TB5 120
      IF (IORAL.EQ.1.AND.NINHAL.EQ.3) WRITE (15,550) (ICLASS(1,IC),IC=1,TB5 125
1NINHAL)
      TB5 130
      IF (IORAL.EQ.2.AND.NINHAL.EQ.1) WRITE (15,560) (ICLASS(1,IC),IC=1,TB5 135
1NINHAL)
      TB5 140
      TB5 145
      TB5 150
      TB5 155
      TB5 160
      TB5 165
      TB5 170
      TB5 175
      TB5 180
      TB5 185

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C                                     TB5 670
      IF (IORAL.EQ.2.AND.NINHAL.EQ.1) GO TO 160      TB5 675
      IF (TABL(I,5,1).NE.BLANK2) GO TO 160          TB5 680
      DO 150 IN=41,50                                TB5 685
      LINE1(IN)=BLANK1                                TB5 690
150  CONTINUE                                         TB5 695
160  CONTINUE                                         TB5 700
      GO TO 430                                       TB5 705
C                                     TB5 710
C 1 ORAL AND 3 INHALATIONS OR 2 ORALS AND 2 INHALATIONS TB5 715
C                                     TB5 720
      170 CONTINUE                                    TB5 725
      CALL CORE (LINE1,132)                          TB5 730
      WRITE (15,690) (WCEO(INDO(ITO,IC),IC),PN(ITO,IC),IC=1,IORAL),(WCEITB5 735
      1 (INDI(ITO,IC),IC),PN(ITO,IC+3),IC=1,NINHAL)   TB5 740
C                                     TB5 745
      IF (TABL(I,1,1).NE.BLANK2) GO TO 190          TB5 750
      DO 180 IN=6,15                                  TB5 755
      LINE1(IN)=BLANK1                                TB5 760
180  CONTINUE                                         TB5 765
190  CONTINUE                                         TB5 770
C                                     TB5 775
      IF (IORAL.EQ.1.AND.NINHAL.EQ.3) GO TO 210      TB5 780
      IF (TABL(I,2,1).NE.BLANK2) GO TO 210          TB5 785
      DO 200 IN=20,29                                TB5 790
      LINE1(IN)=BLANK1                                TB5 795
200  CONTINUE                                         TB5 800
210  CONTINUE                                         TB5 805
C                                     TB5 810
      IF (IORAL.EQ.2.AND.NINHAL.EQ.2) GO TO 230      TB5 815
      IF (TABL(I,4,1).NE.BLANK2) GO TO 230          TB5 820
      DO 220 IN=20,29                                TB5 825
      LINE1(IN)=BLANK1                                TB5 830
220  CONTINUE                                         TB5 835
230  CONTINUE                                         TB5 840
C                                     TB5 845
      IF (IORAL.EQ.1.AND.NINHAL.EQ.3) GO TO 250      TB5 850
      IF (TABL(I,4,1).NE.BLANK2) GO TO 250          TB5 855
      DO 240 IN=34,43                                  TB5 860
      LINE1(IN)=BLANK1                                TB5 865
240  CONTINUE                                         TB5 870
250  CONTINUE                                         TB5 875
C                                     TB5 880
      IF (IORAL.EQ.2.AND.NINHAL.EQ.2) GO TO 270      TB5 885
      IF (TABL(I,5,1).NE.BLANK2) GO TO 270          TB5 890
      DO 260 IN=34,43                                  TB5 895
      LINE1(IN)=BLANK1                                TB5 900
260  CONTINUE                                         TB5 905
270  CONTINUE                                         TB5 910
C                                     TB5 915
      IF (IORAL.EQ.1.AND.NINHAL.EQ.3) GO TO 290      TB5 920
      IF (TABL(I,5,1).NE.BLANK2) GO TO 290          TB5 925
      DO 280 IN=48,57                                  TB5 930
      LINE1(IN)=BLANK1                                TB5 935
280  CONTINUE                                         TB5 940
290  CONTINUE                                         TB5 945
C                                     TB5 950
      IF (IORAL.EQ.2.AND.NINHAL.EQ.2) GO TO 310      TB5 955
      IF (TABL(I,6,1).NE.BLANK2) GO TO 310          TB5 960
      DO 300 IN=48,57                                  TB5 965
      LINE1(IN)=BLANK1                                TB5 970
300  CONTINUE                                         TB5 975
310  CONTINUE                                         TB5 980
      GO TO 430                                       TB5 985
C                                     TB5 990
C 2 ORALS AND 3 INHALATIONS                        TB5 995
C                                     TB5 1000
      320 CONTINUE                                    TB5 1005
      CALL CORE (LINE1,132)                          TB5 1010
      WRITE (15,700) (WCEO(INDO(ITO,IC),IC),PN(ITO,IC),IC=1,IORAL),(WCEITB5 1015
      1 (INDI(ITO,IC),IC),PN(ITO,IC+3),IC=1,NINHAL)   TB5 1020
C                                     TB5 1025
      IF (TABL(I,1,1).NE.BLANK2) GO TO 340          TB5 1030
      DO 330 IN=2,11                                  TB5 1035
      LINE1(IN)=BLANK1                                TB5 1040
330  CONTINUE                                         TB5 1045
340  CONTINUE                                         TB5 1050
C                                     TB5 1055
      IF (TABL(I,2,1).NE.BLANK2) GO TO 360          TB5 1060
      DO 350 IN=16,25                                  TB5 1065
      LINE1(IN)=BLANK1                                TB5 1070
350  CONTINUE                                         TB5 1075
360  CONTINUE                                         TB5 1080
C                                     TB5 1085
      IF (TABL(I,4,1).NE.BLANK2) GO TO 380          TB5 1090
      DO 370 IN=30,39                                  TB5 1095
      LINE1(IN)=BLANK1                                TB5 1100
370  CONTINUE                                         TB5 1105
380  CONTINUE                                         TB5 1110
C                                     TB5 1115
      IF (TABL(I,5,1).NE.BLANK2) GO TO 400          TB5 1120
      DO 390 IN=44,53                                  TB5 1125
      LINE1(IN)=BLANK1                                TB5 1130
390  CONTINUE                                         TB5 1135
400  CONTINUE                                         TB5 1140
C                                     TB5 1145

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      IF (TAEI(I,6,1).NE.BLANK2) GO TO 420
      DO 410 IN=58,67
      LINE1(IN)=BLANK1
410 CONTINUE
420 CONTINUE
C
430 CONTINUE
      WRITE (15,710) LINE1
C
440 CONTINUE
C
      RETURN
C
450 FORMAT ('1','WEIGHTED COMMITTED DOSE EQUIVALENT IN TARGET',' ORGAN',
15 OR TISSUES'/' ' ,8X,'PER INTAKE OF UNIT',' ACTIVITY (Sv/Bq) OF ' ,
2A8)
460 FORMAT ('1',3X,'WEIGHTED COMMITTED DOSE EQUIVALENT IN',' TARGET OR
1GANS OF TISSUES'/' ' ,11X,' PER INTAKE OF',' UNIT ACTIVITY (Sv/Bq)
2OF ' ,A8)
470 FORMAT ('0',20X,'ORAL',7X,'INHALATION'/'+' ,20X,4(' ' ),7X,10(' ' ))
480 FORMAT ('0',13X,'ORAL',14X,'INHALATION'/'+' ,13X,4(' ' ),14X,10(' ' ))
490 FORMAT ('0',6X,'ORAL',21X,'INHALATION'/'+' ,6X,4(' ' ),21X,10(' ' ))
500 FORMAT ('0',21X,'ORAL',13X,'INHALATION'/'+' ,21X,4(' ' ),13X,10(' ' ))
510 FORMAT ('0',14X,'ORAL',20X,'INHALATION'/'+' ,14X,4(' ' ),20X,10(' ' ))
520 FORMAT ('0',10X,'ORAL',27X,'INHALATION'/'+' ,10X,4(' ' ),27X,10(' ' ))
530 FORMAT ('0',33X,'CLASS ',A1)
540 FORMAT ('0',26X,'CLASS ',A1,7X,'CLASS ',A1)
550 FORMAT ('0',12X,3('CLASS ',A1,7X))
560 FORMAT ('0',40X,'CLASS ',A1)
570 FORMAT ('0',33X,'CLASS ',A1,7X,'CLASS ',A1)
580 FORMAT ('0',29X,3('CLASS ',A1,7X))
590 FORMAT (' ' ,18X,'f1'=,1PE6.0,5X,'f1'=,E6.0)
600 FORMAT (' ' ,11X,'f1'=,1PE6.0,5X,'f1'=,E6.0,5X,'f1'=,E6.0)
610 FORMAT (' ' ,4X,4('f1'=,1PE6.0,5X))
620 FORMAT (' ' ,5('f1'=,1PE6.0,5X))
630 FORMAT ('0',19X,5A2,4X,5A2)
640 FORMAT ('0',12X,3(5A2,4X))
650 FORMAT ('0',5X,4(5A2,4X))
660 FORMAT ('0',1X,5(5A2,4X))
670 FORMAT (19X,1PE7.1,1X,A2,4X,E7.1,1X,A2)
680 FORMAT (12X,3(1PE7.1,1X,A2,4X))
690 FORMAT (5X,4(1PE7.1,1X,A2,4X))
700 FORMAT (1X,5(1PE7.1,1X,A2,4X))
710 FORMAT (' ' ,132A1)
      END

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SUBROUTINE TAB6 (IORAL,NINHAL,ISTOO,ISTOI,TOTO,TOTT,TNNO,INDI,WCDOTB6 5
1,WCEI,TARGO,TAG,IGLAD3,P1)
      DIMENSION IMAYT(3), IMAXO(3), ALITMI(3), ALITMO(3), HMAXO(3), HMAXTB6 10
      1I(3), ISTOO(3), ISTOI(3), TOTO(34,3), TOTI(34,3), INDO(20,3), INDITB6 15
      2(20,3), ALISTO(3), ALISTI(3), WCEO(34,3), WCEI(34,3), DACI(3), P1(TB6 20
      315,6)
      REAL*8 TAG(15)
      INTEGER*2 TARGO(34,5), ORGAN(6,5), BLANK2/' ' /
      LOGICAL*1 ICLASS(15,3), LINE(70), BLANK1/' ' /
C
C ALISTO(3), ALISTI(3)
C ALISTO(I) - ANNUAL LIMIT ON INTAKE FOR ORAL CASE I.
C ALISTI(I) - ANNUAL LIMIT ON INTAKE FOR INHALATION
C CLASS I
C
C DACI(3)
C DACI(I) - DERIVED AIR CONCENTRATION FOR INHALATION
C CLASS I
C
C ALITMO(3)
C ALITMO(I) - CONTAINS THE ALL STOCHASTIC VALUES WHEN
C NON-STOCHASTIC VALUES ARE USED FOR ORAL CLASS I.
C
C ALITMI(3)
C ALITMI(I) - CONTAINS THE ALL STOCHASTIC VALUES WHEN
C NON-STOCHASTIC VALUES ARE USED FOR INHALATION CLASS I.
C
C ORGAN(6)
C ORGAN(I) - ORGAN ASSOCIATED WITH THE NON-STOCHASTIC VALUE
C FOR I - 1,2,3 ORAL CLASSES
C - 4,5,6 INHALATION CLASSES
C
C IMAXO(3)
C IMAXO(I) - HOLDS INDEX OF MAXIMUM H50-T VALUE WHEN CALCULATING
C NON-STOCHASTIC ALI FOR ORAL CLASS I
C
C IMAXI(3)
C IMAXI(I) - HOLDS INDEX OF MAXIMUM H50-T VALUE WHEN CALCULATING
C NON-STOCHASTIC ALI FOR INHALATION CLASS I
C
C HMAXO(3)
C HMAXO(I) - HOLDS MAXIMUM H50-T VALUE WHEN CALCULATING

```

C	NON-STOCHASTIC ALI FOR ORAL CLASS I	TB6 215
C		TB6 220
C	HMAXI(3)	TB6 225
C	HMAXI(I) - HOLDS MAXIMUM H50-T VALUE WHEN CALCULATING	TB6 230
C	NON-STOCHASTIC ALI FOR INHALATION CLASS I	TB6 235
C		TB6 240
C		TB6 245
C	CLACULATE STOCHASTIC ALI	TB6 250
C		TB6 255
	DO 30 IC=1, IORAL	TB6 260
	IND=ISTOO(IC)	TB6 265
	ALISTO(IC)=WCEO(INDO(1,IC),IC)	TB6 270
	IF (ISTOO(IC).EQ.1) GO TO 20	TB6 275
	DO 10 ITO=2, IND	TB6 280
	ALISTO(IC)=ALISTO(IC)+WCEO(INDO(ITO,IC),IC)	TB6 285
10	CONTINUE	TB6 290
20	CONTINUE	TB6 295
	ALISTO(IC)=0.05/ALISTO(IC)	TB6 300
30	CONTINUE	TB6 305
	DO 60 IC=1, NINHAL	TB6 310
	IND=ISTOI(IC)	TB6 315
	ALISTI(IC)=WCEI(INDI(1,IC),IC)	TB6 320
	IF (ISTOI(IC).EQ.1) GO TO 50	TB6 325
	DO 40 ITC=2, IND	TB6 330
	ALISTI(IC)=ALISTI(IC)+WCEI(INDI(ITO,IC),IC)	TB6 335
40	CONTINUE	TB6 340
50	CONTINUE	TB6 345
	ALISTI(IC)=0.05/ALISTI(IC)	TB6 350
60	CONTINUE	TB6 355
C	ZERO IMAXI, IMAXO, ALITMI, AND ALITMO	TB6 360
C		TB6 365
	DO 70 IC=1,3	TB6 370
	IMAXI(IC)=0	TB6 375
	IMAXO(IC)=0	TB6 380
	ALITMI(IC)=0.	TB6 385
	ALITMO(IC)=0.	TB6 390
70	CONTINUE	TB6 395
	DO 80 IC=1,6	TB6 400
	DO 80 K=1,5	TB6 405
	ORGAN(IC,K)=BLANK2	TB6 410
80	CONTINUE	TB6 415
C		TB6 420
C	CHECK TO SEE IF H50T*ALI FOR EACH ORGAN CHOSEN	TB6 425
C	IN COMPUTING ALI IS GREATER THAN .5. IF NOT,	TB6 430
C	USE ALI STOCHASTIC; OTHERWISE, COMPUTE AN ALI	TB6 435
C	NON-STOCHASTIC	TB6 440
C		TB6 445
	DO 100 IC=1, IORAL	TB6 450
	HMAXO(IC)=0.	TB6 455
	IE=ISTOO(IC)	TB6 460
	DO 90 I=1, IE	TB6 465
	PROD=TOTO(INDO(I,IC),IC)*ALISTO(IC)	TB6 470
	IF (PROD.GT.0.5) ISTOO(IC)=0	TB6 475
	IF (TOTO(INDO(I,IC),IC).LE.HMAXO(IC)) GO TO 90	TB6 480
	HMAXO(IC)=TOTO(INDO(I,IC),IC)	TB6 485
	IMAXO(IC)=INDO(I,IC)	TB6 490
90	CONTINUE	TB6 495
100	CONTINUE	TB6 500
	DO 120 IC=1, NINHAL	TB6 505
	HMAXI(IC)=0.	TB6 510
	IE=ISTOI(IC)	TB6 515
	DO 110 I=1, IE	TB6 520
	PROD=TCTI(INDI(I,IC),IC)*ALISTI(IC)	TB6 525
	IF (PROD.GT.0.5) ISTOI(IC)=0	TB6 530
	IF (TOTI(INDI(I,IC),IC).LE.HMAXI(IC)) GO TO 110	TB6 535
	HMAXI(IC)=TOTI(INDI(I,IC),IC)	TB6 540
	IMAXI(IC)=INDI(I,IC)	TB6 545
110	CONTINUE	TB6 550
120	CONTINUE	TB6 555
C		TB6 560
C	COMPUTE ALI NONSTOCHASTIC IF ALI STOCHASTIC	TB6 565
C	IS UNSUITABLE	TB6 570
C		TB6 575
	DO 140 IC=1, IORAL	TB6 580
	IF (ISTOO(IC).GT.0) GO TO 140	TB6 585
	ALITMO(IC)=ALISTO(IC)	TB6 590
	DO 130 K=1,5	TB6 595
	ORGAN(IC,K)=TARGO(IMAXO(IC),K)	TB6 600
130	CONTINUE	TB6 605
	ALISTO(IC)=0.5/HMAXO(IC)	TB6 610
140	CONTINUE	TB6 615
	DO 160 IC=1, NINHAL	TB6 620
	IF (ISTOI(IC).GT.0) GO TO 160	TB6 625
	ALITMI(IC)=ALISTI(IC)	TB6 630
	DO 150 K=1,5	TB6 635
	ORGAN(IC+3,K)=TARGO(IMAXI(IC),K)	TB6 640
150	CONTINUE	TB6 645
	ALISTI(IC)=0.5/HMAXI(IC)	TB6 650
160	CONTINUE	TB6 655
C		TB6 660
C	CALCULATE DAC - DERIVED AIR CONCENTRATION	TB6 665
C		TB6 670
	DO 170 IC=1, NINHAL	TB6 675
	DACI(IC)=ALISTI(IC)/2.4E3	TB6 680
170	CONTINUE	TB6 685
C		TB6 690


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1NINHAL) TB5 190
IF (IORAL.EQ.2.AND.NINHAL.EQ.2) WRITE (15,570) (ICLASS(1,IC),IC=1,TB5 195
1NINHAL) TB5 200
IF (IORAL.EQ.2.AND.NINHAL.EQ.3) WRITE (15,580) (ICLASS(1,IC),IC=1,TB5 205
1NINHAL) TB5 210
C TB5 215
C P1 LINE TB5 220
C TB5 225
ID=1 TB5 230
IF (IORAL.EQ.1.AND.NINHAL.EQ.1) WRITE (15,590) P1(ID,4),P1(ID,1) TB5 235
IF (IORAL.EQ.1.AND.NINHAL.EQ.2) WRITE (15,600) P1(ID,4),(P1(ID,IC) TB5 240
1,IC=1,NINHAL) TB5 245
IF (IORAL.EQ.1.AND.NINHAL.EQ.3) WRITE (15,610) P1(ID,4),(P1(ID,IC) TB5 250
1,IC=1,NINHAL) TB5 255
IF (IORAL.EQ.2.AND.NINHAL.EQ.1) WRITE (15,600) P1(ID,4),P1(ID,5),PTB5 260
11(ID,1) TB5 265
IF (IORAL.EQ.2.AND.NINHAL.EQ.2) WRITE (15,610) P1(ID,4),P1(ID,5),(TB5 270
1F1(ID,IC),IC=1,NINHAL) TB5 275
IF (IORAL.EQ.2.AND.NINHAL.EQ.3) WRITE (15,620) P1(ID,4),P1(ID,5),(TB5 280
1F1(ID,IC),IC=1,NINHAL) TB5 285
C TB5 290
C WRITE THE TABLE TB5 295
C TB5 300
DO 440 I=1,IMAX TB5 305
ITO=I TB5 310
C TB5 315
C WRITE ORGAN NAMES TB5 320
C TB5 325
IF (IORAL.EQ.1.AND.NINHAL.EQ.1) WRITE (15,630) (TABL(I,1,K),K=1,5) TB5 330
1,(TABL(I,4,K),K=1,5) TB5 335
IF (IORAL.EQ.1.AND.NINHAL.EQ.2) WRITE (15,640) (TABL(I,1,K),K=1,5) TB5 340
1,((TABL(I,IC+3,K),K=1,5),IC=1,NINHAL) TB5 345
IF (IORAL.EQ.1.AND.NINHAL.EQ.3) WRITE (15,650) (TABL(I,1,K),K=1,5) TB5 350
1,((TABL(I,IC+3,K),K=1,5),IC=1,NINHAL) TB5 355
IF (IORAL.EQ.2.AND.NINHAL.EQ.1) WRITE (15,640) ((TABL(I,IC,K),K=1,TB5 360
15),IC=1,IORAL),(TABL(I,4,K),K=1,5) TB5 365
IF (IORAL.EQ.2.AND.NINHAL.EQ.2) WRITE (15,650) ((TABL(I,IC,K),K=1,TB5 370
15),IC=1,IORAL),((TABL(I,IC+3,K),K=1,5),IC=1,NINHAL) TB5 375
IF (IORAL.EQ.2.AND.NINHAL.EQ.3) WRITE (15,660) ((TABL(I,IC,K),K=1,TB5 380
15),IC=1,IORAL),((TABL(I,IC+3,K),K=1,5),IC=1,NINHAL) TB5 385
ICODE=IORAL+NINHAL-1 TB5 390
GO TO (10,60,170,320),ICODE TB5 395
C TB5 400
C 1 ORAL AND 1 INHALATION TB5 405
C TB5 410
10 CONTINUE TB5 415
CALL CCRE (LINE1,132) TB5 420
WRITE (15,670) (WCEO(INDO(ITO,IC),IC),PN(ITO,IC),IC=1,IORAL),(WCEITB5 425
1(INDI(ITO,IC),IC),PN(ITO,IC+3),IC=1,NINHAL) TB5 430
C TB5 435
IF (TABL(I,1,1).NE.BLANK2) GO TO 30 TB5 440
DO 20 IN=20,29 TB5 445
LINE1(IN)=BLANK1 TB5 450
20 CONTINUE TB5 455
30 CONTINUE TB5 460
C TB5 465
IF (TABL(I,4,1).NE.BLANK2) GO TO 50 TB5 470
DO 40 IN=34,43 TB5 475
LINE1(IN)=BLANK1 TB5 480
40 CONTINUE TB5 485
50 CONTINUE TB5 490
GO TO 430 TB5 495
C TB5 500
C 1 ORAL AND 2 INHALATIONS OR 2 ORALS AND 1 INHALATION TB5 505
C TB5 510
60 CONTINUE TB5 515
CALL CORE (LINE1,132) TB5 520
WRITE (15,680) (WCEO(INDO(ITO,IC),IC),PN(ITO,IC),IC=1,IORAL),(WCEITB5 525
1(INDI(ITO,IC),IC),PN(ITO,IC+3),IC=1,NINHAL) TB5 530
IF (TABL(I,1,1).NE.BLANK2) GO TO 80 TB5 535
DO 70 IN=13,22 TB5 540
LINE1(IN)=BLANK1 TB5 545
70 CONTINUE TB5 550
80 CONTINUE TB5 555
C TB5 560
IF (IORAL.EQ.1.AND.NINHAL.EQ.2) GO TO 100 TB5 565
IF (TABL(I,2,1).NE.BLANK2) GO TO 100 TB5 570
DO 90 IN=27,36 TB5 575
LINE1(IN)=BLANK1 TB5 580
90 CONTINUE TB5 585
100 CONTINUE TB5 590
C TB5 595
IF (IORAL.EQ.2.AND.NINHAL.EQ.1) GO TO 120 TB5 600
IF (TABL(I,4,1).NE.BLANK2) GO TO 120 TB5 605
DO 110 IN=27,36 TB5 610
LINE1(IN)=BLANK1 TB5 615
110 CONTINUE TB5 620
120 CONTINUE TB5 625
C TB5 630
C TB5 635
IF (IORAL.EQ.1.AND.NINHAL.EQ.2) GO TO 140 TB5 640
IF (TABL(I,4,1).NE.BLANK2) GO TO 140 TB5 645
DO 130 IN=41,50 TB5 650
LINE1(IN)=BLANK1 TB5 655
130 CONTINUE TB5 660
140 CONTINUE TB5 665

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GO TO (220,320), IORAL
220 CONTINUE
IF (ISTOC(1).EQ.0) GO TO 240
DO 230 IN=2,12
LINE(IN)=BLANK1
230 CONTINUE
240 CONTINUE
IF (ISTOI(1).EQ.0) GO TO 260
DO 250 IN=16,26
LINE(IN)=BLANK1
250 CONTINUE
260 CONTINUE
IF (NINHAL.LT.2) GO TO 300
IF (ISTOI(2).EQ.0) GO TO 280
DO 270 IN=30,37
LINE(IN)=BLANK1
270 CONTINUE
280 CONTINUE
IF (NINHAL.LT.3) GO TO 300
IF (ISTOI(3).EQ.0) GO TO 300
DO 290 IN=44,51
LINE(IN)=BLANK1
290 CONTINUE
300 CONTINUE
IF (NINHAL.EQ.1) IB=27
IF (NINHAL.EQ.2) IB=38
IF (NINHAL.EQ.3) IB=52
IF=70
DO 310 IN=IB,IE
LINE(IN)=BLANK1
310 CONTINUE
GO TO 440

C
320 CONTINUE
IF (ISTOO(1).EQ.0) GO TO 340
DO 330 IN=2,9
LINE(IN)=BLANK1
330 CONTINUE
340 CONTINUE
IF (ISTOO(2).EQ.0) GO TO 360
DO 350 IN=16,23
LINE(IN)=BLANK1
350 CONTINUE
360 CONTINUE
IF (ISTOI(1).EQ.0) GO TO 380
DO 370 IN=30,37
LINE(IN)=BLANK1
370 CONTINUE
380 CONTINUE
IF (NINHAL.LT.2) GO TO 420
IF (ISTOI(2).EQ.0) GO TO 400
DO 390 IN=44,51
LINE(IN)=BLANK1
390 CONTINUE
400 CONTINUE
IF (NINHAL.LT.3) GO TO 420
IF (ISTOI(3).EQ.0) GO TO 420
DO 410 IN=58,65
LINE(IN)=BLANK1
410 CONTINUE
420 CONTINUE
IF (NINHAL.EQ.1) IB=38
IF (NINHAL.EQ.2) IB=52
IF (NINHAL.EQ.3) IB=66
IF=70
DO 430 IN=IB,IE
LINE(IN)=BLANK1
430 CONTINUE
440 CONTINUE
IF (IORAL.EQ.1.AND.NINHAL.EQ.1) WRITE (15,820) LINE
IF (.NOT.(IORAL.EQ.1.AND.NINHAL.EQ.1)) WRITE (15,820) LINE
IF (IORAL.EQ.1.AND.NINHAL.EQ.1) WRITE (15,830) ((ORGAN(IC,K),K=1,5),IC=1,NINHAL)
IF (.NOT.(IORAL.EQ.1.AND.NINHAL.EQ.1)) WRITE (15,840) ((ORGAN(IC,K),K=1,5),IC=1,NINHAL)
450 CONTINUE

C
RPTUPN

C
460 FORMAT ('1','ANNUAL LIMITS ON INTAKE, ALI, AND DERIVED',' AIR'/' 'TB61570
1,'X','CONCENTRATIONS, DAC, (40 Hr/Wk) FOR ',A8) TB61575
470 FORMAT ('1',10X,'ANNUAL LIMITS ON INTAKE, ALI, AND DERIVED',' AIR'/'TB61580
1/' '11X,'CONCENTRATIONS, DAC, (40 Hr/Wk) FOR ',A8) TB61585
480 FORMAT ('1',24X,'ANNUAL LIMITS ON INTAKE, ALI, AND DERIVED',' AIR'/'TB61590
1/' '25X,'CONCENTRATIONS, DAC, (40 Hr/Wk) FOR ',A8) TB61595
490 FORMAT ('1',3X,'ANNUAL LIMITS ON INTAKE, ALI, AND DERIVED',' AIR'/'TB61600
1/' '4X,'CONCENTRATIONS, DAC, (40 Hr/Wk) FOR ',A8) TB61605
500 FORMAT ('1',17X,'ANNUAL LIMITS ON INTAKE, ALI, AND DERIVED',' AIR'/'TB61610
1/' '18X,'CONCENTRATIONS, DAC, (40 Hr/Wk) FOR ',A8) TB61615
510 FORMAT ('1',26X,'ANNUAL LIMITS ON INTAKE, ALI, AND DERIVED',' AIR'/'TB61620
1/' '27X,'CONCENTRATIONS, DAC, (40 Hr/Wk) FOR ',A8) TB61625
520 FORMAT ('0',10X,'ALI (Bg)',11X,'DAC (Bg/m3)'/'+'1,10X,8(' '11X,12TB61630
1(' ')) TB61635
530 FORMAT ('0',14X,'ALI (Bg)',25X,'DAC (Bg/m3)'/'+'1,14X,8(' '25X,12TB61640
1(' ')) TB61645
540 FORMAT ('0',21X,'ALI (Bg)',39X,'DAC (Bg/m3)'/'+'1,21X,8(' '39X,12TB61650

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1 (' '))
550 FORMAT ('0',14X,'ALI (Bq)',18X,'DAC (Bq/m3)'/'+' ,14X,8 ('_') ,18X,12TB6 1660
1 (' '))
560 FORMAT ('0',21X,'ALI (Bq)',32X,'DAC (Bq/m3)'/'+' ,21X,8 ('_') ,32X,12TB6 1670
1 (' '))
570 FORMAT ('0',24X,'ALI (Bq)',50X,'DAC (Bq/m3)'/'+' ,24X,8 ('_') ,50X,12TB6 1680
1 (' '))
580 FORMAT ('0',5X,'ORAL',7X,'INHALATION',4X,'INHALATION'/'+' ,5X,4 ('_') ,4X,10 ('_') ,4X,10 ('_'))
1),7X,10 ('_') ,4X,10 ('_'))
590 FORMAT ('0',2X,'ORAL',14X,'INHALATION',18X,'INHALATION'/'+' ,2X,4 ('_') ,14X,10 ('_') ,18X,10 ('_'))
1),14X,10 ('_') ,18X,10 ('_'))
600 FORMAT ('0',2X,'ORAL',21X,'INHALATION',32X,'INHALATION'/'+' ,2X,4 ('_') ,21X,10 ('_') ,32X,10 ('_'))
1),21X,10 ('_') ,32X,10 ('_'))
610 FORMAT ('0',10X,'ORAL',13X,'INHALATION',4X,'INHALATION'/'+' ,10X,4 ('_') ,13X,10 ('_') ,4X,10 ('_'))
1),13X,10 ('_') ,4X,10 ('_'))
620 FORMAT ('0',10X,'ORAL',20X,'INHALATION',18X,'INHALATION'/'+' ,10X,4 ('_') ,20X,10 ('_') ,18X,10 ('_'))
1),20X,10 ('_') ,18X,10 ('_'))
630 FORMAT ('0',10X,'ORAL',27X,'INHALATION',32X,'INHALATION'/'+' ,10X,4 ('_') ,27X,10 ('_') ,32X,10 ('_'))
1),27X,10 ('_') ,32X,10 ('_'))
640 FORMAT ('0',18X,2 ('CLASS ',A1,7X))
650 FORMAT ('0',15X,4 ('CLASS ',A1,7X))
660 FORMAT ('0',15X,6 ('CLASS ',A1,7X))
670 FORMAT ('0',29X,2 ('CLASS ',A1,7X))
680 FORMAT ('0',29X,4 ('CLASS ',A1,7X))
690 FORMAT ('0',29X,6 ('CLASS ',A1,7X))
700 FORMAT (' ',3X,3 ('fi'=,1PE6.0,5X))
710 FORMAT (' ',5 ('fi'=,1PE6.0,5X))
720 FORMAT (' ',7 ('fi'=,1PE6.0,5X))
730 FORMAT (' ',4 ('fi'=,1PE6.0,5X))
740 FORMAT (' ',6 ('fi'=,1PE6.0,5X))
750 FORMAT (' ',8 ('fi'=,1PE6.0,5X))
760 FORMAT ('0',5X,3(1PE6.0,8X))
770 FORMAT ('0',2X,8(1PE6.0,8X))
780 FORMAT (4X,2 (' ',1PE6.0,' ',6X))
790 FORMAT (1X,3 (' ',1PE6.0,' ',6X))
800 FORMAT (1X,4 (' ',1PE6.0,' ',6X))
810 FORMAT (1X,4 (' ',1PE6.0,' ',6X)) , (' ',1PE6.0,' '))
820 FORMAT (' ',70A1)
830 FORMAT (' ',4X,5 (5A2,4X))
840 FORMAT (' ',1X,5 (5A2,4X))
END

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	SUBROUTINE TITLE (IKOUNT,TAG,TITL1,TITL2,ID)	TIT	5
C		TIT	10
C	CENTER TITLES	TIT	15
C		TIT	20
	REAL*8 TAG(15),TAG1	TIT	25
	LOGICAL*1 ATNSYN(8),TITL1(132),TITL2(132),BLANK/' '/	TIT	30
	LOGICAL*1 SPEP(63)/'S','P','E','C','I','F','I','C',' ','E','P','P'	TIT	35
	1,'E','C','T','I','V','E',' ','E','N','E','R','G','Y',' ','M','	TIT	40
	2e,'V',' ','P','E','R',' ','G','R','A','M',' ','P','E','R',' ','T'	TIT	45
	3,'R','A','N','S',' ','O','R',' ','A','T','I','O','N',' ')',' ','O','	TIT	50
	4P,' ','SRCORG(7)'/ 'S','O','U','R','C','E','S' /	TIT	55
	EQUIVALENCE (TAG1,ATNSYN(1))	TIT	60
	TAG1=TAG(ID)	TIT	65
C		TIT	70
C	BLANK OUT TITL1 AND TITL2	TIT	75
C		TIT	80
	DO 10 I=1,132	TIT	85
	TITL1(I)=BLANK	TIT	90
	TITL2(I)=BLANK	TIT	95
	10 CONTINUE	TIT	100
C		TIT	105
C	CENTER FIRST TITLE	TIT	110
		TIT	115
	NSPACS=10+IKOUNT*10	TIT	120
	IF (NSPACS.LE.69) NSPACS=69	TIT	125
	IB=(NSPACS-69)/2	TIT	130
	IE=IB+63	TIT	135
	DO 20 I=1,63	TIT	140
	TITL1(I+IB)=SPEP(I)	TIT	145
	20 CONTINUE	TIT	150
C		TIT	155
C	MOVE IN TAG	TIT	160
C		TIT	165
	DO 30 I=1,8	TIT	170
	TITL1(I+IE)=ATNSYN(I)	TIT	175
	30 CONTINUE	TIT	180
C		TIT	185
C	CENTER SECOND TITLE	TIT	190
		TIT	195
	IB=(NSPACS-7)/2	TIT	200
	IE=IB+7	TIT	205
	DO 40 I=1,7	TIT	210
	TITL2(I+IB)=SRCORG(I)	TIT	215
	40 CONTINUE	TIT	220
C		TIT	225
	RETURN	TIT	230
	END	TIT	235-

	SUBROUTINE WEIGHT (WT,ISTOI,ISTOO,KREMI,KRENO,IORAL,NINHAL)	WPI 5
C		WEI 10
C	FORM ARRAY OF WEIGHTS TO BE PRINTED UNDER REMAINDER	WEI 15
C	ORGAN IN THE DOSE EQUIVALENT TABLE	WEI 20
C		WEI 25
	REAL*8 WT(11,6),BLANK8/' '	WEI 30
	DIMENSION ISTOI(3),ISTOO(3),KREMI(3),KRENO(3)	WEI 35
	REAL*8 W(5)/'WT=.06 ','WT=.12 ','WT=.18 ','WT=.24 ','WT=.30 '	WEI 40
	1/	WEI 45
	DO 10 I=1,11	WEI 50
	DO 10 J=1,6	WEI 55
	WT(I,J)=BLANK8	WEI 60
10	CONTINUE	WEI 65
	DO 20 IC=1,IORAL	WEI 70
	IF (KRENO(IC).EQ.0) GO TO 20	WEI 75
	WT(ISTCO(IC),IC)=W(KRENO(IC))	WEI 80
20	CONTINUE	WEI 85
	DO 30 IC=1,NINHAL	WEI 90
	IF (KREMI(IC).EQ.0) GO TO 30	WEI 95
	WT(ISTOI(IC),IC+3)=W(KREMI(IC))	WEI 100
30	CONTINUE	WEI 105
	RETURN	WEI 110
	END	WEI 115-

APPENDIX G

SAMPLE INPUT AND OUTPUT TO THE DØSE PROGRAM

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APPENDIX G
SAMPLE INPUT TO THE DØSE PROGRAM

Appendix G contains the sample input and output to the DØSE program for the radionuclide ^{54}Mn .

The input (see Table 4.7) consists of:

1. Source organ names (2 sets) and target organ names are prescribed by ICRP Committee 2.
2. Cards describing ^{54}Mn .

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BLADDER	CONTENT
ST	CONTENT
SI	CONTENT
ULI	CONTENT
LLI	CONTENT
	KIDNEYS
	LIVER
	SAL GLND
	TE REGION
	LUNGS
RESP	LYM NODE
	BREAST
	GONADS
	PANCREAS
	CORT BONE
	TRAB BONE
	R MARROW
	Y MARROW
	SKIN
	SPLEEN
	GONADS
	THYROID
TOTAL	BODY
	CLOUD
	ADRENALS

BLAD CONTENT
ST CONTENT
SI CONTENT
ULI CONTENT
LLI CONTENT
KIDNEYS
LIVER
SAL GLND
TE REGION
LUNGS
LYM NODE
BREAST
GONADS
PANCREAS
CORT BONE
TRAB BONE
R MARROW
Y MARROW
SKIN
SPLEEN
GONADS
THYROID
OTHER TISSUE
CLOUD
ADRENALS
BLAD WALL
ST WALL
SI WALL
ULI WALL
LLI WALL
KIDNEYS
LIVER
LUNGS
SAL GLND
TE REGION
P REGION
LYM NODE
BREAST
GONADS
PANCREAS
BONE
CORT BONE
TRAB BONE
R MARROW
Y MARROW
T MARROW
CORT E CL
TRAB E CL
T E CL
SKIN
SPLEEN
GONADS
THYMUS
THYROID
UTERUS
T BODY
ADRENALS
BONE SURF
REMAINDER
1

54.	MANGANESE	25.	DW	.1	.1	.1
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Sample Output from the DØSE Program

The printed output for the DØSE code for ^{52}Mn is in two parts:

- (1) output to unit 6 and
- (2) output to unit 15.

Output to unit 6 contains the cumulated activity for each oral and inhalation class broken down by the three types of deposition for each source organ in the metabolic model. Also included is the committed dose equivalent and fraction of deposition for each target organ.

Output to unit 15 consists of the tables for publication by ICRP.

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Output to Unit 5 From D0SE Program

TIME INTERVAL = 18262.5 DAYS

BECQUEREL-SECONDS FOR MN-54

SOURCE	CLASS D	CLASS W	CLASS	ORAL
ORGAN	D3 D4 D5	D3 D4 D5	D3 D4 D5	1 2 3
FB REG	0.0 1.944E 02 0.0	0.0 1.046E 03 4.631E 03 0.0	0.0 0.0	0.0 0.0 0.0
LUNGS	0.0 0.0 1.556E 04 0.0	0.0 0.0 8.183E 05 0.0	0.0 0.0	0.0 0.0 0.0
RESP LYM	0.0 0.0 3.106E 03 0.0	0.0 0.0 5.790E 04 0.0	0.0 0.0	0.0 0.0 0.0
S CONT	5.399E 02 1.439E 01 0.0	9.707E 02 1.439E 02 6.687E 02 0.0	0.0 0.0	3.600E 03 0.0 0.0
SI+CONT	1.943E 03 5.178E 01 0.0	3.493E 03 5.178E 02 2.407E 03 0.0	0.0 0.0	1.295E 04 0.0 0.0
ULI CONT	5.308E 03 1.681E 02 0.0	1.134E 04 1.681E 03 7.812E 03 0.0	0.0 0.0	4.205E 04 0.0 0.0
LLI CONT	1.162E 04 3.096E 02 0.0	2.089E 04 3.096E 03 1.439E 04 0.0	0.0 0.0	7.746E 04 0.0 0.0
COR BONE	1.278E 05 5.920E 04 1.933E 05	4.413E 04 3.409E 04 4.663E 04 0.0	0.0 0.0	7.745E 04 0.0 0.0
CAN BONE	1.276E 05 5.909E 04 1.930E 05	4.405E 04 3.403E 04 4.655E 04 0.0	0.0 0.0	7.732E 04 0.0 0.0
LIVER	1.176E 05 5.444E 04 1.778E 05	4.059E 04 3.135E 04 4.289E 04 0.0	0.0 0.0	7.123E 04 0.0 0.0
OTH TISS	1.666E 05 7.716E 04 2.520E 05	5.752E 04 4.443E 04 6.079E 04 0.0	0.0 0.0	1.010E 05 0.0 0.0

INTAKE OF 1 BECQUEREL MN-54

DOSE (SIEVERT) FROM MN-54

I N H A L A T I O N

O R A L

TARGET	CLASS D	(D3,D4,D5)	CLASS W	(D3,D4,D5)	CLASS	(D3,D4,D5)	1	2	3
BLAD WAL	7.24E-10	(37., 15., 48.)	3.75E-10	(38., 19., 43.)	0.0	(0., 0., 0.)	3.72E-10	0.0	0.0
S WALL	9.44E-10	(35., 15., 50.)	1.15E-09	(14., 8., 78.)	0.0	(0., 0., 0.)	4.11E-10	0.0	0.0
SI+CONT	1.11E-09	(40., 14., 45.)	8.34E-10	(39., 14., 47.)	0.0	(0., 0., 0.)	9.85E-10	0.0	0.0
ULI WALL	1.25E-09	(42., 14., 44.)	1.07E-09	(40., 13., 47.)	0.0	(0., 0., 0.)	1.35E-09	0.0	0.0
LLI WALL	1.18E-09	(51., 12., 37.)	1.32E-09	(49., 12., 39.)	0.0	(0., 0., 0.)	2.20E-09	0.0	0.0
KIDNEYS	1.37E-09	(34., 15., 51.)	8.90E-10	(21., 14., 65.)	0.0	(0., 0., 0.)	3.82E-10	0.0	0.0
LIVER	4.61E-09	(34., 15., 51.)	2.47E-09	(22., 17., 61.)	0.0	(0., 0., 0.)	1.00E-09	0.0	0.0
LUNGS	1.18E-09	(30., 14., 56.)	6.66E-09	(2., 2., 97.)	0.0	(0., 0., 0.)	2.29E-10	0.0	0.0
MUSCLE	9.13E-10	(34., 15., 51.)	8.59E-10	(15., 10., 75.)	0.0	(0., 0., 0.)	2.77E-10	0.0	0.0
OVARIES	8.85E-10	(42., 14., 44.)	7.09E-10	(43., 14., 43.)	0.0	(0., 0., 0.)	9.48E-10	0.0	0.0
PANCREAS	1.41E-09	(34., 15., 51.)	1.44E-09	(13., 9., 78.)	0.0	(0., 0., 0.)	3.81E-10	0.0	0.0
R MARROW	1.66E-09	(34., 15., 50.)	1.10E-09	(21., 14., 65.)	0.0	(0., 0., 0.)	4.89E-10	0.0	0.0
SKIN	6.21E-10	(34., 15., 51.)	4.91E-10	(16., 11., 72.)	0.0	(0., 0., 0.)	1.60E-10	0.0	0.0
SPLEEN	9.18E-10	(34., 15., 51.)	1.18E-09	(11., 7., 82.)	0.0	(0., 0., 0.)	2.65E-10	0.0	0.0
TESTES	6.95E-10	(35., 15., 50.)	2.73E-10	(36., 24., 40.)	0.0	(0., 0., 0.)	2.11E-10	0.0	0.0
THYMUS	7.82E-10	(32., 15., 52.)	1.82E-09	(5., 4., 91.)	0.0	(0., 0., 0.)	1.60E-10	0.0	0.0
THYROID	6.52E-10	(33., 15., 52.)	7.40E-10	(10., 8., 82.)	0.0	(0., 0., 0.)	1.33E-10	0.0	0.0
UTERUS	9.24E-10	(37., 15., 46.)	4.92E-10	(38., 19., 43.)	0.0	(0., 0., 0.)	5.03E-10	0.0	0.0
ADRENALS	1.81E-09	(34., 15., 51.)	1.55E-09	(14., 11., 75.)	0.0	(0., 0., 0.)	4.13E-10	0.0	0.0
BON SURF	2.56E-09	(34., 15., 51.)	1.25E-09	(25., 18., 57.)	0.0	(0., 0., 0.)	5.71E-10	0.0	0.0

Output to Unit 15 from D0SE Program

SPECIFIC EFFECTIVE ENERGY (MeV PER GRAM PER TRANSFORMATION) OF MN-54

SOURCES

TARGETS	LUNGS	ST CONTENT	SI CONTENT	ULI CONTENT	LLI CONTENT	LIVER	CORT BONE	TRAB BONE	TOTAL BODY
GCNADS	4.7E-07	3.3E-06	2.7E-05	2.5E-05	4.6E-05	1.6E-06	2.8E-06	2.8E-06	4.0E-06
BREAST	3.7E-06	3.9E-06	4.3E-06	4.1E-06	4.7E-06	3.1E-06	3.1E-06	3.1E-06	4.1E-06
R MARROW	3.4E-06	2.8E-06	6.7E-06	5.6E-06	8.4E-06	2.8E-06	8.6E-06	1.0E-05	4.5E-06
LUNGS	4.5E-05	5.0E-06	9.7E-07	1.1E-06	4.0E-07	6.7E-06	2.8E-06	2.8E-06	4.1E-06
BCNE SURF	2.7E-06	1.6E-06	2.2E-06	1.9E-06	2.8E-06	2.0E-06	1.8E-05	1.8E-05	4.1E-06
SI WALL	8.7E-07	7.1E-06	8.9E-05	4.4E-05	2.4E-05	4.4E-06	2.3E-06	2.3E-06	5.5E-06
ULI WALL	1.1E-06	3.5E-06	5.2E-05	1.3E-04	1.1E-05	6.7E-06	2.1E-06	2.1E-06	5.3E-06
LLI WALL	2.5E-07	3.7E-06	1.9E-05	8.9E-06	1.6E-04	8.1E-07	2.9E-06	2.9E-06	5.5E-06
KIDNEYS	2.8E-06	9.0E-06	8.8E-06	7.8E-06	2.5E-06	1.0E-05	3.1E-06	3.1E-06	5.1E-06
LIVER	6.6E-06	5.5E-06	5.1E-06	6.9E-06	1.1E-06	7.3E-05	2.0E-06	2.0E-06	5.0E-06
PANCREAS	6.6E-06	4.6E-05	5.6E-06	5.5E-06	2.1E-06	1.2E-05	2.7E-06	2.7E-06	4.7E-06
THYMUS	1.1E-05	1.8E-06	4.3E-07	4.7E-07	2.0E-07	2.7E-06	2.3E-06	2.3E-06	3.8E-06
UTERUS	3.2E-07	2.6E-06	2.3E-05	1.3E-05	1.5E-05	1.1E-06	2.3E-06	2.3E-06	6.2E-06
ADRENALS	6.6E-06	5.9E-06	3.3E-06	3.3E-06	1.4E-06	1.3E-05	5.1E-06	5.1E-06	5.5E-06

NUMBER OF NUCLEAR TRANSFORMATIONS OVER 50 YEARS
IN SOURCE ORGANS OR TISSUES PER UNIT INTAKE OF ACTIVITY
(TRANSFORMATIONS/Bq) OF MN-54

ORGAN	ORAL	INHALATION	
	$f_1=1.E-01$	CLASS D $f_1=1.E-01$	CLASS W $f_1=1.E-01$
LUNGS		1.9E 04	8.8E 05
ST CONTENT	3.6E 03	5.5E 02	1.8E 03
SI CONTENT	1.3E 04	2.0E 03	6.4E 03
ULI CONTENT	4.2E 04	6.5E 03	2.1E 04
LLI CONTENT	7.7E 04	1.2E 04	3.8E 04
LIVER	7.1E 04	3.5E 05	1.1E 05
CORT BONE	7.7E 04	3.8E 05	1.2E 05
TRAB BONE	7.7E 04	3.8E 05	1.2E 05
OTHER TISSUE (63200g)	1.0E 05	5.0E 05	1.6E 05

COMMITTED DOSE EQUIVALENT IN TARGET ORGANS OR TISSUES
PER INTAKE OF UNIT ACTIVITY (Sv/Bq) OF MN-54

	ORAL	INHALATION	
	$f_1=1.E-01$	CLASS D $f_1=1.E-01$	CLASS W $f_1=1.E-01$
GONADS	5.5E-10	GONADS 8.9E-10 (42, 14, 44)	GONADS 7.1E-10 (43, 14, 43)
BREAST	2.8E-10	BREAST 9.1E-10 (34, 15, 51)	BREAST 8.6E-10 (15, 10, 75)
R MARROW	4.9E-10	R MARROW 1.7E-09 (34, 15, 51)	R MARROW 1.1E-09 (21, 14, 65)
LUNGS	2.3E-10	LUNGS 1.2E-09 (30, 14, 56)	LUNGS 6.7E-09 (2, 2, 96)
SI WALL	9.8E-10	BONE SURF 2.6E-09 (34, 15, 51)	LIVER 2.5E-09 (22, 17, 61)
ULI WALL	1.4E-09	ULI WALL 1.3E-09 (42, 14, 44)	REMAINDER 1.8E-09 (5, 4, 91) WT=.18
LLI WALL	2.2E-09	LIVER 4.6E-09 (34, 15, 51)	
LIVER	1.0E-09	REMAINDER 1.0E-09 (34, 15, 51) WT=.18	
REMAINDER	5.0E-10 WT=.06		

WEIGHTED COMMITTED DOSE EQUIVALENT IN TARGET ORGANS OR TISSUES
PER INTAKE OF UNIT ACTIVITY (Sv/Bq) OF MN-54

<u>ORAL</u>	<u>INHALATION</u>	
$f_1=1.E-01$	CLASS D $f_1=1.E-01$	CLASS W $f_1=1.E-01$
GONADS 2.4E-10	GONADS 2.2E-10	GONADS 1.8E-10
BREAST 4.2E-11	BREAST 1.4E-10	BREAST 1.3E-10
R MARROW 5.9E-11	R MARROW 2.0E-10	R MARROW 1.3E-10
LUNGS 2.7E-11	LUNGS 1.4E-10	LUNGS 8.0E-10
SI WALL 5.9E-11	BONE SURF 7.7E-11	LIVER 1.5E-10
ULI WALL 8.1E-11	ULI WALL 7.5E-11	REMAINDER 3.3E-10
ILI WALL 1.3E-10	LIVER 2.8E-10	
LIVER 6.0E-11	REMAINDER 3.3E-10	
REMAINDER 3.0E-11		

ANNUAL LIMITS ON INTAKE, ALI, AND DERIVED AIR
CONCENTRATIONS, DAC, (40 Hr/Wk) FOR MN-54

<u>ALI (Bq)</u>		<u>DAC (Bq/m³)</u>	
<u>ORAL</u>	<u>INHALATION</u>	<u>INHALATION</u>	
$f_1=1.E-01$	CLASS D $f_1=1.E-01$	CLASS W $f_1=1.E-01$	CLASS D $f_1=1.E-01$
7.E 07	3.E 07	3.E 07	1.E 04
			1.E 04

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