Using Gamma Cameras to Assess Internal Contamination from Intakes of Radioisotopes

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Contents

Tables

Page

Figures

Page

PREFACE

During the past three years, S. Cohen and Associates, sponsored by the Centers for Disease Control and Prevention, prepared a series of reports which is being expanded, revised, and reissued under the title "Use of Radiation Detection, Measuring, and Imaging Instruments to Assess Internal Contamination from Intakes of Radionuclides."

Part I of the series (Anigstein et al. 2007a) described a study to evaluate radiation detection and imaging systems commonly found in hospitals to determine their suitability for rapidly scanning individuals for internal contamination, and to develop recommendations regarding their potential use. That report describes the measurement of count rates from single discrete radioactive sources of ^{60}Co, ^{137}Cs, ^{192}Ir, and ^{241}Am, using a Philips AXIS gamma camera, an Atomlab thyroid uptake system, and a Ludlum waste monitor.

Part II (Anigstein et al. 2007b) extended the earlier investigation by using realistic anthropomorphic phantoms to study the responses of four instruments to five radionuclides distributed in the lungs. The experimental measurements were performed on sources in the lung region of a Rando Phantom—an anthropomorphic phantom that contains a human skeleton embedded in a tissue-equivalent urethane rubber. Count rates from each of five radionuclides—^{60}Co, ^{90}Sr, ^{137}Cs, ^{192}Ir, and ^{241}Am—were measured on a Siemens e.cam gamma camera, an Atomlab thyroid probe, a Ludlum survey meter, and a Ludlum waste monitor. In a preliminary analysis, the Los Alamos MCNPX (Monte Carlo N Particle eXtended) computer code was used to calculate calibration factors that relate count rates on these instruments to lung burdens of each of the five nuclides. A mathematical model of each of the instruments was constructed, using engineering drawings and other data obtained from the manufacturers. This model was combined with an MCNP model of a Rando Phantom, constructed from CT scans of this phantom (Wang et al. 2004). The combined model was used to simulate the response of each instrument to sources in the phantom. The agreement between the calculated and measured responses validated the MCNP models of the four instruments.

Part III (Anigstein et al. 2007c) extended the investigations to the Philips SKYLight camera. The study was narrowed to three of the five radionuclides reported in part II: ^{60}Co, ^{137}Cs, and ^{241}Am. This study encompassed measurements and corresponding MCNP simulations of sources of the three nuclides located in the lung region of a Rando Phantom. In addition, measurements and simulations were carried out of the source capsules in air. The agreement between the calculated and measured responses validated the MCNP model of this instrument.

Part IV (Anigstein et al. 2010) extended the earlier investigations to the response of the Philips SKYLight camera to bremsstrahlung x rays following the β decay of ^{90}Sr and its short-lived daughter, ^{90}Y. These studies utilized, as a primary standard, a calibrated source of ^{90}Sr procured from the National Institute of Standards and Technology. Measurements and Monte Carlo simulations of this source, which was in the form of an aqueous solution sealed in a glass ampoule, were supplemented by further studies on the encapsulated sources described in part II of this series of reports. The agreement between the calculated and measured responses was adequate to justify the use of the model for simulating the response of this camera to distributions of ^{90}Sr/^{90}Y in the human body.

Part V (Anigstein and Olsher 2010) developed calibration factors to enable the use of gamma cameras for assessing intakes of radionuclides and the resulting doses. The study utilized biokinetic models to determine the retention of activity taken into the body and the distribution of such activity among different regions of the body as a function of time following exposure. Normalized count rates from activities of six radionuclides—^{60}Co, ^{90}Sr, ^{131}I, ^{137}Cs, ^{192}Ir, and ^{241}Am—in various anatomical regions of children of five ages and adult men and women are calculated by MCNPX. Adult men and women were represented by the NORMAN and NAOMI voxel phantoms (Dimbylow 1998, 2005), while children were represented by the revised ORNL phantom series described by Han et al. (2006). The Siemens e.cam and Philips SKYLight gamma cameras were represented by models developed during the studies described in parts II and III, respectively.

The present report distills the results of the previous studies into a form that is usable by hospital personnel. Chapter 1 provides detailed directions to the nuclear medicine technologist on using the camera equipment to determine the intakes of the six radionuclides for which calibration factors were developed. Chapter 2 describes the use of the computer code package Assess (Anigstein et al. 2009), which utilizes the calculations described in part V to enable the user to compute the intake activity and resulting doses to an exposed individual. These calculations can be performed by the technologist, a health physicist, or a physician. Chapter 3 presents a technical description of the Assess program. Appendices A and B contain tables of calibration factors and dose coefficients, respectively, that allow hospital personnel to calculate intakes and doses if the Assess code is not available. These appendices replicate appendices D and E of part V, with some revisions of the introductory text of each appendix.

The authors gratefully acknowledge the support and assistance of a number of individuals and organizations, without whom this work would not have been possible. Keith Eckerman of the Oak Ridge National Laboratory provided advice and information on the use of the DCAL software system. Peter Dimbylow of the Radiation Protection Division of the Health Protection Agency in the United Kingdom provided access to the NORMAN and NAOMI databases and furnished additional data and information on the use of these models. Wesley Bolch, Professor of Radiological and Biomedical Engineering at the University of Florida, provided the MCNP models of the revised ORNL phantom series. Julie Timins, former Attending Radiologist, Christ Hospital, Jersey City, NJ, reviewed an earlier version of these instructions and made thoughtful comments and recommendations.

Chapter 1

INSTRUCTIONS TO NUCLEAR MEDICINE TECHNOLOGISTS

1.1 Introduction

The purpose of this set of instructions is to enable the nuclear medicine technologist to use a gamma camera to assess the activity of a known radioisotope taken in by an exposed individual at a known time after intake. These procedures apply under the following conditions:

- There is a single radioisotope that has been identified
- The duration of exposure was brief compared to the elapsed time since the exposure
- The time when the exposure occurred is known

Procedures have been developed for the assessment of six radioisotopes: ^{60}Co, ^{90}Sr, ^{131}I, ^{137}Cs, ^{192}Ir, and ^{241}Am. Procedures have been developed for two gamma camera models: the Siemens e.cam and the Philips SKYLight (cameras similar to the SKYLight were produced by ADAC Laboratories, now a division of Philips, and are often referred to as ADAC cameras). Section 1.5 explains how these procedures can be adapted to other makes and models of gamma cameras. Because of differences in control consoles and software at individual installations, even for the same model of gamma camera, these procedures are generic in nature. Each facility may wish to develop more detailed instructions that are consistent with the configuration of its gamma cameras and with its normal operating procedures.

The remainder of this chapter is addressed to the nuclear medicine technologist.

1.2 Preliminary Steps

1.2.1 Preparation of Nuclear Medicine Facility

Prior to receiving any exposed individuals, clear the nuclear medicine area of all radiation sources so as to reduce the radiation background, which could interfere with the assessments. All patients who have been administered radiopharmaceuticals and still retain any activity in the body should be cleared from the nuclear medicine area. Remove any radioactive materials, such as radiopharmaceuticals or calibration or flood sources.

Obtain a survey meter and survey the area for any stray sources of radiation. A GM (Geiger-Müller) counter is usually more sensitive in locating stray sources. Next, use a survey meter containing an ionization chamber to check the background. If one is not available, another type of survey meter may be used. Record the background reading—you will need this information later.

1.2.2 Setting up the Gamma Camera

As the first step in setting up the camera, remove the collimators and cover the detectors to protect them from contamination. You can use plastic sheeting, plastic bags, blue plastic chucks,

or any thin, lightweight materials. Next, set up energy windows specific to the camera and to the radioisotope. Set the same energy windows on both detectors.

Energy Windows

Siemens e.cam

Use six energy windows with the Siemens camera for the most accurate results in counting ^{60}Co, ^{90}Sr, ^{131}I, ^{137}Cs, or ^{192}Ir. Group all six windows together in a single frame. Use two energy windows for counting ^{241}Am. These windows are listed in table 1.

Table 1. Primary Set of Energy Windows for Siemens e.cam Gamma Camera

Isotope:	Co-60, Cs-137		Sr-90/Y-90, I-131, Ir-192		Am-241	
Window No.	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)
1	41	50	35	50	35	50
2	69	50	59	50	59	50
3	116	50	99	50		
4	194	50	166	50		
5	324	50	277	50		
6	541	50	462	50		

If setting six windows is too cumbersome, or if the camera does not accept these windows, use an alternate set of three windows for counting ^{60}Co, ^{90}Sr, ^{131}I, ^{137}Cs, or ^{192}Ir. Group these windows in a single frame. These alternate windows are listed in table 2.

Table 2. Alternate Set of Energy Windows for Siemens e.cam Gamma Camera

Isotope:	Co-60		Sr-90/Y-90		I-131		Cs-137		Ir-192	
Window	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)
1	101.3	50	46.3	50	109.9	50	97.3	50	96.0	50
2	168.9	50	77.2	50	183.3	50	162.3	50	160.1	50
3	281.6	50	128.7	50	305.6	50	270.6	50	266.9	50

Philips SKYLight

Use a set of two energy windows on the Philips camera to count ^{60}Co, ^{90}Sr, ^{131}I, ^{137}Cs, or ^{192}Ir. Set a single energy window to count ^{241}Am. These windows are listed in table 3.

Table 3. Energy Windows of Philips SKYLight Gamma Camera

Isotope:	Co-60		Sr-90/Y-90		I-131		Cs-137		Ir-192		Am-241	
Window	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)	Peak (keV)	Width (%)
1	124.6	86	59.6	100	87	100	191.2	86	94.7	86	51.3	83
2	312.6	86	138.7	71.1	261	100	479.6	86	237.5	86		

Counting Background

After setting the energy windows appropriate to the radioisotope that is the likely contaminant, perform a static 2-minute acquisition and record the background count in each detector. Count for 10 minutes if the likely contaminant is ^{90}Sr or ^{241}Am. You can enter "background" as the patient name. If the background counts are unusually high, or if the background of one detector is very different from the other, check for any stray sources of radiation in the area. Designate the detector that will face the front of the patient as "anterior," the other as "posterior." Enter the background counts and the energy window in the patient record.

Repeat the background counts after each patient if the patient count rate is more than twice the previous background. Check for radiation sources, including exposed patients in the vicinity of the camera room, if the background in either detector has increased significantly.

1.2.3 Preparing Patient

Prior to the patient being referred to the nuclear medicine department, he or she should undergo a thorough external decontamination by the emergency responders, by the hospital's health physics personnel, or by nuclear medicine personnel. This may require a complete change of clothing, showering or other forms of decontamination of the entire body, including the hair. Do not allow any exposed individuals into the nuclear medicine area unless they are free of external radioactive contamination.

1.3 Performing Assessment

Admit only one patient at a time to the area near the gamma camera. Have other patients wait well away from the camera room.

1.3.1 Preliminary Screening

Before using the gamma camera to measure internal radioactivity, check if the activity level of the patient could be high enough to cause significant count rate losses in the camera.[1] To do this, hold a survey meter 1 meter away from the front of the patient at the waist level. Record the exposure rate read from the meter and subtract the background that you previously recorded for this instrument. Note this net exposure rate in the patient record.

If the exposure rate minus the background exceeds the value in table 4 for the given isotope, note that fact in the patient record and inform the appropriate medical or health physics personnel that the activity in the patient may be higher than the value calculated from the count rates on the gamma camera. Proceed to count the patient using the gamma camera unless you are otherwise instructed.

[1] Some cameras will lose a significant fraction of the counts if the count rate, including background, is above 100 kcps.

Table 4
Threshold Exposure Rates at 1 m from Patients with Internal Radioactive Contamination

Isotope	Exposure rate (μR/h above bkg)
Co-60	35
Cs-137	12
Others	5

Note: These exposure rates correspond to count rates on gamma cameras of approximately 100 kcps under some typical exposure conditions and geometries, which could result in significant count-rate losses.

1.3.2 Positioning Patient

The calibration factors for each isotope for the Siemens and Philips gamma cameras were calculated from computer simulations in which lifelike representations of pediatric patients of several ages and adults of both sexes were placed in positions similar to those used clinically for lung or whole-body scans. It is therefore important to place the patient in the same position as was used in the computer simulation; otherwise, the calibration factors will not produce a good estimate of the activity taken in by the patient.

If a child is old enough to stand up and follow directions, have her stand between the two camera heads, as shown in figure 1.[2] Place younger children on the scanner bed and restrain them as necessary. Unlike the acquisition of an image using collimators, when any movement of the patient would result in a blurred image, slight movements (of a fraction of an inch) will not affect the accuracy of the counts.

Figures 2 to 15 show cross-sectional views in the median plane of children of various ages and of adults of both sexes, and their positions with respect to the gamma cameras. These figures were created by the computer models used to generate the calibration factors for the two gamma cameras. The models of children shown in figures 2 to 11 are stylized geometrical forms; the models of adults shown in figures 12 to 15 are based on MRI scans of normal volunteers, adjusted to the heights and weights of reference adults listed in table 5.

Figure 1. Pediatric Patient with Philips SKYLight (courtesy of Philips Healthcare)

Use the diagrams in figures 2 to 15 to position the patients. For the Siemens e.cam camera, keep the two camera heads facing each other (at the same height, if the heads are in the

[2] All figures in this chapter are reproduced from Anigstein and Olsher 2010.

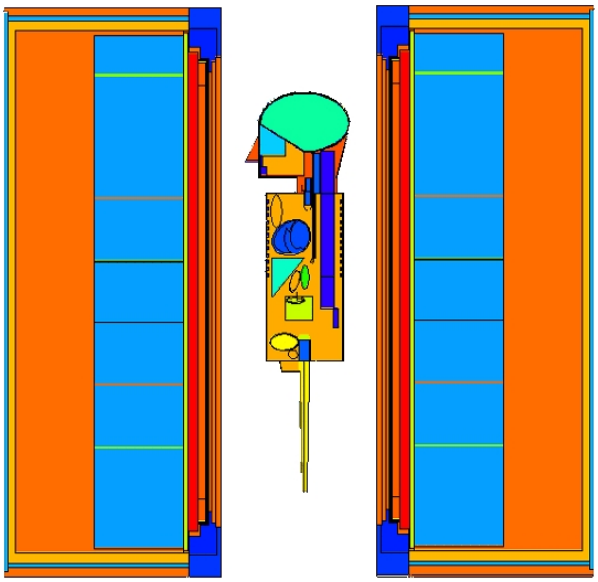

Figure 2. Infant–Siemens e.cam

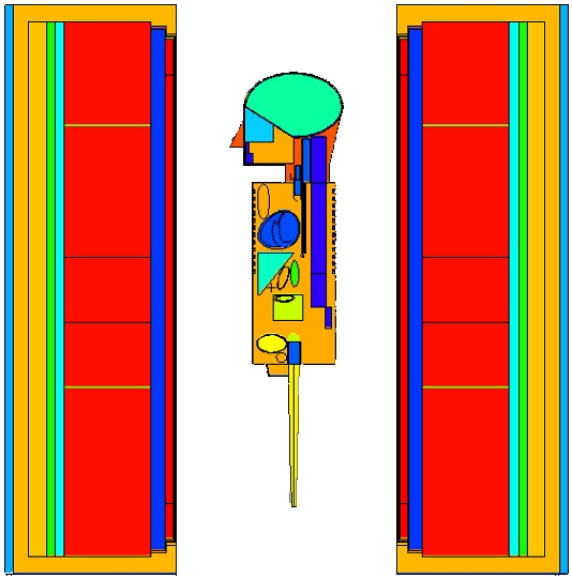

Figure 3. Infant–Philips SKYLight

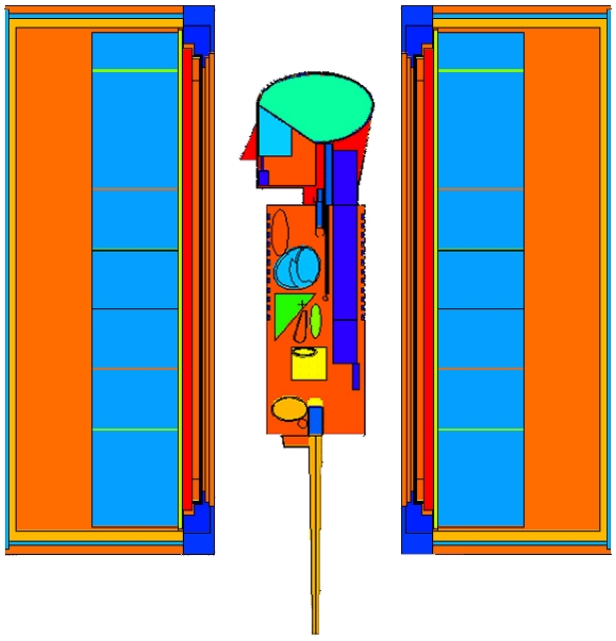

Figure 4. 1-y-old–Siemens e.cam

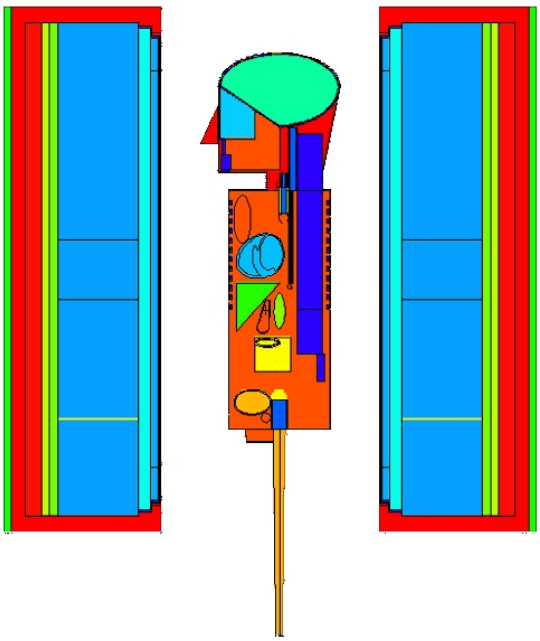

Figure 5. 1-y-old–Philips SKYLight

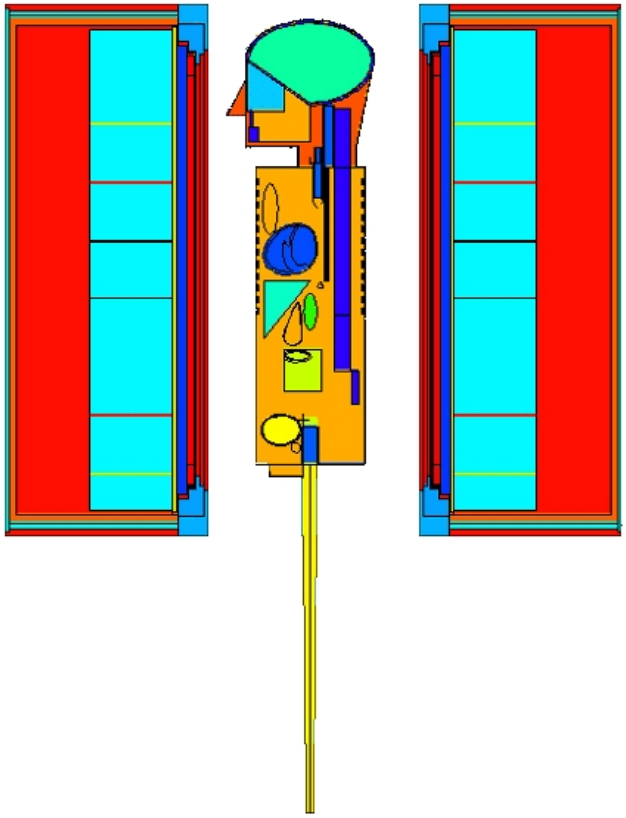

Figure 6. 5-y-old–Siemens e.cam

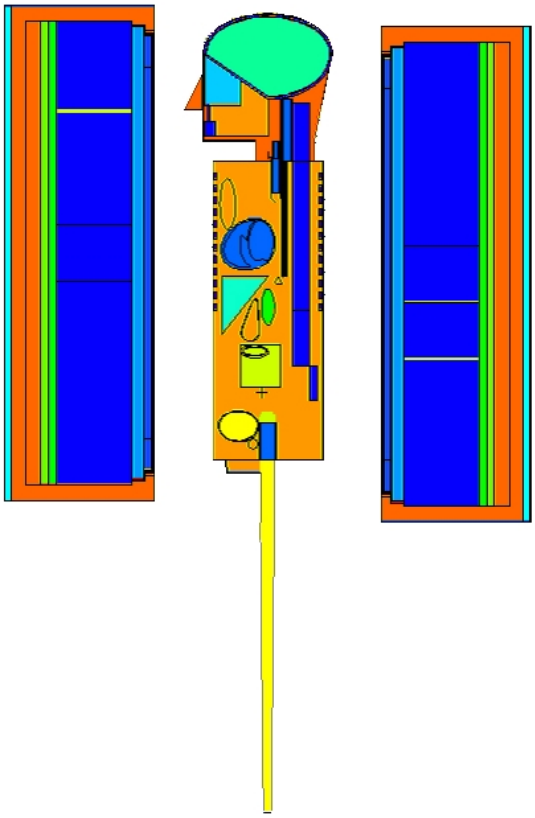

Figure 7. 5-y-old–Philips SKYLight

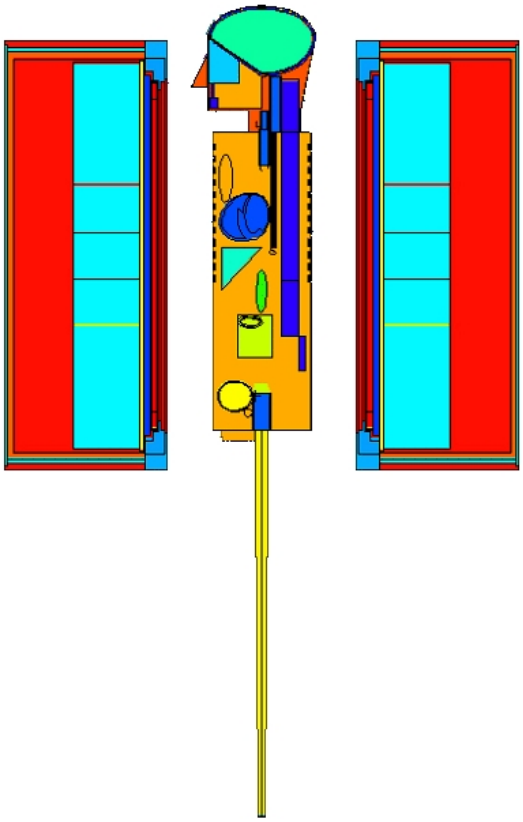

Figure 8. 10-y-old–Siemens e.cam

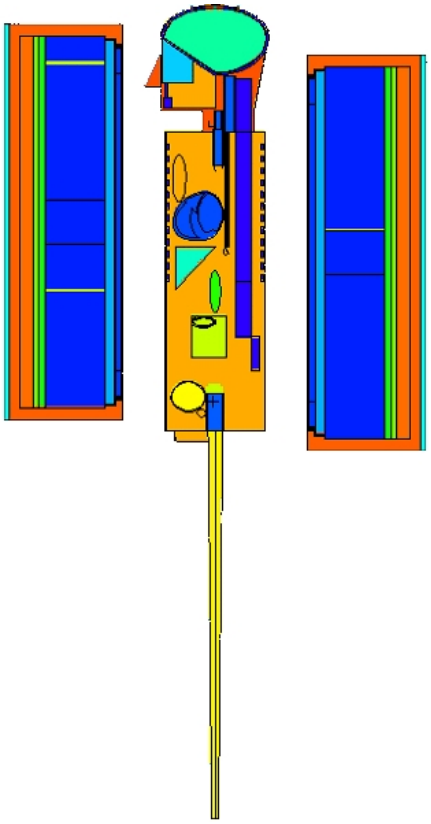

Figure 9. 10-y-old–Philips SKYLight

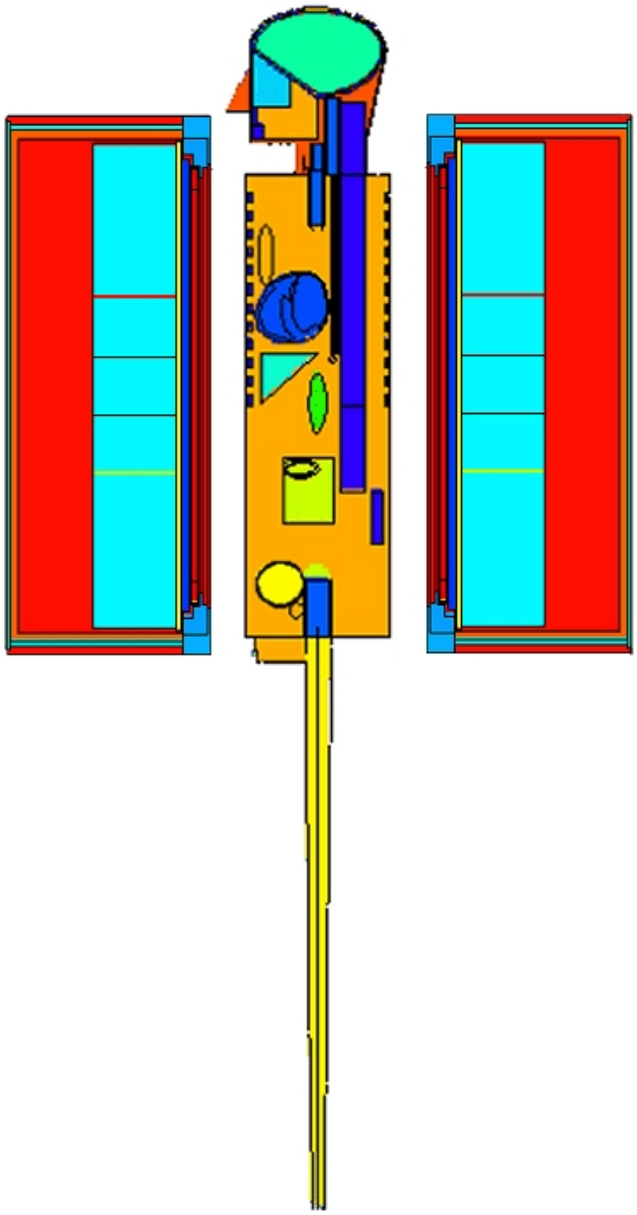

Figure 10. 15-y-old–Siemens e.cam

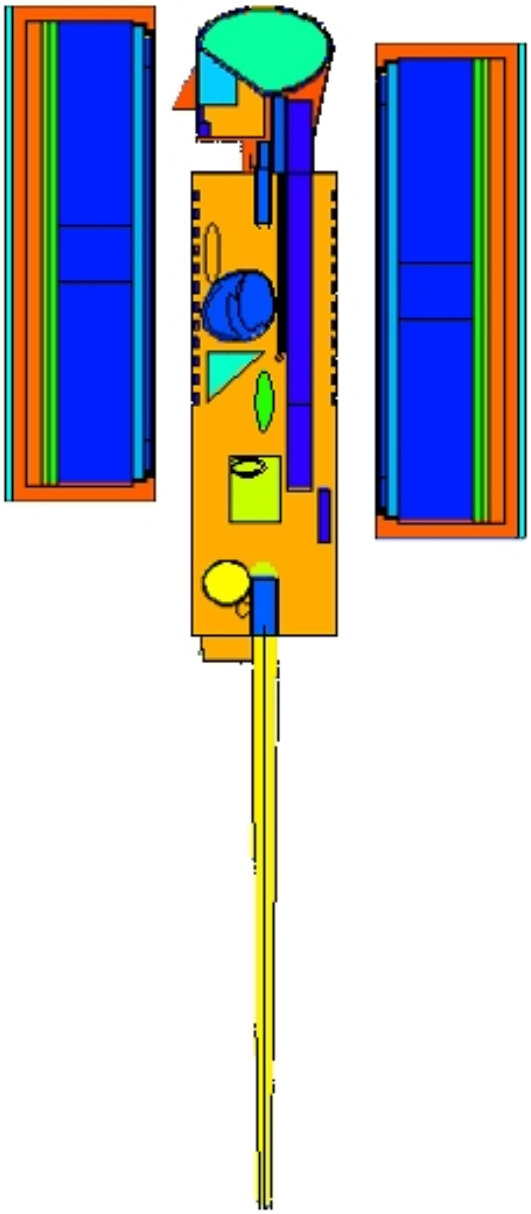

Figure 11. 15-y-old–Philips SKYLight

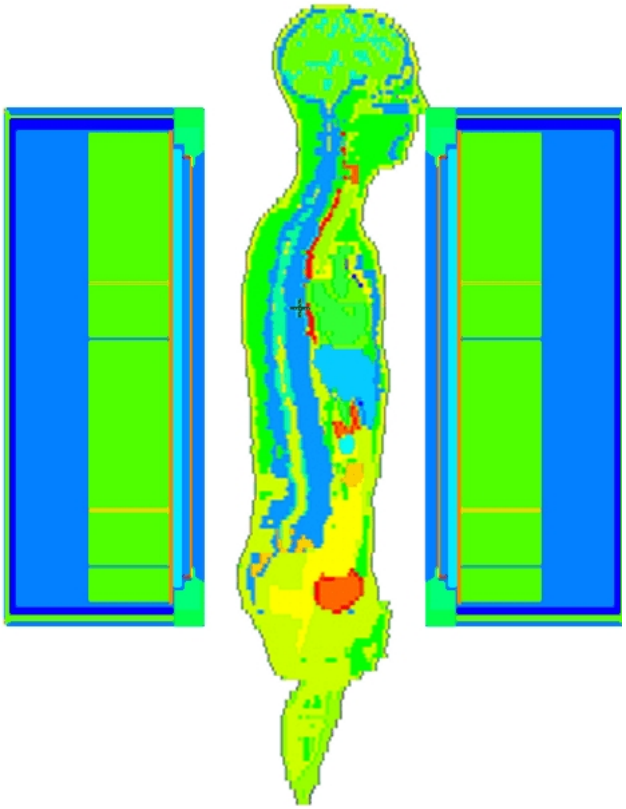

Figure 12. Adult Male–Siemens e.cam

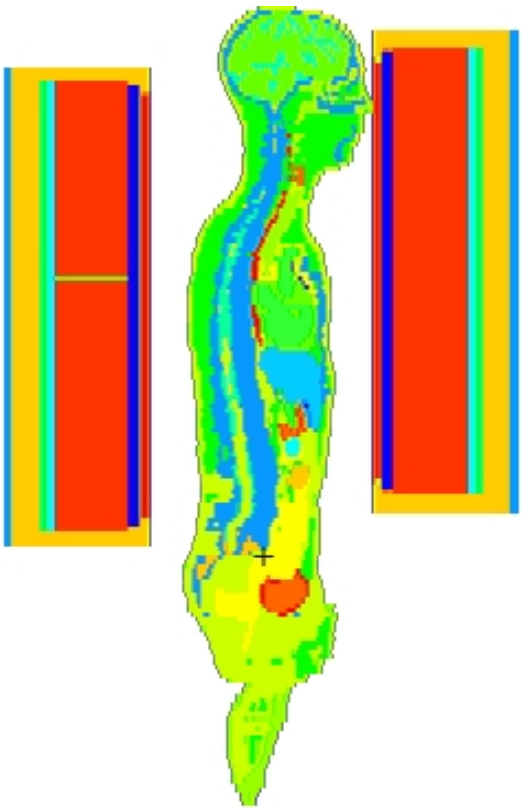

Figure 13. Adult Male–Philips SKYLight

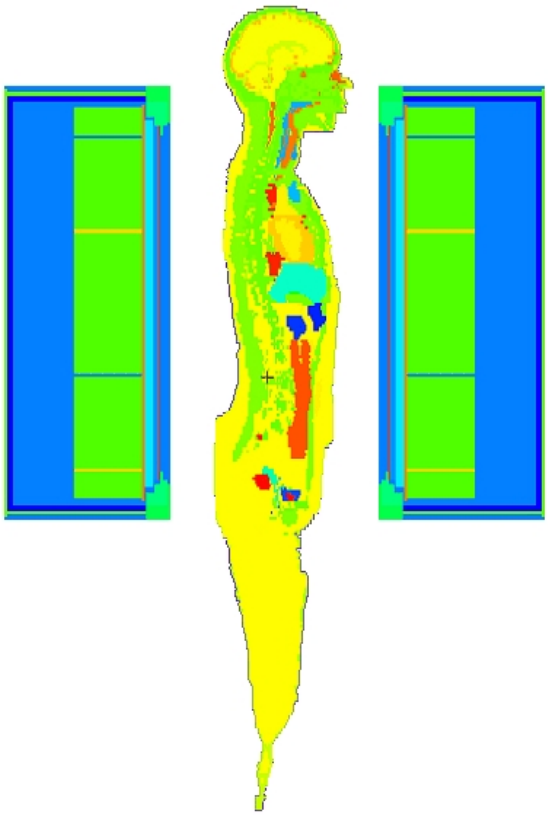

Figure 14. Adult Female–Siemens e.cam

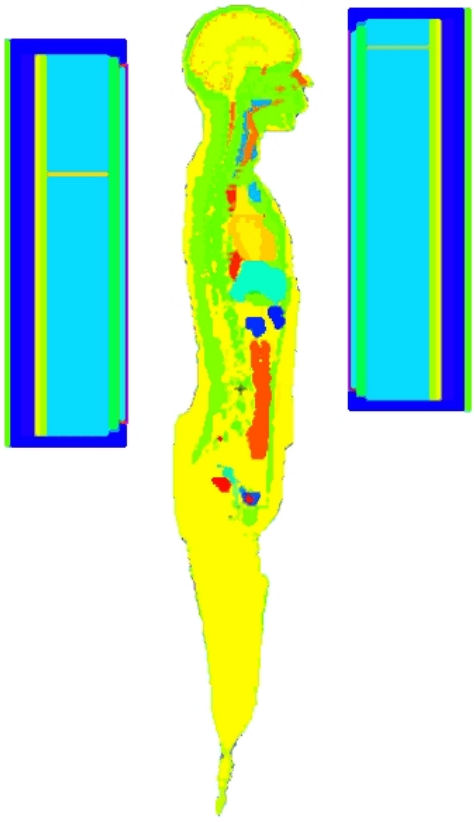

Figure 15. Adult Female–Philips SKYLight

Table 5. Height and Weight of Reference Individual

Age (sex)	Height		Weight	
	cm	in	kg	lb
Newborn	51	20	3.5	7.7
1 y	76	30	10	22
5 y	109	43	19	42
10 y	138	54	32	71
15 y	167	66	56	123
Adult male	176	69	73	161
Adult female	163	64	60	132

Source: ICRP 2002, table 2.9

vertical position). For the Philips camera, set the two detectors at different heights for all but the smallest pediatric patients to afford a better view of the internal organs.

The heights of the children represented by stylized diagrams shown in figures 2 to 11 are based on average sizes of children of the indicated age, which are listed in table 5. The actual size will, of course, vary from one child to another. Find the age of the reference individual in table 5 that is nearest *in height* to the actual patient and use the diagram and the following description of the position corresponding to that age to position the patient, rather than basing the position on the actual age of the patient.

Position an infant so that the entire body is centered on the field of view (FOV) of each camera. Position a one-year-old with the top of the head at the top of the FOV, which encompasses all but the lower legs. (With the collimator removed, counts are registered from regions of the body outside the normal field of view, but with reduced efficiencies.) Position a 5-year-old with the lower pelvis at the bottom edge of the FOV. When counting a 10-year-old with a Siemens camera, center the detectors on the region extending from the nose to the base of the trunk. (A significant fraction of inhaled activity is contained in the anterior nasal cavity during the first day following exposure.) Position the two heads of the Philips SKYLight such that the nasal cavity of the 10-year-old is included in the FOV of the anterior detector, while all the major organs in the trunk are within the FOV of the posterior detector. The positions of the 15-year-old and the adults are typical of adults undergoing lung scans.

The nose of the adult male in figures 12 and 13 is touching the camera. This is due to the rigidity of the figure in the computer model: the real patient would tilt his head back. In the sagittal sections of the adult female shown in figures 14 and 15, the buttocks appear flattened due to the supine position of the subject during the MRI scan. In addition, the breasts do not appear in this medial view. The spacing of the camera heads shown in these figures maintains a 5-cm distance from the natural contours of the body of a patient standing erect. Because the median plane lies between the lower legs of both individuals, only the upper portions of the legs are shown in figures 12 to 15.

Since the collimators are removed, it may be necessary to set the collision override to enable you to move the camera heads and use the camera system to perform acquisitions. In all cases, keep a distance of 5 cm (about 2 inches) between the camera and the nearest portion of the body.

Such a separation is needed because, without a collimator, there is no pressure-sensitive alarm to protect the patient from potential injury by contact with the detector, nor is the detector protected from being damaged by contact with the patient. This separation was incorporated into the computer simulations used to calculate the calibration factors and therefore needs to be maintained while counting the patient.

For longer acquisition times, or if the patient is not comfortable standing, a stool may be used by adults or taller children, provided the position of the trunk is approximately the same as shown in the appropriate diagram. Alternatively, the patient, especially a young child, can lie on the imaging table. Since the calibration factors are based on a 5-cm space between the patient and the aluminum window, it may be necessary to position the lower detector as close as possible to the bottom of the table. Estimate and record the distance between the front of the aluminum window and the lowermost part of the body.

All patients should face in the same direction, so that the "anterior" and "posterior" background counts recorded previously always correspond to the anterior and posterior patient counts.

1.3.3 Acquiring Counts

Enter the name of the patient to begin an acquisition. If the patient has not been assigned a patient number, assign numbers sequentially to successive patients. Weigh or estimate the weight of children who are less than 15 years old—this information is needed for calculating the intake. You can record the weight in either pounds or kilograms.

Counts should be acquired for one minute. Count for 10 minutes if the likely isotope is ^{90}Sr or ^{241}Am. Record the counts from each detector without subtracting the background. Specify the detector facing the front of the patient as "anterior," the one behind the patient as "posterior." The preferred units are cpm, kcpm, total counts, or total kcounts—use whichever is most convenient. For total counts or total kcounts, you must also enter the counting time in minutes.

1.3.4 Example of Gamma Camera Procedure

The procedures to be followed by the nuclear medicine technologist are illustrated by the following example.

You are operating a Philips SKYLight gamma camera. You were alerted to expect patients that have been exposed to airborne dust contaminated with ^{241}Am. You send all ambulatory patients who have been administered radioisotopes out of the nuclear medicine area and arrange for the transportation of nonambulatory cases. You remove all radiopharmaceuticals, check sources, flood sources, and other radioactive materials to a shielded area away from the gamma camera. You obtain a GM counter and observe the reading while you walk around the room—the reading is steady, indicating that there are no stray sources left in the area. You obtain a survey meter and read and record a background exposure rate of 5 μR/h.

You remove both collimators from the camera and cover the detectors with plastic sheeting. You then set an energy window with a peak of 51.3 keV and a width of 83%. You perform a static acquisition for a preset time of 10 minutes. When the acquisition stops, you note that

98.9 kcounts were acquired in detector 1 and 72.2 kcounts in detector 2. You record this information in an appropriate log book.

You now receive the patient: a 12-year-old male who is 160 cm (63 in) tall and weighs 50 kg (110 lb). You enter this information in the patient record. You hold the survey meter at a distance of 1 meter (~3 ft) away from the patient at waist level. The meter reads 5–6 μR/h, which is less than 1 μR/h above background. You note this in the patient record. Since the reading is less than 5 μR/h above background, the threshold exposure rate from isotopes other than ^{60}Co and ^{137}Cs listed in table 4, the count rate on the gamma camera will not be high enough to result in significant count-rate losses.

You check table 5 and see that the patient's height is closest to the height of the reference 15-year-old. You position him between the two heads of the camera, facing detector 1. You position the camera heads as shown in figure 11, which illustrates the 15-year-old with the Philips SKYLight. You perform a 10-minute static acquisition and note that 122 kcounts were acquired in detector 1 and 80.3 kcounts in detector 2. You record these counts in the patient record, together with the most recent background counts which were listed in the log book.

1.4 Calculating Intakes and Doses

Chapter 2 describes the use of the Assess computer code (Anigstein et al. 2009) to compute the intake activity and resulting doses to an exposed individual from the counts measured with the gamma camera. Assess has the advantage of allowing the use of energy windows other than those described in tables 1 to 3, as well as taking into account the weight as well as the age of children under the age of 15. If the assessment will be performed with Assess, you can skip the rest of section 1.4.

If the Assess code is not available, you can calculate intakes and doses using the tables in appendices A and B, as described in the following sections.

1.4.1 Calculating Count Rates

Calculate the count rate in kcpm (thousands of counts per minute) separately for each detector by dividing the total counts by the acquisition time in minutes. Some systems display the total as kcounts. If the total is displayed as actual counts, divide by 1,000. Next, calculate the background count rate for each detector, and subtract the background from the calculated count rate *for that detector*. The two detectors will usually have different count rates.

1.4.2 Calculating Intake

Tables A-2 to A-17 list calibration factors for assessing activities inhaled or ingested by exposed individuals at selected times after intake. These factors relate the count rate measured by a given camera to the intake of a given radioisotope.

If the intake is by inhalation, you may need to know the lung absorption type of the isotope, which depends on its chemical form. The lung absorption types of elements corresponding to

the isotopes for which calibration factors were calculated are listed in table 6. If the chemical form is not known, use the lung absorption type corresponding to unspecified compounds.

Table 6. Lung Absorption Types

Element	Lung Type	Chemical forms
Co	M	Unspecified compounds
	S	Oxides, hydroxides, halides, and nitrates
Sr	F	Unspecified compounds
	S	Strontium titanate ($SrTiO_3$)
I	F	All compounds
Cs	F	All compounds
Ir	F	Unspecified compounds
	M	Metallic iridium, halides, and nitrates
	S	Oxides and hydroxides
Am	M	All compounds

Source: ICRP 1994b, annexe F

When assessing a child, use the calibration factors for a reference individual nearest in weight to that of the patient. The weights of reference individuals are listed in table 5. For an adult, use the calibration factors appropriate to the sex of the patient. Next, find the time post intake closest to the time elapsed between the peak exposure and the time the counts were taken. Then find the calibration factor in the column corresponding to the gamma camera and the set of energy windows used in measuring the count rate. Linear interpolation may be used to determine a calibration factor for a time between two consecutive time steps, especially if there is a large difference between the calibration factors for the two time steps.

Multiply the count rate in kcpm by the appropriate calibration factor to determine the inhaled activity in becquerels (Bq). Divide by 37,000 to obtain a value in microcuries (μCi). Perform separate calculations for the count rates from the detectors in the anterior and posterior positions and take the average of the two results. However, if the patient was counted on the imaging table, and if the count rate from the posterior detector (the one beneath the table) yields a lower intake than the one from the anterior detector, use the higher value of the estimated intake.

1.4.3 Example Calculation of Intake

The calculation of the estimated intake, which should be performed by a health physicist, a physician, a technologist, or another qualified health care professional, is illustrated by the following example. The patient is the same one described in section 1.3.4.

Since both the background counts and the patient counts were acquired for 10 minutes, you subtract the total background counts from the patient counts in each detector to get the net counts. Since the anterior patient counts in this example are shown to the nearest kcounts, you round off the background counts.

Anterior counts = 122 – 99 = 23 kcounts

Posterior counts = 80.3 – 72.2 = 8.1 kcounts

Since the counting time was 10 minutes, you divide each value by 10:

Anterior count rate = 2.3 kcpm

Posterior count rate = 0.81 kcpm

You enter this information in the patient record, along with the time and date of the acquisition.

In the present example, the exposure to radioactive dust occurred at 2 p.m., while the counts were recorded at approximately 5 p.m., 3 hours later. The patient weighs 50 kg. According to table 5, this is nearest to the weight of a 15-year-old. Therefore, you use the calibration factors for a 15-year-old, even though the patient is 12 years old. Since the isotope is presumed to be ^{241}Am, you look in table A-11 under "15-y-old" and calculate calibration factors for 3 hours post exposure by interpolating between the 2-h and 4-h factors for the Philips SKYLight, the camera used to measure the count rates. You obtain the following values:

$$\textbf{Anterior factor} = \frac{780 + 861}{2} = 821 \text{ Bq/kcmp}$$

$$\textbf{Posterior factor} = \frac{2{,}245 + 2{,}336}{2} = 2{,}291 \text{ Bq/kcmp}$$

You calculate the intake separately for the anterior and posterior counts:

Intake (anterior) = 2.3 × 821 = 1,888 Bq

Intake (posterior) = 0.81 × 2,291 = 1,856 Bq

Taking the average of the two values, you report the estimated intake as 1,872 Bq (0.051 μCi).

Note that this is the total inhaled activity, and includes a fraction that was promptly expelled. The total inhaled activity is the relevant quantity for estimating doses to the patient.

1.4.4 Calculating Doses

Tables B-1 to B-6 list coefficients that you can use to calculate the cumulative effective dose, which is the integrated effective dose from the time of intake until the time of the assessment, as well as the lifetime effective dose commitment to the exposed individual, absent any medical intervention. To calculate either dose, look up the appropriate dose coefficient and multiply it by the inhaled or ingested activity calculated above.

The calculation of the estimated doses, which should be performed by a health physicist, a physician, a technologist, or another qualified health care professional, is illustrated by the following example. The patient is the same one described in section 1.3.4.

The dose assessment is performed soon after the patient was counted, so the time post intake is still approximately 3 hours. Since the isotope is presumed to be ^{241}Am, you look in table B-6 under inhalation in the column headed "15 y" and calculate the cumulative effective dose coefficient at 3 hours post intake by interpolating between the 2-h and 4-h coefficients.

$$\textbf{Cumulative effective dose coefficient} = \frac{2.08 \times 10^{-8} + 3.91 \times 10^{-8}}{2} = 3.00 \times 10^{-8}$$

The cumulative effective dose to the present time is estimated by multiplying this coefficient by the inhaled activity:

$$\textbf{1,872 Bq} \times 3 \times 10^{-8} \textbf{ Sv/Bq} = 5.6 \times 10^{-5} \textbf{ Sv (5.6 mrem)}$$

To calculate the lifetime dose effective dose commitment without any medical intervention, find the coefficient for the lifetime committed dose for inhalation for age 15 y in table B-6 and multiply the inhaled activity by this coefficient:

$$\textbf{1,872 Bq} \times 4.03 \times 10^{-5} = \textbf{0.075 Sv (7.5 rem)}$$

These doses can be used in estimating the efficacy of possible medical intervention.

1.5 Using Other Models of Gamma Cameras

These instructions may be applicable to some other models of gamma cameras, provided they meet the following criteria:

- The detectors are equipped with ⅜-inch (0.95 cm) NaI(Tl) crystals. This is the most common thickness; however, some models have crystals up to 1-inch thick. The calibration factors for thicker crystals would be significantly different from the ones utilized in these assessments.

- The field of view (FOV) is rectangular and approximately 51 × 38 cm (20 × 15 inches) or larger. Cameras that are 1 inch smaller in either dimension are acceptable. (The FOV of the Philips SKYLight is in the shape an irregular octagon—a rectangle with the corners cut off. Such a shape is acceptable for this purpose.)

Set the energy windows according to the settings in tables 1 to 3, or other settings that result in similar energy ranges. Avoid overlapping windows, which will not be accepted by some camera models.

Chapter 2

CALCULATING INTAKES AND DOSES USING ASSESS

The intakes and subsequent doses can be calculated by use of the Assess computer code. This program uses the count rates measured on a gamma camera, along with information about the camera, the patient, the time of exposure, and the radioactive material. The remainder of this chapter contains instructions for using the program—a modified version of these instructions can be accessed while executing the program. A technical overview of the program is presented in chapter 3.

2.1 Quick-Reference Guide to Assess

Assess includes three screens for user input and output. The first screen is displayed when the program opens—you can return to it by pressing the *Patient* tab in the upper left-hand corner of each screen. The other two screens are marked *Camera* and *Energy Windows*. The use of these screens is discussed below. The fourth screen, marked *Quick Reference*, displays a modified version of the quick-reference guide presented in this section.

On some computer display monitors, the first screen may overflow the size of the display. Scroll bars are provided on the right and bottom sides of the screen to enable you to see the rest of the screen. The screen prompts are underlined in the directions that follow. All entries are required unless stated otherwise.

1. *Patient*: This screen is used to enter information about the patient and the incident leading to his or her exposure. The results of the assessment are also displayed on this screen. The screen consists of five panels. The panels are discussed in counterclockwise order, starting with the upper left-hand corner.
   a. First Panel (upper left-hand side of screen)
      i. Last name
      ii. First name (optional)
      iii. Age of patient
         (1) Actual age must be entered for all patients younger than 25
         (2) For older patients, select “25 or older"
         (3) For infants under 1 year, enter age in months
      iv. Sex of patient (required for patients over 15 years old)
      v. Weight of patient: Specify weight if patient is less than 15 years old. This entry is optional; however, entering the weight enables a more accurate assessment since body size affects the count rate from a given intake.
   b. Second Panel (lower left-hand side of screen)
      i. Date counts were measured and Time counts were measured: The correct date and time are important, since the counts will change with time.

ii. Background counts

(1) Anterior view and Posterior view refer to the detectors used for the two views.

(2) Count units: cpm, kcpm, total counts, or total kcounts: You can use whichever units are most convenient. For total counts or total kcounts you must also enter the counting time in minutes. The same counting time will appear in the window for the second detector. However, you can change this entry if the counting times were different for the two detectors.

iii. Patient counts: Enter the patient counts in the same manner as described for background counts, above.

c. Third Panel (lower right-hand side of screen)

i. Principal mode of intake: If the patient was exposed to radioactive material that was dispersed as an aerosol or airborne dust, the intake was most likely by inhalation. If the individual consumed radioactively contaminated food or drink, the intake would have been by ingestion.

ii. Date patient inhaled or ingested radioactive material and Time: Enter the date and time of intake as accurately as possible, since the assessment depends on the time from intake until the counts are measured. Assessments cannot be performed if the intake was less than 1 hour or more than 30 days before the time the patient was counted.

iii. Principal isotope: Any of the six listed radioisotopes can be assessed by this program. The isotope should be identified by radiation professionals.

iv. Lung absorption type: required for inhalation of ^{60}Co, ^{90}Sr, or ^{192}Ir. A field will appear to the right of the principal isotope selection buttons listing the different lung absorption types for any of these three isotopes. *F* (fast), *M* (medium), and *S* (slow) refer to the speed with which different chemical forms of the isotope are absorbed by the lungs. The various chemical forms corresponding to the lung absorption types of each isotope are also listed. If the chemical form is unknown, select the type that corresponds to Unspecified compounds.

v. Clear Incident Data: Press this button to clear all data which were entered in the *Patient* screen.

d. Fourth Panel (middle of right-hand side of screen)

i. Notes (optional): You can use this window to enter notes into the patient's record

e. Fifth Panel (upper right-hand side of screen)

i. Calculate Results: (Do not press this button until you have reviewed or revised entries in the next two screens.) The information on each patient is saved to a text file in the \Patient subfolder. The file is named according to the following convention: *lastname_firstname_yyyy_mn_dd_hh_mm.*txt, where *yyyy* is the four-digit year, *mn* refers to the minutes after the hour that the file was saved, *dd* is the day of the month, *hh* is the hour in 24-hour time, and *mm* is the month expressed as a 2-digit number.

ii. Results: Select units for displaying results

(1) Conventional units: intake in μCi (microcuries), doses in rem

(2) SI: intake in MBq, doses in mSv.

(3) Calculated intake: For the inhalation pathway, this is the inhaled activity, and includes a large fraction that is promptly expelled. Dose calculations are based on the entire intake, including the expelled fraction. For the ingestion pathway, it is the total ingested activity.

(4) Cumulative effective dose (to present time): This is the effective dose that is delivered to the patient from the time of intake to the time you press the Calculate Results button (not to the time the counts were measured).

(5) Committed effective dose (lifetime): dose in the absence of medical intervention over the 50 years following intake in the case of adults, or until age 70 for younger patients

iii. Print Results: Press after pressing Calculate Results to open the printer dialogue on your computer and produce a one-page report on the individual patient that lists the calculated results as well as all the information you have entered.

iv. Next Patient: Press to reset all the patient-specific data. New entries must be made as follows.

(1) The patient's name

(2) The patient's age will be reset to "25 or older"; you must make a new entry if this is not correct.

(3) The patient's sex if the age is 15 or older

(4) The weight should be entered if the patient is younger than 15.

(5) The date the counts were measured will be reset to today's date—it must be changed if this is not correct.

(6) The time will be reset to midnight—a new time must be entered.

(7) The background counts will not be reset, but should be re-entered if the background counts have changed since the previous patient was counted.

(8) The patient counts, and count time if applicable, must be entered.

(9) All other entries will remain unchanged. However, you should review these entries to make sure they are still valid.

2. *Camera*: This screen is used to select the model of the gamma camera used in the assessment and to identify the position of the patient with respect to the camera.

a. Camera: Specify the model of the gamma camera. The three choices are Siemens e.cam, Philips SKYLight, or Other.

b. Which diagram best illustrates position of patient with respect to camera? Once the camera is specified, you will see schematic diagrams of patient positions with respect to the camera heads based on the age or weight of the patient as entered in the *Patient* screen. Select the

view that most closely resembles the actual position used for counting the patient. If unsure, select diagram 1, which is usually appropriate for the selected camera.

3. *Energy Windows*: This screen is used to select the set of energy windows used in the assessment and to enter new window parameters or to modify existing settings.

   a. Energy window

      i. Primary: You will see a set of primary energy windows that are recommended for counting the specific isotope with the camera selected in the *Camera* screen. If the camera is specified as Other, the heading will nevertheless read "Siemens e.cam gamma camera" and the Siemens e.cam primary and alternate energy windows will appear but will be dimmed. You can select either set by pressing the corresponding button—these windows will then be used in the assessment.

      ii. Alternate: For the Siemens e.cam and any isotope except ^{241}Am, you will see an alternate set of windows with fewer channels. The primary set produces the greatest sensitivity; the alternate set involves fewer channels and may be quicker to set up, but makes the camera somewhat less sensitive. There are no alternate sets of windows for the Philips SKYLight.

      iii. Custom: There are initially no values under Custom. You can create a custom set of energy windows using the procedure described under Edit Windows, below.

   b. Edit Windows: You can edit any set of windows by selecting that set and pressing Edit Windows. The background in the boxes will change color and you will be able to enter or edit the values. When adding new windows, you must first enter a nonzero value for the width before entering the peak energy for each channel. To exit the Edit Windows dialogue, press Save Changes or Restore Defaults.

2.2 Interpretation of Results

There are several cautions that should be observed in interpreting the results calculated with this program.

2.2.1 High Count Rates

If the gross count rate (patient counts without background subtraction) exceeds 100 kcps (6 million cpm), the camera may begin to lose counts. If the net exposure rate measured on a survey meter at a distance of 1 m from the patient is more than 5 times the rate listed in table 4, the gamma camera may become saturated, in which case the count rate will not provide a reliable assessment of this patient. To determine if the system is saturated, count the patient in the normal position, then move one of the detectors away from the patient in a stepwise manner and observe the count rate in that detector. If the count rate increases as the detector is moved away, the camera is saturated and cannot be used to assess that patient. The calibration factors used by the program do not apply to patient positions other than those described in chapter 1.

2.2.2 Accuracy of Model

The Assess code utilizes calibration factors that are based on computer simulations of the response of gamma cameras to radioisotopes distributed in various regions of the human body. These calculations are based on anatomical models of the human body and biokinetic models that describe how radionuclides are distributed in the body at various times after intake (Anigstein and Olsher 2010). These models were developed to determine radiation protection standards for the general population; they do not necessarily reflect the anatomy or physiology of any given individual.

Chapter 3

TECHNICAL DESCRIPTION OF ASSESS PROGRAM

This chapter presents a technical overview of the Assess program. It is not a complete description of the code, nor is intended to be a programer's guide.

3.1 Installation Notes[3]

Assess can be installed on a computer operating under Microsoft Windows by running the program setup.exe, which is part of the package. Minimum system requirements are Windows XP and approximately 30 MB of free disk space. Assess can be installed to the default folder, \Program Files, or in another folder specified by the user. A folder named "Assess" will be created in the specified location and all files will be installed in that folder or in subfolders created during the installation. A button named "Disk Cost...", which appears during setup, can be used to check available disk space on your computer. During the installation, Setup will ask if the program should be available to anyone using this computer or just yourself. On computers that are part of a network, the "Everyone" option can only be used by system administrators—all other users should select "Just me," which is the default.

3.2 Modules

The Assess code comprises two modules. One is the driver program, compiled with Microsoft Visual Basic 2005, that provides the user interface described in chapter 2. The other is the analytical program, which is written in Fortran 90 and compiled with the Lahey Fortran 90 compiler.

3.3 Folder Structure

The Assess folder (directory) structure, with a summary description of the files in each subfolder, is listed below. The symbol \ precedes the main folder and each subfolder. The levels of the subfolders are indicated by successive indentations. Names of individual files are listed in italics.

\Assess: Executable images and lf90.eer—required for running programs compiled with Lahey Fortran 90

- \Activity: Activity distribution files accessed by analytical program
- \Calib: Files of camera-specific calibration factors accessed by analytical program
- \Dat: Other permanent data files and *QuickReference.rtf*, similar to section 2.1
- \Dose: Dose coefficients accessed by analytical program
- \Patient: Case files on each individual patient saved by driver program

[3] Similar installation notes are found in a file named "Readme.txt" which is part of the Assess installation package.

\Run: Files created/modified by Assess during program execution:

PARAMS.DAT
INPUT.DAT
OUTPUT.DAT

\Spectra: Spectra of count rates accessed by analytical program

\Child-A: Spectra for infant

\Child-B: Spectra for 1-y-old

\Child-C: Spectra for 5-y-old

\Child-D: Spectra for 10-y-old

\Child-E: Spectra for 15-y-old

\Naomi: Spectra for adult female

\Norman: Spectra for adult male

3.4 Calculation of Intakes and Doses

3.4.1 Adults

The element-specific systemic biokinetic models incorporated in the DCAL System (ORNL 2006) define the onset of adulthood as age 20 for most elements, but age 25 for some bone-seeking elements, including strontium and americium (Eckerman et al. 2006). Individuals of age 25 and older are therefore defined as adults for assessing intakes of ^{90}Sr and ^{241}Am, while assessments of the other four nuclides in the present study define the age of adults as 20 or older.

Assessment Using Tabulated Energy Windows

If the counts from an adult were collected using one of the sets of energy windows listed in tables 1 to 3, the assessment is relatively straightforward. The assessment uses calibration factors for adult males and females that are contained in data files in the subfolder \Calib. These factors correspond to those listed in appendix A; however, the factors in the data files are tabulated for 50 time steps, spaced logarithmically over the interval 1 h–30 d, rather than the 12 steps in appendix A. Furthermore, they are the inverses of the factors in appendix A and are tabulated in units of cps/Bq.

First, the calibration factors for the detectors with anterior and posterior views of the patient are calculated by linear interpolation between the time steps that span the elapsed time between the intake of the radioactive material and the counting of the patient with the gamma camera. The net count rates (patient counts minus background) from these detectors, converted to cps, are divided by the respective calibration factors. The estimated intake reported by the program is the average of the intakes calculated from the count rates on the two detectors.

Next, the dose that has been already delivered to the patient from the time of intake until the time the Assess program is executed is calculated by use of dose coefficients listed in data files in the

subfolder \Dose.[4] These coefficients, a subset of which is listed in appendix B, are tabulated for the same 50 time steps as the calibration factors discussed above. A coefficient corresponding to the elapsed time is calculated by linear interpolation of the tabulated values and is multiplied by the calculated intake to yield the cumulative effective dose. The committed effective dose resulting from the intake is calculated by multiplying the intake by the coefficient for the lifetime effective dose, which is also listed in appendix B. This is the dose that will be delivered during 50 years following intake, absent any medical intervention.

Assessment Using Other Energy Windows

If a set of energy windows other than one of those listed in tables 1 to 3 is used, new calibration factors are calculated that are specific to the individual case. The normalized count rate from each anatomical region that is a source region in the biokinetic model of the given nuclide for the pathway in question (inhalation or ingestion) is calculated by summing the normalized counts in the spectra of count rates from that nuclide in each 1-keV energy bin that is within a given window.[5] The spectra from regions of adult females are tabulated in data files in the subfolder \Spectra\Naomi, while those from males are in \Spectra\Norman. If one of the window limits falls between the limits of a 1-keV bin (i.e., if the window limit, expressed in keV, is not an integer), the counts in that bin are apportioned according to the fraction of the bin that lies inside the window. Next, the normalized count rates from each region registered by the detectors with anterior and posterior views of the patient are multiplied by the fractional activity in that region at the time of the counting. These fractional activities, a subset of which is listed by Anigstein and Olsher (2010, appendix A), are tabulated in data files in the \Activity subfolder, using the same 50 time steps as the calibration factors discussed previously. Linear interpolation is used to calculate the fractional activity at the precise time following intake. Finally, these products of fractional activity and normalized count rate from each region are summed to produce calibration factors for the anterior and posterior views. The remainder of the assessment is performed in the same manner as described previously.

3.4.2 Pre-Adults: 15 Years and Older

The assessment of a 15-year-old patient is performed in a manner analogous to that of an adult, using the appropriate age-dependent data. If the individual is older than 15 but younger than an adult, two separate assessments are performed: one for a 15-year-old, the other for an adult of the same sex as the patient. The intakes and doses to this individual are calculated by linear interpolation between the values derived from these two assessments, using the patient's actual age.

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[4] It is assumed that the computer has a clock and that the date and time are set correctly. Note that the time of the execution of the program will, in general, occur later than the gamma camera counting.

[5] The source regions comprise all anatomical regions which, in the aggregate, contain at least 99% of the activity of the nuclide during the time span addressed in the present study. These regions, and the normalized count rates on cameras using the sets of energy windows listed in tables 1 to 3 in the present report, are listed by Anigstein and Olsher (2010, appendix C). Regions that do not contain significant fractions of the intake activity are omitted from the compressed model constructed for the present studies. A detailed discussion of the biokinetic models as they are applied in these assessments is presented by Anigstein and Olsher (2010, sections 2 and 3).

The committed effective dose to children (age 15 or younger) is defined as the dose delivered from time of intake to age 70.

3.4.3 Children Under Age 15

The spectra of count rates from anatomical regions of children 15 years old and younger were calculated using anatomical models based on reference individuals whose heights and weights are listed in table 5. However, the response of the gamma camera to activity in a given region is more likely to correlate to the weight of the patient rather than to his or her age. Therefore, unless the weight exactly corresponds to the weight of the reference individual of that age, as interpolated from table 5, Assess calculates calibration factors specific to the weight and age of the patient. This is done by first calculating the normalized count rates from regions of reference individuals whose weights span the weight of the patient, using the tabulated spectra and the energy windows used for counting the patient, as described in section 3.4.1, and interpolating between them, based on the patient's weight. The time-dependent fractional activity in each region of reference individuals whose ages span the age of the patient is calculated as discussed previously. An age-specific fractional activity is then calculated by interpolating between these sets of fractional activities. (Age, rather than weight, is used for consistency with the age-dependent biokinetic models.) The weight-adjusted count rates from each region are then multiplied by the age-specific activity fractions to yield calibration factors for the individual patient.

Appendix A

CALIBRATION FACTORS FOR CONVERTING COUNT RATES TO INTAKES[6]

Tables A-2 to A-17 list an alternate set of calibration factors that was calculated to provide a simple method of estimating intakes without using the Assess computer code, as described in section 1.4.2. Factors that relate the count rate measured by a gamma camera to the inhaled activity of a given radionuclide with a given lung absorption type are listed in tables A-2 to A-11. Corresponding factors for assessing ingested activities are listed in tables A-12 to A-17.

Calibration factors for assessing all nuclides except ^{241}Am with the Siemens e.cam camera were calculated for two sets of energy windows: one set consisted of six 50% windows, while the second, narrower set consisted of three such windows. These windows are specified in tables 1 and 2. The calibration factors for these five nuclides using the first set of windows with the Siemens camera are listed in tables A-2 to A-10 and A-12 to A-16 under the column heading "6 Windows," while those using the second set are under the heading "3 Windows." Calibration factors for assessing intakes of ^{241}Am with the Siemens camera, listed in tables A-11 and A-17, are based on a single set of two 50% windows. Calibration factors for the Philips SKYLight camera are based on a single set of energy windows for each radionuclide, specified in table 3. Separate calibration factors were calculated for the detectors in a two-headed camera system: one with an anterior view of the phantom, the other with a posterior view. They are specific to the default f_1 values supplied with the DCAL System (ORNL 2006), which are listed in table A-1 and, for the inhalation pathway, to a particle size distribution with a 1 μm AMAD.

Table A-1. f_1 Values Used in DCAL Calculations

Element	Pathway	Lung Type	Age		
			Infant	1–15 y	Adult
Co	Ingestion		0.6	0.3	0.1
	Inhalation	M	0.2	0.1	0.1
		S	0.02	0.01	0.01
Sr	Ingestion		0.6	0.4	0.3
	Inhalation	F	0.6	0.4	0.3
		S	0.02	0.01	0.01
I	Ingestion		1	1	1
	Inhalation	F	1	1	1
Cs	Ingestion		1	1	1
	Inhalation	F	1	1	1
Ir	Ingestion		0.02	0.01	0.01
	Inhalation	All	0.02	0.01	0.01
Am	Ingestion		0.005	0.0005	0.0005
	Inhalation	M	0.005	0.0005	0.0005

[6] This appendix is taken from Anigstein and Olsher 2010, appendix D, with some revisions of the introductory text.

Table A-2. Inhaled Activity of Type *M* ^{60}Co vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	169	211	239	295	238	291
0.083	2	172	209	244	292	243	289
0.167	4	179	213	253	298	252	294
0.333	8	192	225	272	316	271	311
0.5	12	209	239	295	336	293	331
1	24	273	297	385	417	384	411
2	48	461	465	648	653	645	642
4	96	829	768	1,165	1,085	1,160	1,063
8	192	1,045	943	1,468	1,334	1,461	1,305
10	240	1,092	985	1,534	1,393	1,526	1,363
20	480	1,288	1,160	1,809	1,641	1,800	1,605
30	720	1,456	1,311	2,045	1,855	2,035	1,814
1-y-old							
0.042	1	169	223	236	308	215	277
0.083	2	174	221	243	305	222	276
0.167	4	182	226	253	311	231	281
0.333	8	196	239	272	330	249	298
0.5	12	213	254	296	350	270	317
1	24	282	314	392	434	358	393
2	48	486	491	673	679	616	612
4	96	892	809	1,236	1,123	1,126	1,003
8	192	1,115	977	1,544	1,358	1,403	1,208
10	240	1,157	1,014	1,603	1,409	1,457	1,253
20	480	1,340	1,172	1,856	1,630	1,686	1,449
30	720	1,506	1,318	2,086	1,833	1,895	1,629
5-y-old							
0.042	1	196	296	272	405	246	354
0.083	2	203	294	282	402	256	352
0.167	4	211	300	293	411	268	359
0.333	8	227	317	314	434	288	379
0.5	12	246	337	341	461	314	403
1	24	323	413	447	566	414	493
2	48	534	619	737	848	681	737
4	96	904	944	1,248	1,297	1,132	1,124
8	192	1,093	1,109	1,507	1,525	1,357	1,320
10	240	1,132	1,148	1,561	1,578	1,405	1,366
20	480	1,304	1,323	1,799	1,819	1,619	1,574
30	720	1,466	1,487	2,022	2,045	1,820	1,770
10-y-old							
0.042	1	226	306	313	421	254	358
0.083	2	234	304	324	417	268	356
0.167	4	243	310	337	426	283	365
0.333	8	259	329	359	452	305	388
0.5	12	280	350	388	481	334	413
1	24	365	431	504	593	444	511
2	48	598	651	824	895	723	766
4	96	1,006	1,005	1,383	1,381	1,157	1,162
8	192	1,213	1,183	1,668	1,627	1,368	1,361
10	240	1,257	1,225	1,727	1,684	1,416	1,408
20	480	1,449	1,412	1,992	1,941	1,631	1,623
30	720	1,631	1,589	2,242	2,184	1,836	1,826

Table A-2 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	255	320	355	444	295	408
0.083	2	264	318	368	441	321	423
0.167	4	273	325	381	451	346	442
0.333	8	288	344	401	477	378	472
0.5	12	308	365	429	507	414	505
1	24	389	440	542	612	538	611
2	48	587	622	818	863	777	803
4	96	874	870	1,213	1,204	1,030	995
8	192	1,013	994	1,406	1,375	1,152	1,099
10	240	1,048	1,027	1,454	1,421	1,189	1,134
20	480	1,206	1,181	1,674	1,634	1,367	1,303
30	720	1,359	1,330	1,886	1,840	1,543	1,469
Adult male							
0.042	1	265	334	364	458	270	417
0.083	2	274	343	375	470	290	441
0.167	4	284	351	389	482	310	458
0.333	8	302	363	414	498	339	477
0.5	12	326	379	447	520	373	502
1	24	415	447	570	614	496	597
2	48	617	620	848	850	746	790
4	96	877	855	1,205	1,174	1,023	1,003
8	192	1,000	972	1,373	1,334	1,149	1,112
10	240	1,032	1,003	1,417	1,377	1,184	1,147
20	480	1,182	1,149	1,623	1,576	1,354	1,311
30	720	1,328	1,291	1,824	1,771	1,522	1,474
Adult female							
0.042	1	267	339	369	464	314	411
0.083	2	266	351	366	481	330	439
0.167	4	265	365	365	501	337	460
0.333	8	275	383	378	527	351	480
0.5	12	294	403	404	553	380	504
1	24	376	476	516	654	500	599
2	48	587	662	807	907	774	809
4	96	911	918	1,252	1,255	1,119	1,064
8	192	1,067	1,046	1,465	1,428	1,276	1,192
10	240	1,102	1,079	1,513	1,474	1,316	1,229
20	480	1,263	1,236	1,735	1,688	1,506	1,406
30	720	1,420	1,388	1,951	1,897	1,694	1,580

Table A-3. Inhaled Activity of Type *S* ^{60}Co vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	168	210	238	294	237	291
0.083	2	171	207	242	290	241	287
0.167	4	176	210	249	294	248	290
0.333	8	187	220	265	308	263	304
0.5	12	202	232	284	325	283	320
1	24	263	287	370	401	368	395
2	48	465	470	653	660	649	648
4	96	939	865	1,318	1,222	1,308	1,193
8	192	1,186	1,058	1,665	1,497	1,651	1,459
10	240	1,215	1,083	1,706	1,533	1,692	1,494
20	480	1,334	1,188	1,872	1,682	1,858	1,640
30	720	1,443	1,286	2,026	1,820	2,010	1,774
1-y-old							
0.042	1	168	222	235	306	214	276
0.083	2	173	220	242	303	221	274
0.167	4	180	223	251	308	229	278
0.333	8	192	235	268	324	244	293
0.5	12	208	248	289	342	264	310
1	24	275	306	381	422	349	382
2	48	482	487	667	673	611	607
4	96	928	836	1,285	1,161	1,168	1,034
8	192	1,141	992	1,580	1,380	1,432	1,223
10	240	1,166	1,013	1,615	1,409	1,464	1,249
20	480	1,271	1,104	1,761	1,536	1,595	1,361
30	720	1,368	1,189	1,896	1,653	1,718	1,466
5-y-old							
0.042	1	195	294	271	403	245	352
0.083	2	201	291	280	399	255	348
0.167	4	209	296	290	405	265	354
0.333	8	222	311	308	426	283	371
0.5	12	240	328	332	450	307	392
1	24	313	400	432	548	401	477
2	48	523	606	721	830	667	720
4	96	909	946	1,254	1,300	1,134	1,124
8	192	1,077	1,088	1,485	1,496	1,331	1,292
10	240	1,100	1,111	1,517	1,527	1,360	1,319
20	480	1,198	1,210	1,652	1,664	1,481	1,437
30	720	1,290	1,303	1,779	1,792	1,594	1,548
10-y-old							
0.042	1	224	304	310	417	252	355
0.083	2	232	300	321	412	266	352
0.167	4	239	305	331	419	280	359
0.333	8	253	321	349	441	300	378
0.5	12	271	340	375	467	326	401
1	24	351	415	484	571	430	492
2	48	582	634	802	872	706	745
4	96	1,007	1,002	1,384	1,377	1,146	1,154
8	192	1,191	1,156	1,636	1,588	1,324	1,323
10	240	1,216	1,180	1,671	1,621	1,352	1,350
20	480	1,326	1,286	1,822	1,767	1,473	1,471
30	720	1,428	1,385	1,963	1,903	1,586	1,584

Table A-3 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	252	317	351	440	293	404
0.083	2	261	314	364	435	321	419
0.167	4	268	319	373	442	346	438
0.333	8	279	335	389	465	377	466
0.5	12	297	353	414	490	411	496
1	24	372	423	518	587	528	595
2	48	567	600	789	833	754	775
4	96	855	848	1,187	1,174	985	952
8	192	971	948	1,346	1,311	1,073	1,026
10	240	991	967	1,374	1,338	1,095	1,046
20	480	1,082	1,055	1,501	1,460	1,196	1,141
30	720	1,168	1,138	1,621	1,574	1,290	1,231
Adult male							
0.042	1	260	327	357	448	266	408
0.083	2	268	335	367	460	287	432
0.167	4	275	342	378	469	307	448
0.333	8	290	350	398	480	333	463
0.5	12	311	363	426	498	366	485
1	24	393	424	540	582	481	570
2	48	586	590	806	810	715	751
4	96	839	821	1,151	1,126	967	951
8	192	935	913	1,283	1,252	1,058	1,031
10	240	953	931	1,308	1,277	1,078	1,050
20	480	1,036	1,012	1,422	1,388	1,171	1,141
30	720	1,114	1,088	1,529	1,492	1,258	1,226
Adult female							
0.042	1	264	334	364	457	311	404
0.083	2	262	345	360	474	326	432
0.167	4	258	358	355	491	332	452
0.333	8	264	373	363	513	343	468
0.5	12	280	389	384	535	368	489
1	24	355	455	487	625	479	573
2	48	558	633	767	868	738	771
4	96	878	886	1,206	1,210	1,063	1,012
8	192	1,007	987	1,382	1,347	1,183	1,108
10	240	1,027	1,006	1,410	1,373	1,206	1,129
20	480	1,118	1,093	1,534	1,492	1,311	1,227
30	720	1,202	1,176	1,651	1,604	1,409	1,318

Table A-4. Inhaled Activity of Type *F* ^{90}Sr vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	3,607	6,841	4,804	8,737	4,660	8,712
0.083	2	3,704	6,956	4,935	8,909	4,799	8,882
0.167	4	3,868	7,200	5,153	9,262	5,021	9,229
0.333	8	4,186	7,531	5,564	9,716	5,429	9,657
0.5	12	4,518	7,786	5,988	10,049	5,846	9,962
1	24	5,525	8,529	7,262	11,016	7,100	10,854
2	48	7,287	9,833	9,469	12,720	9,280	12,452
4	96	9,031	11,161	11,635	14,459	11,427	14,102
8	192	10,011	12,257	12,877	15,887	12,653	15,489
10	240	10,297	12,657	13,245	16,408	13,016	16,000
20	480	11,249	14,113	14,467	18,300	14,219	17,861
30	720	11,787	14,990	15,156	19,440	14,897	18,984
1-y-old							
0.042	1	4,231	9,160	5,509	11,415	5,060	10,679
0.083	2	4,462	9,228	5,813	11,518	5,355	10,779
0.167	4	4,806	9,476	6,263	11,858	5,781	11,088
0.333	8	5,362	9,878	6,974	12,383	6,455	11,569
0.5	12	5,925	10,235	7,685	12,836	7,131	11,988
1	24	7,788	11,401	10,014	14,307	9,356	13,348
2	48	11,902	13,836	15,095	17,393	14,237	16,178
4	96	17,906	17,194	22,415	21,659	21,309	20,081
8	192	22,847	20,957	28,513	26,418	27,167	24,475
10	240	24,445	22,375	30,501	28,204	29,076	26,134
20	480	30,175	27,531	37,606	34,664	35,947	32,160
30	720	33,885	30,877	42,190	38,840	40,409	36,070
5-y-old							
0.042	1	5,685	14,347	7,400	17,745	6,580	16,128
0.083	2	6,077	14,752	7,930	18,256	7,072	16,612
0.167	4	6,667	15,482	8,714	19,181	7,778	17,478
0.333	8	7,604	16,427	9,928	20,366	8,879	18,564
0.5	12	8,508	17,118	11,079	21,221	9,947	19,331
1	24	11,476	19,166	14,813	23,750	13,459	21,599
2	48	18,333	23,406	23,318	29,022	21,554	26,348
4	96	29,157	29,483	36,537	36,607	34,285	33,191
8	192	38,594	36,637	48,206	45,517	45,351	41,286
10	240	41,755	39,349	52,162	48,884	49,037	44,376
20	480	53,982	49,319	67,467	61,222	63,160	55,858
30	720	62,664	55,996	78,333	69,461	73,100	63,620
10-y-old							
0.042	1	8,258	17,068	10,608	20,892	7,887	18,751
0.083	2	9,039	17,624	11,644	21,582	8,663	19,467
0.167	4	10,103	18,628	13,048	22,838	9,699	20,690
0.333	8	11,551	19,819	14,906	24,324	11,175	22,077
0.5	12	12,837	20,579	16,517	25,263	12,563	22,923
1	24	16,856	22,671	21,491	27,850	17,056	25,204
2	48	25,408	26,779	31,911	32,948	26,996	29,671
4	96	36,929	31,982	45,738	39,412	40,952	35,347
8	192	45,571	37,419	56,273	46,134	50,916	41,335
10	240	48,441	39,417	59,811	48,598	54,031	43,533
20	480	59,322	46,290	73,201	57,046	65,479	51,026
30	720	66,380	50,313	81,858	61,980	72,702	55,378

Table A-4 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	13,811	21,981	17,070	26,617	9,209	25,897
0.083	2	15,850	22,712	19,670	27,532	10,147	27,469
0.167	4	18,382	23,916	22,915	29,054	11,340	28,958
0.333	8	20,941	25,182	26,139	30,653	13,055	30,325
0.5	12	22,755	25,890	28,363	31,538	14,741	31,278
1	24	27,724	27,694	34,386	33,777	20,283	33,536
2	48	36,540	30,938	45,026	37,799	32,251	36,743
4	96	45,786	34,392	56,170	42,074	47,290	39,888
8	192	51,997	37,533	63,755	45,928	54,812	43,180
10	240	54,105	38,659	66,345	47,305	56,640	44,387
20	480	61,982	42,428	76,014	51,900	62,708	48,288
30	720	66,754	44,479	81,860	54,395	66,055	50,339
Adult male							
0.042	1	16,633	27,181	20,218	32,926	9,444	33,094
0.083	2	18,102	28,726	22,070	34,925	10,352	36,752
0.167	4	20,272	30,023	24,794	36,632	11,556	39,766
0.333	8	23,258	31,207	28,489	38,141	13,468	42,209
0.5	12	25,805	32,336	31,607	39,529	15,532	44,443
1	24	33,412	36,543	40,888	44,676	23,196	51,703
2	48	48,915	46,589	59,866	57,015	45,090	66,372
4	96	71,933	62,819	88,210	77,036	93,099	87,842
8	192	97,024	81,746	119,084	100,305	137,375	113,665
10	240	106,463	88,728	130,627	108,815	150,909	123,831
20	480	146,587	116,554	179,332	142,393	209,639	167,054
30	720	179,342	137,659	218,830	167,658	259,034	201,674
Adult female							
0.042	1	14,093	23,114	17,268	28,022	11,300	26,780
0.083	2	14,797	25,638	18,212	31,174	12,217	30,770
0.167	4	15,842	28,464	19,574	34,722	13,214	34,694
0.333	8	17,480	30,951	21,629	37,826	14,816	37,628
0.5	12	19,151	32,607	23,690	39,857	16,726	39,685
1	24	24,828	37,641	30,666	46,015	23,801	46,108
2	48	38,050	48,843	46,940	59,813	41,883	59,925
4	96	60,504	66,285	74,679	81,418	75,508	81,077
8	192	84,353	87,041	104,180	107,041	106,793	105,975
10	240	92,967	95,350	114,789	117,248	116,404	115,633
20	480	129,788	132,352	159,833	162,502	153,217	156,666
30	720	160,372	163,527	197,020	200,491	180,784	189,658

Table A-5. Inhaled Activity of Type *S* ^{90}Sr vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	3,590	6,895	4,758	8,701	4,611	8,688
0.083	2	3,733	6,779	4,939	8,536	4,799	8,501
0.167	4	3,903	6,874	5,152	8,650	5,013	8,592
0.333	8	4,223	7,186	5,554	9,051	5,403	8,956
0.5	12	4,627	7,516	6,065	9,473	5,899	9,345
1	24	6,297	8,985	8,199	11,338	7,970	11,120
2	48	11,656	13,831	15,036	17,491	14,624	17,076
4	96	24,467	23,085	31,178	29,292	30,393	28,536
8	192	31,101	27,187	39,455	34,536	38,500	33,634
10	240	31,806	27,763	40,347	35,269	39,369	34,348
20	480	34,592	30,214	43,886	38,389	42,813	37,388
30	720	37,120	32,461	47,100	41,249	45,940	40,174
1-y-old							
0.042	1	4,055	9,194	5,251	11,368	4,794	10,537
0.083	2	4,264	8,992	5,516	11,100	5,050	10,292
0.167	4	4,496	9,097	5,809	11,221	5,324	10,384
0.333	8	4,906	9,523	6,326	11,750	5,799	10,851
0.5	12	5,417	9,969	6,969	12,308	6,400	11,367
1	24	7,499	11,828	9,586	14,635	8,856	13,526
2	48	13,944	17,420	17,655	21,659	16,377	19,889
4	96	28,351	26,669	35,463	33,394	32,743	30,206
8	192	35,378	30,479	44,072	38,247	40,565	34,424
10	240	36,138	31,078	45,017	39,001	41,430	35,099
20	480	39,199	33,685	48,834	42,280	44,937	38,045
30	720	42,008	36,086	52,338	45,300	48,158	40,760
5-y-old							
0.042	1	5,221	13,291	6,740	16,232	6,015	14,735
0.083	2	5,510	13,084	7,114	15,974	6,385	14,431
0.167	4	5,824	13,312	7,506	16,246	6,770	14,617
0.333	8	6,362	14,012	8,163	17,092	7,407	15,324
0.5	12	7,027	14,694	8,981	17,922	8,197	16,036
1	24	9,651	17,220	12,231	21,017	11,314	18,739
2	48	17,091	23,839	21,394	29,178	19,981	25,923
4	96	30,936	33,067	38,172	40,641	35,497	36,008
8	192	36,891	36,729	45,331	45,194	42,013	40,013
10	240	37,642	37,428	46,251	46,057	42,862	40,774
20	480	40,802	40,561	50,139	49,919	46,459	44,183
30	720	43,722	43,462	53,733	53,496	49,785	47,341
10-y-old							
0.042	1	7,137	15,541	9,065	18,833	6,932	16,696
0.083	2	7,577	15,204	9,610	18,405	7,497	16,358
0.167	4	7,986	15,447	10,108	18,679	8,031	16,643
0.333	8	8,624	16,310	10,878	19,710	8,813	17,602
0.5	12	9,450	17,147	11,889	20,725	9,785	18,528
1	24	12,773	20,165	15,966	24,420	13,578	21,789
2	48	21,889	27,935	27,099	33,983	23,478	29,931
4	96	37,544	38,631	45,976	47,255	39,113	40,798
8	192	43,975	42,832	53,691	52,474	45,230	45,057
10	240	44,851	43,635	54,759	53,461	46,116	45,898
20	480	48,615	47,243	59,363	57,896	49,972	49,698
30	720	52,096	50,580	63,622	61,999	53,540	53,214

Table A-5 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	11,046	18,858	13,548	22,644	8,298	21,534
0.083	2	11,794	18,511	14,447	22,212	9,158	22,297
0.167	4	12,316	18,829	15,067	22,593	10,062	23,195
0.333	8	12,948	19,865	15,813	23,855	11,311	24,556
0.5	12	13,884	20,820	16,932	25,024	12,676	25,892
1	24	17,706	23,914	21,520	28,813	17,418	29,603
2	48	26,815	30,796	32,453	37,262	27,437	34,843
4	96	38,815	38,840	46,813	47,188	38,814	38,916
8	192	43,349	42,076	52,245	51,173	42,854	40,982
10	240	44,183	42,844	53,251	52,110	43,667	41,710
20	480	47,939	46,379	57,785	56,425	47,369	45,155
30	720	51,433	49,661	62,004	60,432	50,811	48,359
Adult male							
0.042	1	12,229	20,304	14,809	24,369	8,053	22,586
0.083	2	12,265	20,899	14,879	25,095	8,657	23,959
0.167	4	12,396	21,076	15,064	25,331	9,318	24,651
0.333	8	13,111	21,073	15,948	25,362	10,402	25,017
0.5	12	14,244	21,434	17,323	25,819	11,669	25,728
1	24	18,589	23,908	22,573	28,837	16,195	28,808
2	48	27,629	30,797	33,505	37,164	25,918	34,902
4	96	37,421	39,557	45,389	47,719	37,029	40,890
8	192	40,957	43,105	49,688	51,991	40,909	43,543
10	240	41,721	43,901	50,615	52,951	41,666	44,323
20	480	45,216	47,548	54,854	57,349	45,101	47,977
30	720	48,468	50,937	58,800	61,436	48,295	51,376
Adult female							
0.042	1	11,972	18,061	14,576	21,648	9,886	19,275
0.083	2	11,333	19,022	13,843	22,835	10,250	20,893
0.167	4	10,748	19,891	13,163	23,918	10,316	22,054
0.333	8	10,773	20,599	13,208	24,799	10,737	22,723
0.5	12	11,455	21,211	14,039	25,545	11,740	23,386
1	24	14,976	23,728	18,307	28,590	16,243	26,073
2	48	24,723	30,279	30,076	36,525	27,171	32,122
4	96	40,361	38,483	48,830	46,494	41,248	38,791
8	192	46,620	41,828	56,317	50,556	46,286	41,623
10	240	47,552	42,599	57,441	51,488	47,167	42,376
20	480	51,615	46,142	62,345	55,770	51,102	45,877
30	720	55,391	49,434	66,903	59,750	54,761	49,134

Table A-6. Inhaled Activity of Type *F* ^{131}I vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	139	201	164	236	167	236
0.083	2	149	212	175	248	179	248
0.167	4	170	242	200	283	205	284
0.333	8	216	313	255	366	262	369
0.5	12	267	390	316	456	324	460
1	24	434	602	512	703	526	712
2	48	748	863	881	1,009	901	1,020
4	96	1,222	1,193	1,438	1,395	1,460	1,404
8	192	2,137	2,017	2,515	2,360	2,548	2,374
10	240	2,779	2,621	3,270	3,067	3,313	3,085
20	480	10,312	9,726	12,136	11,380	12,294	11,445
30	720	38,114	35,949	44,857	42,059	45,441	42,303
1-y-old							
0.042	1	147	235	175	280	160	250
0.083	2	157	245	187	293	171	262
0.167	4	179	279	213	333	195	297
0.333	8	226	357	270	426	248	381
0.5	12	279	440	333	524	305	469
1	24	451	656	538	782	492	699
2	48	785	903	938	1,075	854	958
4	96	1,283	1,203	1,535	1,433	1,387	1,274
8	192	2,148	1,935	2,572	2,305	2,320	2,050
10	240	2,729	2,457	3,267	2,927	2,948	2,603
20	480	9,064	8,161	10,853	9,722	9,791	8,646
30	720	30,117	27,119	36,063	32,305	32,535	28,728
5-y-old							
0.042	1	183	339	221	415	195	350
0.083	2	194	351	235	430	207	364
0.167	4	217	392	262	479	232	408
0.333	8	274	499	331	608	292	521
0.5	12	342	617	413	751	363	648
1	24	570	930	688	1,128	599	988
2	48	992	1,263	1,203	1,529	1,039	1,345
4	96	1,567	1,633	1,909	1,979	1,644	1,735
8	192	2,486	2,499	3,033	3,028	2,613	2,652
10	240	3,080	3,095	3,756	3,749	3,238	3,283
20	480	9,063	9,109	11,055	11,037	9,532	9,663
30	720	26,758	26,895	32,641	32,587	28,144	28,530
10-y-old							
0.042	1	239	382	293	478	216	383
0.083	2	256	400	314	500	232	403
0.167	4	290	456	355	569	262	460
0.333	8	373	600	456	748	329	608
0.5	12	473	769	578	956	406	781
1	24	802	1,258	979	1,555	651	1,281
2	48	1,331	1,779	1,632	2,191	1,076	1,813
4	96	1,937	2,266	2,390	2,790	1,618	2,307
8	192	2,881	3,283	3,560	4,042	2,435	3,341
10	240	3,468	3,946	4,286	4,859	2,936	4,016
20	480	8,850	10,040	10,938	12,364	7,526	10,222
30	720	22,793	25,835	28,171	31,816	19,410	26,306

Table A-6 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	315	445	398	574	244	459
0.083	2	343	474	435	610	260	483
0.167	4	400	554	507	714	290	550
0.333	8	545	772	689	994	353	706
0.5	12	732	1,048	923	1,349	419	871
1	24	1,403	1,995	1,765	2,561	620	1,296
2	48	2,378	3,091	3,009	3,963	972	1,724
4	96	3,261	3,919	4,153	5,023	1,440	2,176
8	192	4,734	5,587	6,037	7,160	2,164	3,158
10	240	5,666	6,674	7,227	8,551	2,609	3,797
20	480	14,150	16,575	18,047	21,229	6,646	9,608
30	720	35,855	41,916	45,730	53,679	16,963	24,466
Adult male							
0.042	1	367	515	460	657	233	534
0.083	2	399	562	499	715	247	581
0.167	4	452	661	563	840	270	675
0.333	8	566	909	702	1,156	315	888
0.5	12	691	1,219	853	1,547	361	1,124
1	24	1,017	2,242	1,241	2,831	502	1,776
2	48	1,359	3,420	1,650	4,299	757	2,465
4	96	1,728	4,356	2,098	5,470	1,106	3,134
8	192	2,508	6,187	3,047	7,769	1,657	4,513
10	240	3,011	7,361	3,658	9,242	1,995	5,400
20	480	7,529	17,824	9,154	22,373	5,037	13,339
30	720	18,897	43,933	22,983	55,138	12,710	33,244
Adult female							
0.042	1	331	459	413	586	280	475
0.083	2	354	497	441	634	298	517
0.167	4	402	582	500	742	330	602
0.333	8	511	791	633	1,006	392	786
0.5	12	633	1,044	781	1,325	454	987
1	24	973	1,836	1,192	2,313	633	1,532
2	48	1,378	2,714	1,686	3,401	921	2,109
4	96	1,807	3,455	2,217	4,326	1,295	2,688
8	192	2,631	4,938	3,230	6,184	1,922	3,881
10	240	3,156	5,889	3,875	7,377	2,313	4,648
20	480	7,866	14,390	9,663	18,031	5,825	11,525
30	720	19,704	35,647	24,214	44,672	14,679	28,786

Table A-7. Inhaled Activity of Type *F* ^{137}Cs vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	213	293	361	465	293	396
0.083	2	221	293	374	467	303	396
0.167	4	232	297	392	476	318	401
0.333	8	250	307	422	494	344	414
0.5	12	267	316	449	510	367	426
1	24	312	339	520	550	429	457
2	48	377	371	618	604	518	500
4	96	447	415	725	677	614	559
8	192	540	497	874	809	741	669
10	240	590	542	954	883	809	730
20	480	915	841	1,481	1,371	1,256	1,133
30	720	1,425	1,310	2,306	2,135	1,956	1,764
1-y-old							
0.042	1	226	337	367	508	286	426
0.083	2	235	338	383	512	299	426
0.167	4	250	345	407	524	318	435
0.333	8	274	359	446	548	350	454
0.5	12	298	371	482	569	380	470
1	24	359	401	574	618	461	509
2	48	450	442	705	683	583	562
4	96	555	503	856	778	721	639
8	192	700	625	1,076	967	910	794
10	240	779	696	1,198	1,076	1,013	883
20	480	1,328	1,186	2,042	1,835	1,727	1,505
30	720	2,263	2,022	3,481	3,127	2,944	2,566
5-y-old							
0.042	1	280	485	446	710	353	618
0.083	2	295	491	471	722	372	624
0.167	4	318	508	506	750	401	644
0.333	8	353	540	563	800	449	682
0.5	12	387	566	614	841	495	714
1	24	472	620	741	927	615	780
2	48	591	682	908	1,021	788	854
4	96	716	762	1,082	1,142	969	953
8	192	868	910	1,308	1,364	1,178	1,138
10	240	944	989	1,422	1,483	1,281	1,237
20	480	1,380	1,446	2,080	2,168	1,873	1,808
30	720	1,920	2,011	2,892	3,015	2,604	2,515
10-y-old							
0.042	1	361	537	553	780	391	681
0.083	2	385	548	591	799	416	693
0.167	4	417	572	642	837	454	724
0.333	8	467	615	719	904	518	781
0.5	12	510	649	785	958	577	827
1	24	613	717	935	1,063	732	918
2	48	737	785	1,108	1,166	947	1,007
4	96	859	867	1,278	1,288	1,159	1,111
8	192	1,001	1,001	1,486	1,486	1,362	1,282
10	240	1,064	1,063	1,579	1,579	1,448	1,362
20	480	1,346	1,345	1,999	1,998	1,831	1,723
30	720	1,602	1,600	2,380	2,378	2,179	2,050

Table A-7 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	454	601	676	868	438	817
0.083	2	489	616	728	891	464	834
0.167	4	534	646	798	939	508	883
0.333	8	598	698	895	1,018	589	978
0.5	12	651	738	975	1,080	670	1,057
1	24	758	812	1,134	1,195	894	1,212
2	48	858	876	1,276	1,291	1,236	1,347
4	96	940	939	1,393	1,383	1,558	1,462
8	192	1,013	1,008	1,499	1,485	1,721	1,573
10	240	1,036	1,031	1,534	1,519	1,762	1,609
20	480	1,127	1,121	1,668	1,652	1,916	1,749
30	720	1,215	1,208	1,799	1,781	2,066	1,886
Adult male							
0.042	1	530	693	771	984	411	952
0.083	2	577	726	841	1,037	437	995
0.167	4	638	767	933	1,101	479	1,056
0.333	8	726	822	1,065	1,188	559	1,150
0.5	12	798	864	1,174	1,255	640	1,225
1	24	944	941	1,394	1,378	883	1,370
2	48	1,070	1,009	1,580	1,483	1,310	1,500
4	96	1,161	1,071	1,712	1,575	1,748	1,608
8	192	1,232	1,132	1,816	1,665	1,928	1,702
10	240	1,254	1,152	1,848	1,695	1,964	1,732
20	480	1,343	1,234	1,979	1,815	2,104	1,855
30	720	1,431	1,316	2,110	1,935	2,242	1,977
Adult female							
0.042	1	482	640	713	915	515	865
0.083	2	512	669	760	960	548	911
0.167	4	558	710	831	1,025	601	980
0.333	8	632	770	944	1,119	699	1,085
0.5	12	696	817	1,039	1,193	793	1,171
1	24	829	903	1,237	1,330	1,050	1,338
2	48	954	977	1,417	1,443	1,421	1,482
4	96	1,046	1,040	1,548	1,537	1,741	1,594
8	192	1,112	1,099	1,643	1,625	1,888	1,688
10	240	1,131	1,119	1,673	1,654	1,922	1,718
20	480	1,212	1,198	1,791	1,771	2,059	1,840
30	720	1,292	1,277	1,910	1,888	2,195	1,962

Table A-8. Inhaled Activity of Type *F* ^{192}Ir vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	58	84	72	103	75	106
0.083	2	60	84	74	103	77	106
0.167	4	63	86	78	106	80	109
0.333	8	68	91	84	111	87	114
0.5	12	73	95	91	117	94	120
1	24	93	111	115	136	119	139
2	48	139	148	172	181	177	185
4	96	204	197	251	242	259	247
8	192	242	229	298	281	307	287
10	240	253	240	312	295	321	300
20	480	307	290	378	357	389	364
30	720	359	339	442	417	456	425
1-y-old							
0.042	1	62	99	77	121	73	114
0.083	2	64	99	80	122	75	114
0.167	4	68	102	84	125	79	117
0.333	8	74	108	92	132	87	124
0.5	12	81	114	100	139	95	131
1	24	105	132	130	163	124	153
2	48	161	174	199	214	189	201
4	96	240	229	296	281	281	263
8	192	285	264	351	325	334	304
10	240	298	277	368	340	349	318
20	480	361	335	446	412	423	385
30	720	423	392	522	481	495	451
5-y-old							
0.042	1	78	143	97	177	89	159
0.083	2	81	144	101	178	93	160
0.167	4	85	148	106	184	98	164
0.333	8	93	158	117	196	108	175
0.5	12	102	167	128	207	120	185
1	24	134	195	167	242	158	216
2	48	203	254	254	315	241	281
4	96	297	327	370	406	352	361
8	192	351	377	437	467	415	416
10	240	368	394	458	489	435	435
20	480	445	477	554	592	527	527
30	720	521	558	649	692	616	616
10-y-old							
0.042	1	101	159	127	200	100	173
0.083	2	105	160	132	200	105	174
0.167	4	110	164	138	206	112	179
0.333	8	120	175	151	220	124	191
0.5	12	131	185	164	233	138	203
1	24	168	218	212	273	185	240
2	48	248	284	312	356	282	312
4	96	353	367	444	459	405	400
8	192	415	422	521	528	476	459
10	240	435	442	546	552	499	480
20	480	527	535	662	669	604	581
30	720	617	626	775	783	707	680

Table A-8 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	132	184	168	235	118	222
0.083	2	137	184	175	236	127	230
0.167	4	144	190	183	243	139	243
0.333	8	155	202	198	258	159	267
0.5	12	167	214	214	273	181	289
1	24	208	247	266	316	252	346
2	48	286	311	366	396	386	424
4	96	376	384	480	488	533	495
8	192	434	438	553	556	619	556
10	240	454	458	579	581	647	581
20	480	550	555	702	704	782	703
30	720	644	649	822	823	914	821
Adult male							
0.042	1	149	217	187	274	111	257
0.083	2	153	222	192	280	118	269
0.167	4	158	227	198	286	127	280
0.333	8	169	233	213	294	144	296
0.5	12	183	242	230	305	163	312
1	24	229	274	289	345	228	364
2	48	314	348	396	438	363	455
4	96	405	441	511	555	526	553
8	192	465	506	586	637	616	627
10	240	487	530	613	667	645	656
20	480	590	642	743	807	779	793
30	720	691	751	870	945	911	927
Adult female							
0.042	1	133	194	167	246	130	224
0.083	2	132	202	167	256	135	238
0.167	4	133	211	168	267	141	252
0.333	8	140	224	176	284	153	271
0.5	12	150	235	189	299	170	289
1	24	190	270	239	343	232	341
2	48	274	341	346	433	366	434
4	96	380	429	480	543	530	540
8	192	444	491	561	621	622	617
10	240	465	514	587	650	652	645
20	480	564	622	713	787	790	781
30	720	661	728	836	921	925	913

Table A-9. Inhaled Activity of Type *M* ^{192}Ir vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	57	84	71	102	73	105
0.083	2	59	83	73	101	75	103
0.167	4	61	84	75	102	77	105
0.333	8	65	87	80	107	83	109
0.5	12	70	92	87	112	90	115
1	24	93	111	115	136	118	139
2	48	164	174	202	213	208	217
4	96	322	298	396	367	407	372
8	192	414	368	510	453	524	459
10	240	432	384	533	473	547	479
20	480	523	465	644	573	662	581
30	720	622	555	766	684	787	693
1-y-old							
0.042	1	60	97	74	119	70	111
0.083	2	62	96	77	117	73	109
0.167	4	65	97	81	119	76	111
0.333	8	70	102	87	125	82	117
0.5	12	76	107	95	132	89	123
1	24	103	130	127	159	120	149
2	48	181	197	224	242	212	225
4	96	345	316	426	388	400	359
8	192	436	380	539	468	505	432
10	240	455	396	562	488	527	450
20	480	550	480	679	590	637	545
30	720	654	572	808	704	758	650
5-y-old							
0.042	1	73	135	92	167	84	149
0.083	2	77	133	96	165	88	147
0.167	4	80	135	100	168	93	149
0.333	8	86	142	108	177	101	157
0.5	12	94	150	118	187	110	165
1	24	125	179	157	223	147	198
2	48	212	260	264	322	249	285
4	96	368	384	458	475	424	421
8	192	451	451	561	559	516	496
10	240	471	471	585	583	538	517
20	480	570	571	709	708	653	628
30	720	681	684	847	847	780	751
10-y-old							
0.042	1	92	147	116	185	92	159
0.083	2	96	145	121	182	98	157
0.167	4	101	147	127	185	104	160
0.333	8	107	156	135	196	113	169
0.5	12	116	164	146	207	124	179
1	24	152	198	192	248	168	216
2	48	252	287	317	360	279	312
4	96	427	427	536	533	452	455
8	192	521	503	652	627	541	533
10	240	543	524	681	654	565	556
20	480	659	637	826	794	687	676
30	720	789	763	988	951	824	810

Table A-9 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	117	166	150	213	109	195
0.083	2	123	164	158	210	121	202
0.167	4	128	167	164	213	132	211
0.333	8	134	175	172	224	146	225
0.5	12	143	185	183	236	162	240
1	24	181	218	232	278	215	282
2	48	273	296	350	376	319	352
4	96	405	401	515	507	431	419
8	192	474	461	603	582	493	468
10	240	495	481	629	607	515	488
20	480	602	584	766	737	631	597
30	720	722	701	918	885	763	720
Adult male							
0.042	1	123	174	155	219	99	199
0.083	2	126	179	158	225	107	211
0.167	4	129	182	162	229	115	219
0.333	8	137	185	172	233	127	225
0.5	12	147	190	186	239	141	234
1	24	189	218	238	274	191	270
2	48	281	292	353	366	294	342
4	96	393	396	493	494	412	422
8	192	454	456	568	568	473	475
10	240	473	475	592	593	494	496
20	480	575	579	720	722	603	606
30	720	690	696	864	868	727	730
Adult female							
0.042	1	120	165	152	209	118	182
0.083	2	117	172	148	218	124	197
0.167	4	114	180	144	228	125	207
0.333	8	116	188	147	238	130	215
0.5	12	124	195	156	247	141	224
1	24	160	225	201	284	190	258
2	48	256	300	323	378	304	334
4	96	408	404	514	508	451	427
8	192	488	465	614	583	526	485
10	240	509	485	641	608	549	506
20	480	617	589	777	740	670	618
30	720	738	708	930	888	807	745

Table A-10. Inhaled Activity of Type *S* ^{192}Ir vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	57	84	70	102	72	105
0.083	2	58	82	72	101	75	103
0.167	4	60	83	75	102	77	104
0.333	8	65	87	80	106	82	109
0.5	12	70	91	87	112	89	114
1	24	93	111	115	136	118	139
2	48	167	177	206	217	211	221
4	96	343	315	422	388	434	393
8	192	446	391	550	482	565	487
10	240	465	407	573	501	588	507
20	480	556	486	685	599	703	606
30	720	656	573	808	707	829	715
1-y-old							
0.042	1	59	97	74	119	69	111
0.083	2	62	95	77	117	72	109
0.167	4	65	96	80	119	76	111
0.333	8	70	101	87	124	81	116
0.5	12	76	107	94	131	89	122
1	24	102	129	127	159	120	148
2	48	184	199	227	245	214	228
4	96	361	328	446	404	418	372
8	192	459	395	567	486	530	447
10	240	477	410	589	505	551	464
20	480	568	488	701	600	656	552
30	720	667	573	824	706	771	649
5-y-old							
0.042	1	73	134	91	166	83	148
0.083	2	76	132	95	164	88	146
0.167	4	80	134	100	167	92	148
0.333	8	86	141	107	175	100	155
0.5	12	93	148	117	185	109	163
1	24	124	178	155	221	146	196
2	48	213	260	265	322	249	285
4	96	376	389	468	482	431	427
8	192	461	455	572	563	523	499
10	240	479	472	595	585	544	518
20	480	569	561	707	695	646	616
30	720	669	660	831	818	760	725
10-y-old							
0.042	1	91	146	114	183	91	158
0.083	2	96	144	120	180	97	155
0.167	4	100	146	126	183	103	158
0.333	8	106	154	133	193	112	167
0.5	12	114	162	144	204	123	177
1	24	150	195	189	245	166	214
2	48	252	287	317	360	278	312
4	96	435	432	546	539	454	459
8	192	529	506	662	630	541	534
10	240	549	525	687	654	561	554
20	480	653	624	818	778	668	659
30	720	769	734	962	915	786	775

Table A-10 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	116	165	148	210	109	192
0.083	2	122	162	156	207	120	199
0.167	4	126	164	162	210	131	208
0.333	8	132	173	169	221	145	221
0.5	12	141	182	180	233	160	235
1	24	178	215	228	274	212	276
2	48	272	294	347	373	312	344
4	96	406	400	516	505	418	408
8	192	473	457	601	576	472	450
10	240	491	474	624	598	490	467
20	480	586	564	744	711	584	556
30	720	690	665	877	838	689	655
Adult male							
0.042	1	121	170	152	214	98	194
0.083	2	124	175	155	221	106	206
0.167	4	127	178	159	224	113	214
0.333	8	134	181	168	228	125	220
0.5	12	144	186	182	234	139	228
1	24	186	213	234	267	188	262
2	48	277	286	348	359	287	331
4	96	389	388	488	484	398	407
8	192	445	442	557	551	451	453
10	240	462	459	578	572	468	469
20	480	548	545	686	679	556	557
30	720	645	641	806	798	653	654
Adult female							
0.042	1	119	162	150	205	117	179
0.083	2	116	170	146	215	122	193
0.167	4	113	177	142	224	124	203
0.333	8	114	185	144	234	128	211
0.5	12	122	192	153	243	139	219
1	24	157	220	198	279	186	251
2	48	254	295	320	372	298	325
4	96	410	399	516	500	440	414
8	192	487	454	613	569	507	464
10	240	505	471	636	590	527	481
20	480	601	560	757	701	626	571
30	720	707	657	890	824	735	671

Table A-11. Inhaled Activity of Type *M* ^{241}Am vs. Count Rate (Bq/kcpm)

Time post intake		Camera			
		Siemens e.cam		Philips SKYLight	
d	h	Anterior	Posterior	Anterior	Posterior
Infant					
0.042	1	310	597	355	675
0.083	2	323	586	370	661
0.167	4	337	592	386	666
0.333	8	362	614	414	691
0.5	12	393	638	449	717
1	24	524	749	597	841
2	48	926	1,116	1,052	1,251
4	96	1,767	1,773	2,006	1,988
8	192	2,145	2,050	2,434	2,299
10	240	2,182	2,090	2,476	2,344
20	480	2,320	2,258	2,635	2,534
30	720	2,438	2,407	2,770	2,704
1-y-old					
0.042	1	351	846	375	887
0.083	2	372	829	397	870
0.167	4	393	838	420	880
0.333	8	427	872	457	917
0.5	12	470	906	503	954
1	24	645	1,049	690	1,105
2	48	1,161	1,473	1,241	1,548
4	96	2,201	2,120	2,337	2,215
8	192	2,666	2,379	2,824	2,482
10	240	2,718	2,424	2,880	2,529
20	480	2,929	2,621	3,108	2,738
30	720	3,118	2,801	3,313	2,928
5-y-old					
0.042	1	467	1,302	485	1,319
0.083	2	497	1,281	519	1,295
0.167	4	527	1,300	553	1,313
0.333	8	574	1,359	605	1,373
0.5	12	632	1,412	669	1,427
1	24	863	1,609	919	1,627
2	48	1,492	2,119	1,587	2,147
4	96	2,572	2,787	2,693	2,827
8	192	3,012	3,060	3,134	3,106
10	240	3,070	3,121	3,195	3,168
20	480	3,316	3,398	3,454	3,452
30	720	3,537	3,654	3,687	3,714
10-y-old					
0.042	1	685	1,593	578	1,576
0.083	2	739	1,563	631	1,552
0.167	4	782	1,587	679	1,580
0.333	8	838	1,666	747	1,665
0.5	12	913	1,735	829	1,741
1	24	1,216	1,980	1,148	1,995
2	48	2,008	2,589	1,945	2,589
4	96	3,241	3,362	3,109	3,312
8	192	3,729	3,681	3,554	3,612
10	240	3,803	3,754	3,626	3,685
20	480	4,128	4,093	3,942	4,021
30	720	4,426	4,409	4,234	4,335

Table A-11 (continued)

Time post intake		Camera			
		Siemens e.cam		Philips SKYLight	
d	h	Anterior	Posterior	Anterior	Posterior
15-y-old					
0.042	1	1,111	2,065	702	2,165
0.083	2	1,204	2,035	780	2,245
0.167	4	1,262	2,070	861	2,336
0.333	8	1,318	2,175	971	2,465
0.5	12	1,409	2,264	1,090	2,580
1	24	1,784	2,534	1,504	2,870
2	48	2,623	3,095	2,376	3,230
4	96	3,624	3,705	3,366	3,498
8	192	4,004	3,982	3,733	3,684
10	240	4,084	4,062	3,813	3,760
20	480	4,448	4,437	4,179	4,129
30	720	4,783	4,789	4,523	4,478
Adult male					
0.042	1	1,196	2,358	660	2,434
0.083	2	1,185	2,434	708	2,584
0.167	4	1,184	2,428	762	2,641
0.333	8	1,246	2,379	854	2,645
0.5	12	1,355	2,390	963	2,693
1	24	1,779	2,611	1,354	2,952
2	48	2,623	3,273	2,213	3,488
4	96	3,461	4,107	3,225	4,025
8	192	3,756	4,477	3,588	4,307
10	240	3,823	4,574	3,660	4,403
20	480	4,128	5,027	3,988	4,863
30	720	4,403	5,458	4,292	5,306
Adult female					
0.042	1	1,138	1,914	823	1,897
0.083	2	1,058	2,029	847	2,074
0.167	4	985	2,125	847	2,197
0.333	8	976	2,185	880	2,250
0.5	12	1,034	2,227	965	2,293
1	24	1,352	2,425	1,348	2,488
2	48	2,226	2,980	2,281	2,959
4	96	3,586	3,673	3,474	3,487
8	192	4,103	3,983	3,897	3,748
10	240	4,173	4,065	3,971	3,828
20	480	4,468	4,451	4,297	4,212
30	720	4,724	4,815	4,592	4,579

Table A-12. Ingested Activity of ^{60}Co vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	93	101	129	140	128	137
0.083	2	97	100	134	139	133	137
0.167	4	102	103	141	144	140	141
0.333	8	110	111	153	155	152	152
0.5	12	120	119	166	167	165	164
1	24	155	151	215	212	215	208
2	48	248	237	346	333	345	328
4	96	425	400	596	564	595	555
8	192	595	557	835	787	835	775
10	240	658	616	924	870	923	856
20	480	924	865	1,298	1,222	1,297	1,202
30	720	1,097	1,027	1,541	1,451	1,540	1,428
1-y-old							
0.042	1	97	107	132	147	122	133
0.083	2	100	106	137	145	126	131
0.167	4	104	108	141	148	130	134
0.333	8	110	115	151	157	139	143
0.5	12	120	123	164	169	151	153
1	24	161	160	220	220	204	201
2	48	310	298	425	411	394	374
4	96	802	746	1,106	1,032	1,023	937
8	192	1,351	1,239	1,869	1,720	1,727	1,558
10	240	1,501	1,376	2,077	1,910	1,919	1,730
20	480	2,114	1,936	2,925	2,687	2,701	2,433
30	720	2,512	2,300	3,476	3,193	3,211	2,891
5-y-old							
0.042	1	92	121	125	165	118	143
0.083	2	96	120	131	164	125	142
0.167	4	100	123	137	168	130	146
0.333	8	107	132	147	180	140	157
0.5	12	117	143	160	195	154	169
1	24	162	190	221	259	213	226
2	48	321	362	439	495	426	431
4	96	867	932	1,196	1,281	1,134	1,123
8	192	1,497	1,571	2,073	2,165	1,930	1,906
10	240	1,665	1,746	2,307	2,407	2,146	2,119
20	480	2,349	2,460	3,254	3,392	3,026	2,986
30	720	2,795	2,926	3,872	4,033	3,600	3,551
10-y-old							
0.042	1	93	120	128	165	121	142
0.083	2	98	120	135	164	131	141
0.167	4	103	124	141	169	139	147
0.333	8	112	134	153	184	150	160
0.5	12	123	146	168	200	167	175
1	24	171	196	234	269	239	237
2	48	345	380	474	522	489	461
4	96	973	1,015	1,340	1,398	1,299	1,223
8	192	1,723	1,747	2,378	2,409	2,189	2,092
10	240	1,918	1,943	2,648	2,680	2,433	2,327
20	480	2,708	2,739	3,739	3,778	3,430	3,280
30	720	3,223	3,258	4,450	4,494	4,080	3,901

Table A-12 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	82	109	114	151	175	188
0.083	2	88	109	121	151	207	197
0.167	4	92	114	128	158	224	206
0.333	8	101	126	140	174	239	224
0.5	12	112	138	155	192	269	252
1	24	159	189	221	263	403	365
2	48	328	371	457	516	815	716
4	96	936	991	1,304	1,377	1,759	1,589
8	192	1,658	1,699	2,310	2,357	2,612	2,415
10	240	1,846	1,889	2,572	2,620	2,891	2,675
20	480	2,607	2,664	3,633	3,695	4,060	3,758
30	720	3,104	3,169	4,325	4,395	4,821	4,464
Adult male							
0.042	1	89	125	122	172	172	193
0.083	2	94	130	127	179	200	212
0.167	4	98	134	133	183	216	221
0.333	8	106	138	145	190	232	230
0.5	12	118	147	161	202	261	248
1	24	175	195	239	267	407	345
2	48	410	415	563	570	995	758
4	96	1,921	1,865	2,644	2,562	3,947	3,145
8	192	5,942	5,831	8,204	8,021	8,909	8,220
10	240	6,763	6,642	9,340	9,137	9,989	9,276
20	480	9,601	9,420	13,261	12,959	14,090	13,110
30	720	11,436	11,214	15,795	15,427	16,750	15,591
Adult female							
0.042	1	91	126	124	172	162	178
0.083	2	89	133	121	183	172	199
0.167	4	87	140	119	193	166	211
0.333	8	90	149	123	205	163	219
0.5	12	98	159	134	219	178	234
1	24	140	209	191	289	268	315
2	48	323	442	441	610	652	678
4	96	1,588	1,950	2,178	2,691	3,039	2,930
8	192	5,634	5,930	7,772	8,173	8,899	8,368
10	240	6,466	6,743	8,922	9,294	10,099	9,484
20	480	9,211	9,556	12,712	13,171	14,323	13,424
30	720	10,982	11,373	15,158	15,675	17,058	15,972

Table A-13. Ingested Activity of ^{90}Sr vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	2,614	3,451	3,293	4,307	3,192	4,187
0.083	2	2,715	3,323	3,424	4,165	3,334	4,045
0.167	4	2,755	3,337	3,492	4,222	3,412	4,098
0.333	8	2,812	3,452	3,578	4,399	3,503	4,272
0.5	12	2,909	3,539	3,706	4,519	3,628	4,387
1	24	3,290	3,915	4,199	5,014	4,111	4,868
2	48	4,106	4,882	5,258	6,285	5,156	6,111
4	96	5,021	6,074	6,454	7,862	6,338	7,659
8	192	5,568	6,813	7,162	8,830	7,037	8,609
10	240	5,728	7,039	7,368	9,125	7,240	8,898
20	480	6,261	7,854	8,052	10,184	7,914	9,939
30	720	6,561	8,344	8,437	10,821	8,293	10,567
1-y-old							
0.042	1	3,214	4,655	3,942	5,668	3,623	5,236
0.083	2	3,444	4,453	4,220	5,432	3,905	5,019
0.167	4	3,616	4,430	4,452	5,432	4,131	5,010
0.333	8	3,857	4,586	4,770	5,655	4,443	5,219
0.5	12	4,133	4,766	5,115	5,889	4,787	5,449
1	24	5,188	5,591	6,420	6,932	6,067	6,447
2	48	8,114	8,110	10,061	10,114	9,574	9,418
4	96	13,514	12,646	16,835	15,899	16,040	14,751
8	192	17,895	16,406	22,330	20,681	21,277	19,160
10	240	19,175	17,551	23,925	22,123	22,807	20,499
20	480	23,713	21,635	29,553	27,241	28,248	25,273
30	720	26,647	24,282	33,178	30,545	31,777	28,366
5-y-old							
0.042	1	3,441	6,100	4,191	7,324	3,991	6,569
0.083	2	3,769	5,915	4,592	7,129	4,427	6,355
0.167	4	4,084	6,040	4,985	7,314	4,825	6,502
0.333	8	4,539	6,457	5,550	7,848	5,385	6,983
0.5	12	4,992	6,811	6,105	8,290	5,950	7,385
1	24	6,543	8,138	8,005	9,933	7,866	8,872
2	48	10,865	12,059	13,359	14,808	13,055	13,298
4	96	19,595	19,394	24,357	24,022	23,189	21,726
8	192	27,192	25,811	33,958	32,065	31,960	29,081
10	240	29,473	27,783	36,817	34,515	34,615	31,330
20	480	38,179	34,892	47,716	43,314	44,672	39,516
30	720	44,360	39,648	55,452	49,182	51,750	45,045
10-y-old							
0.042	1	3,812	6,959	4,604	8,310	4,510	7,423
0.083	2	4,243	6,736	5,113	8,060	5,216	7,222
0.167	4	4,724	6,937	5,702	8,327	5,882	7,493
0.333	8	5,406	7,532	6,546	9,071	6,753	8,212
0.5	12	6,023	7,994	7,301	9,645	7,591	8,758
1	24	8,060	9,561	9,784	11,578	10,288	10,536
2	48	13,649	13,920	16,648	16,972	16,979	15,386
4	96	24,402	21,206	30,027	26,077	28,113	23,434
8	192	32,153	26,417	39,698	32,568	35,960	29,182
10	240	34,242	27,878	42,279	34,371	38,204	30,789
20	480	42,008	32,793	51,836	40,413	46,373	36,149
30	720	47,038	35,662	58,007	43,932	51,522	39,253

Table A-13 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	4,037	7,741	4,838	9,152	8,456	12,755
0.083	2	4,577	7,545	5,475	8,943	11,248	12,933
0.167	4	5,196	7,870	6,224	9,375	13,162	12,915
0.333	8	6,069	8,644	7,291	10,350	14,617	13,629
0.5	12	6,838	9,211	8,224	11,054	16,204	14,611
1	24	9,319	11,005	11,226	13,258	20,573	17,421
2	48	15,992	15,532	19,360	18,835	27,286	22,010
4	96	28,090	21,912	34,321	26,764	33,215	26,368
8	192	34,944	25,261	42,842	30,909	36,960	29,087
10	240	36,436	26,053	44,678	31,879	38,176	29,920
20	480	41,795	28,622	51,257	35,011	42,299	32,577
30	720	45,036	30,015	55,228	36,707	44,573	33,971
Adult male							
0.042	1	4,190	9,698	5,054	11,527	8,797	13,756
0.083	2	4,328	10,077	5,236	12,009	10,696	15,212
0.167	4	4,662	10,047	5,660	12,038	12,013	15,407
0.333	8	5,478	10,058	6,665	12,120	13,667	15,586
0.5	12	6,401	10,443	7,789	12,613	15,948	16,557
1	24	9,843	12,842	11,957	15,555	24,762	21,261
2	48	20,854	21,917	25,327	26,643	47,644	35,923
4	96	52,684	47,315	64,382	57,885	87,482	69,527
8	192	86,345	72,865	105,967	89,403	123,112	101,443
10	240	95,290	79,484	116,920	97,482	135,214	110,921
20	480	131,621	104,713	161,029	127,934	188,208	150,031
30	720	161,224	123,801	196,728	150,785	232,839	181,328
Adult female							
0.042	1	4,119	7,986	4,987	9,461	7,209	9,981
0.083	2	3,865	8,744	4,707	10,405	7,341	11,607
0.167	4	3,758	9,480	4,600	11,350	6,799	12,695
0.333	8	4,042	10,219	4,961	12,294	6,885	13,438
0.5	12	4,528	10,824	5,558	13,039	7,776	14,233
1	24	6,585	13,393	8,074	16,154	12,045	17,769
2	48	13,879	22,925	17,010	27,756	25,633	30,113
4	96	40,644	49,813	50,007	60,923	60,884	62,383
8	192	74,815	77,535	92,391	95,339	95,337	94,489
10	240	83,151	85,357	102,669	104,959	104,290	103,555
20	480	116,518	118,822	143,497	145,893	137,653	140,695
30	720	144,154	146,990	177,101	180,220	162,586	170,519

Table A-14. Ingested Activity of ^{131}I vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	84	96	99	112	99	111
0.083	2	93	98	109	115	109	114
0.167	4	110	111	129	130	129	129
0.333	8	147	146	173	171	174	170
0.5	12	188	185	221	216	222	216
1	24	294	282	346	330	350	331
2	48	389	368	458	430	464	433
4	96	501	472	589	552	597	556
8	192	836	788	984	922	996	928
10	240	1,086	1,024	1,278	1,198	1,295	1,205
20	480	4,029	3,800	4,741	4,446	4,803	4,471
30	720	14,890	14,044	17,524	16,431	17,753	16,527
1-y-old							
0.042	1	93	111	112	133	100	117
0.083	2	104	113	124	135	112	119
0.167	4	123	126	148	151	133	134
0.333	8	165	164	197	196	178	174
0.5	12	210	204	251	243	226	216
1	24	325	301	389	359	351	319
2	48	426	384	510	458	460	407
4	96	539	485	645	577	582	513
8	192	858	773	1,028	921	927	819
10	240	1,089	981	1,305	1,169	1,177	1,039
20	480	3,618	3,258	4,332	3,881	3,909	3,451
30	720	12,023	10,826	14,397	12,897	12,988	11,469
5-y-old							
0.042	1	95	136	116	168	102	139
0.083	2	106	138	130	169	115	141
0.167	4	123	152	150	186	134	156
0.333	8	161	194	196	237	175	200
0.5	12	208	242	253	295	224	251
1	24	343	364	418	442	364	383
2	48	464	468	566	567	487	496
4	96	579	580	706	703	607	616
8	192	878	882	1,071	1,069	923	936
10	240	1,087	1,092	1,326	1,323	1,143	1,159
20	480	3,198	3,214	3,901	3,894	3,363	3,410
30	720	9,441	9,490	11,517	11,498	9,930	10,067
10-y-old							
0.042	1	104	149	129	188	106	148
0.083	2	119	153	149	192	123	153
0.167	4	141	172	175	215	147	173
0.333	8	186	229	232	285	191	230
0.5	12	244	297	303	370	242	300
1	24	418	491	517	607	375	498
2	48	577	662	713	816	488	674
4	96	709	810	876	997	596	824
8	192	1,023	1,165	1,264	1,434	864	1,186
10	240	1,231	1,400	1,521	1,724	1,042	1,425
20	480	3,140	3,562	3,880	4,386	2,670	3,627
30	720	8,086	9,165	9,994	11,287	6,886	9,332

Table A-14 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	100	151	128	197	129	169
0.083	2	119	158	152	204	145	172
0.167	4	146	183	187	236	169	193
0.333	8	204	256	261	330	211	250
0.5	12	282	353	360	455	249	312
1	24	565	691	722	888	333	465
2	48	878	1,048	1,120	1,344	402	589
4	96	1,086	1,288	1,384	1,651	488	716
8	192	1,548	1,827	1,975	2,341	708	1,033
10	240	1,853	2,182	2,363	2,796	853	1,241
20	480	4,626	5,419	5,900	6,941	2,173	3,141
30	720	11,722	13,704	14,951	17,550	5,546	7,999
Adult male							
0.042	1	118	170	150	219	145	187
0.083	2	141	191	178	244	165	207
0.167	4	168	229	211	291	187	245
0.333	8	213	319	266	405	215	328
0.5	12	262	433	325	550	237	421
1	24	384	817	470	1,031	280	669
2	48	485	1,209	589	1,520	321	880
4	96	591	1,487	717	1,867	388	1,071
8	192	851	2,100	1,034	2,636	562	1,531
10	240	1,022	2,498	1,241	3,136	677	1,832
20	480	2,554	6,047	3,106	7,591	1,709	4,525
30	720	6,411	14,905	7,797	18,707	4,312	11,279
Adult female							
0.042	1	121	152	154	196	143	161
0.083	2	137	171	173	219	163	183
0.167	4	160	204	201	260	188	220
0.333	8	206	281	259	358	224	293
0.5	12	259	376	323	478	255	372
1	24	394	676	486	852	317	580
2	48	508	963	623	1,207	372	754
4	96	621	1,180	762	1,477	451	919
8	192	893	1,676	1,096	2,099	652	1,317
10	240	1,071	1,998	1,315	2,503	785	1,577
20	480	2,669	4,882	3,278	6,117	1,976	3,910
30	720	6,685	12,094	8,215	15,156	4,980	9,766

Table A-15. Ingested Activity of ^{137}Cs vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	129	142	205	223	175	191
0.083	2	137	139	218	222	186	187
0.167	4	143	138	229	222	195	186
0.333	8	147	139	236	225	201	187
0.5	12	150	140	241	227	205	189
1	24	155	143	251	233	213	193
2	48	163	150	263	244	223	202
4	96	177	163	287	266	243	220
8	192	211	194	342	316	290	261
10	240	230	212	373	345	316	285
20	480	358	329	579	536	491	443
30	720	557	512	901	834	764	689
1-y-old							
0.042	1	143	163	216	243	183	206
0.083	2	155	160	235	241	199	201
0.167	4	165	160	252	244	213	201
0.333	8	174	163	266	250	225	206
0.5	12	180	166	276	255	234	210
1	24	191	172	294	266	248	218
2	48	203	182	313	281	264	230
4	96	226	202	347	312	294	256
8	192	279	250	430	386	363	317
10	240	311	278	478	429	404	352
20	480	530	473	815	732	689	601
30	720	903	807	1,389	1,248	1,175	1,024
5-y-old							
0.042	1	144	198	213	287	190	252
0.083	2	161	198	239	290	213	250
0.167	4	178	202	265	299	236	254
0.333	8	193	212	288	315	257	266
0.5	12	203	220	304	327	273	275
1	24	220	233	332	349	298	291
2	48	235	246	354	369	319	308
4	96	257	270	388	404	349	337
8	192	306	321	461	481	416	401
10	240	333	349	501	523	452	436
20	480	487	510	734	765	661	638
30	720	677	709	1,020	1,064	919	887
10-y-old							
0.042	1	156	211	229	304	200	271
0.083	2	180	214	264	311	230	272
0.167	4	203	223	299	326	261	281
0.333	8	225	238	332	350	294	301
0.5	12	240	249	355	367	318	317
1	24	265	268	394	397	359	343
2	48	284	284	422	422	387	364
4	96	308	308	458	458	420	395
8	192	355	355	527	527	483	455
10	240	377	377	560	560	513	483
20	480	478	477	709	709	650	611
30	720	568	568	844	843	773	727

Table A-15 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	146	205	213	294	240	311
0.083	2	172	211	251	304	268	307
0.167	4	198	221	290	321	302	319
0.333	8	223	238	328	348	350	351
0.5	12	241	251	355	368	387	378
1	24	271	273	401	402	453	422
2	48	291	290	431	427	494	452
4	96	309	307	457	453	525	480
8	192	331	329	490	485	563	514
10	240	339	337	501	497	576	526
20	480	368	366	545	540	626	572
30	720	397	395	588	582	675	617
Adult male							
0.042	1	172	231	248	326	271	344
0.083	2	206	254	298	361	312	368
0.167	4	243	275	353	395	360	396
0.333	8	280	295	408	427	419	430
0.5	12	306	308	447	449	464	454
1	24	350	330	515	485	544	494
2	48	377	347	555	510	590	521
4	96	396	364	584	535	620	547
8	192	418	384	616	565	655	577
10	240	425	391	627	575	666	588
20	480	456	419	672	616	714	629
30	720	486	446	716	656	761	671
Adult female							
0.042	1	177	217	254	307	271	304
0.083	2	199	236	289	338	308	335
0.167	4	225	257	328	371	352	369
0.333	8	255	279	374	406	409	409
0.5	12	278	294	409	430	454	438
1	24	317	319	468	471	532	486
2	48	340	337	503	498	577	517
4	96	357	353	528	522	607	543
8	192	377	373	558	551	641	573
10	240	384	380	567	561	652	583
20	480	411	407	608	601	699	624
30	720	438	433	648	641	745	665

Table A-16. Ingested Activity of ^{192}Ir vs. Count Rate (Bq/kcpm)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant							
0.042	1	34	40	41	48	42	49
0.083	2	34	39	42	47	43	48
0.167	4	35	39	43	47	43	48
0.333	8	35	40	44	49	44	49
0.5	12	38	42	46	51	47	52
1	24	50	53	61	65	62	66
2	48	110	113	135	138	138	140
4	96	607	603	744	737	762	751
8	192	2,873	2,729	3,536	3,355	3,644	3,420
10	240	3,191	3,020	3,927	3,715	4,050	3,787
20	480	3,907	3,694	4,809	4,544	4,960	4,632
30	720	4,573	4,323	5,630	5,318	5,807	5,421
1-y-old							
0.042	1	38	47	47	57	44	53
0.083	2	39	46	49	56	46	52
0.167	4	40	46	49	57	47	53
0.333	8	41	48	51	59	48	55
0.5	12	44	51	55	63	52	59
1	24	60	66	74	82	71	76
2	48	137	143	170	177	162	166
4	96	838	846	1,035	1,041	987	977
8	192	6,523	6,116	8,048	7,521	7,650	7,041
10	240	7,635	7,090	9,418	8,719	8,947	8,160
20	480	9,437	8,742	11,640	10,749	11,056	10,060
30	720	11,047	10,231	13,627	12,580	12,943	11,774
5-y-old							
0.042	1	38	56	47	71	45	61
0.083	2	40	55	50	69	48	60
0.167	4	41	56	51	70	50	61
0.333	8	43	60	54	75	52	65
0.5	12	46	64	58	80	57	70
1	24	65	85	81	106	80	92
2	48	150	186	188	232	189	203
4	96	928	1,102	1,162	1,376	1,170	1,205
8	192	7,353	7,995	9,163	9,923	8,778	8,812
10	240	8,626	9,273	10,741	11,500	10,218	10,230
20	480	10,669	11,436	13,284	14,180	12,618	12,620
30	720	12,492	13,385	15,554	16,597	14,773	14,771
10-y-old							
0.042	1	40	60	51	75	49	65
0.083	2	43	58	54	74	54	64
0.167	4	44	59	56	75	57	65
0.333	8	46	64	58	81	60	70
0.5	12	50	69	63	87	66	76
1	24	71	92	90	117	98	104
2	48	167	204	211	258	240	233
4	96	1,043	1,218	1,321	1,539	1,494	1,389
8	192	8,609	8,910	10,828	11,163	10,185	9,752
10	240	10,158	10,345	12,762	12,945	11,708	11,261
20	480	12,582	12,762	15,804	15,965	14,420	13,877
30	720	14,735	14,937	18,508	18,687	16,880	16,241

Table A-16 (continued)

Time post intake		Camera					
		Siemens e.cam				Philips SKYLight	
		6 Windows		3 Windows			
d	h	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
15-y-old							
0.042	1	38	60	49	78	82	101
0.083	2	41	59	53	76	108	108
0.167	4	43	60	55	78	127	116
0.333	8	45	66	58	85	139	130
0.5	12	50	71	64	93	158	148
1	24	72	98	93	127	258	227
2	48	174	221	225	287	697	564
4	96	1,100	1,322	1,423	1,709	3,952	3,145
8	192	8,860	9,148	11,327	11,634	13,861	12,343
10	240	10,412	10,544	13,289	13,383	15,052	13,503
20	480	12,888	12,988	16,443	16,478	18,318	16,453
30	720	15,094	15,200	19,256	19,285	21,420	19,240
Adult male							
0.042	1	41	71	52	91	80	103
0.083	2	42	74	54	95	96	116
0.167	4	44	75	55	96	106	121
0.333	8	47	76	60	97	114	123
0.5	12	53	79	68	101	130	131
1	24	82	103	104	130	216	181
2	48	211	224	268	285	604	416
4	96	1,359	1,347	1,731	1,705	3,625	2,430
8	192	9,985	10,708	12,602	13,482	14,179	13,891
10	240	11,580	12,577	14,596	15,822	15,497	15,674
20	480	14,296	15,554	18,014	19,564	18,887	19,220
30	720	16,741	18,209	21,095	22,903	22,091	22,486
Adult female							
0.042	1	41	65	51	83	70	85
0.083	2	39	70	49	90	73	98
0.167	4	37	75	46	96	68	106
0.333	8	37	79	46	102	65	110
0.5	12	40	84	50	108	70	116
1	24	58	109	74	140	110	154
2	48	143	237	181	304	294	343
4	96	929	1,404	1,178	1,800	1,941	2,021
8	192	9,051	10,489	11,448	13,300	13,495	13,409
10	240	10,967	12,214	13,864	15,465	15,532	15,380
20	480	13,674	15,077	17,285	19,082	19,149	18,924
30	720	16,026	17,647	20,259	22,334	22,425	22,145

Table A-17. Ingested Activity of ^{241}Am vs. Count Rate (Bq/kcpm)

Time post intake		Camera			
		Siemens e.cam		Philips SKYLight	
d	h	Anterior	Posterior	Anterior	Posterior
Infant					
0.042	1	207	290	230	321
0.083	2	216	281	240	310
0.167	4	218	281	242	311
0.333	8	222	290	246	321
0.5	12	234	301	261	333
1	24	313	375	349	416
2	48	699	788	780	875
4	96	4,288	4,750	4,798	5,285
8	192	40,066	50,296	45,576	56,938
10	240	46,627	59,920	53,206	68,087
20	480	48,495	61,917	55,397	70,428
30	720	48,969	61,926	55,962	70,455
1-y-old					
0.042	1	264	433	278	451
0.083	2	284	418	300	436
0.167	4	292	423	308	441
0.333	8	299	443	317	465
0.5	12	320	465	340	490
1	24	442	590	472	624
2	48	1,024	1,258	1,100	1,336
4	96	6,864	8,082	7,387	8,600
8	192	256,642	283,625	277,124	301,996
10	240	642,551	655,176	696,902	697,957
20	480	848,823	829,245	922,862	883,596
30	720	854,288	831,746	928,929	886,269
5-y-old					
0.042	1	295	621	317	617
0.083	2	324	600	353	594
0.167	4	336	613	370	607
0.333	8	348	656	386	651
0.5	12	378	698	421	694
1	24	538	900	612	898
2	48	1,287	1,940	1,489	1,941
4	96	8,754	12,519	10,230	12,541
8	192	318,906	431,601	361,769	436,217
10	240	763,973	972,624	828,880	994,278
20	480	987,163	1,217,807	1,048,670	1,251,302
30	720	993,680	1,221,893	1,055,431	1,255,542
10-y-old					
0.042	1	340	762	375	758
0.083	2	379	735	438	734
0.167	4	397	754	473	758
0.333	8	414	817	502	830
0.5	12	452	878	558	900
1	24	656	1,149	855	1,201
2	48	1,598	2,501	2,206	2,653
4	96	10,986	16,200	15,642	17,290
8	192	409,347	550,221	518,390	574,385
10	240	1,010,709	1,214,861	1,085,992	1,232,133
20	480	1,326,686	1,507,093	1,322,786	1,509,801
30	720	1,336,571	1,511,716	1,331,755	1,514,264

Table A-17 (continued)

Time post intake		Camera			
		Siemens e.cam		Philips SKYLight	
d	h	Anterior	Posterior	Anterior	Posterior
15-y-old					
0.042	1	381	965	799	1,589
0.083	2	428	931	1,234	1,724
0.167	4	450	968	1,661	1,906
0.333	8	472	1,079	1,839	2,234
0.5	12	522	1,182	2,116	2,621
1	24	785	1,600	3,698	4,269
2	48	1,986	3,563	11,453	11,442
4	96	13,957	23,291	89,681	80,996
8	192	515,149	744,153	1,339,578	1,376,298
10	240	1,244,965	1,525,333	1,706,729	1,847,380
20	480	1,616,458	1,838,392	1,793,607	1,961,216
30	720	1,628,444	1,847,031	1,802,761	1,968,548
Adult male					
0.042	1	383	1,273	837	1,701
0.083	2	376	1,327	1,037	1,946
0.167	4	374	1,263	1,138	1,945
0.333	8	406	1,163	1,215	1,831
0.5	12	468	1,161	1,411	1,878
1	24	777	1,430	2,575	2,474
2	48	2,196	3,043	8,598	5,571
4	96	16,528	19,579	72,313	36,674
8	192	545,676	735,841	1,171,780	1,168,950
10	240	1,119,740	1,883,311	1,523,384	2,387,603
20	480	1,350,327	2,519,307	1,608,115	2,882,729
30	720	1,357,713	2,537,818	1,616,726	2,905,060
Adult female					
0.042	1	371	904	645	1,056
0.083	2	327	1,011	626	1,290
0.167	4	291	1,098	530	1,447
0.333	8	285	1,141	484	1,471
0.5	12	308	1,177	527	1,509
1	24	457	1,444	866	1,876
2	48	1,154	3,011	2,552	3,973
4	96	8,116	19,157	19,820	25,411
8	192	323,665	674,438	632,219	839,264
10	240	887,155	1,570,476	1,240,252	1,797,082
20	480	1,230,879	2,004,745	1,469,546	2,208,986
30	720	1,238,046	2,020,491	1,476,613	2,224,238

Appendix B

CUMULATIVE EFFECTIVE DOSE AT SELECTED TIMES AFTER INTAKE[7]

As was discussed in section 1.4.4, two sets of dose coefficients are listed to help in assessing the biological effects of internal exposure. The first are coefficients for the cumulative effective dose, which is the integrated dose from the time of acute intake until the time of the assessment. The second set represents the lifetime effective dose commitment to the exposed individual, absent any medical intervention. The lifetime dose commitment to a child is defined as the integrated dose until age 70. The committed dose to an adult is the dose integrated over a period of 50 years following intake.

The coefficients in tables B-1 to B-6 are tabulated at 12 time steps, a subset of the 50 time steps used by the Assess computer code. They are specific to the f_1 values listed in table A-1 and, for the inhalation pathway, to a particle size distribution with a 1 μm AMAD. These coefficients can be used to determine doses resulting from intakes that are calculated using the calibration factors in appendix A, an alternative to using Assess. Such dose calculations can be useful in assessing the efficacy of any potential intervention.

[7] This appendix is taken from Anigstein and Olsher 2010, appendix D, with some revisions of the introductory text.

Table B-1. Cumulative Effective Dose Following Intake of ^{60}Co (Sv/Bq)

Time post intake		Age					
d	h	3 mo	1 y	5 y	10 y	15 y	20 y
Inhalation: Type *M*							
0.042	1	9.97e-11	6.88e-11	3.62e-11	2.54e-11	1.93e-11	1.54e-11
0.083	2	1.91e-10	1.34e-10	7.07e-11	4.97e-11	3.70e-11	2.96e-11
0.167	4	3.60e-10	2.60e-10	1.37e-10	9.67e-11	7.03e-11	5.66e-11
0.333	8	7.00e-10	5.17e-10	2.71e-10	1.91e-10	1.34e-10	1.09e-10
0.5	12	1.05e-09	7.83e-10	4.08e-10	2.85e-10	1.98e-10	1.61e-10
1	24	2.01e-09	1.53e-09	7.88e-10	5.50e-10	3.76e-10	3.05e-10
2	48	3.41e-09	2.61e-09	1.36e-09	9.47e-10	6.59e-10	5.32e-10
4	96	4.95e-09	3.79e-09	2.04e-09	1.43e-09	1.05e-09	8.43e-10
8	192	6.90e-09	5.27e-09	2.96e-09	2.10e-09	1.65e-09	1.32e-09
10	240	7.75e-09	5.92e-09	3.37e-09	2.40e-09	1.92e-09	1.53e-09
20	480	1.14e-08	8.74e-09	5.14e-09	3.68e-09	3.08e-09	2.45e-09
30	720	1.42e-08	1.10e-08	6.55e-09	4.68e-09	3.98e-09	3.17e-09
Lifetime committed dose		4.16e-08	3.39e-08	2.13e-08	1.46e-08	1.21e-08	1.02e-08
Inhalation: Type *S*							
0.042	1	1.04e-10	7.18e-11	3.79e-11	2.67e-11	2.04e-11	1.62e-11
0.083	2	2.01e-10	1.41e-10	7.45e-11	5.25e-11	3.94e-11	3.15e-11
0.167	4	3.84e-10	2.74e-10	1.46e-10	1.03e-10	7.52e-11	6.05e-11
0.333	8	7.63e-10	5.53e-10	2.90e-10	2.04e-10	1.45e-10	1.17e-10
0.5	12	1.16e-09	8.44e-10	4.40e-10	3.08e-10	2.14e-10	1.74e-10
1	24	2.29e-09	1.67e-09	8.60e-10	6.00e-10	4.11e-10	3.33e-10
2	48	3.93e-09	2.87e-09	1.49e-09	1.04e-09	7.25e-10	5.84e-10
4	96	5.64e-09	4.16e-09	2.23e-09	1.57e-09	1.16e-09	9.25e-10
8	192	7.69e-09	5.76e-09	3.24e-09	2.30e-09	1.82e-09	1.45e-09
10	240	8.60e-09	6.48e-09	3.69e-09	2.63e-09	2.13e-09	1.69e-09
20	480	1.26e-08	9.66e-09	5.72e-09	4.10e-09	3.47e-09	2.75e-09
30	720	1.59e-08	1.23e-08	7.40e-09	5.31e-09	4.57e-09	3.62e-09
Lifetime committed dose		9.15e-08	8.57e-08	5.88e-08	4.03e-08	3.42e-08	3.07e-08
Ingestion							
0.042	1	2.79e-10	1.80e-10	1.01e-10	6.56e-11	4.65e-11	3.74e-11
0.083	2	4.65e-10	3.16e-10	1.79e-10	1.17e-10	8.11e-11	6.60e-11
0.167	4	7.69e-10	5.76e-10	3.28e-10	2.17e-10	1.46e-10	1.22e-10
0.333	8	1.33e-09	1.12e-09	6.37e-10	4.24e-10	2.79e-10	2.44e-10
0.5	12	1.88e-09	1.69e-09	9.56e-10	6.36e-10	4.16e-10	3.73e-10
1	24	3.36e-09	3.22e-09	1.82e-09	1.21e-09	7.87e-10	7.31e-10
2	48	5.35e-09	5.21e-09	2.95e-09	1.95e-09	1.27e-09	1.19e-09
4	96	7.08e-09	6.61e-09	3.74e-09	2.47e-09	1.61e-09	1.48e-09
8	192	8.47e-09	7.24e-09	4.11e-09	2.71e-09	1.77e-09	1.56e-09
10	240	8.99e-09	7.43e-09	4.22e-09	2.78e-09	1.82e-09	1.58e-09
20	480	1.10e-08	8.15e-09	4.64e-09	3.05e-09	2.00e-09	1.63e-09
30	720	1.24e-08	8.70e-09	4.96e-09	3.26e-09	2.15e-09	1.67e-09
Lifetime committed dose		5.42e-08	2.68e-08	1.69e-08	1.12e-08	7.94e-09	3.42e-09

Table B-2. Cumulative Effective Dose Following Intake of ^{90}Sr (Sv/Bq)

Time post intake		Age					
d	h	3 mo	1 y	5 y	10 y	15 y	25 y
Inhalation: Type *F*							
0.042	1	4.20e-11	2.56e-11	1.20e-11	7.81e-12	5.79e-12	4.61e-12
0.083	2	6.61e-11	4.04e-11	1.83e-11	1.16e-11	7.87e-12	6.49e-12
0.167	4	1.09e-10	6.96e-11	3.15e-11	1.96e-11	1.20e-11	1.03e-11
0.333	8	2.09e-10	1.47e-10	6.58e-11	4.03e-11	2.23e-11	2.00e-11
0.5	12	3.26e-10	2.42e-10	1.08e-10	6.54e-11	3.46e-11	3.19e-11
1	24	7.20e-10	5.71e-10	2.52e-10	1.51e-10	7.64e-11	7.35e-11
2	48	1.52e-09	1.21e-09	5.35e-10	3.19e-10	1.60e-10	1.58e-10
4	96	2.86e-09	2.13e-09	9.54e-10	5.71e-10	2.98e-10	2.83e-10
8	192	5.23e-09	3.40e-09	1.53e-09	9.47e-10	5.33e-10	4.51e-10
10	240	6.36e-09	3.94e-09	1.78e-09	1.11e-09	6.44e-10	5.20e-10
20	480	1.13e-08	6.09e-09	2.73e-09	1.80e-09	1.14e-09	8.04e-10
30	720	1.54e-08	7.68e-09	3.43e-09	2.34e-09	1.56e-09	1.02e-09
Lifetime committed dose		1.23e-07	5.17e-08	3.08e-08	4.09e-08	5.25e-08	2.39e-08
Inhalation: Type *S*							
0.042	1	8.66e-11	5.54e-11	2.87e-11	2.01e-11	1.72e-11	1.33e-11
0.083	2	1.57e-10	1.02e-10	5.32e-11	3.73e-11	3.20e-11	2.49e-11
0.167	4	2.85e-10	1.90e-10	1.00e-10	7.05e-11	5.93e-11	4.65e-11
0.333	8	6.12e-10	4.15e-10	2.13e-10	1.47e-10	1.15e-10	9.18e-11
0.5	12	1.03e-09	7.03e-10	3.51e-10	2.39e-10	1.78e-10	1.42e-10
1	24	2.54e-09	1.73e-09	8.33e-10	5.55e-10	3.85e-10	3.11e-10
2	48	5.45e-09	3.71e-09	1.79e-09	1.18e-09	8.11e-10	6.58e-10
4	96	9.28e-09	6.44e-09	3.23e-09	2.18e-09	1.58e-09	1.29e-09
8	192	1.46e-08	1.05e-08	5.64e-09	3.89e-09	3.07e-09	2.52e-09
10	240	1.72e-08	1.25e-08	6.84e-09	4.74e-09	3.83e-09	3.14e-09
20	480	2.94e-08	2.21e-08	1.26e-08	8.79e-09	7.34e-09	6.08e-09
30	720	4.01e-08	3.05e-08	1.76e-08	1.23e-08	1.03e-08	8.61e-09
Lifetime committed dose		4.14e-07	3.94e-07	2.69e-07	1.83e-07	1.59e-07	1.57e-07
Ingestion							
0.042	1	2.31e-10	1.26e-10	6.10e-11	3.45e-11	2.33e-11	1.82e-11
0.083	2	3.50e-10	1.95e-10	9.46e-11	5.38e-11	3.57e-11	2.79e-11
0.167	4	5.49e-10	3.32e-10	1.63e-10	9.38e-11	5.88e-11	4.70e-11
0.333	8	1.04e-09	7.28e-10	3.61e-10	2.12e-10	1.25e-10	1.05e-10
0.5	12	1.62e-09	1.23e-09	6.16e-10	3.63e-10	2.10e-10	1.81e-10
1	24	3.54e-09	2.95e-09	1.48e-09	8.73e-10	4.98e-10	4.47e-10
2	48	6.98e-09	5.95e-09	2.99e-09	1.77e-09	1.01e-09	9.19e-10
4	96	1.10e-08	8.92e-09	4.50e-09	2.67e-09	1.52e-09	1.37e-09
8	192	1.57e-08	1.09e-08	5.52e-09	3.32e-09	1.94e-09	1.63e-09
10	240	1.77e-08	1.16e-08	5.87e-09	3.55e-09	2.11e-09	1.71e-09
20	480	2.66e-08	1.44e-08	7.23e-09	4.53e-09	2.84e-09	2.02e-09
30	720	3.40e-08	1.64e-08	8.22e-09	5.29e-09	3.47e-09	2.27e-09
Lifetime committed dose		2.27e-07	7.24e-08	4.68e-08	5.97e-08	7.89e-08	2.77e-08

Table B-3. Cumulative Effective Dose Following Intake of ^{131}I (Sv/Bq)

Time post intake		Age					
d	h	3 mo	1 y	5 y	10 y	15 y	20 y
Inhalation: Type *F*							
0.042	1	5.90e-11	4.04e-11	1.90e-11	1.14e-11	8.07e-12	6.21e-12
0.083	2	1.31e-10	9.85e-11	4.58e-11	2.46e-11	1.61e-11	1.19e-11
0.167	4	3.66e-10	3.05e-10	1.43e-10	6.99e-11	4.38e-11	3.06e-11
0.333	8	1.15e-09	1.01e-09	4.72e-10	2.20e-10	1.34e-10	9.05e-11
0.5	12	2.23e-09	1.99e-09	9.25e-10	4.24e-10	2.57e-10	1.71e-10
1	24	6.18e-09	5.58e-09	2.59e-09	1.17e-09	7.03e-10	4.62e-10
2	48	1.43e-08	1.30e-08	6.08e-09	2.75e-09	1.64e-09	1.07e-09
4	96	2.78e-08	2.57e-08	1.21e-08	5.52e-09	3.30e-09	2.15e-09
8	192	4.60e-08	4.33e-08	2.08e-08	9.70e-09	5.80e-09	3.79e-09
10	240	5.20e-08	4.93e-08	2.39e-08	1.13e-08	6.73e-09	4.40e-09
20	480	6.67e-08	6.49e-08	3.23e-08	1.58e-08	9.47e-09	6.21e-09
30	720	7.06e-08	6.96e-08	3.52e-08	1.75e-08	1.05e-08	6.92e-09
Lifetime committed dose		7.21e-08	7.16e-08	3.66e-08	1.86e-08	1.12e-08	7.39e-09
Ingestion							
0.042	1	2.60e-10	1.51e-10	7.51e-11	4.29e-11	2.95e-11	2.30e-11
0.083	2	4.47e-10	2.84e-10	1.44e-10	7.83e-11	5.33e-11	4.00e-11
0.167	4	9.78e-10	7.30e-10	3.78e-10	1.89e-10	1.26e-10	8.84e-11
0.333	8	2.85e-09	2.37e-09	1.24e-09	5.82e-10	3.83e-10	2.53e-10
0.5	12	5.52e-09	4.74e-09	2.49e-09	1.14e-09	7.45e-10	4.82e-10
1	24	1.55e-08	1.37e-08	7.16e-09	3.23e-09	2.10e-09	1.33e-09
2	48	3.63e-08	3.23e-08	1.70e-08	7.66e-09	4.96e-09	3.13e-09
4	96	7.08e-08	6.39e-08	3.41e-08	1.55e-08	1.00e-08	6.31e-09
8	192	1.17e-07	1.08e-07	5.87e-08	2.73e-08	1.77e-08	1.11e-08
10	240	1.33e-07	1.23e-07	6.74e-08	3.16e-08	2.05e-08	1.29e-08
20	480	1.70e-07	1.62e-07	9.14e-08	4.44e-08	2.89e-08	1.83e-08
30	720	1.81e-07	1.74e-07	9.94e-08	4.93e-08	3.22e-08	2.04e-08
Lifetime committed dose		1.84e-07	1.79e-07	1.04e-07	5.24e-08	3.42e-08	2.17e-08

Table B-4. Cumulative Effective Dose Following Intake of ^{137}Cs (Sv/Bq)

Time post intake		Age					
d	h	3 mo	1 y	5 y	10 y	15 y	20 y
Inhalation: Type *F*							
0.042	1	1.24e-10	8.50e-11	3.88e-11	2.49e-11	1.55e-11	1.31e-11
0.083	2	1.78e-10	1.23e-10	5.68e-11	3.57e-11	2.17e-11	1.83e-11
0.167	4	2.60e-10	1.85e-10	8.68e-11	5.38e-11	3.21e-11	2.69e-11
0.333	8	3.97e-10	2.91e-10	1.38e-10	8.50e-11	5.00e-11	4.18e-11
0.5	12	5.21e-10	3.86e-10	1.85e-10	1.13e-10	6.62e-11	5.53e-11
1	24	8.37e-10	6.24e-10	3.00e-10	1.84e-10	1.07e-10	8.91e-11
2	48	1.32e-09	9.74e-10	4.68e-10	2.86e-10	1.66e-10	1.39e-10
4	96	2.04e-09	1.47e-09	7.03e-10	4.32e-10	2.49e-10	2.11e-10
8	192	3.19e-09	2.24e-09	1.07e-09	6.63e-10	3.84e-10	3.29e-10
10	240	3.68e-09	2.57e-09	1.23e-09	7.64e-10	4.46e-10	3.85e-10
20	480	5.58e-09	3.75e-09	1.85e-09	1.19e-09	7.38e-10	6.50e-10
30	720	6.77e-09	4.44e-09	2.28e-09	1.53e-09	1.01e-09	8.97e-10
Lifetime committed dose		8.76e-09	5.42e-09	3.66e-09	3.75e-09	4.46e-09	4.67e-09
Ingestion							
0.042	1	3.12e-10	1.76e-10	8.72e-11	5.09e-11	3.51e-11	2.77e-11
0.083	2	4.51e-10	2.56e-10	1.28e-10	7.48e-11	5.12e-11	4.06e-11
0.167	4	5.79e-10	3.35e-10	1.68e-10	9.92e-11	6.71e-11	5.35e-11
0.333	8	7.37e-10	4.38e-10	2.22e-10	1.33e-10	8.81e-11	7.09e-11
0.5	12	8.87e-10	5.37e-10	2.74e-10	1.65e-10	1.09e-10	8.79e-11
1	24	1.34e-09	8.34e-10	4.31e-10	2.63e-10	1.70e-10	1.39e-10
2	48	2.22e-09	1.42e-09	7.40e-10	4.54e-10	2.89e-10	2.38e-10
4	96	3.88e-09	2.53e-09	1.32e-09	8.17e-10	5.14e-10	4.25e-10
8	192	6.79e-09	4.43e-09	2.35e-09	1.46e-09	9.21e-10	7.70e-10
10	240	8.06e-09	5.24e-09	2.80e-09	1.74e-09	1.11e-09	9.35e-10
20	480	1.29e-08	8.20e-09	4.56e-09	2.94e-09	2.00e-09	1.72e-09
30	720	1.60e-08	9.93e-09	5.77e-09	3.91e-09	2.82e-09	2.45e-09
Lifetime committed dose		2.10e-08	1.24e-08	9.68e-09	1.01e-08	1.34e-08	1.36e-08

Table B-5. Cumulative Effective Dose Following Intake of ^{192}Ir (Sv/Bq)

Time post intake		Age					
d	h	3 mo	1 y	5 y	10 y	15 y	20 y
Inhalation: Type *F*							
0.042	1	5.93e-11	3.77e-11	1.79e-11	1.18e-11	8.35e-12	6.71e-12
0.083	2	9.73e-11	6.23e-11	2.90e-11	1.88e-11	1.23e-11	1.00e-11
0.167	4	1.70e-10	1.12e-10	5.17e-11	3.33e-11	2.01e-11	1.67e-11
0.333	8	3.46e-10	2.33e-10	1.07e-10	6.79e-11	3.84e-11	3.20e-11
0.5	12	5.50e-10	3.73e-10	1.70e-10	1.07e-10	5.89e-11	4.92e-11
1	24	1.16e-09	7.89e-10	3.56e-10	2.24e-10	1.19e-10	9.97e-11
2	48	2.04e-09	1.40e-09	6.31e-10	3.93e-10	2.09e-10	1.75e-10
4	96	2.89e-09	1.99e-09	9.07e-10	5.59e-10	3.04e-10	2.55e-10
8	192	3.78e-09	2.61e-09	1.22e-09	7.39e-10	4.15e-10	3.49e-10
10	240	4.16e-09	2.88e-09	1.35e-09	8.16e-10	4.63e-10	3.90e-10
20	480	5.78e-09	4.05e-09	1.93e-09	1.15e-09	6.74e-10	5.70e-10
30	720	7.09e-09	5.01e-09	2.41e-09	1.43e-09	8.48e-10	7.19e-10
Lifetime committed dose		1.52e-08	1.14e-08	5.70e-09	3.32e-09	2.06e-09	1.76e-09
Inhalation: Type *M*							
0.042	1	1.08e-10	7.05e-11	3.63e-11	2.52e-11	2.05e-11	1.60e-11
0.083	2	1.96e-10	1.30e-10	6.77e-11	4.72e-11	3.80e-11	2.99e-11
0.167	4	3.55e-10	2.43e-10	1.27e-10	8.87e-11	7.00e-11	5.55e-11
0.333	8	7.10e-10	4.93e-10	2.55e-10	1.76e-10	1.32e-10	1.06e-10
0.5	12	1.11e-09	7.69e-10	3.92e-10	2.69e-10	1.95e-10	1.57e-10
1	24	2.25e-09	1.57e-09	7.85e-10	5.35e-10	3.74e-10	3.01e-10
2	48	3.93e-09	2.75e-09	1.38e-09	9.43e-10	6.66e-10	5.34e-10
4	96	5.66e-09	4.03e-09	2.09e-09	1.45e-09	1.08e-09	8.63e-10
8	192	7.67e-09	5.57e-09	3.03e-09	2.15e-09	1.73e-09	1.37e-09
10	240	8.53e-09	6.23e-09	3.44e-09	2.45e-09	2.01e-09	1.59e-09
20	480	1.20e-08	8.94e-09	5.12e-09	3.68e-09	3.14e-09	2.49e-09
30	720	1.45e-08	1.09e-08	6.32e-09	4.55e-09	3.93e-09	3.11e-09
Lifetime committed dose		2.34e-08	1.83e-08	1.08e-08	7.60e-09	6.45e-09	5.22e-09
Inhalation: Type *S*							
0.042	1	1.13e-10	7.41e-11	3.83e-11	2.67e-11	2.18e-11	1.71e-11
0.083	2	2.07e-10	1.38e-10	7.20e-11	5.03e-11	4.08e-11	3.21e-11
0.167	4	3.76e-10	2.57e-10	1.36e-10	9.49e-11	7.55e-11	5.97e-11
0.333	8	7.50e-10	5.22e-10	2.71e-10	1.88e-10	1.43e-10	1.14e-10
0.5	12	1.17e-09	8.13e-10	4.16e-10	2.87e-10	2.10e-10	1.68e-10
1	24	2.38e-09	1.66e-09	8.34e-10	5.69e-10	4.03e-10	3.23e-10
2	48	4.14e-09	2.91e-09	1.47e-09	1.01e-09	7.18e-10	5.74e-10
4	96	5.99e-09	4.27e-09	2.23e-09	1.55e-09	1.18e-09	9.35e-10
8	192	8.19e-09	5.96e-09	3.27e-09	2.33e-09	1.90e-09	1.50e-09
10	240	9.13e-09	6.69e-09	3.73e-09	2.67e-09	2.22e-09	1.75e-09
20	480	1.30e-08	9.76e-09	5.64e-09	4.08e-09	3.53e-09	2.79e-09
30	720	1.59e-08	1.21e-08	7.07e-09	5.13e-09	4.48e-09	3.55e-09
Lifetime committed dose		2.82e-08	2.25e-08	1.35e-08	9.51e-09	8.16e-09	6.62e-09
Ingestion							
0.042	1	3.13e-10	1.82e-10	9.30e-11	5.57e-11	3.85e-11	3.06e-11
0.083	2	4.93e-10	2.94e-10	1.52e-10	9.22e-11	6.26e-11	4.98e-11
0.167	4	8.29e-10	5.19e-10	2.73e-10	1.68e-10	1.09e-10	8.71e-11
0.333	8	1.70e-09	1.11e-09	5.86e-10	3.62e-10	2.26e-10	1.80e-10
0.5	12	2.75e-09	1.82e-09	9.55e-10	5.91e-10	3.62e-10	2.89e-10
1	24	5.79e-09	3.87e-09	2.03e-09	1.26e-09	7.58e-10	6.05e-10
2	48	9.74e-09	6.53e-09	3.42e-09	2.12e-09	1.27e-09	1.02e-09
4	96	1.21e-08	8.15e-09	4.27e-09	2.65e-09	1.59e-09	1.27e-09
8	192	1.26e-08	8.43e-09	4.42e-09	2.74e-09	1.64e-09	1.31e-09
10	240	1.26e-08	8.44e-09	4.43e-09	2.74e-09	1.65e-09	1.31e-09
20	480	1.27e-08	8.48e-09	4.45e-09	2.76e-09	1.65e-09	1.32e-09
30	720	1.28e-08	8.52e-09	4.47e-09	2.77e-09	1.66e-09	1.33e-09
Lifetime committed dose		1.34e-08	8.74e-09	4.59e-09	2.85e-09	1.71e-09	1.37e-09

Table B-6. Cumulative Effective Dose Following Intake of ^{241}Am (Sv/Bq)

Time post intake		Age					
d	h	3 mo	1 y	5 y	10 y	15 y	20 y
Inhalation: Type *M*							
0.042	1	3.39e-08	2.47e-08	1.63e-08	1.17e-08	1.10e-08	8.98e-09
0.083	2	6.46e-08	4.70e-08	3.11e-08	2.23e-08	2.08e-08	1.70e-08
0.167	4	1.24e-07	8.99e-08	5.93e-08	4.23e-08	3.91e-08	3.22e-08
0.333	8	2.31e-07	1.67e-07	1.10e-07	7.81e-08	7.17e-08	5.94e-08
0.5	12	3.29e-07	2.38e-07	1.56e-07	1.11e-07	1.01e-07	8.41e-08
1	24	5.91e-07	4.29e-07	2.80e-07	1.99e-07	1.81e-07	1.50e-07
2	48	1.05e-06	7.66e-07	4.97e-07	3.53e-07	3.22e-07	2.66e-07
4	96	1.90e-06	1.39e-06	8.95e-07	6.38e-07	5.82e-07	4.78e-07
8	192	3.43e-06	2.52e-06	1.62e-06	1.15e-06	1.05e-06	8.63e-07
10	240	4.13e-06	3.03e-06	1.95e-06	1.39e-06	1.27e-06	1.04e-06
20	480	7.06e-06	5.20e-06	3.33e-06	2.37e-06	2.15e-06	1.76e-06
30	720	9.25e-06	6.84e-06	4.36e-06	3.09e-06	2.80e-06	2.29e-06
Lifetime committed dose		7.38e-05	6.97e-05	5.11e-05	4.06e-05	4.03e-05	4.17e-05
Ingestion							
0.042	1	1.33e-09	7.30e-10	3.52e-10	1.99e-10	1.35e-10	1.05e-10
0.083	2	2.01e-09	1.11e-09	5.39e-10	3.07e-10	2.03e-10	1.59e-10
0.167	4	3.29e-09	1.88e-09	9.18e-10	5.30e-10	3.32e-10	2.61e-10
0.333	8	7.02e-09	4.15e-09	2.05e-09	1.20e-09	7.05e-10	5.60e-10
0.5	12	1.17e-08	7.00e-09	3.47e-09	2.04e-09	1.18e-09	9.38e-10
1	24	2.60e-08	1.55e-08	7.71e-09	4.56e-09	2.59e-09	2.08e-09
2	48	4.56e-08	2.67e-08	1.33e-08	7.88e-09	4.46e-09	3.58e-09
4	96	6.15e-08	3.38e-08	1.69e-08	9.98e-09	5.65e-09	4.54e-09
8	192	7.43e-08	3.57e-08	1.78e-08	1.05e-08	5.97e-09	4.78e-09
10	240	7.98e-08	3.60e-08	1.79e-08	1.06e-08	6.03e-09	4.83e-09
20	480	1.07e-07	3.78e-08	1.88e-08	1.11e-08	6.35e-09	5.06e-09
30	720	1.33e-07	3.96e-08	1.97e-08	1.16e-08	6.66e-09	5.28e-09
Lifetime committed dose		3.73e-06	3.75e-07	2.74e-07	2.22e-07	2.04e-07	2.04e-07

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