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SEECAL: Program To Calculate Age-Dependent Specific Effective Energies

Mark Cristy
Keith F. Eckerman

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SEECAL: PROGRAM TO CALCULATE AGE-DEPENDENT SPECIFIC EFFECTIVE ENERGIES

Mark Cristy
Keith F. Eckerman

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ABSTRACT

This report describes the computer program SEECAL, which calculates specific effective energies (*SEE*) to specified target regions for ages newborn, 1 y, 5 y, 10 y, 15 y, a 70–kg adult male, and a 58–kg adult female. The dosimetric methodology is that of the International Commission on Radiological Protection (ICRP) and is generally consistent with the schema of the Medical Internal Radiation Dose committee of the U.S. Society of Nuclear Medicine. Computation of *SEE*s is necessary in the computation of equivalent dose rate in a target region, for occupational or public exposure to radionuclides taken into the body. Program SEECAL replaces the program SEE that was previously used by the Dosimetry Research Group at Oak Ridge National Laboratory. The program SEE was used in the dosimetric calculations for occupational exposures for ICRP Publication 30 and is limited to adults. SEECAL was used to generate age-dependent *SEE*s for ICRP Publication 56, Part 1. SEECAL is also incorporated into DCAL, a radiation dose and risk calculational system being developed for the Environmental Protection Agency. Electronic copies of the program and data files and this report are available from the Radiation Shielding Information Center at Oak Ridge National Laboratory.

I. INTRODUCTION

For computations of specific effective energy, the computer program SEECAL replaces the program SEE that was previously used by the Dosimetry Research Group at Oak Ridge National Laboratory. The program SEE was used in the dosimetric calculations for occupational exposures for ICRP Publication 30 (1979); it produced *SEE*s for adults only (70-kg body size, hermaphroditic) and is described in Watson and Ford (1980). The newer program computes *SEE*s for ages newborn, 1 year, 5 years, 10 years, 15 years, a 70-kg adult male, and a 58-kg adult female. An earlier version of SEECAL, written for a mini-computer, was used to generate age-dependent *SEE*s for ICRP Publication 56, Part 1. The PC-based version described here gives the same results but has been changed to operate in a PC environment and has been used in the calculations for ICRP 56, Part 2. Program SEE ran on an IBM mainframe computer.

SEECAL is written in a modular fashion, so that it can be easily changed whenever improvements in dosimetric methods are developed. For example, the new ICRP lung model will be published soon (Bair 1989), and we anticipate improved methods for electron dosimetry in skeletal tissues; and these changes can then be incorporated into the program.

SEECAL can be run (1) by itself, (2) in conjunction with the nuclear decay extraction program DEXRAX, or (3) as part of a comprehensive radiation protection software system being developed for the Environmental Protection Agency (Eckerman et al., in preparation). The last is referred to here as the DCAL system; the second-mentioned is referred to as SEEDEX.

SEECAL requires standard input data on energies and intensities emitted in spontaneous nuclear transformation of the radionuclides (nuclear decay data); age-dependent absorbed fractions (ϕ) or specific absorbed fractions (Φ) for source region-target region pairs for alpha, electron, and photon radiations; and age-dependent masses of the source and target regions. These standard input data are supplied with SEECAL and may be obtained (along with this report) by requesting package CCC-620 (with the same title as this document) from the Radiation Shielding Information Center (RSIC), Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831-6362. The nuclear decay data are extracted from data files by the program DEXRAX (Eckerman, Westfall, Ryman, and Cristy 1993), which is also available from RSIC in a separate package (package DLC-172, entitled *NUCDECAY, ICRP and MIRD Nuclear Decay Data*).

Output from SEECAL is in SI units: equivalent dose per nuclear transformation in Sv/nt or absorbed dose per nuclear transformation in Gy/nt. The data in the standard input files are also in SI units, except that energy is in MeV but is converted to joules in SEECAL. The *SEE*s are given with four digits, more than are really significant, for computational reasons: it is desirable that parallel dose or risk computations agree to three digits, i.e., that computations using total *SEE* values in equivalent dose (where the radiation weighting factors have been included) agree with computations using component *SEE* values in absorbed dose (e.g., separate low- and high-LET *SEE* values) where the radiation weighting factors are added at the end of the computation.

II. DOSIMETRIC METHODOLOGY

The dosimetric methodology embodied in the SEECAL software is that of the International Commission on Radiological Protection (ICRP) and is generally consistent with the schema of the Medical Internal Radiation Dose committee (MIRD) of the U.S. Society of Nuclear Medicine. The methodology considers two sets of anatomical regions within the body. One set specifies the location of radioactivity within the body and is referred to as the source regions. The methodology places no constraints on the nature of the source regions — each might be represented by a point, a plane, or a volume. The second set of regions are the so-called target regions or the regions over which the radiation dose is of interest. Both the ICRP and MIRD consider the mean absorbed dose to a target region as the fundamental dosimetric quantity. The principal biological effect of interest in radiation protection, cancer induction, is cellular in origin and the mean dose in a target is relevant to the extent that dose is representative of the dose to the cells at risk. For lack of information, the cells at risk are assumed to be uniformly distributed in the target region and thus the mean dose is the relevant quantity.

In prospective dosimetric applications it has been common practice to define the source regions as consisting of explicitly identified anatomical regions and a collective representation of the rest of the body. The latter, referred to as *Other*, is treated here as a single region defined as the complement of the set of explicitly identified regions. The construct of this source region is dependent on the assumptions of the dosimetric methodology stated below.

The assumptions of the dosimetric methodology are:

1. The radioactivity in each source region is assumed to be uniformly distributed. For most regions the distribution is by volume. However, for mineral bone regions it may also be by surface area. For a source in *Lung Contents*, the activity may be considered to be either in the volume of air or deposited on surfaces within the lung.

2. For all target regions, the mean energy absorbed in the target volume averaged over the mass of the target is the relevant quantity.

The mean energy absorbed in the target region depends on the nature of the radiations emitted in the source regions, the spatial relationships between the source and target regions, and the nature of the tissues between the regions. The details of these considerations are embodied in the *SEE* coefficient computed by SEECAL.

Dosimetric Quantities

Computation of specific effective energy, *SEE*, is necessary in the computation of equivalent dose rate in a target region, for occupational or public exposure to radionuclides taken into the body. Whether one is interested in committed equivalent dose to a region, committed effective dose, or assessment of risk, the basic quantity to be computed first is the equivalent dose rate at various times. From ICRP Publication 56, Part 1 (1989), and substituting newer terminology from ICRP Publication 60 (1991) and substituting the word "region" for "organ" or "tissue", we may define equivalent dose rate $\dot{H}$ and specific effective energy *SEE* as follows:

"The equivalent dose rate in target region T includes contributions from each radionuclide in the body and from each region in which radionuclides are present. The equivalent dose rate at age t in region T of an individual of age t_0 at the time of intake, $\dot{H}_T(t,t_0)$, can be expressed as:

$$\dot{H}_T(t,t_0) = c \sum_S \sum_j q_{S,j}(t)\ SEE(T \leftarrow S;t)_j \ , \tag{1}$$

where $q_{S,j}(t)$ is the activity of radionuclide j present in source region S at age t, $SEE(T \leftarrow S;t)_j$ is the specific effective energy deposited in target region T per nuclear transformation of radionuclide j in source region S at age t, and c is any numerical constant required by the units of q and SEE. ...

For any radionuclide, the specific effective energy at age t is defined as

$$SEE(T \leftarrow S;t) = \sum_i \frac{w_{R,i}\ Y_i\ E_i\ \phi_i(T \leftarrow S;t)}{M_T(t)} \ , \tag{2}$$

where $w_{R,i}$ is the radiation weighting factor for radiation type i, Y_i is the yield of radiations of type i per nuclear transformation, E_i is the average or unique energy of radiation type i, $\phi_i(T \leftarrow S;t)$ is the fraction of energy emitted in source region S that is absorbed within target region T at age t, and $M_T(t)$ is the mass of target region T at age t ... The age dependence in SEE arises from the age dependence of the absorbed fraction and the mass of the target region."

The quantity $\phi_i(T \leftarrow S;t)$ is called the absorbed fraction, and when divided by the mass of the target region, M_T, is called the specific absorbed fraction, $\Phi_i(T \leftarrow S;t)$. They are also commonly referred to as AF and SAF, respectively.

The <u>specific effective energy</u> might better be termed the <u>specific equivalent energy</u>, because *effective* may imply that the tissue weighting factor has been applied, whereas *equivalent* would imply that the radiation weighting factor is included in the quantity. SEE can also be thought of as an equivalent dose per nuclear transformation, and in fact, program SEECAL labels its output in this way. SEECAL includes an option to compute SEE without the radiation weighting factor (i.e., a specific energy, SE), which is identified in the output tables as absorbed dose per nuclear transformation. Although technically this is not an "SEE" value, in general the distinction between SEE and SE will be ignored in the discussion of the SEECAL program for economy of words.

III. DOSIMETRY USED IN SEECAL

Shorthand Terminology for Radiations

The following shorthand terminology will frequently be used in this manuscript: "photons" for x radiations, gamma radiations, and annihilation quanta; "electrons" for beta+ particles, beta− particles, internal conversion electrons, and Auger electrons; and "alphas" for alpha particles and alpha recoil nuclei.

Nuclear Decay Data

In Eqn. (2), there are two terms from the nuclear decay data: Y_i is the yield of radiations of type i per nuclear transformation, and E_i is the average or unique energy of radiation type i. The radiations that contribute the overwhelming majority of the energy per nuclear transformation are tabulated in ICRP Publication 38 (1983) and a MIRD publication (Weber et al. 1989). With program DEXRAX, *all* the radiations from data files that the Dosimetry Research Group assembled during preparation of ICRP 38 or the MIRD publication may be extracted for input to SEECAL. (Use of the ICRP 38 data is the default setup when DEXRAX is installed; the user may switch to the MIRD data by editing the Dexrax.ini file — see Table 6.) Additional information on the nuclear decay data may be found in the document describing DEXRAX (Eckerman et al. 1993).

Note that the decay data files include the beta spectra and DEXRAX can extract beta spectra. However, these data are not currently used by SEECAL — only the average energy of each beta transition is used. In future, the beta spectra may be used, especially for dosimetry of beta emitters in the lung and the skeleton.

The nuclear decay data files accessed by DEXRAX include the kinetic energies of each emitted alpha particle but not the corresponding kinetic energies of the recoiling nucleus. SEECAL computes the recoil energy E_r for an alpha transition as

$$E_r = \frac{4.0026\ E_\alpha}{A - 4}\ , \tag{3}$$

where E_α is the kinetic energy of the alpha particle, A is the mass number of the nuclide, and 4.0026 is the atomic mass of an alpha particle.

Radiation Weighting Factors, w_R

Radiation weighting factors, formerly called quality factors, are 1 for photons and electrons and 20 for alpha particles and alpha recoil nuclei (ICRP Publication 60, 1991). Spontaneous fission and its radiations are not currently handled by SEECAL.

Specific Absorbed Fractions for Photons

Photon Φ's used by SEECAL are derived from radiation transport calculations in anthropomorphic phantoms for phantoms representing newborn, 1 year, 5 years, 10 years, 15-year-old male/adult female, and adult male. The radioactivity was assumed to be uniformly distributed within each source region. These Φ's are as published in Cristy and Eckerman (1987), except for the changes noted below, which include substantial changes in the adult female. The Φ's used by SEECAL contain an additional digit beyond the two-digit values published. The additional digit reduces the potential for "loss-of-significance" in the second digit in some SEECAL computations.

The energy deposition within the active bone marrow and within the endosteal cells on bone surfaces was based on the microscopic geometry of bone represented in the pathlength distributions compiled by Beddoe et al. (1976), a significant improvement over previous dosimetry of photons in bone. See Cristy and Eckerman (1987) for further details.

The specific absorbed fractions are tabulated for 12 energies between 10 keV and 4 MeV. For a particular energy of a photon radiation, SEECAL interpolates linearly between energies. Photons of energy below 10 keV are treated in SEECAL as nonpenetrating radiations for most regions and are considered to be absorbed in the source region. For bone dosimetry and for sources in the contents of walled organs like the GI tract, special dosimetry is done, the same as that done for electrons (see section on absorbed fractions for electrons, below).

The changes in dosimetry from Cristy and Eckerman (1987) are as follows:

1) Values of Φ*(urinary bladder wall ← urinary bladder contents)* have been changed for all ages. For the adult male, the bladder modeled in the phantom is relatively full, with a content of 211 g. For

dosimetric purposes, a bladder mid-way in the void cycle, about half full, makes more sense. Data being assembled for the revision of Reference Man indicate that the half full, or average, bladder contents are 10, 25, 65, 75, 85, and 115 ml for newborns, age 1, age 5, age 10, age 15, and adult male, respectively (Bloom et al. 1993; Larsson and Victor 1988; Goellner, Ziegler, and Fomon 1981). The error in using the average size rather than considering the whole cycle is only about 10%, and consequently we are adopting these average values to derive Φ values. Also in deriving $\Phi(wall \leftarrow contents;t)$ values, we make use of the fact that *log* Φ vs. *log mass(contents + wall)* is linear — meaning that we can derive a power function $\Phi = a \cdot Mass^{b}$ — and that it is relatively independent of wall thickness, except at the very low photon energies of 10-15 keV (see Fig. 1). Thus at each photon energy from the data for the six phantoms for urinary bladder to wall, we can derive the *a* and *b* values for the power function and compute Φ for the desired mass of bladder contents.

2) The <u>definition of the source region *Whole Body*</u> was changed to exclude the contents of the GI tract (stomach, small intestine, upper large intestine, lower large intestine), the urinary bladder, and the gall bladder. This was done by subtracting contributions from these regions and then also correcting for the new mass of *Whole Body*:

$$\Phi_k(T \leftarrow WB;t) = \frac{M_{WB'}\,\Phi_k(T \leftarrow WB';t) - \sum_{cont} M_{cont}\,\Phi_k(T \leftarrow cont;t)}{M_{WB'} - \sum_{cont} M_{cont}} \tag{4}$$

where *WB* is the *Whole Body* without these contents, *WB′* is the *Whole Body* with these contents, *cont* refers to one of the contents, *M* is mass, *T* is a particular target region, and the subscript *k* refers to a particular photon energy in the standard grid of 12 energies. The masses of *Whole Body* with the old and new definitions are given in Table 1.

For the adult male, the values $\Phi(T \leftarrow WB)$ were then changed to account for the smaller Reference Man mass of 68.8 kg compared with the adult male phantom mass of 72.3 kg (each without contents). The correction was simply to multiply the values by 72.3/68.8, a change of about 5%. This adjustment is correct within a few percent at all energies when the whole body mass change is relatively small.

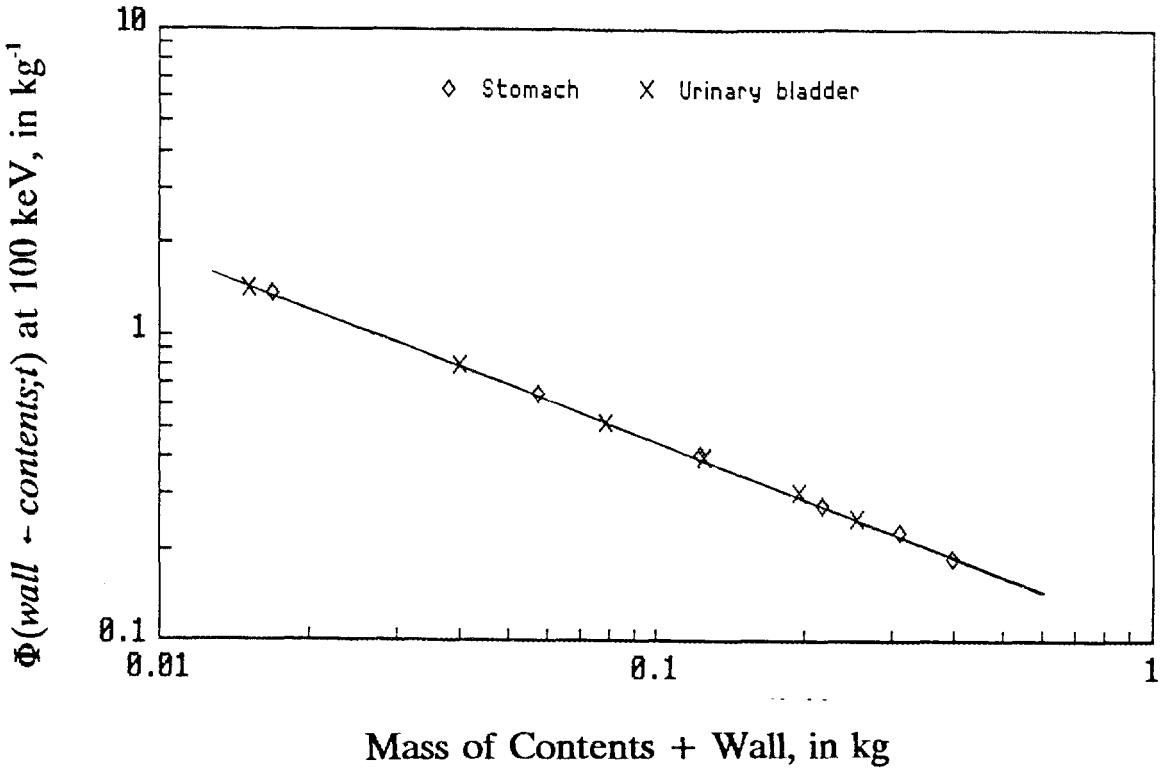

Figure 1. Phantom data used in deriving Φ(*urinary bladder wall ← urinary bladder contents;t*) for the various bladder volumes adopted. This figure shows data for Φ(*wall ← cont;t*) for stomach and urinary bladder plotted against the mass of the contents and wall combined, at photon energy of 100 keV. Stomach wall is relatively thicker than bladder wall, with the ratio mass(wall)/mass(cont) being 0.60-0.65 for stomach and 0.21-0.23 for bladder for the various phantoms. The straight line is drawn through newborn and adult male values for urinary bladder.

Table 1. Mass of *Whole Body* with Old Definition including Various Contents vs. Mass with New Definition excluding these Contents.

Age	Mass with Old Definition	Mass with New Definition
Newborn	3.60 kg	3.54 kg
1 y	9.72	9.54
5 y	19.8	19.5
10 y	33.2	32.6
15 y	56.8	55.8
Adult Male	70	68.8
Adult Female	58	56.9

3) Values of $\Phi(Lung\ Tissue \leftarrow WB;t)$. Small changes were made at energies of 10-100 keV. Changes were at most 12% at 10 keV and 6% at 100 keV. These changes resulted from deriving reciprocity correction factors directly for these two regions instead of multiplying two other reciprocity correction factors from Cristy and Eckerman (1987).

4) The region masses used for the adult male in SEECAL are those from Reference Man (ICRP Publication 23, 1975), rather than the actual masses in the phantom. For age 15, masses for breasts, ovaries, and uterus are adult values from Reference Man. For self-dose, $\Phi(S \leftarrow S;t)$, this calls for a small correction from the Φ's computed for the phantom. Except at low energies, one would expect theoretically that *log* Φ vs. *log mass* would be linear with a slope of -2/3. Empirically, for a wide variety of regions in the phantoms, we find that this holds approximately true for photons with energies from 30 keV to 4 MeV (unpublished data). At energies of 10, 15, and 20 keV, the slope was approximately -0.95, -0.90, and -0.80. Thus, we made corrections by adjusting the Φ's computed for the phantom with this relationship, assuming a slope of -2/3 for energies from 30 keV to 4 MeV and the empirical slopes from 10 to 20 keV.

5) New adult female definition. The single file of Φ values and the single file of region masses derived from the dual purpose age-15-male/adult female phantom have each been split into 2 files, one for age 15 male and one for adult female. The files for age 15 are the same as the old files. For the adult female, several changes were made: (i) Region masses are now mostly reference values from ICRP Publication 23 or, where none given, scaled from reference adult male. Masses for cortical and trabecular bone and for endosteal tissue ("BSurface") are 75% of the male values, instead of the 68% used in ICRP 23, which is too low based on data being assembled for the revision of Reference Man (R. W. Leggett, personal communication). For urinary bladder contents and wall, the age-15-male values were used instead of the ICRP 23 values, which are the same for males and females. (ii) For self-dose, $\Phi(S \leftarrow S;t)$, the correction described in the preceding paragraph was done. (iii) Values of $\Phi(urinary\ bladder\ wall \leftarrow urinary\ bladder\ contents)$ for age 15 were retained for adult female (see paragraph 1, above). (iv) The correction for $\Phi(T \leftarrow WB)$ described in paragraph 2 was done for the adult female. Here the correction was about 2%.

6) In Cristy and Eckerman (1987) for skin and for some walled organs (stomach wall, upper large intestine wall, lower large intestine wall, urinary bladder wall, and gall bladder wall), self-dose values

were based on point-source kernel values, whereas values for newborn and adult male were based on more accurate Monte Carlo values. We found that interpolating on a *log* Φ vs. *log mass* plot between the newborn and adult male values was superior to using the point-source kernel values. Consequently these values are now being used.

The specific absorbed fractions, with these changes, are given in the electronic files PSAFtxt.a??, which are located in directory $DCAL\DAT\SAF after SEECAL is installed (see Table 5 for explanation of notation "$DCAL".)

Absorbed Fractions for Electrons

For electrons, the radiation is assumed to be absorbed entirely in the source region, except when the source is in part of the skeleton or when the source is in the contents of a walled organ (e.g., source is in the stomach contents and target region is the stomach wall). For solid regions, then

$$\phi(T \leftarrow S;t) = \begin{cases} 1, \ if \ T = S \\ 0, \ if \ T \neq S \ and \ S \neq WB \\ M_T \ / \ M_{WB}, \ if \ S = WB \end{cases} \tag{5}$$

Note that if the source region is the *Whole Body* of mass M_{WB}, then the fraction of the whole body activity in the target region is M_T/M_{WB}, to which an absorbed fraction of 1 is applied (third line of Eqn 5).

The ϕ's for radiosensitive tissues in bone are taken from ICRP Publication 30, Part 1 (1979), and are given in Table 2. They are used for all ages.

For contents of walled organs, we use the now-standard assumption used by Snyder et al. (1974) that the dose to the wall is the dose at the surface of a half-space, or half the equilibrium dose to the contents:

$$\Phi(wall \leftarrow cont;t) = \frac{0.5}{M_{cont}} \tag{6}$$

Table 2. Absorbed Fractions used for Dosimetry of Radionuclides in Bone, as Recommended in ICRP Publication 30, Parts 1 and 2.

Source Region[a]	Target Region[a]	α-emitter	β-emitter, $\bar{E}_\beta < 0.2\ MeV$	β-emitter, $\bar{E}_\beta \geq 0.2\ MeV$
C BONE-S	RMarrow	0.0	0.0	0.0
C BONE-V		0.0	0.0	0.0
T BONE-S		0.5	0.5	0.5
T BONE-V		0.05	0.35	0.35
C BONE-S	BSurface	0.25	0.25	0.015
C BONE-V		0.01	0.015	0.015
T BONE-S		0.25	0.25	0.025
T BONE-V		0.025	0.025	0.025
R Marrow	R Marrow	1	1	1
R Marrow	BSurface	(fraction of endosteal tissue associated with red marrow) • (mass of endosteal tissue) ÷ (mass of red marrow)[b]		

[a]The source and target regions are listed in the names used in SEECAL. "C BONE" and "T BONE" are cortical bone and trabecular bone. The "-S" refers to radioactivity distributed on the surface of bone, and "-V" refers to radioactivity distributed uniformly within the volume of bone. The target region BSurface (for Bone Surfaces) refers to the endosteal tissue adjacent to bone surfaces, and RMarrow (for Red Marrow) refers to the hematopoietically active bone marrow. The absorbed fractions recommended for average energy of β-emitters are used for all electrons.

[b]This equation corresponds to the assumption that the specific absorbed fraction in endosteal tissue is the same as that in the red marrow itself. The fraction of endosteal tissue in whole skeleton associated with red marrow is assumed to be 1.0, 0.83, 0.65, 0.65, 0.65, and 0.5 for ages newborn, 1-y, 5-y, 10-y, 15-y, and adult, respectively. Adult value is from ICRP Publication 30, and other values are from Cristy and Eckerman (1987).

Absorbed Fractions for Alpha Particles and Recoil Nuclei

For alpha particles and alpha recoil nuclei, the radiation is also assumed to be absorbed entirely in the source region, except when the source is in part of the skeleton or when the source is in the contents of a walled organ. Eqn (5) applies to all solid regions.

Alpha ϕ's for radiosensitive tissues in bone are taken from ICRP Publication 30, Part 1 (1979), and are given in Table 2. They are used for all ages.

For contents of walled organs, for alpha particles we use the assumptions of ICRP Publication 30 that the equation for electrons should be reduced by one-hundredth to account for the reduced penetration of alphas into the wall to radiosensitive cells and that alpha recoil nuclei do not reach these cells at all:

$$\Phi(wall \leftarrow cont; t) = \frac{0.01 \cdot 0.5}{M_{cont}} \; for\ alpha\ particles \qquad (7)$$
$$= 0 \; for\ alpha\ recoil\ nuclei$$

Spontaneous Fission

Spontaneous fission as a decay mode is not handled in SEECAL. The *SEE* from the radiations emitted by other decay modes of a spontaneously fissioning radionuclide are computed, and a warning message is written to the output file as well as the screen and log file that the contribution from spontaneous fission was ignored. The SEE code of Watson and Ford (1980) addressed, in the adult, the radiations associated with spontaneous fission. At present the necessary age-specific information is not available to include these radiations in SEECAL. A future version of SEECAL may include spontaneous fission.

IV. SOURCE AND TARGET REGIONS USED IN SEECAL

Table 3 shows the source and target regions available to SEECAL, as listed in menus of program SEEPAR. SEEPAR is a utility program that prepares a problem-dependent input file for SEECAL. Table 4 gives the same list, but with source and target regions in parallel columns and with full names and other notes. Note first that most of the regions can be either source or target regions. Note second that there is only one target region that is not also a source region: *Bone Surface (BSurface)*, i.e., the endosteal tissue adjacent to bone surfaces. Most of the regions defined as source regions only are various contents: contents of the GI tract (food and digestive products), urinary bladder (urine), gall bladder (bile), heart (blood passing through the heart chambers), and lungs (air or surface deposition). The other regions defined as source regions only are those in mineral bone (*C Bone-S*, *C Bone-V*, *T Bone-S*, and *T Bone-V*), whole body (*W Body*), *Blood*, soft tissues of whole body (*WB-Soft*), and *Other*. These will be discussed in succeeding paragraphs.

Source Region is in Mineral Bone. SEECAL allows for four different distributions of radioactivity within mineral bone: distribution of activity on surfaces of cortical bone or trabecular bone (*C Bone-S* or *T Bone-S*) or distribution of activity within the volume of cortical or trabecular bone (*C Bone-V* or *T Bone-V*). None of these are target regions, because mineral bone is not radiosensitive. A common point of confusion is the use of the term *Bone Surface* (*BSurface*) for the radiosensitive target region endosteal tissue, because it is neither "bone" in its composition nor a "surface" — it is the volume of soft tissue within 10 μm of the endosteal surface of bone. A source on bone surfaces refers to radioactivity associated with the surface of the mineral bone, not activity within the endosteal cells.

Source Region is *Whole Body (W Body)*. Source region *Whole Body* is used primarily in describing the distribution of systemic activity and in the computation for source region *Other*. It is no longer used as a target region because of the focus on individual organs and tissues in deriving the effective dose. Our definition of *Whole Body* now excludes the contents of the GI tract, the urinary bladder, and the gall bladder. Thus for 70-kg Reference Man, for example, our mass of *Whole Body* is somewhat less than 70 kg because the definition refers only to "living tissues" (see Table 1).

Source Region is *Blood*. Currently source region *Whole Body* is used as a surrogate for blood.

Table 3. Source and Target Regions, as Listed in Menus in Program SEEPAR.

< Source Regions >

Adrenals	St Wall	Lng Tiss	GB Cont
UB Cont	SI Cont	Muscle	GB Wall
UB Wall	SI Wall	Ovaries	Ht Cont
C Bone-S	ULI Cont	Pancreas	Ht Wall
C Bone-V	ULI Wall	R Marrow	Uterus
T Bone-S	LLI Cont	Skin	W Body
T Bone-V	LLI Wall	Spleen	Blood
Brain	Kidneys	Testes	WB-Soft
Breasts	Liver	Thymus	Other
St Cont	Lng Cont	Thyroid	

< Target Regions >

Adrenals	Liver	Thyroid
UB Wall	Lng Tiss	GB Wall
BSurface	Muscle	Ht Wall
Brain	Ovaries	Uterus
Breasts	Pancreas	
St Wall	R Marrow	
SI Wall	Skin	
ULI Wall	Spleen	
LLI Wall	Testes	
Kidneys	Thymus	

Table 4. Names of Source and Target Regions, in Order They Appear in SEEPAR Menus.

Source Regions	Target Regions	Full Names / Notes
Adrenals	Adrenals	
UB Cont		Urinary Bladder Contents
UB Wall	UB Wall	Urinary Bladder Wall
Mineral Bone:		
C Bone-S		Cortical Bone-distributed on Surface
C Bone-V		Cortical Bone-distributed in Volume
T Bone-S		Trabecular Bone-distributed on Surface
T Bone-V		Trabecular Bone-distributed in Volume
	BSurface	Bone Surface – really, the endosteal tissue adjacent to bone surfaces, a soft tissue.
Brain	Brain	
Breasts	Breasts	
Gastrointestinal Tract:		
St Cont		Stomach Contents
St Wall	St Wall	Stomach Wall
SI Cont		Small Intestine Contents
SI Wall	SI Wall	Small Intestine Wall
ULI Cont		Upper Large Intestine Contents
ULI Wall	ULI Wall	Upper Large Intestine Wall
LLI Cont		Lower Large Intestine Contents
LLI Wall	LLI Wall	Lower Large Intestine Wall
Kidneys	Kidneys	
Liver	Liver	
Lng Cont		Lung Contents (air within the lungs or surface deposition)
Lng Tiss	Lng Tiss	Lung Tissue
Muscle	Muscle	
Ovaries	Ovaries	
Pancreas	Pancreas	
R Marrow	R Marrow	Red Marrow
Skin	Skin	
Spleen	Spleen	
Testes	Testes	
Thymus	Thymus	At present also used as a surrogate for esophagus in SEECAL.
Thyroid	Thyroid	
GB Cont		Gall Bladder Contents
GB Wall	GB Wall	Gall Bladder Wall
Ht Cont		Heart Contents
Ht Wall	Ht Wall	Heart Wall
Uterus	Uterus	
W Body		Whole Body (see text for definition).
Blood		See text for definition.
WB-Soft		Soft Tissues of Whole Body (excludes cortical and trabecular bone; includes R Marrow).
Other		See text for definition.

Source Region is Soft Tissues of the Whole Body (*WB-Soft*). *WB-Soft* is a newly defined source region which represents the whole body minus cortical and trabecular bone. This new source region is applicable to radionuclides that are distributed throughout the soft tissues of the body but with little deposition in mineral bone. Φ's for this source region are calculated within SEECAL from other input data, i.e.,

$$\Phi(T \leftarrow WBS;t) = \frac{M_{WB}\,\Phi(T \leftarrow WB;t) - M_{CBV}\,\Phi(T \leftarrow CBV;t) - M_{TBV}\,\Phi(T \leftarrow TBV;t)}{M_{WB} - M_{CBV} - M_{TBV}}, \quad (8)$$

where T is a particular target region, M is mass, *WBS* is *WB-Soft*, *WB* is *Whole Body*, *CBV* is *C Bone-V*, and *TBV* is *T Bone-V*.

Source Region is *Other*. Consider a biokinetic model that explicitly assigns the activity entering body fluid (the systemic activity) to the source regions *Liver, Kidneys, C Bone-V, T Bone-V*, and *R Marrow*, and then specifies that the remaining activity be uniformly distributed in the rest of the body. Source region *Other* is the rest of the body, i.e., *Whole Body* minus the specified regions. *Heart Contents* (*Ht Cont*) is also excluded from *Other*. If we assume that the user runs SEECAL and requests these five source regions plus *Other*, then SEECAL computes the specific absorbed fraction for source region *Other* with the following equation:

$$\Phi(T \leftarrow Other;t) = \frac{M_{WB}\,\Phi(T \leftarrow WB;t) - \sum_S M_S\,\Phi(T \leftarrow S;t) - M_{HtC}\,\Phi(T \leftarrow HtC;t)}{M_{WB} - \sum_S M_S - M_{HtC}}, \quad (9)$$

where T is a particular target region, M is mass, *WB* is *Whole Body*, S is one of the source regions specified in the biokinetic model, and *HtC* is *Heart Contents*. For electrons and alpha particles and target regions other than *R Marrow* and *BSurface*, this equation simplifies to $\Phi(T \leftarrow Other;t) = 0$ if T is one of the source regions S or $1/M_{Other}$ otherwise.

Special Rule for Deposition in Bone. As noted above, the contribution of radiations emitted in *Other* to the energy deposition in target region T is derived assuming that the radioactivity is distributed uniformly by mass in the rest of the body. Since the source regions *C Bone-S* and *T Bone-S* are not volume sources, they cannot be part of *Other*. *C Bone-V* and *T Bone-V* are, however, volume sources and they may be part of *Other*. In computing the *SEE*s for *Other* the following approach is followed:

1. If no source regions in the volume of mineral bone or on its surfaces are explicitly identified, then SEECAL's *Other* includes radioactivity uniformly distributed by mass in the volume of both cortical and trabecular bone, i.e., *C Bone-V* plus *T Bone-V*.

2. If *any* source region in the volume or on the surfaces of mineral bone is explicitly identified, then *Other* does not include any activity in mineral bone, i.e. neither *C Bone-V* nor *T Bone-V*.

The second assumption is based on the premise that, if the user explicitly identifies some mineral region as a source, then he will be complete in the specification for mineral regions. For example, if *C Bone-V* and *Other* were specified as source regions, then it is assumed that *Other* does not include *T Bone-V*. Similarly, the specification of *C Bone-S* and *Other* or *C Bone-S*, *T Bone-S*, and *Other* would result in *Other* not including *C Bone-V* or *T Bone-V*.

Note that the entire mineral bone (*C Bone-V* plus *T Bone-V*) is either included in *Other* or the entire mineral bone is excluded. It is never separated. Note also that the active marrow (*R Marrow*) will always be part of *Other* unless it is explicitly identified as a source region.

Details and Possible Confusions. Source region *Other* seems to give many users some trouble in concept and execution. To help, we give the following details:

1) It makes no difference in the computation whether the contents of the GI tract, the urinary bladder, or the gall bladder are requested as source regions. This is because these sources are not included in the definition of *Whole Body* and thus are never part of *Other*.

2) It makes no difference in the computation whether *Lung Contents (Lng Cont)* is requested as a source region (inhalation source), because it has zero mass associated with it. It does make a difference whether *Lung Tissue (Lng Tiss)* is requested, since it does have a mass and is part of *Whole Body*.

3) It does make a difference in the computation whether *Heart Contents (Ht Cont)* is requested as a source, because the blood passing through the heart chambers is considered part of the *Whole Body*.

4) It makes no difference in the computation whether the number of requested source regions within mineral bone (*C Bone-S*, *C Bone-V*, *T Bone-S*, *T Bone-V*) is one vs. two vs. three vs. four. The only difference is between zero and (one-to-four). See the special rule, above, for details.

5) It makes no difference in the computation whether *BSurface* is requested as a target region. (Choices of target regions never make a difference.) Target *BSurface*, the soft tissue endosteal tissue, has no relationship with sources deposited on mineral bone (*C Bone-S* or *T Bone-S*).

Definition of *Red Marrow (R Marrow)*. The hematopoietically active marrow, following long-time usage in dosimetry, is called here *Red Marrow* (*R Marrow*), although we don't like the term. (It can be either a source or target region.) It should be noted that some "red" marrow is redder than others, i.e., that the percentage of active marrow cells (cellularity) within a volume of marrow varies from site to site in the skeleton. Both the distribution of marrow within the body and the relative "redness" at each site have been taken into account in the dosimetry.

Esophagus. In the present version of SEECAL, the thymus is used as a surrogate for esophagus.

Age-dependent Region Masses

Age-dependent region masses used by SEECAL are largely from the phantom series of Cristy and Eckerman (1987), except in the adult male and the adult female, where Reference Man masses are substituted. (For additional detail on the adult female masses, see paragraph 5 (New adult female definition) in the section **Specific Absorbed Fractions for Photons**, above.) Mass for *Whole Body* excludes contents of the GI tract, urinary bladder, and gall bladder. Thus whole body mass for the adult male is somewhat less that the 70 kg defined for Reference Man, which includes these contents. That is, it is the same Reference Man, but the *definition* of whole body mass is different. More digits are provided for mass of *Whole Body* (5 digits) than for masses of other regions (3 digits) to avoid loss of significance in computations for source region *Other*.

V. INSTALLING THE SEECAL PROGRAM AND FILES

SEECAL is distributed in one of two ways: (1) with programs DEXRAX and SEEPAR as a stand-alone system, run in "batch" mode only; or (2) as part of the larger DCAL system, where it may be run either from the DCAL menu ("DCAL menu" mode) or in batch mode. Program DEXRAX is documented in Eckerman et al. (1993), and SEEPAR is a utility program that prepares a problem-dependent input file for SEECAL and will be documented here. The DCAL system is a large radiation dose and risk calculational system being developed for the Environmental Protection Agency and will be documented elsewhere. Fig. 2 shows where DEXRAX and SEECAL fit within the DCAL system.

The installation instructions are given with the appropriate distribution packet. In either case, the installation procedure sets up a standard directory structure on the hard disk of the user's PC and installs all standard files into their appropriate directories.

From here on, only the stand-alone system and running SEEPAR and SEECAL — or DEXRAX, SEEPAR, and SEECAL as a unit with batch program SEEDEX — in batch mode are considered. Users of the DCAL system should consult the document on the DCAL system (Eckerman et al., in preparation). The standard files described later for the stand-alone system (Table 5) are identical to the DEXRAX-, SEEPAR-, and SEECAL-related files supplied with the DCAL system, and the directories given in Table 5 are a subset of the directories required for the DCAL system. Running DEXRAX and SEECAL in DCAL menu mode is trivial, because no user responses are required.

Directory Structure and Files Required for DEXRAX, SEEPAR, and SEECAL

The directory structure required for DEXRAX, SEEPAR, and SEECAL and the standard files supplied with these programs are given in Table 5. As mentioned above, this directory structure is automatically set up and the files loaded into the proper directories whichever installation procedure (DCAL system or DEXRAX/SEECAL stand-alone system) is used. The user may choose a directory (or directory plus subdirectory) where the system is installed. The notation "$DCAL", used in Table 5 and in the text below, stands for the name of the place where the user installs the system, e.g., "\DCAL", "\PHOENIX", "\PHOENIX\DCAL", or "\ANYTHNG1\ANYTHNG2". The default is "\DCAL".

DCAL: RADIATION DOSE AND RISK CALCULATIONAL SYSTEM

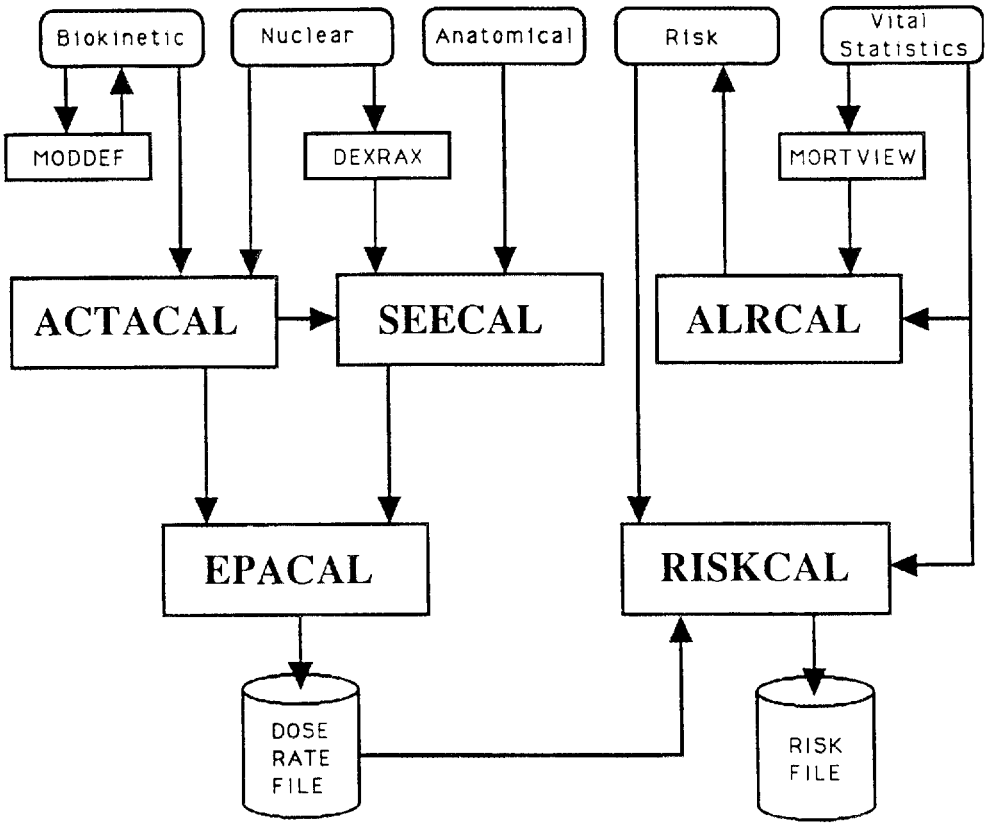

Figure 2. Schematic showing the programs, input data, and flow in the DCAL dosimetric system. The major data elements of the system are shown at the top of the figure (in the rectangles with rounded corners). The two cylinders at the bottom denote the repositories of dosimetric and risk data. Major computation modules in the system have names that end in "CAL" (large rectangles). No naming convention was applied to utilities modules (small rectangles). One might enter into the DCAL system using the utility MODDEF to define an age-specific biokinetic model, run ACTACAL to compute the activity of the radionuclide and any decay products in the body as a function of time following the intake either via ingestion, inhalation, or injection. The module SEECAL computes the dose rate in target tissues and organs per unit activity residing in source regions (as considered by ACTACAL). EPACAL operates on the activity-time information with the data from SEECAL to compute the dose rate as a function of time following the intake. These data can then be processed by RISKCAL with information on the age-specific risk per dose generated by ALRCAL to compute the lifetime risk and years of life lost per unit activity inhaled or ingested. U.S. vital statistical data, including the age and sex-specific cancer mortality data are accessed by MORTVIEW and ALRCAL to compute cancer risk information.

There are one or two work directories set up for output files created when running any of the programs. If the DCAL system is installed, directories $DCAL\WORK and $DCAL\WORK2 are created; if the stand-alone system is installed, only $DCAL\WORK2 is created. All output files created by DEXRAX and SEECAL during DCAL menu runs are put into WORK and all output files created by DEXRAX, SEEPAR, and SEECAL during batch runs are put into WORK2.

The files Dexrax.ini and Seecal.ini contain information on the names and locations of certain standard input files. During the installation procedure, these files are placed into the directory $DCAL\INI. Because some input files are quite large, especially those for DEXRAX, some users may wish to store them elsewhere. This may be done by editing these INI files and moving the appropriate file(s). The contents of the standard INI files are given in Table 6. Note that the first field on each line gives the standard input file name as coded in DEXRAX or SEECAL, and the second field gives the path structure and file name on the user's system. Note: you must not change the name in the first field.

The file StdNames.txt, located in $DCAL\DAT\MIS, defines names of standard age groups and source and target regions used by SEECAL. It is given in Table 7. Files ElAlphAF.a?? give absorbed fractions for electrons and alphas for the various standard age groups, files PhtonSAF.a?? give specific absorbed fractions for photons, and files RegMass.a?? give region masses. These files are in $DCAL\DAT\SAF. Examples of ElAlphAF and RegMass files are given in Tables 8 and 9. An excerpt from a PhtonSAF file is given in Table 10.

Table 5. Standard Directory Structure and Standard Files Supplied for SEECAL and DEXRAX.

The notation "$DCAL" stands for the name of the directory (or directory plus subdirectory) where the user chooses to install the system, e.g., "\DCAL", "\PHOENIX", "\PHOENIX\DCAL", or "\ANYTHNG1\ANYTHNG2". The default is "\DCAL".

Directory	Standard Files	Notes
$DCAL	Dexrax.bat	Batch file to run DEXRAX by itself.
	Seepar.bat	Batch file to run SEEPAR by itself.
	Seecal.bat	Batch file to run SEECAL by itself.
	SeeDex.bat	Batch file to run all 3 programs together.
$DCAL\BIN	Dexrax.exe	Executable file for DEXRAX.
	Seepar.exe	Executable file for SEEPAR.
	Seecal.exe	Executable file for SEECAL.
	SeeDex.exe	Executable file that sets up SEEDEX mode.
$DCAL\INI	Dexrax.ini	Initialization file for DEXRAX.
	Seecal.ini	Initialization file for SEECAL.
	Seepar.ini	Initialization file for SEEPAR.
$DCAL\DAT\MIS	StdNames.txt	Defines standard age names and source and target region names for SEECAL.
$DCAL\DAT\NUC	ICRP38.idx	These files are standard input files for DEXRAX.
	ICRP38.rad	
	ICRP38.bet	The ICRP38.* files give nuclear decay data
	MIRD.idx	corresponding to ICRP Publication 38, and the
	MIRD.rad	MIRD.* files give nuclear decay data corresponding
	MIRD.bet	to a MIRD publication (Weber et al. 1989).
$DCAL\DAT\SAF	ElAlphAF.a00	Absorbed fractions for electrons and alphas.
	ElAlphAF.a01	
	ElAlphAF.a05	File extensions refers to ages newborn, 1 year,
	ElAlphAF.a10	5 years, 10 years, 15 years, adult male, and adult female,
	ElAlphAF.a15	respectively.
	ElAlphAF.am	
	ElAlphAF.af	
	PhtonSAF.a00	Specific absorbed fractions for photons.
	PhtonSAF.a01	
	PhtonSAF.a05	
	PhtonSAF.a10	
	PhtonSAF.a15	
	PhtonSAF.am	
	PhtonSAF.af	

Table 5 (cont'd).

Directory	Standard Files	Notes
$DCAL\DAT\SAF (cont'd)	RegMass.a00 RegMass.a01 RegMass.a05 RegMass.a10 RegMass.a15 RegMass.am RegMass.af	Region masses.
$DCAL\WORK	None	Output files (work files) created when running in DCAL menu mode are put here. This directory is set up only when installing the DCAL system.
$DCAL\WORK2	None	Output files (work files) when running in any other mode are put here.

Table 6. Contents of INI files.

The first field on each line is the standard name of the file as referenced in program DEXRAX or SEECAL or SEEPAR. The second field gives the name and path of the file on the user's system (see Table 5 for explanation of the notation "$DCAL"). If you elect to store these files in directories other than the standard ones, edit the second field to give the new directory. Caution: never change the first field. To change from ICRP Publication 38 nuclear decay data to MIRD nuclear decay data, change "ICRP38.idx" to "MIRD.idx" in the Dexrax.ini file.

Contents of Dexrax.ini file:

```
'Index.dat'   '$DCAL\dat\nuc\ICRP38.idx'
```

Contents of Seecal.ini file:

```
'RegMass.a00'    '$DCAL\dat\saf\RegMass.a00'
'RegMass.a01'    '$DCAL\dat\saf\RegMass.a01'
'RegMass.a05'    '$DCAL\dat\saf\RegMass.a05'
'RegMass.a10'    '$DCAL\dat\saf\RegMass.a10'
'RegMass.a15'    '$DCAL\dat\saf\RegMass.a15'
'RegMass.am'     '$DCAL\dat\saf\RegMass.am'
'RegMass.af'     '$DCAL\dat\saf\RegMass.af'
'PhtonSAF.a00'   '$DCAL\dat\saf\PhtonSAF.a00'
'PhtonSAF.a01'   '$DCAL\dat\saf\PhtonSAF.a01'
'PhtonSAF.a05'   '$DCAL\dat\saf\PhtonSAF.a05'
'PhtonSAF.a10'   '$DCAL\dat\saf\PhtonSAF.a10'
'PhtonSAF.a15'   '$DCAL\dat\saf\PhtonSAF.a15'
'PhtonSAF.am'    '$DCAL\dat\saf\PhtonSAF.am'
'PhtonSAF.af'    '$DCAL\dat\saf\PhtonSAF.af'
'ElAlphAF.a00'   '$DCAL\dat\saf\ElAlphAF.a00'
'ElAlphAF.a01'   '$DCAL\dat\saf\ElAlphAF.a01'
'ElAlphAF.a05'   '$DCAL\dat\saf\ElAlphAF.a05'
'ElAlphAF.a10'   '$DCAL\dat\saf\ElAlphAF.a10'
'ElAlphAF.a15'   '$DCAL\dat\saf\ElAlphAF.a15'
'ElAlphAF.am'    '$DCAL\dat\saf\ElAlphAF.am'
'ElAlphAF.af'    '$DCAL\dat\saf\ElAlphAF.af'
'StdNames.txt'   '$DCAL\dat\mis\StdNames.txt'
```

Contents of Seepar.ini file:

```
'StdNames.txt'    '$DCAL\dat\mis\StdNames.txt'
```

Table 7. Contents of File StdNames.txt.

This file gives the standard names for source regions, target regions, and age group names used by SEECAL. Caution: the only files that should be edited by the user are the INI files. All other standard input files to DEXRAX and SEECAL should not be edited.

```
'SOURCE REGIONS'
'Adrenals'
'UB Cont '
'UB Wall '
'C Bone-S'
'C Bone-V'
'T Bone-S'
'T Bone-V'
'Brain   '
'Breasts '
'St Cont '
'St Wall '
'SI Cont '
'SI Wall '
'ULI Cont'
'ULI Wall'
'LLI Cont'
'LLI Wall'
'Kidneys '
'Liver   '
'Lng Cont'
'Lng Tiss'
'Muscle  '
'Ovaries '
'Pancreas'
'R Marrow'
'Skin    '
'Spleen  '
'Testes  '
'Thymus  '
'Thyroid '
'GB Cont '
'GB Wall '
'Ht Cont '
'Ht Wall '
'Uterus  '
'Reserved'    will become Uterine Contents
'Reserved'    will become Uterine Wall
'W Body  '
'Blood   '
'WB-Soft '
'Other   '
'END SOUR'
```

Table 7 (cont'd). StdNames.txt.

```
'TARGET REGIONS'
'Adrenals'
'UB Wall '
'BSurface'
'Brain   '
'Breasts '
'St Wall '
'SI Wall '
'ULI Wall'
'LLI Wall'
'Kidneys '
'Liver   '
'Lng Tiss'
'Muscle  '
'Ovaries '
'Pancreas'
'R Marrow'
'Skin    '
'Spleen  '
'Testes  '
'Thymus  '
'Thyroid '
'GB Wall '
'Ht Wall '
'Uterus  '
'Reserved'    will become Uterine Wall
'Reserved'    will become Fetus
'END TARG'
'AGE NAMES'
'Newborn'
'Age 1'
'Age 5'
'Age 10'
'Age 15'
'Adult Male'
'Adult Female'
'END AGE NAMES'
```

Table 8. Example of File with Electron and Alpha AFs: File ElAlphAF.a10 for Age 10.

```
Age 10
ELECTRON AFs
Adrenals<-Adrenals        1.0
Brain   <-Brain           1.0
Breasts <-Breasts         1.0
GB Wall <-GB Wall         1.0
LLI Wall<-LLI Wall        1.0
SI Wall <-SI Wall         1.0
St Wall <-St Wall         1.0
ULI Wall<-ULI Wall        1.0
Ht Wall <-Ht Wall         1.0
Kidneys <-Kidneys         1.0
Liver   <-Liver           1.0
Lng Tiss<-Lng Cont        1.0
Lng Tiss<-Lng Tiss        1.0
Muscle  <-Muscle          1.0
Ovaries <-Ovaries         1.0
Pancreas<-Pancreas        1.0
Skin    <-Skin            1.0
Spleen  <-Spleen          1.0
Testes  <-Testes          1.0
Thymus  <-Thymus          1.0
Thyroid <-Thyroid         1.0
UB Wall <-UB Wall         1.0
Uterus  <-Uterus          1.0
END ELECTRON AFs
Age 10
ALPHA AFs
Adrenals<-Adrenals        1.0
Brain   <-Brain           1.0
Breasts <-Breasts         1.0
GB Wall <-GB Wall         1.0
LLI Wall<-LLI Wall        1.0
SI Wall <-SI Wall         1.0
St Wall <-St Wall         1.0
ULI Wall<-ULI Wall        1.0
Ht Wall <-Ht Wall         1.0
Kidneys <-Kidneys         1.0
Liver   <-Liver           1.0
Lng Tiss<-Lng Cont        1.0
Lng Tiss<-Lng Tiss        1.0
Muscle  <-Muscle          1.0
Ovaries <-Ovaries         1.0
Pancreas<-Pancreas        1.0
Skin    <-Skin            1.0
Spleen  <-Spleen          1.0
Testes  <-Testes          1.0
Thymus  <-Thymus          1.0
Thyroid <-Thyroid         1.0
UB Wall <-UB Wall         1.0
Uterus  <-Uterus          1.0
END ALPHA AFs
```

Table 9. Example of Region Mass File: File RegMass.am for Adult Male. (Masses are in kg.)

```
Adult Male
MASS TARGET REGIONS  ICRP Publication 23 masses for adult male, except
Adrenals  1.40E-02   that adult female masses are used for breasts,
Brain     1.40E+00   ovaries, and uterus.
Breasts   3.60E-01
GB Wall   1.00E-02
LLI Wall  1.60E-01
SI Wall   6.40E-01
St Wall   1.50E-01
ULI Wall  2.10E-01
Ht Wall   3.30E-01
Kidneys   3.10E-01
Liver     1.80E+00
Lng Tiss  1.00E+00
Muscle    2.80E+01
Ovaries   1.10E-02
Pancreas  1.00E-01
R Marrow  1.50E+00
BSurface  1.20E-01 from Cristy and Eckerman, ORNL/TM-8381/V1, p. 5 (amended)
Skin      2.60E+00
Spleen    1.80E-01
Testes    3.50E-02
Thymus    2.00E-02
Thyroid   2.00E-02
UB Wall   4.50E-02
Uterus    8.00E-02
END T MASS
Adult Male
MASS SOURCE REGIONS    ICRP Publication 23 masses for adult male, except
Adrenals  1.40E-02     that adult female masses are used for breasts,
Brain     1.40E+00     ovaries, and uterus.
Breasts   3.60E-01
GB Cont   6.20E-02
GB Wall   1.00E-02
LLI Cont  1.35E-01
LLI Wall  1.60E-01
SI Cont   4.00E-01
SI Wall   6.40E-01
St Cont   2.50E-01
St Wall   1.50E-01
ULI Cont  2.20E-01
ULI Wall  2.10E-01
Ht Cont   5.00E-01
Ht Wall   3.30E-01
Kidneys   3.10E-01
Liver     1.80E+00
Lng Tiss  1.00E+00
Lng Cont       0.0
```

Table 9 (cont'd). RegMass.am.

```
Muscle     2.80E+01
Ovaries    1.10E-02
Pancreas   1.00E-01
R Marrow   1.50E+00
C Bone-V   4.00E+00
T Bone-V   1.00E+00
Skin       2.60E+00
Spleen     1.80E-01
Testes     3.50E-02
Thymus     2.00E-02
Thyroid    2.00E-02
UB Cont    1.20E-01   Based on half-void size model.
UB Wall    4.50E-02
Uterus     8.00E-02
W Body     6.8831E+01 excludes contents of gb, ub, st, si, uli, lli.
END S MASS
```

Table 10. Example of Photon SAF File: Beginning of File PhtonSAF.a05 for Age 5.

Age 5 X

PHOTON SAFs X

Adrenals<-Adrenals	1.42E+02	8.15E+01	4.35E+01	1.52E+01	4.85E+00	2.89E+00	3.18E+00	3.58E+00	3.23E+00	2.94E+00	2.73E+00	2.30E+00
UB Wall <-Adrenals	0.0	0.0	3.53E-07	2.79E-04	1.80E-03	2.70E-03	3.10E-03	3.39E-03	3.34E-03	3.25E-03	3.19E-03	2.71E-03
BSurface<-Adrenals	1.45E-03	2.64E-02	7.62E-02	1.33E-01	1.10E-01	4.33E-02	2.38E-02	1.96E-02	1.80E-02	1.66E-02	1.55E-02	1.29E-02
Brain <-Adrenals	0.0	0.0	0.0	2.94E-06	1.15E-04	2.70E-04	4.40E-04	6.70E-04	7.80E-04	8.20E-04	8.50E-04	9.10E-04
Breasts <-Adrenals	0.0	2.42E-09	3.47E-05	3.16E-03	7.54E-03	1.19E-02	1.12E-02	8.44E-03	8.03E-03	7.74E-03	7.46E-03	6.18E-03
St Wall <-Adrenals	0.0	8.23E-05	4.83E-03	3.34E-02	4.81E-02	3.57E-02	2.84E-02	2.83E-02	2.60E-02	2.33E-02	2.16E-02	1.91E-02
SI Wall <-Adrenals	0.0	7.24E-07	3.82E-04	5.90E-03	1.65E-02	1.57E-02	1.52E-02	1.34E-02	1.30E-02	1.19E-02	1.09E-02	8.84E-03
ULI Wall<-Adrenals	0.0	5.13E-07	4.05E-04	6.41E-03	1.85E-02	1.64E-02	1.41E-02	1.45E-02	1.55E-02	1.46E-02	1.34E-02	1.00E-02
LLI Wall<-Adrenals	0.0	3.88E-09	1.92E-05	1.32E-03	3.77E-03	5.57E-03	5.22E-03	4.64E-03	5.11E-03	4.94E-03	4.65E-03	3.94E-03
Kidneys <-Adrenals	1.48E-02	1.26E-01	2.56E-01	2.69E-01	1.61E-01	1.07E-01	1.00E-01	1.06E-01	9.91E-02	8.87E-02	8.09E-02	6.55E-02
Liver <-Adrenals	1.29E-04	1.22E-02	4.97E-02	8.92E-02	7.21E-02	4.88E-02	4.42E-02	4.36E-02	3.96E-02	3.69E-02	3.48E-02	2.83E-02
Lng Tiss<-Adrenals	1.84E-04	1.44E-02	5.26E-02	7.81E-02	5.62E-02	3.57E-02	3.30E-02	3.15E-02	3.12E-02	2.81E-02	2.51E-02	1.84E-02
Muscle <-Adrenals	1.85E-02	3.62E-02	4.03E-02	3.18E-02	2.03E-02	1.44E-02	1.43E-02	1.45E-02	1.39E-02	1.29E-02	1.20E-02	9.92E-03
Ovaries <-Adrenals	0.0	2.30E-10	1.03E-05	1.68E-03	6.27E-03	7.16E-03	7.37E-03	6.90E-03	6.37E-03	6.11E-03	5.93E-03	4.94E-03
Pancreas<-Adrenals	1.95E-06	1.83E-02	1.34E-01	2.76E-01	1.88E-01	1.16E-01	1.12E-01	9.86E-02	9.11E-02	7.89E-02	7.17E-02	7.00E-02
R Marrow<-Adrenals	3.82E-04	6.28E-03	1.69E-02	2.82E-02	2.79E-02	2.27E-02	2.20E-02	2.24E-02	2.05E-02	1.89E-02	1.77E-02	1.46E-02
Skin <-Adrenals	9.93E-09	2.49E-04	1.47E-03	5.12E-03	5.64E-03	4.91E-03	5.28E-03	5.88E-03	5.62E-03	5.43E-03	5.21E-03	4.25E-03
Spleen <-Adrenals	3.67E-07	5.89E-03	5.55E-02	1.43E-01	1.16E-01	6.73E-02	6.50E-02	6.05E-02	5.33E-02	5.43E-02	5.36E-02	3.95E-02
Testes <-Adrenals	0.0	0.0	2.88E-09	2.79E-05	5.22E-04	1.09E-03	1.37E-03	1.62E-03	1.68E-03	1.68E-03	1.68E-03	1.47E-03
Thymus <-Adrenals	0.0	1.15E-09	1.90E-05	4.37E-03	6.63E-03	7.20E-03	6.88E-03	6.61E-03	6.97E-03	6.78E-03	6.44E-03	5.29E-03
Thyroid <-Adrenals	0.0	0.0	1.92E-07	2.22E-04	1.84E-03	2.98E-03	2.93E-03	3.21E-03	3.17E-03	3.09E-03	3.03E-03	2.58E-03
GB Wall <-Adrenals	0.0	2.03E-04	1.12E-02	5.01E-02	7.61E-02	5.40E-02	4.53E-02	4.14E-02	3.48E-02	3.10E-02	2.86E-02	2.34E-02
Ht Wall <-Adrenals	0.0	6.33E-05	6.76E-03	3.36E-02	4.34E-02	3.10E-02	2.84E-02	2.84E-02	2.67E-02	2.44E-02	2.25E-02	1.80E-02
Uterus <-Adrenals	0.0	0.0	5.93E-06	1.30E-03	5.22E-03	6.39E-03	6.87E-03	6.40E-03	5.83E-03	5.59E-03	5.44E-03	4.54E-03
Ut Wall <-Adrenals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00
Fetus <-Adrenals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00
Adrenals<-UB Cont	0.0	0.0	2.89E-07	2.66E-04	1.33E-03	2.79E-03	3.02E-03	3.59E-03	3.24E-03	3.00E-03	2.88E-03	2.70E-03
UB Wall <-UB Cont	2.93E+00	4.11E+00	3.79E+00	2.20E+00	9.02E-01	5.11E-01	5.21E-01	5.30E-01	4.89E-01	4.50E-01	4.16E-01	3.32E-01
BSurface<-UB Cont	5.24E-09	7.37E-06	1.26E-03	1.77E-02	3.25E-02	1.77E-02	9.34E-03	6.37E-03	6.16E-03	5.87E-03	5.57E-03	4.85E-03
Brain <-UB Cont	0.0	0.0	0.0	3.49E-09	1.77E-06	1.03E-05	2.36E-05	5.14E-05	8.74E-05	1.16E-04	1.42E-04	2.25E-04
Breasts <-UB Cont	0.0	0.0	1.57E-09	2.02E-05	4.26E-04	9.28E-04	1.21E-03	1.46E-03	1.54E-03	1.53E-03	1.49E-03	1.35E-03
St Wall <-UB Cont	0.0	2.46E-09	1.79E-05	1.81E-03	4.47E-03	6.64E-03	5.93E-03	5.06E-03	5.00E-03	4.93E-03	4.84E-03	4.53E-03
SI Wall <-UB Cont	2.16E-10	1.50E-04	6.96E-03	4.28E-02	5.43E-02	3.64E-02	3.30E-02	3.01E-02	2.74E-02	2.52E-02	2.34E-02	1.93E-02
ULI Wall<-UB Cont	4.38E-10	1.29E-04	5.06E-03	3.02E-02	4.26E-02	3.14E-02	2.71E-02	2.40E-02	2.35E-02	2.09E-02	1.90E-02	1.67E-02
LLI Wall<-UB Cont	1.54E-05	8.15E-03	6.61E-02	1.60E-01	1.25E-01	7.12E-02	7.01E-02	6.37E-02	5.63E-02	5.47E-02	5.26E-02	4.04E-02
Kidneys <-UB Cont	0.0	1.75E-10	6.02E-06	9.73E-04	4.10E-03	6.08E-03	5.56E-03	5.88E-03	5.16E-03	4.67E-03	4.47E-03	4.58E-03
Liver <-UB Cont	0.0	1.36E-09	1.03E-05	1.39E-03	4.14E-03	4.75E-03	4.65E-03	5.20E-03	5.24E-03	4.89E-03	4.56E-03	3.77E-03
Lng Tiss<-UB Cont	0.0	0.0	2.14E-08	6.23E-05	6.00E-04	7.38E-04	8.95E-04	1.11E-03	1.25E-03	1.33E-03	1.38E-03	1.49E-03
Muscle <-UB Cont	1.60E-03	1.18E-02	2.60E-02	3.61E-02	2.63E-02	1.74E-02	1.65E-02	1.66E-02	1.55E-02	1.44E-02	1.34E-02	1.10E-02
Ovaries <-UB Cont	3.95E-09	1.58E-03	3.16E-02	1.41E-01	1.18E-01	7.51E-02	6.42E-02	5.93E-02	5.62E-02	5.12E-02	4.66E-02	3.55E-02
Pancreas<-UB Cont	0.0	0.0	2.01E-06	6.73E-04	3.01E-03	5.16E-03	5.44E-03	4.99E-03	4.63E-03	4.34E-03	4.15E-03	3.92E-03
R Marrow<-UB Cont	0.0	2.24E-05	5.37E-04	6.18E-03	1.10E-02	9.70E-03	8.79E-03	8.56E-03	7.76E-03	7.23E-03	6.89E-03	6.16E-03
Skin <-UB Cont	2.44E-05	3.67E-04	2.52E-03	8.52E-03	7.75E-03	6.00E-03	6.07E-03	6.77E-03	6.73E-03	6.52E-03	6.18E-03	4.75E-03
Spleen <-UB Cont	0.0	0.0	1.10E-06	5.41E-04	2.41E-03	3.74E-03	3.23E-03	3.21E-03	3.66E-03	3.53E-03	3.39E-03	3.43E-03
Testes <-UB Cont	1.50E-08	2.43E-03	6.09E-02	1.73E-01	1.25E-01	7.38E-02	6.92E-02	6.94E-02	6.53E-02	6.17E-02	5.81E-02	4.65E-02
Thymus <-UB Cont	0.0	0.0	1.46E-10	5.39E-06	1.85E-04	5.11E-04	6.90E-04	9.28E-04	1.02E-03	1.05E-03	1.05E-03	9.58E-04
Thyroid <-UB Cont	0.0	0.0	0.0	3.50E-07	3.64E-05	1.61E-04	2.78E-04	4.18E-04	5.01E-04	5.38E-04	5.67E-04	5.40E-04
GB Wall <-UB Cont	0.0	1.73E-08	6.66E-05	3.78E-03	7.98E-03	8.19E-03	8.41E-03	8.59E-03	8.28E-03	7.98E-03	7.74E-03	6.38E-03
Ht Wall <-UB Cont	0.0	0.0	2.01E-08	6.05E-05	6.77E-04	1.05E-03	1.25E-03	1.37E-03	1.47E-03	1.56E-03	1.63E-03	1.89E-03
Uterus <-UB Cont	1.88E-04	6.76E-02	3.14E-01	5.03E-01	2.94E-01	1.61E-01	1.52E-01	1.51E-01	1.30E-01	1.22E-01	1.16E-01	9.68E-02
Ut Wall <-UB Cont	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00
Fetus <-UB Cont	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00E+00

VI. RUNNING SEECAL FROM SEECAL BATCH MODE AND SEEDEX BATCH MODE

The rest of this document is devoted to explaining how to run SEECAL from batch mode — either by itself (SEECAL batch mode) or as a package with DEXRAX and SEEPAR (SEEDEX batch mode) — and also explaining naming conventions and the contents of the various problem-dependent input and output files. Naming conventions for the stems (but not the extensions) of some of the input and output files for DEXRAX, SEEPAR, and SEECAL are different for SEECAL batch mode, SEEDEX batch mode, and DCAL menu mode. In general, for the modes where more programs are run together (DCAL and SEEDEX), the software chooses a standard stem name more often and gives the user fewer such choices (and you are consequently queried for less information as well). When SEEDEX or DCAL is being run, you are first queried for a single stem name to be used for many of the file names created during the run.

DEXRAX, SEEPAR, SEECAL, and SEEDEX are all run from directory $DCAL, and all output files are written into subdirectory WORK2. (The DCAL menu is also run from $DCAL, but output files are written into subdirectory WORK. Remember that $DCAL is our notation for the parent directory you chose when you installed the software.) It is assumed that you are familiar with running DEXRAX by itself in batch mode. If that is not true, see Eckerman et al. (1993); however, the nuclear decay data file produced by DEXRAX and used in the examples for SEECAL batch mode is provided with the installation package. When DEXRAX is run through SEEDEX, there are fewer queries to the user, but otherwise is identical to a DEXRAX batch run. An example of DEXRAX run through SEEDEX will be given in Section VIII, *EXAMPLE OF RUNNING DEXRAX, SEEPAR, AND SEECAL TOGETHER IN SEEDEX BATCH MODE.*

Input Files

Standard Input Files Supplied with SEECAL

SEECAL requires, for each standard age group, files with data of photon SAFs, electron and alpha AFs, and masses of source and target regions, referred to above. They are ASCII files, except for the photon SAFs, which were made unformatted to save running time. For the photon SAFs, ASCII

files from which the unformatted files were created are supplied for information only. They are named PSAFtxt.a?? and are also in directory $DCAL\DAT\SAF. The files StdNames.txt and Seecal.ini, also referred to above, are ASCII files.

Nuclide Decay Data (Radiations Data) File

When running in SEECAL batch mode, program DEXRAX must first be run to construct the decay data file, which will be read by SEECAL. When running in SEEDEX mode, DEXRAX is executed by the SEEDEX batch file after a few preliminary queries to the user about the run as a whole.

The nuclide decay data file created by DEXRAX always has extension RAD. (Note: in DEXRAX, the RAD file is referred to as the radiations data file, to distinguish it from the beta spectra data file, whose extension is BET. In this document, "decay data" and "radiations data" are used synonymously.) If DEXRAX is run in DEXRAX batch mode, the user has complete choice as to its stem name. If SEEDEX is run, the RAD file has the standard stem name chosen by the user for that SEEDEX run.

DEXRAX can produce RAD files with 1-400 radionuclides, but SEECAL is more limited. If the RAD file input to SEECAL has more than 30 nuclides, or if the total number of radiations for all nuclides combined is greater than 6000, SEECAL will write an error message to the screen and to the log file and stop execution.

SEECAL expects to read the nuclide decay data file from the WORK2 subdirectory.

User Request File; How to Run SEEPAR Utility

Before SEECAL is run, you must also construct a "user request file" with the interactive, menu-driven preparatory program SEEPAR or with a text editor. If SEEDEX is being run, SEEPAR is executed by the SEEDEX batch file after DEXRAX completes execution. The request file always has extension REQ. If SEEPAR is run by itself, you may choose any stem name of 1-8 characters. If SEEPAR is run through SEEDEX, then the stem name chosen for the SEEDEX run is given to this file.

SEECAL expects to read this file from the WORK2 subdirectory.

This file includes title (or information) lines for the *SEE* output files, the dosimetric quantity to be computed, type of *SEE* tables desired, age groups, source regions, and target regions. Examples of user request files are shown in Figs. 3, 7, and 13 (files Example1.req, Example2.req, and Example3.req, respectively) and are discussed in Section VII, *EXAMPLES OF SEECAL BATCH RUNS.* File Example1.req was created with a text editor; file Example2.req was created with SEEPAR; and file Example3.req was copied from Example2.req and edited.

Most of the discussion in the rest of this section is needed only if you are constructing or editing the request file yourself, since SEEPAR is menu-driven. To run SEEPAR by itself, type "seepar" at the DOS prompt from the $DCAL directory and follow the instructions given with the menus. For selecting source or target regions, you are asked first whether you want normal or complement mode: in normal mode, none of the regions is initially selected and you select those you want; in complement mode, all of the regions are initially selected and you de-select those you don't want (by toggling with the space bar, in either case).

Look at the request file Example1.req in Fig. 3. The first line of the REQ file may have anything you want, when using a text editor; SEEPAR puts the file name on the first line and this convention is recommended for REQ files produced with a text editor. You may input 0-9 title lines (0-7 with SEEPAR, because it adds its "time stamp", giving the version of SEEPAR and the time and date run as title line 1 and directory information on the Seepar.exe file as title line 2; see Fig. 7). These title lines will be written to each *SEE* file (one file for each nuclide is created by SEECAL). Each title line may be up to 80 characters long. The delimiters TITLE and END TITLE are required even if you choose to have no title lines in the *SEE* output files. If you choose to have no title lines, these delimiters must be lines 2 and 3 of the request file. If you use SEEPAR, it supplies these and all other delimiters. The input, including delimiters, is case insensitive: except for the title/information lines, everything is converted internally by SEECAL to lower case.

The quantity computed must be "equivalent dose" or "absorbed dose". Units will be Sv or Gy per nuclear transformation. Type of table must be "full table", "total only", or "low-hi let". Choice "full table" gives separate *SEE*s for each kind of radiation (photons, electrons, alphas, spontaneous fissions) as well as total *SEE* (warning: this version of SEECAL does not compute the *SEE* contributed by spontaneous fission — it gives values of zero for this component and writes an error

Figure 3. Example 1: User Request File $DCAL\WORK2\Example1.req (made with Text Editor)

```
This is file Example1.req   | First line can have anything, but must be present.
TITLE                       | Delimiter TITLE, format a5; must be 2nd line.
Run SEECAL with nuclide decay data file Ra224d.dex (Ra-224 and its
radioactive daughters) as Example 1.
Run it for all 6 age groups (Newborn to Adult Male).
Use source regions used in a biokinetic model for radium but with fewer
target regions.
Request dose type to be EQUIVALENT DOSE.
Request type of SEE tables to be TOTAL ONLY.
END TITLE                 | Delimiter END TITLE, format a9.
equivalent dose           | Dose type, format a15.
total only                | Table type, format a10.
AGE GROUPS                | Delimiter AGE GROUPS, format a10.
Newborn                   |
Age 1                     | Names of age groups (maximum = 6), format a20
Age 5                     | (the order input here determines the order
Age 10                    | in the output).
Age 15                    |
Adult Male                |
END AGE GROUPS            | Delimiter END AGE GROUPS, format a20.
SOURCE REGIONS            | Delimiter SOURCE REGIONS, format a14.
LLI Cont                  |
SI Cont                   | Names of source regions, format a8
St Cont                   | (the order input here determines the order
ULI Cont                  | in the output).
Kidneys                   |
Liver                     |
Lng Cont                  |
R Marrow                  |
C Bone-S                  |
C Bone-V                  |
T Bone-S                  |
T Bone-V                  |
Other                     |
END SOURCE REGIONS        | Delimiter END SOUR, format a8.
TARGET REGIONS            | Delimiter TARGET REGIONS, format a14.
Breasts                   |
LLI Wall                  | Names of target regions, format a8
SI Wall                   | (the order input here determines the order
St Wall                   | in the output).
ULI Wall                  |
Kidneys                   |
Liver                     |
Lng Tiss                  |
Ovaries                   |
R Marrow                  |
BSurface                  |
Testes                    |
Thyroid                   |
END TARGET REGIONS        | Delimiter END TARG, format a8.
```

message to the screen, to the log file, and to the *SEE* file). Choice "total only" gives total *SEE* only and is the usual choice when one is interested only in using the *SEE*s for equivalent dose calculations. Choice "low-hi let" gives separate *SEE*s for low and high LET radiations as well as total *SEE*. For this choice the quantity computed is always absorbed dose; if you request "equivalent dose" and "low-hi let" (impossible with the preparatory program SEEPAR), SEECAL writes an error message to the screen and to the log file, changes the quantity to absorbed dose, and continues execution. Names of age groups that you may choose are: Newborn, Age 1, Age 5, Age 10, Age 15, Adult Male, and Adult Female. Names of source and target regions that you may choose were given previously in Tables 3 and 4. The order of age groups and source and target regions in the *SEE* output files is determined by the order in the request file. Since SEEPAR is menu-driven, it forces a certain order. If you desire a different order, you must construct the file yourself with a text editor or edit a file constructed by SEEPAR. Note that beginning and ending delimiters are required for age groups, source regions, and target regions; these delimiters are supplied automatically if you are using SEEPAR. SEECAL has many error traps to detect errors in the request file, should you choose to construct or edit your own. Error messages are written to the screen and to the log file.

Output Files

Log File for Diagnostics/Error Messages

This file contains a listing of everything in the user request input file, as read and interpreted by SEECAL, some diagnostic messages, and error messages. All error messages are also written to the screen. Messages are intended to be self-explanatory. Examples of SEECAL log files are given in Figs. 5 and 19 and are discussed in Section VII, *EXAMPLES OF SEECAL BATCH RUNS*.

Log files always have the extension LOG. If SEECAL batch mode is being run, the name is Seecal.log. SEECAL checks whether a file of this name already exists in the WORK2 subdirectory. If it does, SEECAL gives you 3 options: overwrite the old file, append to the existing file, or rename the file by changing the extension (the sole exception to the rule that log files always have extension LOG), with overwriting being the default. If SEEDEX is being run, the SEECAL log is appended to the existing log file for the run, which has the stem name for the SEEDEX run. Similarly, if SEECAL is run from the DCAL menu, the SEECAL log is appended to the existing log file for the DCAL run.

SEE Files

One *SEE* file is created for each nuclide in the decay data file extracted by DEXRAX. SEECAL constructs the name of each file by adding the extension SEE to a stem formed with the nuclide name as given in the decay data file (minus the hyphen) plus one letter that designates the quantity calculated (*h* for "equivalent dose" or *d* for "absorbed dose") plus one letter that designates the type of the *SEE* tables (*f* for "full table", *t* for "total only", or *l* for "low-hi let"). For example, if the decay data file contained Ra-224 and its radioactive daughters, with nuclide names within this file of Ra-224, Rn-220, Po-216, etc., and "equivalent dose" and "total only" were requested, then the output files would be Ra224ht.see, Rn220ht.see, Po216ht.see, etc. This naming convention is the same for SEECAL batch mode, SEEDEX batch mode, or DCAL menu mode.

SEECAL checks whether one or more files with these filenames already exist in the WORK2 subdirectory; if they do, SEECAL gives you 3 options: (1) overwrite all the old files, (2) give a new extension, which will be used for all the files to be created, or (3) stop execution; the default is overwriting. If you give a new extension and one or more files with these names also exist, you are again given the 3 options (*ad infinitum*). An example of this is shown in Example 3a in Section VII, *EXAMPLES OF SEECAL BATCH RUNS*; see Fig. 18. (In DCAL menu mode, old *SEE* files in the WORK subdirectory are overwritten without remorse.)

Each file contains the *SEE*s for all age groups, source regions, and target regions selected in the user request file. The names of the age groups, source regions, and target regions are written in a standard form with upper and lower case letters, independent of how they appear in the user request file. This standard form is as given in Table 5.

Examples of *SEE* files are given in Figs. 6, 10-12, and 15-17 and are discussed in Section VII, *EXAMPLES OF SEECAL BATCH RUNS*. Note the following about the structure of the *SEE* files:

(1) The file comprises two parts. Part 1 gives general information about what has been computed, including directory information on the input files and the Seecal.exe file; and Part 2 gives the *SEE*s.

(2) Part 1 gives the SEECAL time stamp (line 2) with the version number and date and the date and time it was run; directory information on the Seecal.exe file and all input files, whether permanent or temporary; all data from the user request file (title, dose type, table type, number of age groups and their names, number of source regions and their names, number of target regions and their names); masses of source and target regions as read from the standard input files (or, for source region *Other*, as calculated by SEECAL); the name of the radionuclide, its half-life, and its mode of decay; and flags to indicate whether photon, electron, alpha, or spontaneous fission radiations are present (*y* if present, *n* if not present). The order of the age groups and the source and target regions is determined by the order in the user request file.

Also in Part 1 is the number of source regions per page (always 7 in this version of SEECAL) and the number of pages per age for the *SEE*s in Part 2. In Part 2 a page is defined as all the *SEE* data for one group of 7 source regions and all the target regions. In Fig. 6, for example, each page starts with the line "equivalent dose (Sv/nt) ... ".

Most of the character variables in Part 1 are enclosed in single quotes, and most variables are separated by spaces or commas. This was done to allow most of the data in this part to be read by other programs with list-directed READ statements.

(3) In Part 2 the order of the *SEE*s (by age, source region, and target region) is determined by the order given in Part 1.

(4) Each line (record) of the file is 80 characters long. Part 1 is intended to be read by other programs sequentially. After Part 1 is read, Part 2 may be read either sequentially with data stored in large arrays for later use or as a direct-access file with records read as needed to minimize storage requirements.

The following two sections give examples of SEECAL batch runs and SEEDEX batch runs, respectively.

VII. EXAMPLES OF SEECAL BATCH RUNS

In Examples 1, 2, 3, and 3a (below), the nuclides in the decay file are Ra-224 and its radioactive daughters, the source regions are those chosen for a biokinetic model for radium, and the target regions are a subset of the target regions chosen for the same purpose. Thus the nuclide decay file, Ra224d.rad, is the same for all three runs; and the source and target regions in the user request files are identical. The examples differ in the quantity calculated, type of *SEE* tables, age groups, order of source and target regions, and title/information lines.

For these examples, $DCAL is C:\DCAL; i.e., the user set up the system in the parent directory \DCAL on drive C.

Example 1

Program DEXRAX was run from directory C:\DCAL to extract the nuclide decay data for Ra-224 and its radioactive daughters from the master file ICRP38.RAD. The file created by DEXRAX was named Ra224d.rad, and it was written to the WORK2 subdirectory. The user request file, named Example1.req, was created with a text editor and is given in Fig. 3. Remember that the user request file must be in the WORK2 subdirectory. (Files Ra224d.rad and Example1.req are provided with the installation software.)

The keyboard input/screen output for this run is shown in Fig. 4, with everything typed by the user underlined. The user's input is short: (1) he typed "seecal" from the DOS prompt in directory \DCAL to start execution; (2) in response to SEECAL's prompting for the name of the input file of the decay data, he typed Ra224d, and the required RAD extension was supplied by SEECAL; and (3) in response to SEECAL's prompting for the name of the input file of user requests, he typed Example1, and the required REQ extension was supplied by SEECAL. None of the user input is case sensitive.

Note that SEECAL wrote a number of messages to the screen. First the name of the program, the version number and date, and authors' names were written. Then comes the message, "Log file will be: Seecal.log." Then the user was prompted for the name of the decay data file, followed by a

prompt for the name of the user request file. Then SEECAL wrote the name of each *SEE* output file to be created: the nuclide name (as read from file Ra224d.rad but without the hyphen) + *h* + *t* + extension SEE. The *h* and *t* designate that quantity = "equivalent dose" and type of table = "total only", respectively, were requested in file Example1.req.

Then SEECAL wrote messages regarding what it was doing. The major program loop in SEECAL is by age group. Within each age group SEECAL wrote messages regarding which nuclide it was working on. When finished with all calculations, it again listed the names of the *SEE* files, wrote a message that it had ended normally, and the DOS prompt appeared. The log file, Seecal.log, is given in Fig. 5. Some of the information is the same as that written to the screen. Also given here are the date and time the program was run and the names of the decay data and user request files. Also given here is information from the user request file, as read and interpreted by SEECAL: title lines, number of title lines, quantity calculated, type of *SEE* tables, names of age groups and two indexes used internally in SEECAL, number of age groups, names of source regions and two indexes used internally, number of source regions, names of target regions and two indexes used internally, and number of target regions. One of the *SEE* output files, Ra224ht.see, is given in Fig. 6. See the section *Output Files*, above, for a discussion of most of what appears here. Not mentioned there, however, is the column of *t*'s following the target region name and under the heading *RAD* in the second part of the file, that giving the *SEE* tables. *RAD* means kind of radiation, and *t* means total *SEE*, i.e., that from all kinds of radiation (photon, electron, alpha) combined.

Figure 4. Example 1: Keyboard Input/Screen Output for SEECAL Run.

User's input is underlined. The ellipses ("...") are written to the screen and indicate a possible slight delay in the output while the program is reading data or doing calculations. Places where the full output to the screen is not listed here are indicated by notes in brackets, i.e., "[similar to above]".

```
C:\DCAL> seecal

SEECAL:  calculate Specific Effective Energies
         Ver. 1.0 (Dec 1, 1993)
         Oak Ridge National Laboratory Report ORNL/TM-12351
Authors: M. Cristy and K. F. Eckerman
         Oak Ridge National Laboratory
         Oak Ridge, TN 37831-6383

Log file will be: Seecal.log

Name of input file for decay data, .rad added -> Ra224d

Name of input file for user requests, .req added -> Example1

Press <Enter> to clear screen & continue SEECAL
<Enter>

SEE output file Ra224ht.SEE will be written.
SEE output file Rn220ht.SEE will be written.
SEE output file Po216ht.SEE will be written.
SEE output file Pb212ht.SEE will be written.
SEE output file Bi212ht.SEE will be written.
SEE output file Po212ht.SEE will be written.
SEE output file Tl208ht.SEE will be written.

Press <Enter> to clear screen & continue SEECAL
<Enter>

MAJOR PROGRAM LOOP: working on age # 1 (newborn) ...

     Reading photon SAFs for age = newborn ...
     Reading electron & alpha AFs for age = newborn ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

MAJOR PROGRAM LOOP: working on age # 2 (age 1) ...
     [similar to above]
```

Figure 4 (cont'd).

```
MAJOR PROGRAM LOOP: working on age # 3 (age 5) ...
     [similar to above]

MAJOR PROGRAM LOOP: working on age # 4 (age 10) ...
     [similar to above]

MAJOR PROGRAM LOOP: working on age # 5 (age 15) ...
     [similar to above]

MAJOR PROGRAM LOOP: working on age # 6 (adult male) ...

     Reading photon SAFs for age = adult male ...
     Reading electron & alpha AFs for age = adult male ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

The following SEE files have been written:
Ra224ht.SEE    Rn220ht.SEE    Po216ht.SEE    Pb212ht.SEE    Bi212ht.SEE
Po212ht.SEE    Tl208ht.SEE

Program SEECAL ended normally.
Stop - Program terminated.

C:\DCAL>
```

Figure 5. Example 1: Log File $DCAL\WORK2\Seecal.log.

```
-----------------------------------------------------------------------------
This is SEECAL log file Seecal.log
<<   SEECAL Ver. 1.0 (Dec 1, 1993) --- Run Dec 05, 1993, at 12:04 >>

 ... Title lines from user request file follow:
 Run SEECAL with nuclide decay data file Ra224d.dex (Ra-224 and its
 radioactive daughters) as Example 1.
 Run it for all 6 age groups (Newborn to Adult Male).
 Use source regions used in a biokinetic model for radium but with fewer
 target regions.
 Request dose type to be EQUIVALENT DOSE.
 Request type of SEE tables to be TOTAL ONLY.
 ... End of title lines; number of title lines = 7

 Quantity to be calculated = "equivalent dose"
 Table type for SEE files = "total only"

 Index iACalc; Age Group Name;          Index iAge
           1  "newborn            "   1
           2  "age 1              "   2
           3  "age 5              "   3
           4  "age 10             "   4
           5  "age 15             "   5
           6  "adult male         "   6
 End of age group list; number of age groups = 6

 Index iSCalc; SOURCE Name; Index iS
           1  "lli cont"   16
           2  "si cont "   12
           3  "st cont "   10
           4  "uli cont"   14
           5  "kidneys "   18
           6  "liver   "   19
           7  "lng cont"   20
           8  "r marrow"   25
           9  "c bone-s"    4
          10  "c bone-v"    5
          11  "t bone-s"    6
          12  "t bone-v"    7
          13  "other   "   40
 End of source region list; number of sources = 13

 Index iTCalc; TARGET Name; Index iT
           1  "breasts "    5
           2  "lli wall"    9
           3  "si wall "    7
           4  "st wall "    6
           5  "uli wall"    8
           6  "kidneys "   10
           7  "liver   "   11
           8  "lng tiss"   12
           9  "ovaries "   14
          10  "r marrow"   16
          11  "bsurface"    3
          12  "testes  "   19
          13  "thyroid "   21
 End of target region list; number of targets = 13

 SEE output file Ra224ht.SEE will be written.
 SEE output file Rn220ht.SEE will be written.
 SEE output file Po216ht.SEE will be written.
 SEE output file Pb212ht.SEE will be written.
 SEE output file Bi212ht.SEE will be written.
 SEE output file Po212ht.SEE will be written.
 SEE output file Tl208ht.SEE will be written.

 SEECAL exe file was:              Seecal.exe      317296 12-01-93  12:00a
 User request file was:            Example1.req      2226 12-05-93  11:59a
 Nuclide decay file was:           Ra224d.rad       22831 12-05-93  12:02p
 File with standard names was:     StdNames.txt      1706 12-01-93  12:00a
 Photon SAF file was:              PhtonSAF.a00     63360 12-01-93  12:00a
 Photon SAF file was:              PhtonSAF.a01     63360 12-01-93  12:00a
 Photon SAF file was:              PhtonSAF.a05     63360 12-01-93  12:00a
 Photon SAF file was:              PhtonSAF.a10     63360 12-01-93  12:00a
 Photon SAF file was:              PhtonSAF.a15     63360 12-01-93  12:00a
 Photon SAF file was:              PhtonSAF.am      63360 12-01-93  12:00a
 Electron-alpha AF file was:       ElAlphAF.a00      1779 12-01-93  12:00a
 Electron-alpha AF file was:       ElAlphAF.a01      1777 12-01-93  12:00a
 Electron-alpha AF file was:       ElAlphAF.a05      1777 12-01-93  12:00a
 Electron-alpha AF file was:       ElAlphAF.a10      1778 12-01-93  12:00a
 Electron-alpha AF file was:       ElAlphAF.a15      1778 12-01-93  12:00a
 Electron-alpha AF file was:       ElAlphAF.am       1782 12-01-93  12:00a
 Region mass file was:             RegMass.a00       2184 12-01-93  12:00a
 Region mass file was:             RegMass.a01       2152 12-01-93  12:00a
 Region mass file was:             RegMass.a05       2152 12-01-93  12:00a
 Region mass file was:             RegMass.a10       2153 12-01-93  12:00a
 Region mass file was:             RegMass.a15       2244 12-01-93  12:00a
 Region mass file was:             RegMass.am        2245 12-01-93  12:00a

 MAJOR PROGRAM LOOP: working on age # 1 (newborn) ...

      Reading photon SAFs for age = newborn ...
      Reading electron & alpha AFs for age = newborn ...
      Calculating SEEs for nuclide = Ra-224  ...
      Calculating SEEs for nuclide = Rn-220  ...
      Calculating SEEs for nuclide = Po-216  ...
      Calculating SEEs for nuclide = Pb-212  ...
      Calculating SEEs for nuclide = Bi-212  ...
      Calculating SEEs for nuclide = Po-212  ...
      Calculating SEEs for nuclide = Tl-208  ...

 MAJOR PROGRAM LOOP: working on age # 2 (age 1) ...

      Reading photon SAFs for age = age 1 ...
      Reading electron & alpha AFs for age = age 1 ...
      Calculating SEEs for nuclide = Ra-224  ...
      Calculating SEEs for nuclide = Rn-220  ...
      Calculating SEEs for nuclide = Po-216  ...
      Calculating SEEs for nuclide = Pb-212  ...
      Calculating SEEs for nuclide = Bi-212  ...
      Calculating SEEs for nuclide = Po-212  ...
      Calculating SEEs for nuclide = Tl-208  ...
```

Figure 5 (cont'd). Seecal.log.

```
MAJOR PROGRAM LOOP: working on age # 3 (age 5) ...

     Reading photon SAFs for age = age 5 ...
     Reading electron & alpha AFs for age = age 5 ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

MAJOR PROGRAM LOOP: working on age # 4 (age 10) ...

     Reading photon SAFs for age = age 10 ...
     Reading electron & alpha AFs for age = age 10 ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

MAJOR PROGRAM LOOP: working on age # 5 (age 15) ...

     Reading photon SAFs for age = age 15 ...
     Reading electron & alpha AFs for age = age 15 ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

MAJOR PROGRAM LOOP: working on age # 6 (adult male) ...

     Reading photon SAFs for age = adult male ...
     Reading electron & alpha AFs for age = adult male ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

The following SEE files have been written:
Ra224ht.SEE    Rn220ht.SEE    Po216ht.SEE    Pb212ht.SEE    Bi212ht.SEE
Po212ht.SEE    Tl208ht.SEE

Program SEECAL ended normally.
```

Figure 6. Example 1: SEE Output File $DCAL\WORK2\Ra224ht.scc.

```
This is SEECAL file Ra224ht.SEE
<<   SEECAL Ver. 1.0 (Dec 1, 1993)  --- Run Dec 05, 1993, at 12:04 >>
SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example1.req      2226 12-05-93  11:59a
Nuclide decay file was:             Ra224d.rad       22831 12-05-93  12:02p
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a
6 = number of age groups
Photon SAF file was:                PhtonSAF.a00     63360 12-01-93  12:00a
Photon SAF file was:                PhtonSAF.a01     63360 12-01-93  12:00a
Photon SAF file was:                PhtonSAF.a05     63360 12-01-93  12:00a
Photon SAF file was:                PhtonSAF.a10     63360 12-01-93  12:00a
Photon SAF file was:                PhtonSAF.a15     63360 12-01-93  12:00a
Photon SAF file was:                PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.a00      1779 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.a01      1777 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.a05      1777 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.a10      1778 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.a15      1778 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:               RegMass.a00       2184 12-01-93  12:00a
Region mass file was:               RegMass.a01       2152 12-01-93  12:00a
Region mass file was:               RegMass.a05       2152 12-01-93  12:00a
Region mass file was:               RegMass.a10       2153 12-01-93  12:00a
Region mass file was:               RegMass.a15       2244 12-01-93  12:00a
Region mass file was:               RegMass.am        2245 12-01-93  12:00a
7 = number of title lines, copied from file Example1.req, that follow:
Run SEECAL with nuclide decay data file Ra224d.dex (Ra-224 and its
radioactive daughters) as Example 1.
Run it for all 6 age groups (Newborn to Adult Male).
Use source regions used in a biokinetic model for radium but with fewer
target regions.
Request dose type to be EQUIVALENT DOSE.
Request type of SEE tables to be TOTAL ONLY.
Following 4 lines are header info from nuclide decay file Ra224d.rad
<<   DEXRAX Ver. 1.0 (Sep 1, 1993)  --- Run Dec 05, 1993, at 12:02 >>
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a
'equivalent dose' = dose type (equivalent dose or absorbed dose)
'total only' = table type (full table, total only, or low-hi let)
'Ra-224 ','     3.66d ','A       ' = nuclide, half-life, decay mode
'y' 'y' 'y' 'n' = photon, electron, alpha, spon. fission flags (Yes/No)
Age Group Name
'Newborn            '
'Age 1              '
'Age 5              '
'Age 10             '
'Age 15             '
'Adult Male         '
13, 7, 2 = # of source regions, # of source regions/page, # of pages/age
S. Region  Masses (kg) for each age group, in order as above
'LLI Cont' 6.98E-03 1.83E-02 3.66E-02 6.17E-02 1.09E-01 1.35E-01
'SI Cont ' 2.03E-02 5.31E-02 1.06E-01 1.79E-01 3.22E-01 4.00E-01
'St Cont ' 1.06E-02 3.62E-02 7.51E-02 1.33E-01 1.95E-01 2.50E-01
'ULI Cont' 1.12E-02 2.87E-02 5.79E-02 9.75E-02 1.76E-01 2.20E-01
'Kidneys ' 2.29E-02 6.29E-02 1.16E-01 1.73E-01 2.48E-01 3.10E-01
'Liver   ' 1.21E-01 2.92E-01 5.84E-01 8.87E-01 1.40E+00 1.80E+00
'Lng Cont' 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
'R Marrow' 4.70E-02 1.50E-01 3.20E-01 6.10E-01 1.05E+00 1.50E+00
'C Bone-S' 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
'C Bone-V' 0.00E+00 2.99E-01 8.75E-01 1.58E+00 3.22E+00 4.00E+00
'T Bone-S' 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00 0.00E+00
'T Bone-V' 1.40E-01 2.00E-01 2.19E-01 3.96E-01 8.06E-01 1.00E+00
'Other   ' 3.17E+00 8.47E+00 1.72E+01 2.88E+01 4.88E+01 5.97E+01
13 = number of target regions
T. Region  Masses (kg) for each age group, in order as above
'Breasts ' 1.07E-04 7.32E-04 1.51E-03 2.60E-03 3.60E-01 3.60E-01
'LLI Wall' 7.96E-03 2.06E-02 4.14E-02 7.00E-02 1.27E-01 1.60E-01
'SI Wall ' 3.26E-02 8.49E-02 1.69E-01 2.86E-01 5.16E-01 6.40E-01
'St Wall ' 6.41E-03 2.18E-02 4.91E-02 8.51E-02 1.18E-01 1.50E-01
'ULI Wall' 1.05E-02 2.78E-02 5.52E-02 9.34E-02 1.68E-01 2.10E-01
'Kidneys ' 2.29E-02 6.29E-02 1.16E-01 1.73E-01 2.48E-01 3.10E-01
'Liver   ' 1.21E-01 2.92E-01 5.84E-01 8.87E-01 1.40E+00 1.80E+00
'Lng Tiss' 5.06E-02 1.43E-01 2.90E-01 4.53E-01 6.51E-01 1.00E+00
'Ovaries ' 3.28E-04 7.14E-04 1.73E-03 3.13E-03 1.10E-02 1.10E-02
'R Marrow' 4.70E-02 1.50E-01 3.20E-01 6.10E-01 1.05E+00 1.50E+00
'BSurface' 1.50E-02 2.60E-02 3.70E-02 6.80E-02 1.20E-01 1.20E-01
'Testes  ' 8.43E-04 1.21E-03 1.63E-03 1.89E-03 1.55E-02 3.50E-02
'Thyroid ' 1.29E-03 1.78E-03 3.45E-03 7.93E-03 1.24E-02 2.00E-02
equivalent dose (Sv/nt) for Ra-224  & Age=Newborn            , p. 1 of 2
TARGETS RAD                          SOURCE REGIONS
------- ---LLI Cont  SI Cont   St Cont   ULI Cont  Kidneys   Liver     Lng Cont.
Breasts  t 1.508E-17 2.041E-17 8.618E-17 2.493E-17 2.712E-17 7.435E-17 1.350E-16
LLI Wall t 1.305E-11 3.973E-16 8.860E-17 1.972E-16 5.503E-17 3.875E-17 1.439E-17
SI Wall  t 4.403E-16 4.487E-12 1.620E-16 7.253E-16 1.463E-16 1.272E-16 3.034E-17
St Wall  t 1.207E-16 1.648E-16 8.594E-12 2.187E-16 1.106E-16 1.822E-16 9.087E-17
ULI Wall t 2.329E-16 8.072E-16 2.021E-16 8.134E-12 1.124E-16 1.976E-16 3.369E-17
Kidneys  t 6.596E-17 1.463E-16 1.096E-16 1.149E-16 8.083E-10 1.557E-16 7.418E-17
Liver    t 4.227E-17 1.272E-16 1.792E-16 1.945E-16 1.557E-16 1.530E-10 1.250E-16
Lng Tiss t 1.659E-17 3.035E-17 8.462E-17 3.410E-17 7.422E-17 1.251E-16 3.658E-10
Ovaries  t 8.832E-16 5.999E-16 6.688E-17 4.442E-16 8.392E-17 6.425E-17 2.080E-17
R Marrow t 5.830E-17 4.831E-17 3.397E-17 4.207E-17 5.996E-17 3.867E-17 5.520E-17
BSurface t 9.117E-17 7.940E-17 6.156E-17 6.831E-17 1.085E-16 7.038E-17 9.818E-17
Testes   t 1.576E-16 5.291E-17 2.079E-17 5.129E-17 1.738E-17 1.472E-17 5.924E-18
Thyroid  t 6.468E-18 7.016E-18 1.633E-17 1.304E-17 1.216E-17 2.011E-17 7.587E-17
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Figure 6 (cont'd). Ra224ht.scc.

equivalent dose (Sv/nt) for Ra-224 & Age=Newborn , p. 2 of 2

TARGETS RAD		SOURCE REGIONS						
		R Marrow	C Bone-S	C Bone-V	T Bone-S	T Bone-V	Other	
Breasts	t	3.102E-17	3.936E-17	3.936E-17	3.102E-17	3.102E-17	5.842E-12	0
LLI Wall	t	5.557E-17	6.058E-17	6.058E-17	5.557E-17	5.557E-17	5.842E-12	0
SI Wall	t	4.847E-17	5.191E-17	5.191E-17	4.847E-17	4.847E-17	5.842E-12	0
St Wall	t	3.432E-17	4.164E-17	4.164E-17	3.432E-17	3.432E-17	5.842E-12	0
ULI Wall	t	4.344E-17	4.725E-17	4.725E-17	4.344E-17	4.344E-17	5.842E-12	0
Kidneys	t	5.793E-17	7.213E-17	7.213E-17	5.793E-17	5.793E-17	6.616E-17	0
Liver	t	3.854E-17	4.721E-17	4.721E-17	3.854E-17	3.854E-17	5.619E-17	0
Lng Tiss	t	5.345E-17	6.614E-17	6.614E-17	5.345E-17	5.345E-17	5.842E-12	0
Ovaries	t	5.450E-17	5.629E-17	5.629E-17	5.450E-17	5.450E-17	5.842E-12	0
R Marrow	t	3.938E-10	1.414E-16	1.414E-16	1.969E-10	1.969E-11	6.194E-17	0
BSurface	t	3.938E-10	3.085E-10	1.234E-11	3.085E-10	3.085E-11	9.449E-17	0
Testes	t	2.704E-17	3.871E-17	3.871E-17	2.704E-17	2.704E-17	5.842E-12	0
Thyroid	t	3.535E-17	3.801E-17	3.801E-17	3.535E-17	3.535E-17	5.842E-12	0

equivalent dose (Sv/nt) for Ra-224 & Age=Age 1 , p. 1 of 2

TARGETS RAD		SOURCE REGIONS						
		LLI Cont	SI Cont	St Cont	ULI Cont	Kidneys	Liver	Lng Cont.
Breasts	t	5.703E-18	8.618E-18	3.283E-17	1.061E-17	1.266E-17	3.611E-17	7.469E-17
LLI Wall	t	4.978E-12	1.988E-16	4.040E-17	9.529E-17	2.396E-17	1.645E-17	8.270E-18
SI Wall	t	2.335E-16	1.716E-12	8.266E-17	3.834E-16	7.536E-17	6.283E-17	1.364E-17
St Wall	t	5.991E-17	8.641E-17	2.517E-12	1.087E-16	5.580E-17	9.237E-17	4.334E-17
ULI Wall	t	1.189E-16	4.176E-16	1.041E-16	3.174E-12	6.350E-17	9.838E-17	1.435E-17
Kidneys	t	3.134E-17	7.536E-17	5.753E-17	6.175E-17	2.943E-10	8.116E-17	3.405E-17
Liver	t	1.965E-17	6.283E-17	8.498E-17	9.851E-17	8.116E-17	6.339E-11	6.379E-17
Lng Tiss	t	7.792E-18	1.365E-17	4.430E-17	1.529E-17	3.410E-17	6.394E-17	1.294E-10
Ovaries	t	4.519E-16	3.115E-16	3.156E-17	2.342E-16	4.119E-17	3.038E-17	7.676E-18
R Marrow	t	3.778E-17	3.103E-17	1.798E-17	2.670E-17	3.759E-17	2.089E-17	2.781E-17
BSurface	t	4.530E-17	3.884E-17	2.990E-17	3.459E-17	5.307E-17	3.483E-17	4.713E-17
Testes	t	7.222E-17	2.590E-17	6.968E-18	2.306E-17	8.051E-18	5.606E-18	2.297E-18
Thyroid	t	2.150E-18	2.494E-18	7.901E-18	3.775E-18	4.386E-18	9.527E-18	4.414E-17

equivalent dose (Sv/nt) for Ra-224 & Age=Age 1 , p. 2 of 2

TARGETS RAD		SOURCE REGIONS						
		R Marrow	C Bone-S	C Bone-V	T Bone-S	T Bone-V	Other	
Breasts	t	1.370E-17	1.552E-17	1.552E-17	1.370E-17	1.370E-17	2.186E-12	0
LLI Wall	t	3.662E-17	2.961E-17	2.961E-17	3.662E-17	3.662E-17	2.186E-12	0
SI Wall	t	2.849E-17	2.233E-17	2.233E-17	2.849E-17	2.849E-17	2.186E-12	0
St Wall	t	1.767E-17	1.705E-17	1.705E-17	1.767E-17	1.767E-17	2.186E-12	0
ULI Wall	t	2.861E-17	2.184E-17	2.184E-17	2.861E-17	2.861E-17	2.186E-12	0
Kidneys	t	3.369E-17	3.116E-17	3.116E-17	3.369E-17	3.369E-17	3.212E-17	0
Liver	t	1.927E-17	2.041E-17	2.041E-17	1.927E-17	1.927E-17	2.741E-17	0
Lng Tiss	t	2.487E-17	2.818E-17	2.818E-17	2.487E-17	2.487E-17	2.186E-12	0
Ovaries	t	3.342E-17	2.493E-17	2.493E-17	3.342E-17	3.342E-17	2.186E-12	0
R Marrow	t	1.234E-10	6.926E-17	6.926E-17	6.170E-11	6.171E-12	3.139E-17	0
BSurface	t	1.024E-10	1.780E-10	7.120E-12	1.780E-10	1.780E-11	4.707E-17	0
Testes	t	1.174E-17	1.594E-17	1.594E-17	1.174E-17	1.174E-17	2.186E-12	0
Thyroid	t	1.668E-17	1.732E-17	1.732E-17	1.668E-17	1.668E-17	2.186E-12	0

equivalent dose (Sv/nt) for Ra-224 & Age=Age 5 , p. 1 of 2

TARGETS RAD		SOURCE REGIONS						
		LLI Cont	SI Cont	St Cont	ULI Cont	Kidneys	Liver	Lng Cont.
Breasts	t	2.816E-18	4.096E-18	1.990E-17	5.377E-18	7.235E-18	1.969E-17	5.119E-17
LLI Wall	t	2.489E-12	1.172E-16	2.373E-17	5.821E-17	1.689E-17	9.138E-18	3.301E-18
SI Wall	t	1.412E-16	8.594E-13	4.866E-17	2.454E-16	4.685E-17	3.579E-17	6.535E-18
St Wall	t	3.382E-17	4.940E-17	1.213E-12	6.373E-17	4.339E-17	4.763E-17	2.681E-17
ULI Wall	t	7.012E-17	2.624E-16	6.124E-17	1.574E-12	4.231E-17	5.496E-17	7.653E-18
Kidneys	t	1.921E-17	4.685E-17	3.918E-17	4.148E-17	1.596E-10	5.549E-17	1.846E-17
Liver	t	9.223E-18	3.579E-17	4.807E-17	5.615E-17	5.549E-17	3.170E-11	3.861E-17
Lng Tiss	t	2.986E-18	6.529E-18	2.514E-17	7.646E-18	1.849E-17	3.869E-17	6.383E-11
Ovaries	t	2.647E-16	1.869E-16	1.727E-17	1.490E-16	2.292E-17	1.556E-17	3.348E-18
R Marrow	t	3.120E-17	2.544E-17	1.204E-17	2.072E-17	2.751E-17	1.372E-17	1.730E-17
BSurface	t	2.367E-17	2.023E-17	1.518E-17	1.759E-17	2.582E-17	1.781E-17	2.471E-17
Testes	t	3.792E-17	1.305E-17	2.189E-18	1.093E-17	2.649E-18	2.223E-18	5.693E-19
Thyroid	t	7.114E-19	9.900E-21	3.477E-18	1.481E-18	2.807E-18	4.532E-18	2.443E-17

equivalent dose (Sv/nt) for Ra-224 & Age=Age 5 , p. 2 of 2

TARGETS RAD		SOURCE REGIONS						
		R Marrow	C Bone-S	C Bone-V	T Bone-S	T Bone-V	Other	
Breasts	t	8.828E-18	7.998E-18	7.998E-18	8.828E-18	8.828E-18	1.076E-12	0
LLI Wall	t	2.851E-17	1.685E-17	1.685E-17	2.851E-17	2.851E-17	1.076E-12	0
SI Wall	t	2.422E-17	1.166E-17	1.166E-17	2.422E-17	2.422E-17	1.076E-12	0
St Wall	t	1.239E-17	8.939E-18	8.939E-18	1.239E-17	1.239E-17	1.076E-12	0
ULI Wall	t	2.230E-17	1.156E-17	1.156E-17	2.230E-17	2.230E-17	1.076E-12	0
Kidneys	t	2.564E-17	1.525E-17	1.525E-17	2.564E-17	2.564E-17	1.869E-17	0
Liver	t	1.339E-17	1.040E-17	1.040E-17	1.339E-17	1.339E-17	1.535E-17	0
Lng Tiss	t	1.591E-17	1.457E-17	1.457E-17	1.591E-17	1.591E-17	1.076E-12	0
Ovaries	t	2.849E-17	1.269E-17	1.269E-17	2.849E-17	2.849E-17	1.076E-12	0
R Marrow	t	5.784E-11	3.998E-17	3.998E-17	2.892E-11	2.893E-12	1.858E-17	0
BSurface	t	3.760E-11	1.251E-10	5.003E-12	1.251E-10	1.251E-11	2.717E-17	0
Testes	t	8.130E-18	8.176E-18	8.176E-18	8.130E-18	8.130E-18	1.076E-12	0
Thyroid	t	1.086E-17	1.234E-17	1.234E-17	1.086E-17	1.086E-17	1.076E-12	0

equivalent dose (Sv/nt) for Ra-224 & Age=Age 10 , p. 1 of 2

TARGETS RAD		SOURCE REGIONS						
		LLI Cont	SI Cont	St Cont	ULI Cont	Kidneys	Liver	Lng Cont.
Breasts	t	1.405E-18	2.124E-18	1.121E-17	2.885E-18	5.098E-18	1.241E-17	3.635E-17
LLI Wall	t	1.477E-12	8.131E-17	1.354E-17	3.429E-17	9.472E-18	4.245E-18	1.277E-18
SI Wall	t	9.508E-17	5.090E-13	3.085E-17	1.693E-16	3.232E-17	2.098E-17	3.559E-18
St Wall	t	1.985E-17	3.092E-17	6.852E-13	4.104E-17	3.297E-17	2.822E-17	1.794E-17
ULI Wall	t	4.567E-17	1.835E-16	3.892E-17	9.345E-13	2.814E-17	3.218E-17	4.726E-18
Kidneys	t	1.174E-17	3.232E-17	3.017E-17	2.722E-17	1.070E-10	3.932E-17	1.152E-17
Liver	t	4.808E-18	2.098E-17	2.790E-17	3.358E-17	3.932E-17	2.087E-11	2.680E-17
Lng Tiss	t	1.622E-18	3.561E-18	1.608E-17	4.448E-18	1.153E-17	2.686E-17	4.086E-11
Ovaries	t	1.904E-16	1.250E-16	1.036E-17	9.951E-17	1.302E-17	8.443E-18	1.694E-18
R Marrow	t	2.602E-17	2.118E-17	8.966E-18	1.719E-17	2.161E-17	1.038E-17	1.330E-17
BSurface	t	1.654E-17	1.395E-17	9.929E-18	1.209E-17	1.700E-17	1.198E-17	1.644E-17
Testes	t	2.653E-17	7.205E-18	1.637E-18	6.116E-18	1.368E-18	1.015E-18	3.899E-19
Thyroid	t	2.524E-19	5.242E-19	1.322E-18	6.463E-19	1.114E-18	2.249E-18	1.477E-17

Figure 6 (cont'd). Ra224ht.scc.

equivalent dose (Sv/nt) for Ra-224 & Age=Age 10 , p. 2 of 2

TARGETS	RAD	SOURCE REGIONS R Marrow	C Bone-S	C Bone-V	T Bone-S	T Bone-V	Other	
Breasts	t	6.926E-18	5.163E-18	5.163E-18	6.926E-18	6.926E-18	6.438E-13	0
LLI Wall	t	2.485E-17	1.091E-17	1.091E-17	2.485E-17	2.485E-17	6.438E-13	0
SI Wall	t	2.080E-17	7.804E-18	7.804E-18	2.080E-17	2.080E-17	6.438E-13	0
St Wall	t	8.330E-18	6.239E-18	6.239E-18	8.330E-18	8.330E-18	6.438E-13	0
ULI Wall	t	1.810E-17	6.947E-18	6.947E-18	1.810E-17	1.810E-17	6.438E-13	0
Kidneys	t	2.028E-17	9.695E-18	9.695E-18	2.028E-17	2.028E-17	1.249E-17	0
Liver	t	1.028E-17	6.780E-18	6.780E-18	1.028E-17	1.028E-17	1.038E-17	0
Lng Tiss	t	1.250E-17	9.561E-18	9.561E-18	1.250E-17	1.250E-17	6.438E-13	0
Ovaries	t	2.461E-17	8.673E-18	8.673E-18	2.461E-17	2.461E-17	6.438E-13	0
R Marrow	t	3.034E-11	2.772E-17	2.772E-17	1.517E-11	1.517E-12	1.294E-17	0
BSurface	t	1.972E-11	6.805E-11	2.722E-12	6.805E-11	6.805E-12	1.918E-17	0
Testes	t	5.992E-18	5.410E-18	5.410E-18	5.992E-18	5.992E-18	6.438E-13	0
Thyroid	t	7.914E-18	8.389E-18	8.389E-18	7.914E-18	7.914E-18	6.438E-13	0

equivalent dose (Sv/nt) for Ra-224 & Age=Age 15 , p. 1 of 2

TARGETS	RAD	SOURCE REGIONS LLI Cont	SI Cont	St Cont	ULI Cont	Kidneys	Liver	Lng Cont.
Breasts	t	4.247E-19	8.700E-19	5.982E-18	1.129E-18	2.184E-18	6.994E-18	1.890E-17
LLI Wall	t	8.359E-13	5.796E-17	8.330E-18	2.214E-17	5.695E-18	1.940E-18	6.516E-19
SI Wall	t	6.477E-17	2.830E-13	1.938E-17	1.124E-16	2.059E-17	1.098E-17	1.939E-18
St Wall	t	1.277E-17	1.997E-17	4.674E-13	2.943E-17	2.030E-17	1.583E-17	1.301E-17
ULI Wall	t	2.794E-17	1.252E-16	2.403E-17	5.178E-13	1.922E-17	1.725E-17	2.259E-18
Kidneys	t	7.219E-18	2.059E-17	2.208E-17	1.821E-17	7.464E-11	2.612E-17	7.610E-18
Liver	t	2.335E-18	1.098E-17	1.535E-17	1.771E-17	2.612E-17	1.322E-11	1.941E-17
Lng Tiss	t	7.501E-19	1.940E-18	1.093E-17	2.374E-18	7.617E-18	1.945E-17	2.843E-11
Ovaries	t	1.276E-16	8.328E-17	6.074E-18	6.920E-17	7.598E-18	4.191E-18	7.451E-19
R Marrow	t	1.966E-17	1.583E-17	6.639E-18	1.279E-17	1.559E-17	7.611E-18	1.003E-17
BSurface	t	1.177E-17	9.769E-18	7.052E-18	8.488E-18	1.139E-17	8.667E-18	1.155E-17
Testes	t	1.430E-17	3.612E-18	3.952E-19	2.679E-18	5.856E-19	3.590E-19	1.097E-19
Thyroid	t	7.526E-20	1.309E-19	8.096E-19	1.883E-19	5.729E-19	1.213E-18	8.489E-18

equivalent dose (Sv/nt) for Ra-224 & Age=Age 15 , p. 2 of 2

TARGETS	RAD	SOURCE REGIONS R Marrow	C Bone-S	C Bone-V	T Bone-S	T Bone-V	Other	
Breasts	t	4.421E-18	3.038E-18	3.038E-18	4.421E-18	4.421E-18	3.797E-13	0
LLI Wall	t	1.949E-17	6.821E-18	6.821E-18	1.949E-17	1.949E-17	3.797E-13	0
SI Wall	t	1.628E-17	5.465E-18	5.465E-18	1.628E-17	1.628E-17	3.797E-13	0
St Wall	t	6.973E-18	3.645E-18	3.645E-18	6.973E-18	6.973E-18	3.797E-13	0
ULI Wall	t	1.368E-17	4.399E-18	4.399E-18	1.368E-17	1.368E-17	3.797E-13	0
Kidneys	t	1.515E-17	6.475E-18	6.475E-18	1.515E-17	1.515E-17	8.715E-18	0
Liver	t	7.916E-18	4.894E-18	4.894E-18	7.916E-18	7.916E-18	7.224E-18	0
Lng Tiss	t	9.754E-18	6.591E-18	6.591E-18	9.754E-18	9.754E-18	3.797E-13	0
Ovaries	t	1.945E-17	6.153E-18	6.153E-18	1.945E-17	1.945E-17	3.797E-13	0
R Marrow	t	1.763E-11	1.943E-17	1.943E-17	8.814E-12	8.816E-13	8.323E-18	0
BSurface	t	1.146E-11	3.856E-11	1.543E-12	3.856E-11	3.856E-12	1.282E-17	0
Testes	t	3.931E-18	3.953E-18	3.953E-18	3.931E-18	3.931E-18	3.797E-13	0
Thyroid	t	6.680E-18	6.541E-18	6.541E-18	6.680E-18	6.680E-18	3.797E-13	0

equivalent dose (Sv/nt) for Ra-224 & Age=Adult Male , p. 1 of 2

TARGETS	RAD	SOURCE REGIONS LLI Cont	SI Cont	St Cont	ULI Cont	Kidneys	Liver	Lng Cont.
Breasts	t	2.668E-19	7.288E-19	4.490E-18	8.167E-19	1.761E-18	5.439E-18	1.746E-17
LLI Wall	t	6.749E-13	4.376E-17	6.433E-18	1.659E-17	4.355E-18	1.249E-18	3.349E-19
SI Wall	t	5.263E-17	2.278E-13	1.471E-17	9.226E-17	1.616E-17	8.709E-18	1.164E-18
St Wall	t	9.559E-18	1.579E-17	3.646E-13	2.064E-17	1.862E-17	1.095E-17	8.708E-18
ULI Wall	t	2.183E-17	1.015E-16	1.900E-17	4.142E-13	1.622E-17	1.364E-17	1.530E-18
Kidneys	t	5.699E-18	1.616E-17	1.969E-17	1.608E-17	5.971E-11	2.148E-17	5.100E-18
Liver	t	1.522E-18	8.709E-18	1.084E-17	1.385E-17	2.148E-17	1.028E-11	1.475E-17
Lng Tiss	t	4.729E-19	1.164E-18	7.982E-18	1.426E-18	5.105E-18	1.476E-17	1.851E-11
Ovaries	t	9.165E-17	6.710E-17	4.425E-18	5.521E-17	5.502E-18	3.033E-18	5.932E-19
R Marrow	t	1.597E-17	1.349E-17	5.987E-18	1.094E-17	1.347E-17	6.612E-18	8.641E-18
BSurface	t	9.643E-18	7.824E-18	5.640E-18	6.781E-18	8.769E-18	6.722E-18	8.976E-18
Testes	t	1.115E-17	2.136E-18	3.557E-19	1.705E-18	3.688E-19	1.902E-19	5.160E-20
Thyroid	t	3.765E-20	5.563E-20	3.074E-19	1.021E-19	3.872E-19	8.244E-19	6.501E-18

equivalent dose (Sv/nt) for Ra-224 & Age=Adult Male , p. 2 of 2

TARGETS	RAD	SOURCE REGIONS R Marrow	C Bone-S	C Bone-V	T Bone-S	T Bone-V	Other	
Breasts	t	4.268E-18	2.516E-18	2.516E-18	4.268E-18	4.268E-18	3.100E-13	0
LLI Wall	t	1.519E-17	5.677E-18	5.677E-18	1.519E-17	1.519E-17	3.100E-13	0
SI Wall	t	1.400E-17	4.429E-18	4.429E-18	1.400E-17	1.400E-17	3.100E-13	0
St Wall	t	6.474E-18	3.157E-18	3.157E-18	6.474E-18	6.474E-18	3.100E-13	0
ULI Wall	t	1.192E-17	3.905E-18	3.905E-18	1.192E-17	1.192E-17	3.100E-13	0
Kidneys	t	1.334E-17	4.961E-18	4.961E-18	1.334E-17	1.334E-17	7.463E-18	0
Liver	t	6.893E-18	3.781E-18	3.781E-18	6.893E-18	6.893E-18	5.965E-18	0
Lng Tiss	t	8.521E-18	5.175E-18	5.175E-18	8.521E-18	8.521E-18	3.100E-13	0
Ovaries	t	1.593E-17	5.005E-18	5.005E-18	1.593E-17	1.593E-17	3.100E-13	0
R Marrow	t	1.234E-11	1.584E-17	1.584E-17	6.170E-12	6.171E-13	7.315E-18	0
BSurface	t	6.170E-12	3.856E-11	1.543E-12	3.856E-11	3.856E-12	1.166E-17	0
Testes	t	2.575E-18	3.292E-18	3.292E-18	2.575E-18	2.575E-18	3.100E-13	0
Thyroid	t	5.923E-18	5.949E-18	5.949E-18	5.923E-18	5.923E-18	3.100E-13	0

Example 2. Using SEEPAR to Construct the User Request File

Program SEEPAR was used to prepare request file Example2.req, shown in Fig. 7. The selections were the same as those in Example 1, except as follows: the title lines were changed, the type of *SEE* table was changed to "full table", and only the age group Adult Male was requested. The quantity calculated (dose type) and the source and target regions were not changed. However, the order of the source and target regions is different, the order forced by SEEPAR.

The keyboard input/screen output for SEEPAR is shown in Fig. 8. From the \DCAL directory, the user typed "seepar" to invoke SEEPAR. The first screen asked the user for the name of the stem for the request file, and he typed "Example2". (Note: in SEEDEX batch mode, this question is not asked during the SEEPAR phase of the run, because the stem name chosen for the whole run is used.) On Screen 2 the user was prompted for title/information lines. On Screen 3 he was given menu choices of ABSORBED DOSE vs. EQUIVALENT DOSE. The cursor was already on EQUIVALENT DOSE, and he pressed <Enter> to select that dose type. On Screen 4 he was given menu choices of FULL TABLE and TOTAL ONLY for table type. The cursor was already on TOTAL ONLY, and he pressed <Enter> to choose that table type. Note: since equivalent dose was selected, SEEPAR did not give the user the choice of LOW-HI LET.

On Screen 5 he was given menu choices for age groups. Initially all ages except Adult Female are selected (selected ages are indicated by filled triangles bracketing the age group name). If he had wanted age groups Newborn through Adult Male and not Adult Female, he would have pressed <Enter> immediately. Since he wanted Adult Male only, he had to de-select Newborn through Age 15 by moving the cursor to the appropriate lines and de-selecting those ages by pressing the space bar. (The space bar is a de-select/select toggle, so errors may be easily corrected by toggling again.) When he had only Adult Male selected, he pressed <Enter> to confirm the choice.

On Screen 6 the user was asked whether he wanted normal or complement mode for selecting source regions, which will be given on the following screen. In normal mode, none of the source regions is initially selected, and the user selects the ones he wants with the space-bar toggle. In complement mode, all of the source regions are initially selected, and he de-selects those he doesn't want with the space-bar toggle. He chose *N* for normal mode, the default. Screen 7 then came up, showing all the

possible source regions. Fig. 8 shows the screen as it appeared after he toggled his choices. He then pressed <Enter> to confirm his choices. Screens 8 and 9 gave similar choices for target regions: normal vs. complement mode and names of all possible target regions.

Screens 10 and following printed back the file Example2.req for checking by the user. At the end, he was given the opportunity to start over if there were errors. There were no errors, so he chose *n*, the default. (If you have a minor error to correct, you might want to use a text editor to correct it rather than re-run SEEPAR from the beginning.) SEEPAR then terminated and the DOS prompt reappeared.

At this point the user had the two required problem-dependent input files: the user request file, Example2.req, prepared with SEEPAR, and the nuclide decay data file, Ra224d.rad, prepared with DEXRAX from the previous example, and he was ready to run SEECAL. The keyboard input/screen output for the SEECAL run is shown in Fig. 9.

In Fig. 9 note first that a message was written to the screen that a log file named Seecal.log already existed in the WORK2 subdirectory (that from the previous SEECAL run for Example 1), and he was given three choices: to overwrite the file, to append the current log to the existing file, or to rename the new log file by changing the extension. He chose the default, to overwrite. The rest of the run was similar to that for Example 1: he input the stem names for the RAD and REQ files, and the program ran, giving various messages. Note that the names of the *SEE* files are slightly different from those in Example 1, i.e., that the stem names all end in *hf* — *h* for equivalent dose and *f* for full table.

The log file is similar to that in Example 1 and is not given here.

Three of the *SEE* output files created in this run are given in Figs. 10-12. Looking at file Ra224hf.see (Fig. 10), notice that the *SEE* tables contain the letters *p, e, a*, and *t* under the heading *RAD* — for photon, electron, alpha, and total radiations. This is because "full table" was requested and this nuclide has these kinds of radiations. Looking now at file Tl208hf.see (Fig. 11), notice that the *SEE* tables contain the letters *p, e*, and *t* under radiations — Tl-208 emits no alpha radiations. And looking at file Po212hf.see (Fig. 12), notice that the *SEE* tables contain only the letter *a* under radiations — Po-212 emits alpha radiations only; and *SEE*s for *t* are not listed, to avoid redundancy.

Figure 7. Example 2: User Request File $DCAL\WORK2\Example2.req, Constructed with Utility Program SEEPAR.

```
This is SEEPAR request file EXAMPLE2.REQ
TITLE                     | Delimiter TITLE, format A5.
<<  SEEPAR Ver. 1.0  (Dec 1, 1993 ) --- Run Dec 05, 1993, at 14:07 >>
SEEPAR exe file was:                seepar.exe       79470  12-01-93   0:00a
Example 2: same as Example1 except request Adult Male only
and request type of SEE tables to be FULL TABLE.
END TITLE                 | Delimiter END TITLE, format A9.
EQUIVALENT DOSE           | Dose type, format A15.
FULL TABLE                | Table type, format A10.
AGE GROUPS                | Delimiter AGE GROUPS, format A10.
Adult Male                |
END AGE GROUPS            | Delimiter END AGE GROUPS, format A20.
SOURCE REGIONS            | Delimiter SOURCE REGIONS, format A14.
C Bone-S                  |
C Bone-V                  |
T Bone-S                  |
T Bone-V                  |
St Cont                   |
SI Cont                   |
ULI Cont                  |
LLI Cont                  |
Kidneys                   |
Liver                     |
Lng Cont                  |
R Marrow                  |
Other                     |
END SOURCE REGIONS        | Delimiter END SOUR, format A8.
TARGET REGIONS            | Delimiter TARGET REGIONS, format A14.
BSurface                  |
Breasts                   |
St Wall                   |
SI Wall                   |
ULI Wall                  |
LLI Wall                  |
Kidneys                   |
Liver                     |
Lng Tiss                  |
Ovaries                   |
R Marrow                  |
Testes                    |
Thyroid                   |
END TARGET REGIONS        | Delimiter END TARG, format A8.
```

Figure 8. Example 2: Using SEEPAR to Create Request File $DCAL\WORK2\Example2.req.

User's textual input is underlined. In two cases the user's menu selection is underlined, where it was not otherwise clear what the selection was. Solid horizontal lines indicate screen clearings. Screen numbers have been added here for reference in text.

```
C:\DCAL> seepar
```

SCREEN 1

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
Input name for SEECAL request file; ext. REQ will be added.

File name: ? Example2
```

SCREEN 2

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
Title (0 - 7 lines of 80 characters, blank to terminate list).
Line 1: Example 2: same as Example 1 except request Adult Male only
Line 2: and request type of SEE tables to be FULL TABLE.
Line 3: <Enter>
```

SCREEN 3

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
< Dose Type >
ABSORBED DOSE
EQUIVALENT DOSE
< ↑ ↓ ◄┘ >
```

```
Select absorbed or equivalent dose using arrow keys & press <Enter>.
```

Figure 8 (cont'd).

SCREEN 4

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
< Table Type >
 FULL TABLE
 TOTAL ONLY
< ↑ ↓ ◂┘ >
```

Select table type using arrow keys & press <Enter>.

SCREEN 5

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
< Age Groups >
 Newborn
 Age 1
 Age 5
 Age 10
 Age 15
◂Adult Male  ▸
 Adult Female
< ↑ ↓ ◂┘ >
```

De-Select/Select age group using arrow keys & space bar; <Enter> to process.

SCREEN 6

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

Source Region Selection

Selection mode: [N]ormal or [C]omplement? N

In normal mode toggle on items for inclusion.
In complement mode toggle off items for exclusion.

Figure 8 (cont'd).

SCREEN 7

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
                    < Source Regions >
 Adrenals       St Wall        Lng Tiss       GB Cont
 UB Cont       ◂SI Cont  ▸     Muscle         GB Wall
 UB Wall        SI Wall        Ovaries        Ht Cont
◂C Bone-S ▸    ◂ULI Cont ▸     Pancreas       Ht Wall
◂C Bone-V •     ULI Wall      ◂R Marrow ▸     Uterus
◂T Bone-S ▸    ◂LLI Cont ▸     Skin           W Body
◂T Bone-V ▸     LLI Wall       Spleen         Blood
 Brain         ◂Kidneys  ▸     Testes         WB-Soft
 Breasts       ◂Liver    ▸     Thymus        ◂Other     ▸
◂St Cont  ▸    ◂Lng Cont ▸     Thyroid
                    < ↑ ↓ ◂┘ >
```

In normal mode toggle on items for inclusion.

Select/De-select using arrow keys & space bar; <Enter> to process.

SCREEN 8

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

Target Region Selection

Selection mode: [N]ormal or [C]omplement?_N_

In normal mode toggle on items for inclusion.
In complement mode toggle off items for exclusion.

Figure 8 (cont'd).

SCREEN 9

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                    Dec 1, 1993
```

```
< Target Regions >
 Adrenals      ◄Liver      ►   ◄Thyroid   ►
 UB Wall       ◄Lng Tiss   ►    GB Wall
◄BSurface  ►    Muscle           Ht Wall
 Brain         ◄Ovaries    ►    Uterus
◄Breasts   ►    Pancreas
◄St Wall   ►   ◄R Marrow   ►
◄SI Wall   ►    Skin
◄ULI Wall  ►    Spleen
◄LLI Wall  ►   ◄Testes     ►
◄Kidneys   ►    Thymus
                < ↑ ↓ ◄┘ >
```

In normal mode toggle on items for inclusion.

Select/De-select using arrow keys & space bar; <Enter> to process.

SCREEN 10

```
          PRINT BACK OF FILE : EXAMPLE2.REQ
This is SEEPAR request file EXAMPLE2.REQ
TITLE                      | Delimiter TITLE, format A5.
<<  SEEPAR Ver. 1.0  (Dec 1, 1993 ) --- Run Dec 05, 1993, at 14:07 >>
SEEPAR exe file was:                seepar.exe       79470 12-01-93   0:00a
Example 2: same as Example 1 except request Adult Male only
and request type of SEE tables to be FULL TABLE.
END TITLE                  | Delimiter END TITLE, format A9.
EQUIVALENT DOSE            | Dose type, format A15.
FULL TABLE                 | Table type, format A10.
AGE GROUPS                 | Delimiter AGE GROUPS, format A10.
Adult Male                 |
END AGE GROUPS             | Delimiter END AGE GROUPS, format A20.
SOURCE REGIONS             | Delimiter SOURCE REGIONS, format A14.
C Bone-S                   |
C Bone-V                   |
T Bone-S                   |
T Bone-V                   |
St Cont                    |
SI Cont                    |
ULI Cont                   |

Press any key to continue.
```

Figure 8 (cont'd).

```
SCREEN 11

          PRINT BACK OF FILE : EXAMPLE2.REQ
LLI Cont                  |
Kidneys                   |
Liver                     |
Lng Cont                  |
R Marrow                  |
Other                     |
END SOURCE REGIONS        | Delimiter END SOUR, format A8.
TARGET REGIONS            | Delimiter TARGET REGIONS, format A14.
BSurface                  |
Breasts                   |
St Wall                   |
SI Wall                   |
ULI Wall                  |
LLI Wall                  |
Kidneys                   |
Liver                     |
Lng Tiss                  |
Ovaries                   |
R Marrow                  |
Testes                    |

Press any key to continue.
```

```
SCREEN 12

          PRINT BACK OF FILE : EXAMPLE2.REQ
Thyroid                   |
END TARGET REGIONS        | Delimiter END TARG, format A8.


        Do you wish to start over (y/[n]) ? n
```

```
C:\DCAL>
```

Figure 9. Example 2: Keyboard Input/Screen Output for SEECAL Run.

User's input is underlined. The ellipses ("...") are written to the screen and indicate a possible slight delay in the output while the program is reading data or doing calculations. The entire run is shown.

```
C:\DCAL> seecal

SEECAL:  calculate Specific Effective Energies
         Ver. 1.0 (Dec 1, 1993)
         Oak Ridge National Laboratory Report ORNL/TM-12351
Authors: M. Cristy and K. F. Eckerman
         Oak Ridge National Laboratory
         Oak Ridge, TN 37831-6383

Log file Seecal.log already exists --
[o]verwrite, (a)ppend, or (r)ename by changing extension ([o]/a/r)? o
Log file Seecal.log will be overwritten

Name of input file for decay data, .rad added -> Ra224d

Name of input file for user requests, .req added -> Example2

Press <Enter> to clear screen & continue SEECAL
<Enter>

SEE output file Ra224hf.SEE will be written.
SEE output file Rn220hf.SEE will be written.
SEE output file Po216hf.SEE will be written.
SEE output file Pb212hf.SEE will be written.
SEE output file Bi212hf.SEE will be written.
SEE output file Po212hf.SEE will be written.
SEE output file Tl208hf.SEE will be written.

Press <Enter> to clear screen & continue SEECAL
<Enter>

MAJOR PROGRAM LOOP: working on age # 1 (adult male) ...

     Reading photon SAFs for age = adult male ...
     Reading electron & alpha AFs for age = adult male ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...
```

Figure 9 (cont'd).

```
The following SEE files have been written:
Ra224hf.SEE    Rn220hf.SEE    Po216hf.SEE    Pb212hf.SEE    Bi212hf.SEE
Po212hf.SEE    Tl208hf.SEE

Program SEECAL ended normally.
Stop - Program terminated.

C:\DCAL>
```

Figure 10. Example 2: SEE Output File $DCAL\WORK2\Ra224hf.see.

```
This is SEECAL file Ra224hf.SEE
<<   SEECAL Ver. 1.0 (Dec 1, 1993)  --- Run Dec 05, 1993, at 14:17 >>
SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example2.req      1652 12-05-93   2:12p
Nuclide decay file was:             Ra224d.rad       22831 12-05-93  12:02p
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a
1 = number of age groups
Photon SAF file was:                PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:               RegMass.am        2245 12-01-93  12:00a
4 = number of title lines, copied from file Example2.req, that follow:
<<  SEEPAR Ver. 1.0  (Dec 1, 1993 )  --- Run Dec 05, 1993, at 14:07 >>
SEEPAR exe file was:                seepar.exe       79470 12-01-93   0:00a
Example 2: same as Example1 except request Adult Male only
and request type of SEE tables to be FULL TABLE.
Following 4 lines are header info from nuclide decay file Ra224d.rad
<<   DEXRAX Ver. 1.0 (Sep 1, 1993)  --- Run Dec 05, 1993, at 12:02 >>
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a
'equivalent dose' = dose type (equivalent dose or absorbed dose)
'full table' = table type (full table, total only, or low-hi let)
'Ra-224 ','      3.66d ','A        ' = nuclide, half-life, decay mode
'y' 'y' 'y' 'n' = photon, electron, alpha, spon. fission flags (Yes/No)
Age Group Name
'Adult Male          '
13, 7, 2 = # of source regions, # of source regions/page, # of pages/age
S. Region  Masses (kg) for each age group, in order as above
'C Bone-S' 0.00E+00
'C Bone-V' 4.00E+00
'T Bone-S' 0.00E+00
'T Bone-V' 1.00E+00
'St Cont ' 2.50E-01
'SI Cont ' 4.00E-01
'ULI Cont' 2.20E-01
'LLI Cont' 1.35E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Cont' 0.00E+00
'R Marrow' 1.50E+00
'Other   ' 5.97E+01
13 = number of target regions
T. Region  Masses (kg) for each age group, in order as above
'BSurface' 1.20E-01
'Breasts ' 3.60E-01
'St Wall ' 1.50E-01
'SI Wall ' 6.40E-01
'ULI Wall' 2.10E-01
'LLI Wall' 1.60E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Tiss' 1.00E+00
'Ovaries ' 1.10E-02
'R Marrow' 1.50E+00
'Testes  ' 3.50E-02
'Thyroid ' 2.00E-02
```

equivalent dose (Sv/nt) for Ra-224 & Age=Adult Male , p. 1 of 2

TARGETS	RAD	C Bone-S	C Bone-V	T Bone-S	T Bone-V	St Cont	SI Cont	ULI Cont.
		SOURCE REGIONS						
BSurface	p	2.710E-17	2.710E-17	2.381E-17	2.381E-17	5.640E-18	7.824E-18	6.781E-18
BSurface	e	2.709E-16	4.442E-17	2.909E-16	7.403E-17	.0	.0	.0 0
BSurface	a	3.856E-11	1.542E-12	3.856E-11	3.856E-12	.0	.0	.0 0
BSurface	t	3.856E-11	1.543E-12	3.856E-11	3.856E-12	5.640E-18	7.824E-18	6.781E-18
Breasts	p	2.516E-18	2.516E-18	4.268E-18	4.268E-18	4.490E-18	7.288E-19	8.167E-19
Breasts	e	.0	.0	.0	.0	.0	.0	.0 0
Breasts	a	.0	.0	.0	.0	.0	.0	.0 0
Breasts	t	2.516E-18	2.516E-18	4.268E-18	4.268E-18	4.490E-18	7.288E-19	8.167E-19
St Wall	p	3.157E-18	3.157E-18	6.474E-18	6.474E-18	2.972E-16	1.579E-17	2.064E-17
St Wall	e	.0	.0	.0	.0	7.107E-16	.0	.0 0
St Wall	a	.0	.0	.0	.0	3.636E-13	.0	.0 0
St Wall	t	3.157E-18	3.157E-18	6.474E-18	6.474E-18	3.646E-13	1.579E-17	2.064E-17
SI Wall	p	4.429E-18	4.429E-18	1.400E-17	1.400E-17	1.471E-17	9.898E-17	9.226E-17
SI Wall	e	.0	.0	.0	.0	.0	4.442E-16	.0 0
SI Wall	a	.0	.0	.0	.0	.0	2.272E-13	.0 0
SI Wall	t	4.429E-18	4.429E-18	1.400E-17	1.400E-17	1.471E-17	2.278E-13	9.226E-17
ULI Wall	p	3.905E-18	3.905E-18	1.192E-17	1.192E-17	1.900E-17	1.015E-16	2.414E-16
ULI Wall	e	.0	.0	.0	.0	.0	.0	8.076E-16
ULI Wall	a	.0	.0	.0	.0	.0	.0	4.132E-13
ULI Wall	t	3.905E-18	3.905E-18	1.192E-17	1.192E-17	1.900E-17	1.015E-16	4.142E-13
LLI Wall	p	5.677E-18	5.677E-18	1.519E-17	1.519E-17	6.433E-18	4.376E-17	1.659E-17
LLI Wall	e	.0	.0	.0	.0	.0	.0	.0 0
LLI Wall	a	.0	.0	.0	.0	.0	.0	.0 0
LLI Wall	t	5.677E-18	5.677E-18	1.519E-17	1.519E-17	6.433E-18	4.376E-17	1.659E-17
Kidneys	p	4.961E-18	4.961E-18	1.334E-17	1.334E-17	1.969E-17	1.616E-17	1.608E-17
Kidneys	e	.0	.0	.0	.0	.0	.0	.0 0
Kidneys	a	.0	.0	.0	.0	.0	.0	.0 0
Kidneys	t	4.961E-18	4.961E-18	1.334E-17	1.334E-17	1.969E-17	1.616E-17	1.608E-17
Liver	p	3.781E-18	3.781E-18	6.893E-18	6.893E-18	1.084E-17	8.709E-18	1.385E-17
Liver	e	.0	.0	.0	.0	.0	.0	.0 0
Liver	a	.0	.0	.0	.0	.0	.0	.0 0
Liver	t	3.781E-18	3.781E-18	6.893E-18	6.893E-18	1.084E-17	8.709E-18	1.385E-17
Lng Tiss	p	5.175E-18	5.175E-18	8.521E-18	8.521E-18	7.982E-18	1.164E-18	1.426E-18
Lng Tiss	e	.0	.0	.0	.0	.0	.0	.0 0
Lng Tiss	a	.0	.0	.0	.0	.0	.0	.0 0
Lng Tiss	t	5.175E-18	5.175E-18	8.521E-18	8.521E-18	7.982E-18	1.164E-18	1.426E-18
Ovaries	p	5.005E-18	5.005E-18	1.593E-17	1.593E-17	4.425E-18	6.710E-17	5.521E-17
Ovaries	e	.0	.0	.0	.0	.0	.0	.0 0
Ovaries	a	.0	.0	.0	.0	.0	.0	.0 0
Ovaries	t	5.005E-18	5.005E-18	1.593E-17	1.593E-17	4.425E-18	6.710E-17	5.521E-17
R Marrow	p	1.584E-17	1.584E-17	3.653E-17	3.653E-17	5.987E-18	1.349E-17	1.094E-17
R Marrow	e	.0	.0	1.184E-16	8.291E-17	.0	.0	.0 0
R Marrow	a	.0	.0	6.170E-12	6.170E-13	.0	.0	.0 0
R Marrow	t	1.584E-17	1.584E-17	6.170E-12	6.171E-13	5.987E-18	1.349E-17	1.094E-17
Testes	p	3.292E-18	3.292E-18	2.575E-18	2.575E-18	3.557E-19	2.136E-18	1.705E-18
Testes	e	.0	.0	.0	.0	.0	.0	.0 0
Testes	a	.0	.0	.0	.0	.0	.0	.0 0
Testes	t	3.292E-18	3.292E-18	2.575E-18	2.575E-18	3.557E-19	2.136E-18	1.705E-18
Thyroid	p	5.949E-18	5.949E-18	5.923E-18	5.923E-18	3.074E-19	5.563E-20	1.021E-19
Thyroid	e	.0	.0	.0	.0	.0	.0	.0 0
Thyroid	a	.0	.0	.0	.0	.0	.0	.0 0
Thyroid	t	5.949E-18	5.949E-18	5.923E-18	5.923E-18	3.074E-19	5.563E-20	1.021E-19

Figure 10 (cont'd). Ra224hf.scc.

equivalent dose (Sv/nt) for Ra-224 & Age=Adult Male , p. 2 of 2

TARGETS RAD		SOURCE REGIONS LLI Cont	Kidneys	Liver	Lng Cont	R Marrow	Other	
BSurface	p	9.643E-18	8.769E-18	6.722E-18	8.976E-18	2.381E-17	1.166E-17	0
BSurface	e	.0	.0	.0	.0	1.184E-16	.0	0
BSurface	a	.0	.0	.0	.0	6.170E-12	.0	0
BSurface	t	9.643E-18	8.769E-18	6.722E-18	8.976E-18	6.170E-12	1.166E-17	0
Breasts	p	2.668E-19	1.761E-18	5.439E-18	1.746E-17	4.268E-18	5.971E-18	0
Breasts	e	.0	.0	.0	.0	.0	5.950E-18	0
Breasts	a	.0	.0	.0	.0	.0	3.099E-13	0
Breasts	t	2.668E-19	1.761E-18	5.439E-18	1.746E-17	4.268E-18	3.100E-13	0
St Wall	p	9.559E-18	1.862E-17	1.095E-17	8.708E-18	6.474E-18	9.393E-18	0
St Wall	e	.0	.0	.0	.0	.0	5.950E-18	0
St Wall	a	.0	.0	.0	.0	.0	3.099E-13	0
St Wall	t	9.559E-18	1.862E-17	1.095E-17	8.708E-18	6.474E-18	3.100E-13	0
SI Wall	p	5.263E-17	1.616E-17	8.709E-18	1.164E-18	1.400E-17	1.088E-17	0
SI Wall	e	.0	.0	.0	.0	.0	5.950E-18	0
SI Wall	a	.0	.0	.0	.0	.0	3.099E-13	0
SI Wall	t	5.263E-17	1.616E-17	8.709E-18	1.164E-18	1.400E-17	3.100E-13	0
ULI Wall	p	2.183E-17	1.622E-17	1.364E-17	1.530E-18	1.192E-17	9.889E-18	0
ULI Wall	e	.0	.0	.0	.0	.0	5.950E-18	0
ULI Wall	a	.0	.0	.0	.0	.0	3.099E-13	0
ULI Wall	t	2.183E-17	1.622E-17	1.364E-17	1.530E-18	1.192E-17	3.100E-13	0
LLI Wall	p	2.896E-16	4.355E-18	1.249E-18	3.349E-19	1.519E-17	1.074E-17	0
LLI Wall	e	1.316E-15	.0	.0	.0	.0	5.950E-18	0
LLI Wall	a	6.733E-13	.0	.0	.0	.0	3.099E-13	0
LLI Wall	t	6.749E-13	4.355E-18	1.249E-18	3.349E-19	1.519E-17	3.100E-13	0
Kidneys	p	5.699E-18	3.891E-16	2.148E-17	5.100E-18	1.334E-17	7.463E-18	0
Kidneys	e	.0	1.146E-15	.0	.0	.0	.0	0
Kidneys	a	.0	5.971E-11	.0	.0	.0	.0	0
Kidneys	t	5.699E-18	5.971E-11	2.148E-17	5.100E-18	1.334E-17	7.463E-18	0
Liver	p	1.522E-18	2.148E-17	1.489E-16	1.475E-17	6.893E-18	5.965E-18	0
Liver	e	.0	.0	1.974E-16	.0	.0	.0	0
Liver	a	.0	.0	1.028E-11	.0	.0	.0	0
Liver	t	1.522E-18	2.148E-17	1.028E-11	1.475E-17	6.893E-18	5.965E-18	0
Lng Tiss	p	4.729E-19	5.105E-18	1.476E-17	8.683E-17	8.521E-18	8.525E-18	0
Lng Tiss	e	.0	.0	.0	3.553E-16	.0	5.950E-18	0
Lng Tiss	a	.0	.0	.0	1.851E-11	.0	3.099E-13	0
Lng Tiss	t	4.729E-19	5.105E-18	1.476E-17	1.851E-11	8.521E-18	3.100E-13	0
Ovaries	p	9.165E-17	5.502E-18	3.033E-18	5.932E-19	1.593E-17	1.148E-17	0
Ovaries	e	.0	.0	.0	.0	.0	5.950E-18	0
Ovaries	a	.0	.0	.0	.0	.0	3.099E-13	0
Ovaries	t	9.165E-17	5.502E-18	3.033E-18	5.932E-19	1.593E-17	3.100E-13	0
R Marrow	p	1.597E-17	1.347E-17	6.612E-18	8.641E-18	3.653E-17	7.315E-18	0
R Marrow	e	.0	.0	.0	.0	2.369E-16	.0	0
R Marrow	a	.0	.0	.0	.0	1.234E-11	.0	0
R Marrow	t	1.597E-17	1.347E-17	6.612E-18	8.641E-18	1.234E-11	7.315E-18	0
Testes	p	1.115E-17	3.688E-19	1.902E-19	5.160E-20	2.575E-18	8.802E-18	0
Testes	e	.0	.0	.0	.0	.0	5.950E-18	0
Testes	a	.0	.0	.0	.0	.0	3.099E-13	0
Testes	t	1.115E-17	3.688E-19	1.902E-19	5.160E-20	2.575E-18	3.100E-13	0
Thyroid	p	3.765E-20	3.872E-19	8.244E-19	6.501E-18	5.923E-18	9.768E-18	0
Thyroid	e	.0	.0	.0	.0	.0	5.950E-18	0
Thyroid	a	.0	.0	.0	.0	.0	3.099E-13	0
Thyroid	t	3.765E-20	3.872E-19	8.244E-19	6.501E-18	5.923E-18	3.100E-13	0

Figure 11. Example 2: SEE Output file $DCAL\WORK2\Tl208hf.see.

```
This is SEECAL file Tl208hf.SEE
<<   SEECAL Ver. 1.0 (Dec 1, 1993)  --- Run Dec 05, 1993, at 14:17 >>
SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example2.req       1652 12-05-93   2:12p
Nuclide decay file was:             Ra224d.rad        22831 12-05-93  12:02p
File with standard names was:       StdNames.txt       1706 12-01-93  12:00a
1 = number of age groups
Photon SAF file was:                PhtonSAF.am       63360 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.am        1782 12-01-93  12:00a
Region mass file was:               RegMass.am         2245 12-01-93  12:00a
4 = number of title lines, copied from file Example2.req, that follow:
<<  SEEPAR Ver. 1.0  (Dec 1, 1993 )  --- Run Dec 05, 1993, at 14:07 >>
SEEPAR exe file was:                seepar.exe        79470 12-01-93   0:00a
Example 2: same as Example1 except request Adult Male only
and request type of SEE tables to be FULL TABLE.
Following 4 lines are header info from nuclide decay file Ra224d.rad
<<   DEXRAX Ver. 1.0 (Sep 1, 1993)  --- Run Dec 05, 1993, at 12:02 >>
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a
'equivalent dose' = dose type (equivalent dose or absorbed dose)
'full table' = table type (full table, total only, or low-hi let)
'Tl-208 ','     3.07m ','B-       ' = nuclide, half-life, decay mode
'y' 'y' 'n' 'n' = photon, electron, alpha, spon. fission flags (Yes/No)
Age Group Name
'Adult Male          '
13, 7, 2 = # of source regions, # of source regions/page, # of pages/age
S. Region  Masses (kg) for each age group, in order as above
'C Bone-S' 0.00E+00
'C Bone-V' 4.00E+00
'T Bone-S' 0.00E+00
'T Bone-V' 1.00E+00
'St Cont ' 2.50E-01
'SI Cont ' 4.00E-01
'ULI Cont' 2.20E-01
'LLI Cont' 1.35E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Cont' 0.00E+00
'R Marrow' 1.50E+00
'Other   ' 5.97E+01
13 = number of target regions
T. Region  Masses (kg) for each age group, in order as above
'BSurface' 1.20E-01
'Breasts ' 3.60E-01
'St Wall ' 1.50E-01
'SI Wall ' 6.40E-01
'ULI Wall' 2.10E-01
'LLI Wall' 1.60E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Tiss' 1.00E+00
'Ovaries ' 1.10E-02
'R Marrow' 1.50E+00
'Testes  ' 3.50E-02
'Thyroid ' 2.00E-02
```

equivalent dose (Sv/nt) for Tl-208 & Age=Adult Male , p. 1 of 2

TARGETS	RAD	SOURCE REGIONS C Bone-S	C Bone-V	T Bone-S	T Bone-V	St Cont	SI Cont	ULI Cont.
BSurface	p	6.107E-15	6.106E-15	5.346E-15	5.345E-15	1.132E-15	1.483E-15	1.296E-15
BSurface	e	1.452E-14	1.197E-14	2.239E-14	1.995E-14	.0	.0	.0 0
BSurface	t	2.063E-14	1.807E-14	2.774E-14	2.529E-14	1.132E-15	1.483E-15	1.296E-15
Breasts	p	9.266E-16	9.266E-16	1.504E-15	1.504E-15	1.686E-15	4.105E-16	4.615E-16
Breasts	e	.0	.0	.0	.0	.0	.0	.0 0
Breasts	t	9.266E-16	9.266E-16	1.504E-15	1.504E-15	1.686E-15	4.105E-16	4.615E-16
St Wall	p	9.375E-16	9.375E-16	1.837E-15	1.837E-15	7.647E-14	4.213E-15	5.600E-15
St Wall	e	.0	.0	.0	.0	1.915E-13	.0	.0 0
St Wall	t	9.375E-16	9.375E-16	1.837E-15	1.837E-15	2.680E-13	4.213E-15	5.600E-15
SI Wall	p	1.229E-15	1.229E-15	3.560E-15	3.560E-15	3.946E-15	2.493E-14	2.297E-14
SI Wall	e	.0	.0	.0	.0	.0	1.197E-13	.0 0
SI Wall	t	1.229E-15	1.229E-15	3.560E-15	3.560E-15	3.946E-15	1.446E-13	2.297E-14
ULI Wall	p	1.129E-15	1.129E-15	3.140E-15	3.140E-15	5.005E-15	2.590E-14	6.377E-14
ULI Wall	e	.0	.0	.0	.0	.0	.0	2.176E-13
ULI Wall	t	1.129E-15	1.129E-15	3.140E-15	3.140E-15	5.005E-15	2.590E-14	2.814E-13
LLI Wall	p	1.608E-15	1.608E-15	4.125E-15	4.125E-15	1.981E-15	1.125E-14	4.572E-15
LLI Wall	e	.0	.0	.0	.0	.0	.0	.0 0
LLI Wall	t	1.608E-15	1.608E-15	4.125E-15	4.125E-15	1.981E-15	1.125E-14	4.572E-15
Kidneys	p	1.482E-15	1.482E-15	3.782E-15	3.782E-15	5.032E-15	4.279E-15	4.435E-15
Kidneys	e	.0	.0	.0	.0	.0	.0	.0 0
Kidneys	t	1.482E-15	1.482E-15	3.782E-15	3.782E-15	5.032E-15	4.279E-15	4.435E-15
Liver	p	1.134E-15	1.134E-15	1.976E-15	1.976E-15	2.950E-15	2.525E-15	3.860E-15
Liver	e	.0	.0	.0	.0	.0	.0	.0 0
Liver	t	1.134E-15	1.134E-15	1.976E-15	1.976E-15	2.950E-15	2.525E-15	3.860E-15
Lng Tiss	p	1.528E-15	1.528E-15	2.449E-15	2.449E-15	2.353E-15	5.086E-16	6.473E-16
Lng Tiss	e	.0	.0	.0	.0	.0	.0	.0 0
Lng Tiss	t	1.528E-15	1.528E-15	2.449E-15	2.449E-15	2.353E-15	5.086E-16	6.473E-16
Ovaries	p	1.373E-15	1.373E-15	4.094E-15	4.094E-15	1.528E-15	1.678E-14	1.400E-14
Ovaries	e	.0	.0	.0	.0	.0	.0	.0 0
Ovaries	t	1.373E-15	1.373E-15	4.094E-15	4.094E-15	1.528E-15	1.678E-14	1.400E-14
R Marrow	p	4.430E-15	4.430E-15	1.019E-14	1.019E-14	1.786E-15	3.552E-15	2.955E-15
R Marrow	e	.0	.0	3.192E-14	2.234E-14	.0	.0	.0 0
R Marrow	t	4.430E-15	4.430E-15	4.210E-14	3.253E-14	1.786E-15	3.552E-15	2.955E-15
Testes	p	1.011E-15	1.011E-15	8.097E-16	8.097E-16	2.563E-16	8.967E-16	7.855E-16
Testes	e	.0	.0	.0	.0	.0	.0	.0 0
Testes	t	1.011E-15	1.011E-15	8.097E-16	8.097E-16	2.563E-16	8.967E-16	7.855E-16
Thyroid	p	1.780E-15	1.780E-15	1.732E-15	1.732E-15	2.415E-16	7.629E-17	1.080E-16
Thyroid	e	.0	.0	.0	.0	.0	.0	.0 0
Thyroid	t	1.780E-15	1.780E-15	1.732E-15	1.732E-15	2.415E-16	7.629E-17	1.080E-16

Figure 11 (cont'd). Tl208hf.scc.

equivalent dose (Sv/nt) for Tl-208 & Age=Adult Male , p. 2 of 2

TARGETS RAD		SOURCE REGIONS						
		LLI Cont	Kidneys	Liver	Lng Cont	R Marrow	Other	
BSurface	p	1.857E-15	1.793E-15	1.370E-15	1.848E-15	5.345E-15	2.448E-15	0
BSurface	e	.0	.0	.0	.0	3.192E-14	.0	0
BSurface	t	1.857E-15	1.793E-15	1.370E-15	1.848E-15	3.726E-14	2.448E-15	0
Breasts	p	2.082E-16	8.128E-16	1.792E-15	4.851E-15	1.504E-15	1.825E-15	0
Breasts	e	.0	.0	.0	.0	.0	1.603E-15	0
Breasts	t	2.082E-16	8.128E-16	1.792E-15	4.851E-15	1.504E-15	3.429E-15	0
St Wall	p	2.765E-15	5.073E-15	3.117E-15	2.487E-15	1.837E-15	2.589E-15	0
St Wall	e	.0	.0	.0	.0	.0	1.603E-15	0
St Wall	t	2.765E-15	5.073E-15	3.117E-15	2.487E-15	1.837E-15	4.193E-15	0
SI Wall	p	1.278E-14	4.279E-15	2.525E-15	5.086E-16	3.560E-15	2.939E-15	0
SI Wall	e	.0	.0	.0	.0	.0	1.603E-15	0
SI Wall	t	1.278E-14	4.279E-15	2.525E-15	5.086E-16	3.560E-15	4.542E-15	0
ULI Wall	p	6.141E-15	3.981E-15	3.844E-15	5.790E-16	3.140E-15	2.687E-15	0
ULI Wall	e	.0	.0	.0	.0	.0	1.603E-15	0
ULI Wall	t	6.141E-15	3.981E-15	3.844E-15	5.790E-16	3.140E-15	4.290E-15	0
LLI Wall	p	7.609E-14	1.499E-15	5.385E-16	2.351E-16	4.125E-15	2.903E-15	0
LLI Wall	e	3.546E-13	.0	.0	.0	.0	1.603E-15	0
LLI Wall	t	4.307E-13	1.499E-15	5.385E-16	2.351E-16	4.125E-15	4.506E-15	0
Kidneys	p	1.646E-15	1.052E-13	5.646E-15	1.641E-15	3.782E-15	2.120E-15	0
Kidneys	e	.0	3.089E-13	.0	.0	.0	.0	0
Kidneys	t	1.646E-15	4.141E-13	5.646E-15	1.641E-15	3.782E-15	2.120E-15	0
Liver	p	6.247E-16	5.646E-15	3.882E-14	3.850E-15	1.976E-15	1.728E-15	0
Liver	e	.0	.0	5.319E-14	.0	.0	.0	0
Liver	t	6.247E-16	5.646E-15	9.202E-14	3.850E-15	1.976E-15	1.728E-15	0
Lng Tiss	p	2.631E-16	1.642E-15	3.851E-15	2.183E-14	2.449E-15	2.256E-15	0
Lng Tiss	e	.0	.0	.0	9.575E-14	.0	1.603E-15	0
Lng Tiss	t	2.631E-16	1.642E-15	3.851E-15	1.176E-13	2.449E-15	3.860E-15	0
Ovaries	p	2.422E-14	1.738E-15	1.092E-15	2.924E-16	4.094E-15	3.086E-15	0
Ovaries	e	.0	.0	.0	.0	.0	1.603E-15	0
Ovaries	t	2.422E-14	1.738E-15	1.092E-15	2.924E-16	4.094E-15	4.689E-15	0
R Marrow	p	4.191E-15	3.783E-15	1.975E-15	2.449E-15	1.019E-14	2.005E-15	0
R Marrow	e	.0	.0	.0	.0	6.383E-14	.0	0
R Marrow	t	4.191E-15	3.783E-15	1.975E-15	2.449E-15	7.402E-14	2.005E-15	0
Testes	p	3.074E-15	2.503E-16	1.932E-16	6.757E-17	8.097E-16	2.577E-15	0
Testes	e	.0	.0	.0	.0	.0	1.603E-15	0
Testes	t	3.074E-15	2.503E-16	1.932E-16	6.757E-17	8.097E-16	4.180E-15	0
Thyroid	p	5.808E-17	2.182E-16	3.623E-16	1.999E-15	1.732E-15	2.660E-15	0
Thyroid	e	.0	.0	.0	.0	.0	1.603E-15	0
Thyroid	t	5.808E-17	2.182E-16	3.623E-16	1.999E-15	1.732E-15	4.264E-15	0

Figure 12. Example 2: SEE Output File $DCAL\WORK2\Po212hf.see.

```
This is SEECAL file Po212hf.SEE
<<   SEECAL Ver. 1.0 (Dec 1, 1993)  --- Run Dec 05, 1993, at 14:17 >>
SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example2.req      1652 12-05-93   2:12p
Nuclide decay file was:             Ra224d.rad       22831 12-05-93  12:02p
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a
1 = number of age groups
Photon SAF file was:                PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:               RegMass.am        2245 12-01-93  12:00a
4 = number of title lines, copied from file Example2.req, that follow:
<<  SEEPAR Ver. 1.0  (Dec 1, 1993 )  --- Run Dec 05, 1993, at 14:07 >>
SEEPAR exe file was:                seepar.exe       79470 12-01-93   0:00a
Example 2: same as Example1 except request Adult Male only
and request type of SEE tables to be FULL TABLE.
Following 4 lines are header info from nuclide decay file Ra224d.rad
<<   DEXRAX Ver. 1.0 (Sep 1, 1993)  --- Run Dec 05, 1993, at 12:02 >>
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a
'equivalent dose' = dose type (equivalent dose or absorbed dose)
'full table' = table type (full table, total only, or low-hi let)
'Po-212 ','    0.305us','A        ' = nuclide, half-life, decay mode
'n' 'n' 'y' 'n' = photon, electron, alpha, spon. fission flags (Yes/No)
Age Group Name
'Adult Male          '
13, 7, 2 = # of source regions, # of source regions/page, # of pages/age
S. Region  Masses (kg) for each age group, in order as above
'C Bone-S' 0.00E+00
'C Bone-V' 4.00E+00
'T Bone-S' 0.00E+00
'T Bone-V' 1.00E+00
'St Cont ' 2.50E-01
'SI Cont ' 4.00E-01
'ULI Cont' 2.20E-01
'LLI Cont' 1.35E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Cont' 0.00E+00
'R Marrow' 1.50E+00
'Other   ' 5.97E+01
13 = number of target regions
T. Region  Masses (kg) for each age group, in order as above
'BSurface' 1.20E-01
'Breasts ' 3.60E-01
'St Wall ' 1.50E-01
'SI Wall ' 6.40E-01
'ULI Wall' 2.10E-01
'LLI Wall' 1.60E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Tiss' 1.00E+00
'Ovaries ' 1.10E-02
'R Marrow' 1.50E+00
'Testes  ' 3.50E-02
'Thyroid ' 2.00E-02
```

```
equivalent dose (Sv/nt) for Po-212  & Age=Adult Male          , p. 1 of 2
TARGETS RAD                          SOURCE REGIONS
------- ---C Bone-S  C Bone-V  T Bone-S  T Bone-V  St Cont   SI Cont   ULI Cont.
BSurface a 5.977E-11 2.391E-12 5.977E-11 5.977E-12  .0        .0        .0      0
Breasts  a .0        .0        .0        .0        .0        .0        .0      0
St Wall  a .0        .0        .0        .0        5.629E-13 .0        .0      0
SI Wall  a .0        .0        .0        .0        .0        3.518E-13 .0      0
ULI Wall a .0        .0        .0        .0        .0        .0        6.397E-13
LLI Wall a .0        .0        .0        .0        .0        .0        .0      0
Kidneys  a .0        .0        .0        .0        .0        .0        .0      0
Liver    a .0        .0        .0        .0        .0        .0        .0      0
Lng Tiss a .0        .0        .0        .0        .0        .0        .0      0
Ovaries  a .0        .0        .0        .0        .0        .0        .0      0
R Marrow a .0        .0        9.563E-12 9.563E-13 .0        .0        .0      0
Testes   a .0        .0        .0        .0        .0        .0        .0      0
Thyroid  a .0        .0        .0        .0        .0        .0        .0      0
equivalent dose (Sv/nt) for Po-212  & Age=Adult Male          , p. 2 of 2
TARGETS RAD                          SOURCE REGIONS
------- ---LLI Cont  Kidneys   Liver     Lng Cont  R Marrow  Other
BSurface a .0        .0        .0        .0        9.563E-12 .0        0
Breasts  a .0        .0        .0        .0        .0        4.804E-13 0
St Wall  a .0        .0        .0        .0        .0        4.804E-13 0
SI Wall  a .0        .0        .0        .0        .0        4.804E-13 0
ULI Wall a .0        .0        .0        .0        .0        4.804E-13 0
LLI Wall a 1.042E-12 .0        .0        .0        .0        4.804E-13 0
Kidneys  a .0        9.254E-11 .0        .0        .0        .0        0
Liver    a .0        .0        1.594E-11 .0        .0        .0        0
Lng Tiss a .0        .0        .0        2.869E-11 .0        4.804E-13 0
Ovaries  a .0        .0        .0        .0        .0        4.804E-13 0
R Marrow a .0        .0        .0        .0        1.913E-11 .0        0
Testes   a .0        .0        .0        .0        .0        4.804E-13 0
Thyroid  a .0        .0        .0        .0        .0        4.804E-13 0
```

Example 3

User request file Example2.req was copied to Example3.req and edited, as follows: the title lines were changed and the type of *SEE* table was changed to 'low-hi let'. There were no other changes. See Fig. 13. The keyboard input/screen output for this run is shown in Fig. 14. Note that a new error message appears after the user gave the name of the user request input file: the user failed to change "equivalent dose" to "absorbed dose" when he changed the type of table to "low-hi let" (this is an error because SEECAL always computes absorbed dose when grouping by LET). Here SEECAL changed the quantity to absorbed dose; the error message also appears in the log file; and in the *SEE* tables only the corrected quantity appears. Note that this error is impossible when creating the user request file with program SEEPAR because of the way the menu structure is organized.

Three of the *SEE* output files created in this run are given in Figs. 15-17. Note that the *SEE* filenames contain the letters *d* and *l* for absorbed dose and low-hi let, respectively (e.g., Ra224dl.see). Looking at file Ra224dl.see (Fig. 15), notice that the *SEE* tables contain the letters *l*, *h*, and *t* under the heading *RAD* — for low-LET, high-LET, and total radiations, respectively. This is because "low-hi let" was requested and this nuclide has both low-LET (photon and electron) and high-LET (alpha) radiations. Looking now at file Tl208dl.see (Fig. 16), notice that the *SEE* tables contain only the letter *l* under radiations — Tl-208 contains no high-LET radiations; and *SEE*s for *t* are not listed, to avoid redundancy. And looking at file Po212dl.see (Fig. 17), notice that the *SEE* tables contain only the letter *h* under radiations — Po-212 contains high-LET radiations only; and *SEE*s for *t* are not listed, to avoid redundancy.

Figure 13. Example 3: User Request File $DCAL\WORK2\Example3.req.

```
This is request file EXAMPLE3.REQ -- edited from Example2.req.
TITLE                     | Delimiter TITLE, format A5.
Example 3: same as Example 2, except request type of SEE tables to be LOW-HI LET
END TITLE                 | Delimiter END TITLE, format A9.
EQUIVALENT DOSE           | Dose type, format A15.
LOW-HI LET                | Table type, format A10.
AGE GROUPS                | Delimiter AGE GROUPS, format A10.
Adult Male                |
END AGE GROUPS            | Delimiter END AGE GROUPS, format A20.
SOURCE REGIONS            | Delimiter SOURCE REGIONS, format A14.
C Bone-S                  |
C Bone-V                  |
T Bone-S                  |
T Bone-V                  |
St Cont                   |
SI Cont                   |
ULI Cont                  |
LLI Cont                  |
Kidneys                   |
Liver                     |
Lng Cont                  |
R Marrow                  |
Other                     |
END SOURCE REGIONS        | Delimiter END SOUR, format A8.
TARGET REGIONS            | Delimiter TARGET REGIONS, format A14.
BSurface                  |
Breasts                   |
St Wall                   |
SI Wall                   |
ULI Wall                  |
LLI Wall                  |
Kidneys                   |
Liver                     |
Lng Tiss                  |
Ovaries                   |
R Marrow                  |
Testes                    |
Thyroid                   |
END TARGET REGIONS        | Delimiter END TARG, format A8.
```

Figure 14. Example 3: Keyboard Input/Screen Output for SEECAL Run.

User's input is underlined.

```
C:\DCAL> seecal

SEECAL:  calculate Specific Effective Energies
         Ver. 1.0 (Dec 1, 1993)
         Oak Ridge National Laboratory Report ORNL/TM-12351
Authors: M. Cristy and K. F. Eckerman
         Oak Ridge National Laboratory
         Oak Ridge, TN 37831-6383

Log file Seecal.log already exists --
[o]verwrite, (a)ppend, or (r)ename by changing extension ([o]/a/r)? o
Log file Seecal.log will be overwritten

Name of input file for decay data, .rad added -> Ra224d

Name of input file for user requests, .req added -> Example3

**** Error in user request file Example3.req: you requested style of SEE output
     file to be "low-hi let" and you requested quantity to be calculated to be
     "equivalent dose" --- quantity was changed to "absorbed dose" ****

Press <Enter> to clear screen & continue SEECAL
<Enter>

SEE output file Ra224dl.SEE will be written.
SEE output file Rn220dl.SEE will be written.
SEE output file Po216dl.SEE will be written.
SEE output file Pb212dl.SEE will be written.
SEE output file Bi212dl.SEE will be written.
SEE output file Po212dl.SEE will be written.
SEE output file Tl208dl.SEE will be written.

Press <Enter> to clear screen & continue SEECAL
<Enter>

MAJOR PROGRAM LOOP: working on age # 1 (adult male) ...

     Reading photon SAFs for age = adult male ...
     Reading electron & alpha AFs for age = adult male ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...
```

Figure 14 (cont'd).

```
The following SEE files have been written:
Ra224d1.SEE    Rn220d1.SEE    Po216d1.SEE    Pb212d1.SEE    Bi212d1.SEE
Po212d1.SEE    Tl208d1.SEE

Program SEECAL ended normally.
Stop - Program terminated.

C:\DCAL>
```

Figure 15. Example 3: SEE Output File $DCAL\WORK2\Ra224dl.see.

```
This is SEECAL file Ra224dl.SEE
<<   SEECAL Ver. 1.0 (Dec 1, 1993)  --- Run Dec 05, 1993, at 15:20 >>
SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example3.req      1499 12-05-93   3:19p
Nuclide decay file was:             Ra224d.rad       22831 12-05-93  12:02p
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a
1 = number of age groups
Photon SAF file was:                PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:               RegMass.am        2245 12-01-93  12:00a
1 = number of title lines, copied from file Example3.req, that follow:
Example 3: same as Example 2, except request type of SEE tables to be LOW-HI LE.
Following 4 lines are header info from nuclide decay file Ra224d.rad
<<   DEXRAX Ver. 1.0 (Sep 1, 1993)  --- Run Dec 05, 1993, at 12:02 >>
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a
'absorbed dose  ' = dose type (equivalent dose or absorbed dose)
'low-hi let' = table type (full table, total only, or low-hi let)
'Ra-224 ','     3.66d ','A       ' = nuclide, half-life, decay mode
'y' 'y' 'y' 'n' = photon, electron, alpha, spon. fission flags (Yes/No)
Age Group Name
'Adult Male         '
13, 7, 2 = # of source regions, # of source regions/page, # of pages/age
S. Region  Masses (kg) for each age group, in order as above
'C Bone-S' 0.00E+00
'C Bone-V' 4.00E+00
'T Bone-S' 0.00E+00
'T Bone-V' 1.00E+00
'St Cont ' 2.50E-01
'SI Cont ' 4.00E-01
'ULI Cont' 2.20E-01
'LLI Cont' 1.35E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Cont' 0.00E+00
'R Marrow' 1.50E+00
'Other   ' 5.97E+01
13 = number of target regions
T. Region  Masses (kg) for each age group, in order as above
'BSurface' 1.20E-01
'Breasts ' 3.60E-01
'St Wall ' 1.50E-01
'SI Wall ' 6.40E-01
'ULI Wall' 2.10E-01
'LLI Wall' 1.60E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Tiss' 1.00E+00
'Ovaries ' 1.10E-02
'R Marrow' 1.50E+00
'Testes  ' 3.50E-02
'Thyroid ' 2.00E-02
```

absorbed dose (Gy/nt) for Ra-224 & Age=Adult Male , p. 1 of 2

TARGETS RAD		C Bone-S	C Bone-V	T Bone-S	T Bone-V	St Cont	SI Cont	ULI Cont.
		SOURCE REGIONS						
BSurface	l	2.980E-16	7.151E-17	3.147E-16	9.784E-17	5.640E-18	7.824E-18	6.781E-18
BSurface	h	1.928E-12	7.712E-14	1.928E-12	1.928E-13	.0	.0	.0 0
BSurface	t	1.928E-12	7.720E-14	1.928E-12	1.929E-13	5.640E-18	7.824E-18	6.781E-18
Breasts	l	2.516E-18	2.516E-18	4.268E-18	4.268E-18	4.490E-18	7.288E-19	8.167E-19
Breasts	h	.0	.0	.0	.0	.0	.0	.0 0
Breasts	t	2.516E-18	2.516E-18	4.268E-18	4.268E-18	4.490E-18	7.288E-19	8.167E-19
St Wall	l	3.157E-18	3.157E-18	6.474E-18	6.474E-18	1.008E-15	1.579E-17	2.064E-17
St Wall	h	.0	.0	.0	.0	1.818E-14	.0	.0 0
St Wall	t	3.157E-18	3.157E-18	6.474E-18	6.474E-18	1.919E-14	1.579E-17	2.064E-17
SI Wall	l	4.429E-18	4.429E-18	1.400E-17	1.400E-17	1.471E-17	5.432E-16	9.226E-17
SI Wall	h	.0	.0	.0	.0	.0	1.136E-14	.0 0
SI Wall	t	4.429E-18	4.429E-18	1.400E-17	1.400E-17	1.471E-17	1.191E-14	9.226E-17
ULI Wall	l	3.905E-18	3.905E-18	1.192E-17	1.192E-17	1.900E-17	1.015E-16	1.049E-15
ULI Wall	h	.0	.0	.0	.0	.0	.0	2.066E-14
ULI Wall	t	3.905E-18	3.905E-18	1.192E-17	1.192E-17	1.900E-17	1.015E-16	2.171E-14
LLI Wall	l	5.677E-18	5.677E-18	1.519E-17	1.519E-17	6.433E-18	4.376E-17	1.659E-17
LLI Wall	h	.0	.0	.0	.0	.0	.0	.0 0
LLI Wall	t	5.677E-18	5.677E-18	1.519E-17	1.519E-17	6.433E-18	4.376E-17	1.659E-17
Kidneys	l	4.961E-18	4.961E-18	1.334E-17	1.334E-17	1.969E-17	1.616E-17	1.608E-17
Kidneys	h	.0	.0	.0	.0	.0	.0	.0 0
Kidneys	t	4.961E-18	4.961E-18	1.334E-17	1.334E-17	1.969E-17	1.616E-17	1.608E-17
Liver	l	3.781E-18	3.781E-18	6.893E-18	6.893E-18	1.084E-17	8.709E-18	1.385E-17
Liver	h	.0	.0	.0	.0	.0	.0	.0 0
Liver	t	3.781E-18	3.781E-18	6.893E-18	6.893E-18	1.084E-17	8.709E-18	1.385E-17
Lng Tiss	l	5.175E-18	5.175E-18	8.521E-18	8.521E-18	7.982E-18	1.164E-18	1.426E-18
Lng Tiss	h	.0	.0	.0	.0	.0	.0	.0 0
Lng Tiss	t	5.175E-18	5.175E-18	8.521E-18	8.521E-18	7.982E-18	1.164E-18	1.426E-18
Ovaries	l	5.005E-18	5.005E-18	1.593E-17	1.593E-17	4.425E-18	6.710E-17	5.521E-17
Ovaries	h	.0	.0	.0	.0	.0	.0	.0 0
Ovaries	t	5.005E-18	5.005E-18	1.593E-17	1.593E-17	4.425E-18	6.710E-17	5.521E-17
R Marrow	l	1.584E-17	1.584E-17	1.550E-16	1.194E-16	5.987E-18	1.349E-17	1.094E-17
R Marrow	h	.0	.0	3.085E-13	3.085E-14	.0	.0	.0 0
R Marrow	t	1.584E-17	1.584E-17	3.087E-13	3.097E-14	5.987E-18	1.349E-17	1.094E-17
Testes	l	3.292E-18	3.292E-18	2.575E-18	2.575E-18	3.557E-19	2.136E-18	1.705E-18
Testes	h	.0	.0	.0	.0	.0	.0	.0 0
Testes	t	3.292E-18	3.292E-18	2.575E-18	2.575E-18	3.557E-19	2.136E-18	1.705E-18
Thyroid	l	5.949E-18	5.949E-18	5.923E-18	5.923E-18	3.074E-19	5.563E-20	1.021E-19
Thyroid	h	.0	.0	.0	.0	.0	.0	.0 0
Thyroid	t	5.949E-18	5.949E-18	5.923E-18	5.923E-18	3.074E-19	5.563E-20	1.021E-19

Figure 15 (cont'd). Ra224dl.scc.

absorbed dose (Gy/nt) for Ra-224 & Age=Adult Male , p. 2 of 2

TARGETS RAD		SOURCE REGIONS						
		LLI Cont	Kidneys	Liver	Lng Cont	R Marrow	Other	
BSurface	l	9.643E-18	8.769E-18	6.722E-18	8.976E-18	1.423E-16	1.166E-17	0
BSurface	h	.0	.0	.0	.0	3.085E-13	.0	0
BSurface	t	9.643E-18	8.769E-18	6.722E-18	8.976E-18	3.086E-13	1.166E-17	0
Breasts	l	2.668E-19	1.761E-18	5.439E-18	1.746E-17	4.268E-18	1.192E-17	0
Breasts	h	.0	.0	.0	.0	.0	1.550E-14	0
Breasts	t	2.668E-19	1.761E-18	5.439E-18	1.746E-17	4.268E-18	1.551E-14	0
St Wall	l	9.559E-18	1.862E-17	1.095E-17	8.708E-18	6.474E-18	1.534E-17	0
St Wall	h	.0	.0	.0	.0	.0	1.550E-14	0
St Wall	t	9.559E-18	1.862E-17	1.095E-17	8.708E-18	6.474E-18	1.551E-14	0
SI Wall	l	5.263E-17	1.616E-17	8.709E-18	1.164E-18	1.400E-17	1.683E-17	0
SI Wall	h	.0	.0	.0	.0	.0	1.550E-14	0
SI Wall	t	5.263E-17	1.616E-17	8.709E-18	1.164E-18	1.400E-17	1.551E-14	0
ULI Wall	l	2.183E-17	1.622E-17	1.364E-17	1.530E-18	1.192E-17	1.584E-17	0
ULI Wall	h	.0	.0	.0	.0	.0	1.550E-14	0
ULI Wall	t	2.183E-17	1.622E-17	1.364E-17	1.530E-18	1.192E-17	1.551E-14	0
LLI Wall	l	1.606E-15	4.355E-18	1.249E-18	3.349E-19	1.519E-17	1.669E-17	0
LLI Wall	h	3.367E-14	.0	.0	.0	.0	1.550E-14	0
LLI Wall	t	3.527E-14	4.355E-18	1.249E-18	3.349E-19	1.519E-17	1.551E-14	0
Kidneys	l	5.699E-18	1.535E-15	2.148E-17	5.100E-18	1.334E-17	7.463E-18	0
Kidneys	h	.0	2.985E-12	.0	.0	.0	.0	0
Kidneys	t	5.699E-18	2.987E-12	2.148E-17	5.100E-18	1.334E-17	7.463E-18	0
Liver	l	1.522E-18	2.148E-17	3.463E-16	1.475E-17	6.893E-18	5.965E-18	0
Liver	h	.0	.0	5.142E-13	.0	.0	.0	0
Liver	t	1.522E-18	2.148E-17	5.145E-13	1.475E-17	6.893E-18	5.965E-18	0
Lng Tiss	l	4.729E-19	5.105E-18	1.476E-17	4.422E-16	8.521E-18	1.448E-17	0
Lng Tiss	h	.0	.0	.0	9.255E-13	.0	1.550E-14	0
Lng Tiss	t	4.729E-19	5.105E-18	1.476E-17	9.259E-13	8.521E-18	1.551E-14	0
Ovaries	l	9.165E-17	5.502E-18	3.033E-18	5.932E-19	1.593E-17	1.743E-17	0
Ovaries	h	.0	.0	.0	.0	.0	1.550E-14	0
Ovaries	t	9.165E-17	5.502E-18	3.033E-18	5.932E-19	1.593E-17	1.551E-14	0
R Marrow	l	1.597E-17	1.347E-17	6.612E-18	8.641E-18	2.734E-16	7.315E-18	0
R Marrow	h	.0	.0	.0	.0	6.170E-13	.0	0
R Marrow	t	1.597E-17	1.347E-17	6.612E-18	8.641E-18	6.173E-13	7.315E-18	0
Testes	l	1.115E-17	3.688E-19	1.902E-19	5.160E-20	2.575E-18	1.475E-17	0
Testes	h	.0	.0	.0	.0	.0	1.550E-14	0
Testes	t	1.115E-17	3.688E-19	1.902E-19	5.160E-20	2.575E-18	1.551E-14	0
Thyroid	l	3.765E-20	3.872E-19	8.244E-19	6.501E-18	5.923E-18	1.572E-17	0
Thyroid	h	.0	.0	.0	.0	.0	1.550E-14	0
Thyroid	t	3.765E-20	3.872E-19	8.244E-19	6.501E-18	5.923E-18	1.551E-14	0

Figure 16. Example 3: SEE Output File $DCAL\WORK2\Tl208dl.see.

```
This is SEECAL file Tl208dl.SEE                                          .
<<   SEECAL Ver. 1.0 (Dec 1, 1993)  --- Run Dec 05, 1993, at 15:20 >>    .
SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a   .
User request file was:              Example3.req      1499 12-05-93   3:19p   .
Nuclide decay file was:             Ra224d.rad       22831 12-05-93  12:02p   .
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a   .
1 = number of age groups                                                 .
Photon SAF file was:                PhtonSAF.am      63360 12-01-93  12:00a   .
Electron-alpha AF file was:         ElAlphAF.am       1782 12-01-93  12:00a   .
Region mass file was:               RegMass.am        2245 12-01-93  12:00a   .
1 = number of title lines, copied from file Example3.req, that follow:   .
Example 3: same as Example 2, except request type of SEE tables to be LOW-HI LE.
Following 4 lines are header info from nuclide decay file Ra224d.rad     .
<<   DEXRAX Ver. 1.0 (Sep 1, 1993)  --- Run Dec 05, 1993, at 12:02 >>    .
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a   .
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a   .
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a   .
'absorbed dose  ' = dose type (equivalent dose or absorbed dose)         .
'low-hi let' = table type (full table, total only, or low-hi let)        .
'Tl-208 ','     3.07m ','B-      ' = nuclide, half-life, decay mode      .
'y' 'y' 'n' 'n' = photon, electron, alpha, spon. fission flags (Yes/No)   .
Age Group Name                                                           .
'Adult Male          '                                                   .
13, 7, 2 = # of source regions, # of source regions/page, # of pages/age .
S. Region  Masses (kg) for each age group, in order as above             .
'C Bone-S' 0.00E+00                                                      .
'C Bone-V' 4.00E+00                                                      .
'T Bone-S' 0.00E+00                                                      .
'T Bone-V' 1.00E+00                                                      .
'St Cont ' 2.50E-01                                                      .
'SI Cont ' 4.00E-01                                                      .
'ULI Cont' 2.20E-01                                                      .
'LLI Cont' 1.35E-01                                                      .
'Kidneys ' 3.10E-01                                                      .
'Liver   ' 1.80E+00                                                      .
'Lng Cont' 0.00E+00                                                      .
'R Marrow' 1.50E+00                                                      .
'Other   ' 5.97E+01                                                      .
13 = number of target regions                                            .
T. Region  Masses (kg) for each age group, in order as above             .
'BSurface' 1.20E-01                                                      .
'Breasts ' 3.60E-01                                                      .
'St Wall ' 1.50E-01                                                      .
'SI Wall ' 6.40E-01                                                      .
'ULI Wall' 2.10E-01                                                      .
'LLI Wall' 1.60E-01                                                      .
'Kidneys ' 3.10E-01                                                      .
'Liver   ' 1.80E+00                                                      .
'Lng Tiss' 1.00E+00                                                      .
'Ovaries ' 1.10E-02                                                      .
'R Marrow' 1.50E+00                                                      .
'Testes  ' 3.50E-02                                                      .
'Thyroid ' 2.00E-02                                                      .
```

```
absorbed dose   (Gy/nt) for Tl-208  & Age=Adult Male          , p. 1 of 2   .
TARGETS RAD                          SOURCE REGIONS                      .
------- ---C Bone-S  C Bone-V  T Bone-S  T Bone-V  St Cont   SI Cont   ULI Cont.
BSurface | 2.063E-14 1.807E-14 2.774E-14 2.529E-14 1.132E-15 1.483E-15 1.296E-15
Breasts  | 9.266E-16 9.266E-16 1.504E-15 1.504E-15 1.686E-15 4.105E-16 4.615E-16
St Wall  | 9.375E-16 9.375E-16 1.837E-15 1.837E-15 2.680E-13 4.213E-15 5.600E-15
SI Wall  | 1.229E-15 1.229E-15 3.560E-15 3.560E-15 3.946E-15 1.446E-13 2.297E-14
ULI Wall | 1.129E-15 1.129E-15 3.140E-15 3.140E-15 5.005E-15 2.590E-14 2.814E-13
LLI Wall | 1.608E-15 1.608E-15 4.125E-15 4.125E-15 1.981E-15 1.125E-14 4.572E-15
Kidneys  | 1.482E-15 1.482E-15 3.782E-15 3.782E-15 5.032E-15 4.279E-15 4.435E-15
Liver    | 1.134E-15 1.134E-15 1.976E-15 1.976E-15 2.950E-15 2.525E-15 3.860E-15
Lng Tiss | 1.528E-15 1.528E-15 2.449E-15 2.449E-15 2.353E-15 5.086E-16 6.473E-16
Ovaries  | 1.373E-15 1.373E-15 4.094E-15 4.094E-15 1.528E-15 1.678E-14 1.400E-14
R Marrow | 4.430E-15 4.430E-15 4.210E-14 3.253E-14 1.786E-15 3.552E-15 2.955E-15
Testes   | 1.011E-15 1.011E-15 8.097E-16 8.097E-16 2.563E-16 8.967E-16 7.855E-16
Thyroid  | 1.780E-15 1.780E-15 1.732E-15 1.732E-15 2.415E-16 7.629E-17 1.080E-16
absorbed dose   (Gy/nt) for Tl-208  & Age=Adult Male          , p. 2 of 2   .
TARGETS RAD                          SOURCE REGIONS                      .
------- ---LLI Cont  Kidneys   Liver    Lng Cont  R Marrow  Other          .
BSurface | 1.857E-15 1.793E-15 1.370E-15 1.848E-15 3.726E-14 2.448E-15     0
Breasts  | 2.082E-16 8.128E-16 1.792E-15 4.851E-15 1.504E-15 3.429E-15     0
St Wall  | 2.765E-15 5.073E-15 3.117E-15 2.487E-15 1.837E-15 4.193E-15     0
SI Wall  | 1.278E-14 4.279E-15 2.525E-15 5.086E-16 3.560E-15 4.542E-15     0
ULI Wall | 6.141E-15 3.981E-15 3.844E-15 5.790E-16 3.140E-15 4.290E-15     0
LLI Wall | 4.307E-13 1.499E-15 5.385E-16 2.351E-16 4.125E-15 4.506E-15     0
Kidneys  | 1.646E-15 4.141E-13 5.646E-15 1.641E-15 3.782E-15 2.120E-15     0
Liver    | 6.247E-16 5.646E-15 9.202E-14 3.850E-15 1.976E-15 1.728E-15     0
Lng Tiss | 2.631E-16 1.642E-15 3.851E-15 1.176E-13 2.449E-15 3.860E-15     0
Ovaries  | 2.422E-14 1.738E-15 1.092E-15 2.924E-16 4.094E-15 4.689E-15     0
R Marrow | 4.191E-15 3.783E-15 1.975E-15 2.449E-15 7.402E-14 2.005E-15     0
Testes   | 3.074E-15 2.503E-16 1.932E-16 6.757E-17 8.097E-16 4.180E-15     0
Thyroid  | 5.808E-17 2.182E-16 3.623E-16 1.999E-15 1.732E-15 4.264E-15     0
```

Figure 17. Example 3: SEE Output File $DCAL\WORK2\Po212dl.see.

```
This is SEECAL file Po212dl.SEE
<<   SEECAL Ver. 1.0 (Dec 1, 1993)  --- Run Dec 05, 1993, at 15:20 >>
SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example3.req      1499 12-05-93   3:19p
Nuclide decay file was:             Ra224d.rad       22831 12-05-93  12:02p
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a
1 = number of age groups
Photon SAF file was:                PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:               RegMass.am        2245 12-01-93  12:00a
1 = number of title lines, copied from file Example3.req, that follow:
Example 3: same as Example 2, except request type of SEE tables to be LOW-HI LE.
Following 4 lines are header info from nuclide decay file Ra224d.rad
<<   DEXRAX Ver. 1.0 (Sep 1, 1993)  --- Run Dec 05, 1993, at 12:02 >>
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a
'absorbed dose  ' = dose type (equivalent dose or absorbed dose)
'low-hi let' = table type (full table, total only, or low-hi let)
'Po-212 ','    0.305us','A       ' = nuclide, half-life, decay mode
'n' 'n' 'y' 'n' = photon, electron, alpha, spon. fission flags (Yes/No)
Age Group Name
'Adult Male          '
13, 7, 2 = # of source regions, # of source regions/page, # of pages/age
S. Region  Masses (kg) for each age group, in order as above
'C Bone-S' 0.00E+00
'C Bone-V' 4.00E+00
'T Bone-S' 0.00E+00
'T Bone-V' 1.00E+00
'St Cont ' 2.50E-01
'SI Cont ' 4.00E-01
'ULI Cont' 2.20E-01
'LLI Cont' 1.35E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Cont' 0.00E+00
'R Marrow' 1.50E+00
'Other   ' 5.97E+01
13 = number of target regions
T. Region  Masses (kg) for each age group, in order as above
'BSurface' 1.20E-01
'Breasts ' 3.60E-01
'St Wall ' 1.50E-01
'SI Wall ' 6.40E-01
'ULI Wall' 2.10E-01
'LLI Wall' 1.60E-01
'Kidneys ' 3.10E-01
'Liver   ' 1.80E+00
'Lng Tiss' 1.00E+00
'Ovaries ' 1.10E-02
'R Marrow' 1.50E+00
'Testes  ' 3.50E-02
'Thyroid ' 2.00E-02
```

absorbed dose (Gy/nt) for Po-212 & Age=Adult Male , p. 1 of 2

TARGETS RAD		SOURCE REGIONS							
		C Bone-S	C Bone-V	T Bone-S	T Bone-V	St Cont	SI Cont	ULI Cont	
BSurface	h	2.988E-12	1.195E-13	2.988E-12	2.988E-13	.0	.0	.0	0
Breasts	h	.0	.0	.0	.0	.0	.0	.0	0
St Wall	h	.0	.0	.0	.0	2.815E-14	.0	.0	0
SI Wall	h	.0	.0	.0	.0	.0	1.759E-14	.0	0
ULI Wall	h	.0	.0	.0	.0	.0	.0	3.199E-14	
LLI Wall	h	.0	.0	.0	.0	.0	.0	.0	0
Kidneys	h	.0	.0	.0	.0	.0	.0	.0	0
Liver	h	.0	.0	.0	.0	.0	.0	.0	0
Lng Tiss	h	.0	.0	.0	.0	.0	.0	.0	0
Ovaries	h	.0	.0	.0	.0	.0	.0	.0	0
R Marrow	h	.0	.0	4.781E-13	4.781E-14	.0	.0	.0	0
Testes	h	.0	.0	.0	.0	.0	.0	.0	0
Thyroid	h	.0	.0	.0	.0	.0	.0	.0	0

absorbed dose (Gy/nt) for Po-212 & Age=Adult Male , p. 2 of 2

TARGETS RAD		SOURCE REGIONS						
		LLI Cont	Kidneys	Liver	Lng Cont	R Marrow	Other	
BSurface	h	.0	.0	.0	.0	4.781E-13	.0	0
Breasts	h	.0	.0	.0	.0	.0	2.402E-14	0
St Wall	h	.0	.0	.0	.0	.0	2.402E-14	0
SI Wall	h	.0	.0	.0	.0	.0	2.402E-14	0
ULI Wall	h	.0	.0	.0	.0	.0	2.402E-14	0
LLI Wall	h	5.212E-14	.0	.0	.0	.0	2.402E-14	0
Kidneys	h	.0	4.627E-12	.0	.0	.0	.0	0
Liver	h	.0	.0	7.969E-13	.0	.0	.0	0
Lng Tiss	h	.0	.0	.0	1.434E-12	.0	2.402E-14	0
Ovaries	h	.0	.0	.0	.0	.0	2.402E-14	0
R Marrow	h	.0	.0	.0	.0	9.563E-13	.0	0
Testes	h	.0	.0	.0	.0	.0	2.402E-14	0
Thyroid	h	.0	.0	.0	.0	.0	2.402E-14	0

Example 3a — Illustration of Overwriting or Renaming SEE Files

The user decided to re-run Example 3 but with age 5 instead of Adult Male. He copied file Example3.req to create Exampl3a.req and edited the latter file to change the age group and correct the dosimetric quantity to "absorbed dose", to avoid the error message he got above.

The keyboard input/screen output is shown in Fig. 18. Note first that he chose to append the log file to the existing log file, Seecal.log, in response to the message. Note second that he misspelled both the name of the RAD file and the REQ file, and SEECAL gave him an opportunity to correct his input. Note third that SEECAL wrote a warning message that all 7 of the *SEE* files to be created already existed in the WORK2 subdirectory (i.e., those run in Example 3). The user chose to rename the new files with the extension S05, and SEECAL responded with messages that each of the files would be written.

The log file for Example 3 and for Example3a, appended, is given in Fig. 19.

Figure 18. Example 3a: Keyboard Input/Screen Output for SEECAL Run.

User's input is underlined.

```
C:\DCAL> seecal

SEECAL:  calculate Specific Effective Energies
         Ver. 1.0 (Dec 1, 1993)
         Oak Ridge National Laboratory Report ORNL/TM-12351
Authors: M. Cristy and K. F. Eckerman
         Oak Ridge National Laboratory
         Oak Ridge, TN 37831-6383

Log file Seecal.log already exists --
[o]verwrite, (a)ppend, or (r)ename by changing extension ([o]/a/r)? a
Log file will be appended to existing Seecal.log

Name of input file for decay data, .rad added -> Ra-224d
 Cannot open file -- [c]orrect input or (s)top ([c]/s)? c
Name of input file for decay data, .rad added -> Ra224d

Name of input file for user requests, .req added -> Exam3a
 Cannot open file -- [c]orrect input or (s)top ([c]/s)? c
Name of input file for user requests, .req added -> Exampl3a

Press <Enter> to clear screen & continue SEECAL
<Enter>

**** Warning: SEE output file Ra224dl.SEE already exists ****
**** Warning: SEE output file Rn220dl.SEE already exists ****
**** Warning: SEE output file Po216dl.SEE already exists ****
**** Warning: SEE output file Pb212dl.SEE already exists ****
**** Warning: SEE output file Bi212dl.SEE already exists ****
**** Warning: SEE output file Po212dl.SEE already exists ****
**** Warning: SEE output file Tl208dl.SEE already exists ****

One or more SEE output files (above) already exist --
[o]verwrite, (r)ename by changing extension, or (s)top ([o]/r/s)? r
Give new extension (e.g., .se2) -> .s05

SEE output file Ra224dl.s05 will be written.
SEE output file Rn220dl.s05 will be written.
SEE output file Po216dl.s05 will be written.
SEE output file Pb212dl.s05 will be written.
SEE output file Bi212dl.s05 will be written.
SEE output file Po212dl.s05 will be written.
SEE output file Tl208dl.s05 will be written.

Press <Enter> to clear screen & continue SEECAL
<Enter>
```

Figure 18 (cont'd).

```
MAJOR PROGRAM LOOP: working on age # 1 (adult male) ...

     Reading photon SAFs for age = adult male ...
     Reading electron & alpha AFs for age = adult male ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

The following SEE files have been written:
Ra224dl.s05    Rn220dl.s05    Po216dl.s05    Pb212dl.s05    Bi212dl.s05
Po212dl.s05    Tl208dl.s05

Program SEECAL ended normally.
Stop - Program terminated.


C:\DCAL>
```

Figure 19. Examples 3 and 3a: Combined Log File $DCAL\WORK2\Seecal.log.

```
-----------------------------------------------------------------------------
This is SEECAL log file Seecal.log
<<   SEECAL Ver. 1.0 (Dec 1, 1993) --- Run Dec 05, 1993, at 15:20 >>

 ... Title lines from user request file follow:
Example 3: same as Example 2, except request type of SEE tables to be LOW-HI LET
 ... End of title lines; number of title lines = 1

 **** Error in user request file Example3.req: you requested style of SEE output
      file to be "low-hi let" and you requested quantity to be calculated to be
      "equivalent dose" --- quantity was changed to "absorbed dose" ****


 Quantity to be calculated = "absorbed dose  "
 Table type for SEE files = "low-hi let"

 Index iACalc; Age Group Name;          Index iAge
            1  "adult male          "   6
 End of age group list; number of age groups = 1

 Index iSCalc; SOURCE Name; Index iS
            1  "c bone-s"    4
            2  "c bone-v"    5
            3  "t bone-s"    6
            4  "t bone-v"    7
            5  "st cont "   10
            6  "si cont "   12
            7  "uli cont"   14
            8  "lli cont"   16
            9  "kidneys "   18
           10  "liver   "   19
           11  "lng cont"   20
           12  "r marrow"   25
           13  "other   "   40
 End of source region list; number of sources = 13

 Index iTCalc; TARGET Name; Index iT
            1  "bsurface"    3
            2  "breasts "    5
            3  "st wall "    6
            4  "si wall "    7
            5  "uli wall"    8
            6  "lli wall"    9
            7  "kidneys "   10
            8  "liver   "   11
            9  "lng tiss"   12
           10  "ovaries "   14
           11  "r marrow"   16
           12  "testes  "   19
           13  "thyroid "   21
 End of target region list; number of targets = 13

 SEE output file Ra224dl.SEE will be written.
 SEE output file Rn220dl.SEE will be written.
 SEE output file Po216dl.SEE will be written.
 SEE output file Pb212dl.SEE will be written.
 SEE output file Bi212dl.SEE will be written.
 SEE output file Po212dl.SEE will be written.
 SEE output file Tl208dl.SEE will be written.

SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example3.req      1499 12-05-93   3:19p
Nuclide decay file was:             Ra224d.rad       22831 12-05-93  12:02p
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a
Photon SAF file was:                PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:         ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:               RegMass.am        2245 12-01-93  12:00a

 MAJOR PROGRAM LOOP: working on age # 1 (adult male) ...

      Reading photon SAFs for age = adult male ...
      Reading electron & alpha AFs for age = adult male ...
      Calculating SEEs for nuclide = Ra-224  ...
      Calculating SEEs for nuclide = Rn-220  ...
      Calculating SEEs for nuclide = Po-216  ...
      Calculating SEEs for nuclide = Pb-212  ...
      Calculating SEEs for nuclide = Bi-212  ...
      Calculating SEEs for nuclide = Po-212  ...
      Calculating SEEs for nuclide = Tl-208  ...

 The following SEE files have been written:
 Ra224dl.SEE    Rn220dl.SEE    Po216dl.SEE    Pb212dl.SEE    Bi212dl.SEE
 Po212dl.SEE    Tl208dl.SEE

 Program SEECAL ended normally.
-----------------------------------------------------------------------------
This is SEECAL log file Seecal.log
<<   SEECAL Ver. 1.0 (Dec 1, 1993) --- Run Dec 05, 1993, at 16:02 >>

 ... Title lines from user request file follow:
 Example 3a: same as Example 3, except change age group to age 5 and
 correct dose type to be absorbed dose.
 ... End of title lines; number of title lines = 2

 Quantity to be calculated = "absorbed dose  "
 Table type for SEE files = "low-hi let"

 Index iACalc; Age Group Name;          Index iAge
            1  "adult male          "   6
 End of age group list; number of age groups = 1
```

Figure 19 (cont'd). Seecal.log.

```
Index iSCalc; SOURCE Name; Index iS
          1  "c bone-s"    4
          2  "c bone-v"    5
          3  "t bone-s"    6
          4  "t bone-v"    7
          5  "st cont "   10
          6  "si cont "   12
          7  "uli cont"   14
          8  "lli cont"   16
          9  "kidneys "   18
         10  "liver   "   19
         11  "lng cont"   20
         12  "r marrow"   25
         13  "other   "   40
End of source region list; number of sources = 13

Index iTCalc; TARGET Name; Index iT
          1  "bsurface"    3
          2  "breasts "    5
          3  "st wall "    6
          4  "si wall "    7
          5  "uli wall"    8
          6  "lli wall"    9
          7  "kidneys "   10
          8  "liver   "   11
          9  "lng tiss"   12
         10  "ovaries "   14
         11  "r marrow"   16
         12  "testes  "   19
         13  "thyroid "   21
End of target region list; number of targets = 13

SEE output file Ra224dl.s05 will be written.
SEE output file Rn220dl.s05 will be written.
SEE output file Po216dl.s05 will be written.
SEE output file Pb212dl.s05 will be written.
SEE output file Bi212dl.s05 will be written.
SEE output file Po212dl.s05 will be written.
SEE output file Tl208dl.s05 will be written.

SEECAL exe file was:              Seecal.exe      317296 12-01-93  12:00a
User request file was:            Exampl3a.req      1527 12-05-93   4:02p
Nuclide decay file was:           Ra224d.rad       22831 12-05-93  12:02p
File with standard names was:     StdNames.txt      1706 12-01-93  12:00a
Photon SAF file was:              PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:       ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:             RegMass.am        2245 12-01-93  12:00a
```

```
MAJOR PROGRAM LOOP: working on age # 1 (adult male) ...

     Reading photon SAFs for age = adult male ...
     Reading electron & alpha AFs for age = adult male ...
     Calculating SEEs for nuclide = Ra-224  ...
     Calculating SEEs for nuclide = Rn-220  ...
     Calculating SEEs for nuclide = Po-216  ...
     Calculating SEEs for nuclide = Pb-212  ...
     Calculating SEEs for nuclide = Bi-212  ...
     Calculating SEEs for nuclide = Po-212  ...
     Calculating SEEs for nuclide = Tl-208  ...

The following SEE files have been written:
Ra224dl.s05    Rn220dl.s05    Po216dl.s05    Pb212dl.s05    Bi212dl.s05
Po212dl.s05    Tl208dl.s05

Program SEECAL ended normally.
```

VIII. EXAMPLE OF RUNNING DEXRAX, SEEPAR, AND SEECAL TOGETHER IN SEEDEX BATCH MODE

Example 4

If you plan to use SEEPAR to create the user request file and you have not yet created a nuclide decay data file, we recommend that you use SEEDEX to run DEXRAX, SEEPAR, and SEECAL together. With SEEDEX, there are fewer queries to the user and no file names to remember. With SEEDEX, you are asked at the beginning for a single stem name (1-8 characters) that will be used for the LOG, RAD, and REQ files. Then SEEDEX simply runs DEXRAX, SEEPAR, and SEECAL in succession, supplying these names as they are needed so that the user is not queried to input these names. Also, in DEXRAX, there are fewer queries to the user, because it is assumed that input of nuclide names will be from the keyboard rather than from a file and that beta spectra data are not needed — thus the two menus related to these choices do not appear when running DEXRAX through SEEDEX.

In Fig. 20 is shown the keyboard input/screen output for a SEEDEX run, run from directory $DCAL (C:\DCAL in the example). This example is for Pu-239 plus radioactive daughters, dose type = equivalent dose, table type = total only, 6 source regions, all target regions, and age groups Newborn through Adult Male. On the first screen the user was asked for the single stem name to be used for the LOG, RAD, and REQ files, and he input "Example4". Then a reminder was written that the user would have an opportunity to input textual information about the run during the SEEPAR module. Then DEXRAX was run (screen 2), with the user being queried whether he wanted to include radioactive daughters (he did) and for the names of the nuclides, which he responded to with "Pu-239". Then DEXRAX wrote out some information about the nuclides chosen.

Then SEEPAR was run (screens 3-13). It is exactly like the previous SEEPAR run shown in Fig. 8, except that the first screen asking for the name of the REQ file is omitted. Note on screen 9 that the user chose complement mode for the target region selection, because he wanted all target regions, and that allowed him to just press <Enter> to accept all target regions without having to toggle any target regions on.

Screen 14 shows the SEECAL part of the run. Note that there were no queries to the user, because the usual queries for names of RAD and REQ files were unnecessary. However, if any of the *SEE* files to be created had already existed in the WORK2 subdirectory, he would have been asked the usual question about overwriting the old files or renaming the new files.

The log file for this run is given in Fig. 21. It gives first the version number and date of SEEDEX, the date and time of the run, and directory information on the SeeDex.exe file. Then comes log information from the DEXRAX part of the run and then log information from the SEECAL part of the run. The DEXRAX and SEECAL log information is identical to what you would see if these programs had been run separately. (Note: SEEPAR does not generate a log file. However, some "log information" — the version number and date of SEEPAR, the date and time it was run, and directory information on the file Seepar.exe — are included in the title/information lines written to the request file and are in the SEECAL log.)

None of the *SEE* files are given here, because they are similar in all respects to previous examples. All output files, as usual, were written to the WORK2 subdirectory.

Caution about Abnormal Ending of SEEDEX by User

Programs DEXRAX, SEEPAR, and SEECAL may be run individually or together with SEEDEX, of course. Each program decides which mode it is running in by looking for the existence of a temporary file in the WORK2 subdirectory called $SeeDex.dir. If this file exists, then it is assumed that this is a SEEDEX run; if it does not exist, then it is assumed that the program is being run individually. This file is created by the preliminary part of SEEDEX, just after the user is queried for the stem of file names for the run (this stem is stored in $SeeDex.dir), and it is deleted after its last use during the SEECAL module. This temporary file is also deleted if SEEDEX ends abnormally through one of its fatal errors. However, if the user ends the program abnormally, e.g., by pressing <Ctrl><Break>, then $SeeDex.dir may still exist. This will cause no problem if the next run is another SEEDEX run, because $SeeDex.dir will be overwritten, but it will cause a problem if DEXRAX, SEEPAR, or SEECAL is run individually. Therefore, if you break out of SEEDEX and are not planning another SEEDEX run, you should delete the "temporary" file manually.

Figure 20. Example 4: Keyboard Input/Screen Output for SEEDEX Batch Run.

User's textual input is underlined. In two cases the user's menu selection is underlined, where it was not otherwise clear what the selection was. Solid horizontal lines indicate screen clearings. Screen numbers have been added here for reference in text.

```
C:\DCAL> seedex
```

SCREEN 1

```
SEEDEX - DEXRAX & SEECAL combined
SEEDEX Ver. 1.0 (Dec 1, 1993)

SEEDEX:  DEXRAX, SEEPAR, and SEECAL combined
         Ver. 1.0 (Dec 1, 1993)
         Oak Ridge National Laboratory Reports ORNL/TM-12350 and ORNL/TM-12351
Authors: M. Cristy and K.F. Eckerman
         Oak Ridge National Laboratory
         Oak Ridge, TN 37831-6383

Stem for filenames (.log, .rad, .req) for this run -> Example4

Note: textual information regarding this run may be input during SEEPAR module

Press <Enter> to clear screen & run DEXRAX
<Enter>

Stop - Program terminated.
```

SCREEN 2

```
DEXRAX:  Decay Data Extractor
         Ver. 1.0 (Sep 1, 1993)
         Oak Ridge National Laboratory Report ORNL/TM-12350
Authors: R.J. Westfall, J.C. Ryman, M. Cristy, K.F. Eckerman
         Oak Ridge National Laboratory
         Oak Ridge, TN 37831-6383

Program DEXRAX is now being run from SEEDEX

Add radioactive daughters to nucl. list ([y]/n)? y

Enter nuclides (7 characters maximum!), e.g., Md-258, H-3, Pm-148m
Blank entry terminates the read.
Nuclide # 1: Pu-239
Nuclide # 2: <Enter>
```

Figure 20 (cont'd).

```
No duplicates existed in list of length  14.  List includes:
Pu-239    U-235     Th-231    Pa-231    Ac-227    Th-227    Ra-223    Rn-219
Po-215    Pb-211    Bi-211    Tl-207    Po-211    Fr-223

Data will be extracted from the ICRP38 nuclear decay data files.

                                          Emitted Energy (MeV/nt)
Nuclide    T-1/2    DecMode  # rad.   Alpha   Elec.  Photon
-------  --------- -------  ------  ------  ------  ------
Pu-239     24065 y A        1111    5.1480   .0067   .0008
U-235    703.8E6 y A         396    4.3959   .0492   .1559
Th-231     25.52 h B-        361     .0000   .1651   .0256
Pa-231   3.276E4 y A         544    4.9692   .0646   .0482
Ac-227    21.773 y B-A       232     .0680   .0157   .0002
Th-227    18.718 d A        1664    5.8835   .0534   .1101
Ra-223    11.434 d A         441    5.6673   .0760   .1341
Rn-219      3.96 s A         208    6.7569   .0063   .0561
Po-215  0.001780 s A          52    7.3861   .0000   .0001
Pb-211      36.1 m B-        225     .0000   .4564   .0505
Bi-211      2.14 m A B-       52    6.5500   .0097   .0467
Tl-207      4.77 m B-         59     .0000   .4932   .0022
Po-211     0.516 s A          66    7.4421   .0001   .0078
Fr-223      21.8 m B-        483     .0000   .3998   .0594
Program DEXRAX ended normally.

Press <Enter> to clear screen & run SEEPAR
<Enter>

Stop - Program terminated.
```

SCREEN 3

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
Title (0 - 7 lines of 80 characters, blank to terminate list).
Line 1: Example 4: Run SEEDEX batch run for Pu-239 and its radioactive
Line 2: daughters.  Choose dose type = equivalent dose and table type
Line 3: = total only.  Choose all target regions.  Choose all ages.
Line 4: <Enter>
```

Figure 20 (cont'd).

SCREEN 4

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
< Dose Type >
ABSORBED DOSE
EQUIVALENT DOSE
< ↑ ↓ ◄┘ >
```

Select absorbed or equivalent dose using arrow keys & press <Enter>.

SCREEN 5

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
< Table Type >
FULL TABLE
TOTAL ONLY
< ↑ ↓ ◄┘ >
```

Select table type using arrow keys & press <Enter>.

SCREEN 6

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993
```

```
< Age Groups >
◄Newborn     ►
◄Age 1       ►
◄Age 5       ►
◄Age 10      •
◄Age 15      •
◄Adult Male  •
 Adult Female
< ↑ ↓ ◄┘ >
```

De-Select/Select age group using arrow keys & space bar; <Enter> to process.

Figure 20 (cont'd).

SCREEN 7

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993

                Source Region Selection

        Selection mode: [N]ormal or [C]omplement?_N_

    In normal mode toggle on items for inclusion.
    In complement mode toggle off items for exclusion.
```

SCREEN 8

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993

                    < Source Regions >
 Adrenals      St Wall       Lng Tiss      GB Cont
 UB Cont       SI Cont       Muscle        GB Wall
 UB Wall       SI Wall       Ovaries       Ht Cont
◂C Bone-S ▸    ULI Cont      Pancreas      Ht Wall
◂C Bone-V ▸    ULI Wall      R Marrow      Uterus
◂T Bone-S ▸    LLI Cont      Skin          W Body
◂T Bone-V ▸    LLI Wall      Spleen        Blood
 Brain         Kidneys       Testes        WB-Soft
 Breasts       •Liver    ▸   Thymus       ◂Other    ▸
 St Cont       Lng Cont      Thyroid
                    < ↑ ↓ ◂┘ >

    In normal mode toggle on items for inclusion.

Select/De-select using arrow keys & space bar; <Enter> to process.
```

Figure 20 (cont'd).

SCREEN 9

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993

                Target Region Selection

        Selection mode: [N]ormal or [C]omplement?_C_

    In normal mode toggle on items for inclusion.
    In complement mode toggle off items for exclusion.
```

SCREEN 10

```
SEEPAR 1.0: Prepare SEECAL REQuest file
K.F. Eckerman                Dec 1, 1993

                < Target Regions >
 ◂Adrenals •   ◂Liver     ▸   ◂Thyroid   ▸
 ◂UB Wall  ▸   ◂Lng Tiss •    ◂GB Wall   ▸
 ◂BSurface ▸   ◂Muscle    ▸   ◂Ht Wall   ▸
 ◂Brain    ▸   ◂Ovaries   ▸   ◂Uterus    ▸
 ◂Breasts  ▸   ◂Pancreas  ▸
 ◂St Wall  ▸   ◂R Marrow  •
 ◂SI Wall  ▸   ◂Skin      ▸
 ◂ULI Wall ▸   ◂Spleen    ▸
 ◂LLI Wall ▸   ◂Testes    ▸
 ◂Kidneys  ▸   ◂Thymus    ▸
                < ↑ ↓ ◂┘ >

    In complement mode toggle off items for exclusion.

Select/De-select using arrow keys & space bar; <Enter> to process.
```

Figure 20 (cont'd).

```
SCREEN 11
          PRINT BACK OF FILE : Example4.REQ
This is SEEPAR request file Example4.REQ
TITLE                      | Delimiter TITLE, format A5.
<<  SEEPAR Ver. 1.0  (Dec 1, 1993 ) --- Run Dec 05, 1993, at 16:30 >>
SEEPAR exe file was:                seepar.exe       79470 12-01-93   0:00a
Example 4: Run SEEDEX batch run for Pu-239 and its radioactive
daughters.  Choose dose type = equivalent dose and table type
= total only.  Choose all target regions.  Choose all ages.
END TITLE                  | Delimiter END TITLE, format A9.
EQUIVALENT DOSE            | Dose type, format A15.
TOTAL ONLY                 | Table type, format A10.
AGE GROUPS                 | Delimiter AGE GROUPS, format A10.
Newborn                    |
Age 1                      |
Age 5                      |
Age 10                     |
Age 15                     |
Adult Male                 |
END AGE GROUPS             | Delimiter END AGE GROUPS, format A20.
SOURCE REGIONS             | Delimiter SOURCE REGIONS, format A14.
C Bone-S                   |

Press any key to continue.
```

```
SCREEN 12
          PRINT BACK OF FILE : Example4.REQ
C Bone-V                   |
T Bone-S                   |
T Bone-V                   |
Liver                      |
Other                      |
END SOURCE REGIONS         | Delimiter END SOUR, format A8.
TARGET REGIONS             | Delimiter TARGET REGIONS, format A14.
Adrenals                   |
UB Wall                    |
BSurface                   |
Brain                      |
Breasts                    |
St Wall                    |
SI Wall                    |
ULI Wall                   |
LLI Wall                   |
Kidneys                    |
Liver                      |
Lng Tiss                   |
Muscle                     |

Press any key to continue.
```

Figure 20 (cont'd).

```
SCREEN 13
            PRINT BACK OF FILE : Example4.REQ
Ovaries                    |
Pancreas                   |
R Marrow                   |
Skin                       |
Spleen                     |
Testes                     |
Thymus                     |
Thyroid                    |
GB Wall                    |
Ht Wall                    |
Uterus                     |
END TARGET REGIONS         | Delimiter END TARG, format A8.


         Do you wish to start over (y/[n]) ? n
```

```
SCREEN 14

SEECAL:  calculate Specific Effective Energies
         Ver. 1.0 (Dec 1, 1993)
         Oak Ridge National Laboratory Report ORNL/TM-12351
Authors: M. Cristy and K. F. Eckerman
         Oak Ridge National Laboratory
         Oak Ridge, TN 37831-6383

SEECAL is now being run from SEEDEX

SEE output file Pu239ht.SEE will be written.
SEE output file U235ht.SEE will be written.
SEE output file Th231ht.SEE will be written.
SEE output file Pa231ht.SEE will be written.
SEE output file Ac227ht.SEE will be written.
SEE output file Th227ht.SEE will be written.
SEE output file Ra223ht.SEE will be written.
SEE output file Rn219ht.SEE will be written.
SEE output file Po215ht.SEE will be written.
SEE output file Pb211ht.SEE will be written.
SEE output file Bi211ht.SEE will be written.
SEE output file Tl207ht.SEE will be written.
SEE output file Po211ht.SEE will be written.
SEE output file Fr223ht.SEE will be written.
```

Figure 20 (cont'd).

```
MAJOR PROGRAM LOOP: working on age # 1 (newborn)  ..

     Reading photon SAFs for age = newborn ...
     Reading electron & alpha AFs for age = newborn ...
     Calculating SEEs for nuclide = Pu-239  ...
     Calculating SEEs for nuclide = U-235   ...
     Calculating SEEs for nuclide = Th-231  ...
     Calculating SEEs for nuclide = Pa-231  ...
     Calculating SEEs for nuclide = Ac-227  ...
     Calculating SEEs for nuclide = Th-227  ...
     Calculating SEEs for nuclide = Ra-223  ...
     Calculating SEEs for nuclide = Rn-219  ...
     Calculating SEEs for nuclide = Po-215  ...
     Calculating SEEs for nuclide = Pb-211  ...
     Calculating SEEs for nuclide = Bi-211  ...
     Calculating SEEs for nuclide = Tl-207  ...
     Calculating SEEs for nuclide = Po-211  ...
     Calculating SEEs for nuclide = Fr-223  ...

MAJOR PROGRAM LOOP: working on age # 2 (age 1) ...
     [similar to above]

MAJOR PROGRAM LOOP: working on age # 3 (age 5) ...
     [similar to above]

MAJOR PROGRAM LOOP: working on age # 4 (age 10) ...
     [similar to above]

MAJOR PROGRAM LOOP: working on age # 5 (age 15) ...
     [similar to above]

MAJOR PROGRAM LOOP: working on age # 6 (adult male) ...
     [similar to above]

The following SEE files have been written:
Pu239ht.SEE    U235ht.SEE     Th231ht.SEE    Pa231ht.SEE    Ac227ht.SEE
Th227ht.SEE    Ra223ht.SEE    Rn219ht.SEE    Po215ht.SEE    Pb211ht.SEE
Bi211ht.SEE    Tl207ht.SEE    Po211ht.SEE    Fr223ht.SEE

Program SEECAL ended normally.
Stop - Program terminated.

C:\DCAL>
```

Figure 21. Example 4: Log File $DCAL\WORK2\Example4.log from SEEDEX Run.

The log file from a SEEDEX run is simply log information from the SEEDEX preliminary program plus the normal DEXRAX and SEECAL logs appended to it.

```
This is SEEDEX log file Example4.log
<<   SEEDEX Ver. 1.0 (Dec 1, 1993) --- Run Dec 05, 1993, at 16:30 >>
SEEDEX exe file was:                SeeDex.exe       44885 12-01-93  12:00a
-------------------------------------------------------------------------------
This is DEXRAX   log file Example4.log
<<   DEXRAX Ver. 1.0 (Sep 1, 1993) --- Run Dec 05, 1993, at 16:30 >>

 No duplicates existed in list of length  14.  List includes:
 Pu-239    U-235     Th-231    Pa-231    Ac-227    Th-227    Ra-223    Rn-219
 Po-215    Pb-211    Bi-211    Tl-207    Po-211    Fr-223

 Data will be extracted from the ICRP38 nuclear decay data files.

Radiations data written to file Example4.rad
DEXRAX exe file was:                Dexrax.exe      163816 09-01-93  12:00a
Index file was:                     ICRP38.idx      106556 09-01-93  12:00a
Radiations data read from file:     ICRP38.rad     5971698 09-01-93  12:00a

                                        Emitted Energy (MeV/nt)
 Nuclide    T-1/2   DecMode  # rad.   Alpha   Elec.  Photon
 -------  --------- -------  ------   ------  ------  ------
 Pu-239     24065 y A        1111    5.1480   .0067   .0008
 U-235    703.8E6 y A         396    4.3959   .0492   .1559
 Th-231     25.52 h B-        361     .0000   .1651   .0256
 Pa-231   3.276E4 y A         544    4.9692   .0646   .0482
 Ac-227    21.773 y B-A       232     .0680   .0157   .0002
 Th-227    18.718 d A        1664    5.8835   .0534   .1101
 Ra-223    11.434 d A         441    5.6673   .0760   .1341
 Rn-219      3.96 s A         208    6.7569   .0063   .0561
 Po-215  0.001780 s A          52    7.3861   .0000   .0001
 Pb-211      36.1 m B-        225     .0000   .4564   .0505
 Bi-211      2.14 m A B-       52    6.5500   .0097   .0467
 Tl-207      4.77 m B-         59     .0000   .4932   .0022
 Po-211     0.516 s A          66    7.4421   .0001   .0078
 Fr-223      21.8 m B-        483     .0000   .3998   .0594
Program DEXRAX ended normally.
-------------------------------------------------------------------------------
This is SEECAL   log file Example4.log
<<   SEECAL Ver. 1.0 (Dec 1, 1993) --- Run Dec 05, 1993, at 16:33 >>

 ... Title lines from user request file follow:
 <<  SEEPAR Ver. 1.0  (Dec 1, 1993) --- Run Dec 05, 1993, at 16:30 >>
 SEEPAR exe file was:                seepar.exe       79470  9-01-93   0:00a
 Example 4: Run SEEDEX batch run for Pu-239 and its radioactive
 daughters.  Choose dose type = equivalent dose and table type
 = total only.  Choose all target regions.  Choose all ages.
 ... End of title lines; number of title lines = 5

 Quantity to be calculated = "equivalent dose"
 Table type for SEE files = "total only"

 Index iACalc; Age Group Name;          Index iAge
           1  "newborn             "   1
           2  "age 1               "   2
           3  "age 5               "   3
           4  "age 10              "   4
           5  "age 15              "   5
           6  "adult male          "   6
 End of age group list; number of age groups = 6

 Index iSCalc; SOURCE Name; Index iS
           1  "c bone-s"    4
           2  "c bone-v"    5
           3  "t bone-s"    6
           4  "t bone-v"    7
           5  "liver   "   19
           6  "other   "   40
 End of source region list; number of sources = 6

 Index iTCalc; TARGET Name; Index iT
           1  "adrenals"    1
           2  "ub wall "    2
           3  "bsurface"    3
           4  "brain   "    4
           5  "breasts "    5
           6  "st wall "    6
           7  "si wall "    7
           8  "uli wall"    8
           9  "lli wall"    9
          10  "kidneys "   10
          11  "liver   "   11
          12  "lng tiss"   12
          13  "muscle  "   13
          14  "ovaries "   14
          15  "pancreas"   15
          16  "r marrow"   16
          17  "skin    "   17
          18  "spleen  "   18
          19  "testes  "   19
          20  "thymus  "   20
          21  "thyroid "   21
          22  "gb wall "   22
          23  "ht wall "   23
          24  "uterus  "   24
 End of target region list; number of targets = 24

 SEE output file Pu239ht.SEE will be written.
 SEE output file U235ht.SEE will be written.
 SEE output file Th231ht.SEE will be written.
 SEE output file Pa231ht.SEE will be written.
 SEE output file Ac227ht.SEE will be written.
 SEE output file Th227ht.SEE will be written.
 SEE output file Ra223ht.SEE will be written.
 SEE output file Rn219ht.SEE will be written.
 SEE output file Po215ht.SEE will be written.
 SEE output file Pb211ht.SEE will be written.
 SEE output file Bi211ht.SEE will be written.
 SEE output file Tl207ht.SEE will be written.
 SEE output file Po211ht.SEE will be written.
 SEE output file Fr223ht.SEE will be written.

SEECAL exe file was:                Seecal.exe      317296 12-01-93  12:00a
User request file was:              Example4.req      1982 12-05-93   4:32p
Nuclide decay file was:             Example4.rad    178485 12-05-93   4:30p
File with standard names was:       StdNames.txt      1706 12-01-93  12:00a
```

Figure 21 (cont'd). Example4.log.

```
Photon SAF file was:              PhtonSAF.a00     63360 12-01-93  12:00a
Photon SAF file was:              PhtonSAF.a01     63360 12-01-93  12:00a
Photon SAF file was:              PhtonSAF.a05     63360 12-01-93  12:00a
Photon SAF file was:              PhtonSAF.a10     63360 12-01-93  12:00a
Photon SAF file was:              PhtonSAF.a15     63360 12-01-93  12:00a
Photon SAF file was:              PhtonSAF.am      63360 12-01-93  12:00a
Electron-alpha AF file was:       ElAlphAF.a00      1779 12-01-93  12:00a
Electron-alpha AF file was:       ElAlphAF.a01      1777 12-01-93  12:00a
Electron-alpha AF file was:       ElAlphAF.a05      1777 12-01-93  12:00a
Electron-alpha AF file was:       ElAlphAF.a10      1778 12-01-93  12:00a
Electron-alpha AF file was:       ElAlphAF.a15      1778 12-01-93  12:00a
Electron-alpha AF file was:       ElAlphAF.am       1782 12-01-93  12:00a
Region mass file was:             RegMass.a00       2184 12-01-93  12:00a
Region mass file was:             RegMass.a01       2152 12-01-93  12:00a
Region mass file was:             RegMass.a05       2152 12-01-93  12:00a
Region mass file was:             RegMass.a10       2153 12-01-93  12:00a
Region mass file was:             RegMass.a15       2244 12-01-93  12:00a
Region mass file was:             RegMass.am        2245 12-01-93  12:00a

 MAJOR PROGRAM LOOP: working on age # 1 (newborn) ...

      Reading photon SAFs for age = newborn ...
      Reading electron & alpha AFs for age = newborn ...
      Calculating SEEs for nuclide = Pu-239  ...
      Calculating SEEs for nuclide = U-235   ...
      Calculating SEEs for nuclide = Th-231  ...
      Calculating SEEs for nuclide = Pa-231  ...
      Calculating SEEs for nuclide = Ac-227  ...
      Calculating SEEs for nuclide = Th-227  ...
      Calculating SEEs for nuclide = Ra-223  ...
      Calculating SEEs for nuclide = Rn-219  ...
      Calculating SEEs for nuclide = Po-215  ...
      Calculating SEEs for nuclide = Pb-211  ...
      Calculating SEEs for nuclide = Bi-211  ...
      Calculating SEEs for nuclide = Tl-207  ...
      Calculating SEEs for nuclide = Po-211  ...
      Calculating SEEs for nuclide = Fr-223  ...

 MAJOR PROGRAM LOOP: working on age # 2 (age 1) ...
      [similar to above]

 MAJOR PROGRAM LOOP: working on age # 3 (age 5) ...
      [similar to above]

 MAJOR PROGRAM LOOP: working on age # 4 (age 10) ...
      [similar to above]

 MAJOR PROGRAM LOOP: working on age # 5 (age 15) ...
      [similar to above]

 MAJOR PROGRAM LOOP: working on age # 6 (adult male) ...
      [similar to above]

 The following SEE files have been written:
 Pu239ht.SEE    U235ht.SEE     Th231ht.SEE    Pa231ht.SEE    Ac227ht.SEE
 Th227ht.SEE    Ra223ht.SEE    Rn219ht.SEE    Po215ht.SEE    Pb211ht.SEE
 Bi211ht.SEE    Tl207ht.SEE    Po211ht.SEE    Fr223ht.SEE

 Program SEECAL ended normally.
```

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