Use of Radiation Detection, Measuring, and Imaging Instruments to Assess Internal Contamination from Inhaled Radionuclides

Part IV: Calibration Factors for Gamma Cameras

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PREFACE

Part I of the present series describes 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 (Anigstein et al. 2007a). 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 extends the earlier investigation by using realistic anthropomorphic phantoms to study the responses of four instruments to five radionuclides distributed in the lungs (Anigstein et al. 2007b). 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 Fixed 180 gamma camera, an Atomlab thyroid probe, a Ludlum survey meter, and a Ludlum waste monitor. 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 validates the MCNP models of the four instruments.

Part III (Anigstein et al. 2007c) extends 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 validates the MCNP model of this instrument.

The present study develops calibration factors that would enable the use of gamma cameras for assessing inhaled intakes of radionuclides and subsequent doses. The study utilizes biokinetic models to determine the retention of inhaled activity in 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 four gamma-emitting radionuclides—^{60}Co, ^{137}Cs, ^{192}Ir, and ^{241}Am—in different anatomical regions of children of various ages and adult men and women are calculated by MCNPX. Adult men and women are represented by the NORMAN and NAOMI voxel phantoms (Dimbylow 1998, 2005), while children are represented by the revised ORNL phantom series described by Han et al. (2006). The Siemens e.cam and Philips SKYLight gamma cameras are represented by models developed during the studies described in Parts II and III, respectively.

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Chapter 1

INTRODUCTION

A radiological emergency, such as the detonation of a radioactive dispersion device (RDD or "dirty bomb"), could lead to the inhalation of airborne radioactive material by a large number of people. There would be a need to rapidly assess this inhaled activity and determine the need for medical intervention.

1.1 Use of Gamma Cameras to Assess Exposed Individuals

As reported in Part II of the present series, Anigstein et al. (2007b, Chapter 3) determined empirical relationships between activities of selected radionuclides in the lungs and count rates measured by several instruments, including a Siemens e.cam gamma camera. However, such an empirical relationship cannot, by itself, be used to determine the intake of a given radionuclide by an exposed individual or the prospective dose resulting from such an intake.

1.2 Calibration Factors for Assessment of Intakes

Using a gamma camera to assess the inhaled activity of a given radionuclide by an exposed individual requires a set of calibration factors that relate the intake to the count rate registered by a given camera. Such calibration factors depend on the distribution of the activity in the body at the time of assessment, and vary with the age and sex of the individual. They also depend on the model of the camera and on the energy windows used for the measurement.

The derivation of these calibration factors proceeds in a series of three steps.

1. Use of biokinetic models to determine the fraction of inhaled activity in each region of the body as a function of time after intake. The fraction will depend on:
    a. Time after intake
    b. Particle size distribution
    c. Chemical form of the radionuclide
    d. Stage of development
2. Use of Monte Carlo simulations to determine the count rate in a given camera, normalized to a unit activity in a given region of the body. The count rate will depend on:
    a. Model of camera
    b. Energy window
    c. Age (of children) or sex (of adults)
3. Calculating the inhaled activity corresponding to a nominal count rate of 1,000 cpm.

Chapter 2

BIOKINETIC MODELS

The Life Sciences Division of the Oak Ridge National Laboratory has released a computer code that calculates the activities of radionuclides in various regions of the human body, referred to as "source regions," at various times, ranging from approximately one minute to many years after intake. The Dose and Risk Calculation software, called DCAL (ORNL 2006), "[is] a comprehensive software system for the calculation of tissue dose and subsequent health risk from intakes of radionuclides or exposure to radionuclides present in environmental media" (Eckerman et al. 2006). DCAL has been used in the development of Federal Guidance Report Nos. 12 and 13 (Eckerman and Ryman 1993, and Eckerman et al. 1999) and several ICRP publications.

We utilized DCAL to determine the distribution of activities in the source regions over a range of time following the acute inhalation of a unit activity of each of the four radionuclides in the present study: ^{60}Co, ^{137}Cs, ^{192}Ir, and ^{241}Am. The biokinetic models of these nuclides are the same as those used in Federal Guidance Report No. 13 (Eckerman et al. 1999) and those used to calculate dose coefficients for intakes by members of the public that are listed in ICRP Publication 72 (ICRP 1996).

2.1 DCAL Parameters

The present report addresses individuals at six stages of development—infant (age 100 days), ages 1, 5, 10, and 15 years, and adults—that correspond to the age-specific biokinetic models used by ICRP (1996). We selected nine time steps between the time of intake and the time of assessment: 1, 2, 4, 8, and 12 h, and 1, 2, 4, and 8 d. One hour is the minimum likely time for the exposed individual to be transported to a hospital, undergo external decontamination, and be examined with the gamma camera. The longest time is 8 days: it is most likely that the initial assessment would take place during the first few days after exposure.

All lung clearance types of these four nuclides that are listed in ICRP Publication 68 (ICRP 1994b) are included in the present study. ^{137}Cs and ^{241}Am are each assigned a single lung clearance type by ICRP (1994b, Annex F): all forms of cesium are classified as Type F while americium is always Type M. Unspecified compounds of cobalt are Type M, while oxides, hydroxides, halides, and nitrates are Type S. Iridium can be one of all three types: unspecified compounds are Type F, metallic iridium, halides, and nitrates are Type M, while oxides and hydroxides are Type S. Absent specific information on the likely particle size distribution of the activities dispersed by an RDD, we used a particle size of 1 μm AMAD, which is the default value for environmental exposure assumed by ICRP (1994b).

DCAL calculates relative activities of a given intake of a given radionuclide in as many as 57 different source regions. For the purposes of the present study, we needed to establish a correspondence between the DCAL source regions and the anatomical regions specified in the appropriate model of a pediatric or adult anthropomorphic phantom. In some cases, this required grouping the source regions, as shown in Table 2-1.

Table 2-1.
Anatomical Regions of Anthropomorphic Phantoms Corresponding to DCAL Source Regions

Adult	Child	DCAL[a]	Description
Anterior nasal cavity	Nose contents	ET1-sur	Surface of anterior nasal passage
Lungs	Bronchial mucosa	BBi-gel BBi-sol BBi-seq	Bronchial airways
	Lungs	AI	Alveolar interstitium
		bbe-gel bbe-sol bbe-seq	Bronchiolar airways
Small intestine	Small intestine	SI_Cont	Small intestine content
Cortical bone (50%) + trabecular bone (50%)	Bone	C_Bone-S	Cortical bone surface
		C_Bone-V	Cortical bone volume
		T_Bone-S	Trabecular bone surface
		T_Bone-V	Trabecular bone volume

[a] Names of source regions used in DCAL, based on the ICRP model of the human respiratory tract (ICRP 1994a)

The fractional activities of the relevant lung clearance types of four radionuclides in the source regions of individuals at six different stages of development, at nine different times after intake, are tabulated in Appendix A. For each radionuclide, regions comprising at least 99% of the total activity retained in the body at any time step for any lung clearance type of a given nuclide were included in the analysis.

Chapter 3

MONTE CARLO SIMULATION OF COUNT RATES

Monte Carlo computer models were used to simulate the responses of two gamma cameras to distributions of four radionuclides in various anatomical regions of children of various ages and adults of both sexes. These analyses combined the MCNP model of the Siemens e.cam or Philips SKYLight gamma camera, described in Parts II and III of the present series (Anigstein et al. 2007b, Section 2.1.3; Anigstein et al. 2007c, Section 2.1.2), respectively, with the anthropomorphic phantom representing each of seven potentially exposed individuals addressed by this study. The result of the analyses is a set of empirical relationships between the count rate of a given camera and the activity in a given region of the body.

The methodology was essentially the same as used in the Monte Carlo simulations of count rates in the Siemens e.cam gamma camera from activities in the lungs of the NORMAN phantom using the MCNPX computer code, as described in Part II of the present series (Anigstein et al. 2007b, Chapter 3). The following discussion summarizes the methods used in the analyses, focusing on differences with the previous studies.

3.1 MCNP Models of Anthropomorphic Phantoms

3.1.1 Models of Children

Eckerman et al. (1996) describe a series of anthropomorphic phantoms representing individuals at different stages of development, from infants to adults, developed at the Oak Ridge National Laboratory. Han et al. (2006) describe revisions to the ORNL phantom series that incorporate recent developments in the field, including the new anatomical data in ICRP Publication 89 (ICRP 2002). The MCNP pediatric models—infant (age 100 days), and ages 1, 5, 10, and 15 years—that are based on these revised phantoms were furnished by Prof. Wesley Bolch (2005).[1] These models include both male and female organs. However, the total mass of the 15-year-old phantom—approximately 57 kg—is much closer to the 56-kg reference mass of the 15-y-old male than the 53-kg reference mass of the 15-y-old female (ICRP 2002, Table 2.8). We therefore decided to use these phantoms to represent male individuals and eliminated female breasts and reproductive organs from the models. However, the results of the simulations are also applicable to female children, given the variability among real individuals.

As listed in Table 2-1, some anatomical regions of the Han phantoms correspond to more than one source region in the corresponding DCAL model. Conversely, some source regions comprise more than one anatomical region in the phantoms. Those source regions, and the corresponding anatomical regions, are listed in Table 3-1. The activity in each source region

[1] For the sake of convenience, we will refer to these MCNP models as "Han phantoms." They were constructed wholly or in part by Dr. Eunyoung Han at the University of Florida.

was distributed among the corresponding anatomical regions in each phantom in proportion to the mass of each anatomical region, resulting in equal concentrations in these regions.[2]

Table 3-1. DCAL Source Regions and Corresponding Anatomical Regions in Han Phantoms

DCAL	Han Phantoms
Lung	Lung-left Lung-right
ULI_Cont	Ascending colon contents Proximal transverse colon contents Distal transverse colon contents
LLI_Cont	Descending colon contents Sigmoid colon contents
Kidneys	Left kidney Right kidney

Bone in the Han phantoms comprised 16 anatomical structures. The total bone activity in the DCAL model was distributed among these structures in the proportion to the mass of each structure in each phantom.

The Han phantoms do not have a region for blood, although it is a significant source region in the DCAL model of most radionuclides. We therefore created a blood region, based on the distribution of blood among the regions of the body. ICRP (2002, Table 2.14) lists the distribution of regional blood volumes in adults. Absent comparable data for children, we based the distribution of blood on the ICRP data for adult males.[3] When a given tissue in the ICRP blood-volume distribution corresponded to more than one region in the phantom, the activity in the blood in that tissue was distributed among such regions in proportion to the mass of each region.

The elemental biokinetic models corresponding to three of the radionuclides in the present study—^{60}Co, ^{192}Ir, and ^{241}Am—include a source region described as "Other." This designation refers to all tissues other than those specified in the biokinetic model of the given element.[4] Thus, the tissues comprising this region depend on the particular element being modeled. The "Other" activity was distributed among the anatomical regions corresponding to these tissues in proportion to the mass of each region.

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[2] The mass of each anatomical region depends on the age of the given individual. Thus, the relative activities in the anatomical regions corresponding to a given source region will be different for different ages; however, the activity concentration in each anatomical region corresponding to a given source region in a given phantom will be uniform.

[3] The only differences between the reference values of distribution of blood volumes in adult men and women is the relative proportion of blood in muscle and in fat. We used the distribution for the adult male because the average ratio of muscle to fat in children (newborn to age 15) is closer to the muscle-to-fat ratio in adult males than in females.

[4] Keith Eckerman, Oak Ridge National Laboratory, private communication with Robert Anigstein, SC&A, Inc., April 2007.

The biokinetic model of cesium includes a compartment called "Body Tissues." As the name implies, this includes all living tissues. The activity in "Body Tissues" was distributed among the corresponding anatomical regions in each phantom, similar to the distribution of "Other" activity.

3.1.2 Models of Adults

The NORMAN and NAOMI voxel phantoms were created from MRI images of an adult male and female (Dimbylow 1998, 2005). These models, whose height and mass were scaled to the ICRP reference values for adults (ICRP 2002, Table 2.8), are more realistic representations of the human body than the geometrical models described by Han et al. (2006). (We used the Han phantoms to represent children since pediatric phantoms comparable to NORMAN and NAOMI were not available at the time of these studies.)

There are 37 types of material in NORMAN and 40 in NAOMI. Because these models were originally used for the studies of the effects of nonionizing radiation on human subjects, they did not include the elemental composition of these materials. We assigned elemental compositions to the materials based on several references, in hierarchical order. First preference was given to the data presented by ICRP (2002, Tables 13.2–13.3) which encompass soft tissues. The composition of hydrated cortical bones of adults, which is listed by ICRP (1995, Table 27), was assigned to cortical and trabecular bone. Data on body fluids and other contents of the alimentary tract, including regions of the intestines which combine the wall and the contents, is presented by Jones (1997, Table 1). The composition of lymph is listed by ICRU (1992).

As shown in Table 2-1, some anatomical regions in these voxel phantoms correspond to more than one source region in the corresponding DCAL model. As is the case with the Han phantoms, some other source regions encompass more than one anatomical region in the voxel phantoms. These regions, and the corresponding anatomical regions, are listed in Table 3-2.

Table 3-2. DCAL Source Regions and Corresponding Anatomical Regions in Voxel Phantoms

DCAL	Voxel Phantoms
St_Cont	Small intestine + duodenum
ULI_Cont	Upper large intestines (wall + contents)
LLI_Cont	Lower large intestines (wall + contents)

Unlike the Han phantoms, the voxel phantoms do have anatomical regions for blood. In NORMAN, the blood region encompasses only the contents of the heart and the major vessels. It was therefore necessary to adjust this region to correspond to the distribution of blood in the body presented by ICRP (2002, Table 2.14). According to ICRP, the total blood volume in the aorta and other large arteries, in large veins, and in the heart is significantly greater than the blood region in NORMAN. We therefore needed to adjust the count rates from each radionuclide in the blood region to account for the ICRP distribution. The first step was to separate the contribution from the blood in the heart and the blood in the vessels that are part of the NORMAN blood region. We started by performing an MCNP simulation of count rates from activity in the contents of the heart. By subtracting these count rates, adjusted for the mass of blood in the heart listed by ICRP, from the total count rate from the blood region, adjusted for the total mass of blood in the NORMAN phantom, we derived the count rate from the NORMAN vessels. The normalized count rate from each NORMAN region corresponding to each major tissue or organ, including the vessels and the heart contents, was multiplied by the fraction of the total blood volume in all organs included in our model. The sum of these products—the weighted mean of the normalized count rates from individual regions— represents the normalized count rate from activity uniformly distributed in the blood. This fairly elaborate procedure was employed for calculating the count rates from activities of three nuclides—^{60}Co, ^{137}Cs, and ^{192}Ir—which are found in the blood in significant amounts following inhalation. As shown in Table A-8, relatively little ^{241}Am accumulates in the blood. Given the small contribution that the activity in the blood would make to the total count rate from this nuclide, we employed simpler procedures in this case. For NORMAN, we apportioned the blood among the various organs, as listed by ICRP, but did not distinguish between the contribution of the heart contents and the major blood vessels.

In the case of NAOMI, the blood region consists primarily of the heart contents. In the MCNP simulations, we distributed the activity in the blood among the heart contents and the other regions in the NAOMI model in the proportions listed by ICRP (2002, Table 2.14). In the case of ^{241}Am, we used a narrower range, consisting of the blood region, the liver, and the lungs.

The count rates from activities of ^{60}Co, ^{192}Ir, and ^{241}Am in “Other” tissues and ^{137}Cs in “Body Tissues” were calculated in a manner similar to that used for the Han phantoms, described in Section 3.1.1.

3.1.3 Position of Patient

Each phantom was placed in a position similar to the one that would be used in the clinical situation. In performing lung scans of adult patients with the Siemens e.cam Fixed 180 camera, the two camera heads are of necessity at the same elevation, and the patient is positioned so that the lungs are within the field of view of the detectors. The heads of the Philips SKYLight can be positioned independently. The positions of the adult phantoms with respect to this camera are based on the illustration in Figure 3-1, furnished by Philips Medical Systems N. A. An illustration of a child is shown in Figure 3-2.

The position of each phantom with respect to each of the two gamma cameras in the present analysis is illustrated in Appendix B.

3.1.4 MCNP Simulations of Gamma Cameras

The calculations utilized the MCNP pulse height tallies, which record the detector events that fall into specified energy bins. In the present analysis, we utilized bins that were 1-keV wide and spanned the entire energy spectrum of each radionuclide. This enables us to estimate the

Figure 3-1. Lung Scan of Adult Patient with Philips SKYLight (Garrard 2006)

Figure 3-2. Pediatric Patient with Philips SKYLight (Garrard 2007)

count rates in any arbitrary energy window of the respective gamma camera. The analyses of the Siemens e.cam used the two sets of energy windows that were used for the preliminary calibration factors of lung burdens presented in Part II of the present series (Anigstein et al. 2007b, Section 3.2.2). The first set, consisting of six 50% windows, corresponds to the settings used in measuring count rates from sources of ^{60}Co, ^{137}Cs, and ^{192}Ir on this instrument. Two 50% windows were used for measurements of ^{241}Am. The second set, applied only to ^{60}Co, ^{137}Cs, and ^{192}Ir, spans a narrower range and consists of three 50% windows. These settings were selected to span a range that maximizes the count rates yet simplifies the setup on the camera for use in a radiological emergency. Since the ^{241}Am measurements utilized only two energy windows, a second set is not needed. The energy windows used in the analysis of the Siemens e.cam gamma camera are listed in Table 3-3.

The simulations of the Philips SKYLight camera used some of the energy windows used in the measurements reported in Part III of the present series (Anigstein et al. 2007c). These settings are listed in Table 3-4. Because setting two contiguous windows is relatively straightforward and produces the optimum count rates, only one set of windows was used in the simulation of count rates from ^{60}Co, ^{137}Cs, and ^{192}Ir on this instrument. For ^{241}Am, a single window was sufficient to span the part of its spectrum that lies within the energy range of this camera system.

3.2 Results

The results of the MCNP simulations of the normalized count rates in the two camera systems from activities in the various anatomical regions of the anthropomorphic phantoms are presented in Appendix C. These regions are identified by the same names as those of the corresponding source regions in the DCAL model.

Table 3-3. Energy Windows of Siemens e.cam Gamma Camera (keV)

Set No.	Channel	Window	Peak	Min	Max	Peak	Min	Max	Peak	Min	Max
		Nuclide:	Co-60, Cs-137			Ir-192			Am-241		
1	1	1	41	30.75	51.25	35	30.75	43.75	35	26.25	43.75
	2	2	69	51.75	86.25	59	51.75	73.75	59	44.25	73.75
		3	116	87.00	145.00	99	87.00	123.75			
		4	194	145.50	242.50	166	145.50	207.50			
		5	324	243.00	405.00	277	243.00	346.25			
	3	6	541	405.75	676.25	462	405.75	577.50			
		Nuclide:	Co-60			Cs-137			Ir-192		
2	1	1	101.3	75.975	126.625	97.3	72.975	121.625	96.0	72.000	120.000
	2	2	168.9	126.675	211.125	162.3	121.725	202.875	160.1	120.075	200.125
	3	3	281.6	211.200	352.000	270.6	202.950	338.250	266.9	200.175	333.625

Note: All windows have widths equal to 50% of the peak energy

Table 3-4. Energy Windows of Philips SKYLight Gamma Camera (keV)

Nuclide:	Co-60			Cs-137			Ir-192			Am-241		
Window	Peak	Min	Max	Peak	Min	Max	Peak	Min	Max	Peak	Min	Max
1	124.6	71.0	178.2	191.2	109.0	273.4	94.7	54.0	135.4	51.3	30.0	72.6
2	312.6	178.2	447.0	479.6	273.4	685.8	237.5	135.4	339.6			

Note: All windows for ^{60}Co, ^{137}Cs, and ^{192}Ir have widths equal to 86% of the peak energy; ^{241}Am used a 83% window

Chapter 4

CALCULATION OF CALIBRATION FACTORS

Chapter 2 describes the distribution of inhaled activities among various regions of the human body, while Chapter 3 describes the calculation of normalized count rates in gamma cameras from activities in these same regions. In the present chapter, we combine these results to develop sets of calibration factors that can be used to estimate the inhaled activity of a given radionuclide, in a chemical form corresponding to a given Lung Absorption Type, by a given individual, based on the count rate in a given gamma camera with a given set of energy windows at a given time after intake.

The calculation of such calibration factors entails the following steps:

- For each time step, multiply the fractional activity in a given source region (listed in Appendix A) by the normalized count rate registered by the camera from activity in the corresponding anatomical region (listed in Appendix C).
- Add the count rates from all the regions.
- Divide the total count rate into 1,000 cpm to yield a calibration factor in units of Bq/kcpm.

The resulting calibration factor can be described by the following expression

$$F_{gijklt} = \frac{1}{k_f \sum_m c_{giklm} f_{gijmt}}$$

F_{gijklt} = calibration factor for assessment of individual *g* (characterized by age of juvenile or sex of adult) exposed to radionuclide *i* with chemical form *j* measured with camera *k*, using set of energy windows *i*, at time *t* after intake (Bq/kcpm)

k_f = factor for converting cps to kcpm
= 0.06

c_{giklm} = normalized count rate from radionuclide *i* in organ *m* of individual *g* measured with camera *k* using set of energy windows *i* (cps/Bq)

f_{gijmt} = fraction of inhaled activity of radionuclide *i* with chemical form *j* in organ *m* of individual *g* at time *t* after intake

The resulting calibration factors are tabulated in Appendix D, along with a more detailed discussion of the use of these factors for assessing intakes by exposed individuals.

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APPENDIX A

NORMALIZED ACTIVITIES IN DCAL SOURCE REGIONS AT DIFFERENT TIMES AFTER INTAKE

Appendix A

ACTIVITIES IN DCAL SOURCE REGIONS AT DIFFERENT TIMES AFTER INTAKE

Tables A-2 to A-8 list the activities in DCAL source regions in children and adults at several different times after intake. The first three time steps—0.042, 0.083, and 0.167 day—are approximately 1, 2, and 4 hours after intake. The column headings correspond to regions in the DCAL model. In some cases, these regions are grouped according to the corresponding anatomical regions in the appropriate MCNP model of the body, as shown in Table 2-1. Further descriptions of these regions are listed in Table A-1.

The source regions included in the analysis of the distribution of a given radionuclide in an individual of a given age are those that contain a total of 99% or more of the retained activity of any Lung Absorption Type of that nuclide at any time step. No activities are listed for certain regions that do not meet that criterion in certain individuals. This was done to eliminate the need to perform MCNP analyses for regions that make no significant contributions to the total count rates.

Table A-1. Description of DCAL Source Regions Listed in Tables A-2 to A-8

Column heading	Description
ET1	Surface of anterior nasal passage (ET_1 in ICRP 1994a)
Stomach	Stomach contents
SI	Small intestine contents
ULI	Upper large intestine contents
LLI	Lower large intestine contents
Other	All tissues not specified in biokinetic model of given element
Body tissues	All tissues in the body
C_Bone	Cortical bone surface + volume
T_Bone	Trabecular bone surface + volume
Retained	Fraction of inhaled activity retained in body

Note: See also Table 2-1.

Table A-2. Activity of Type M ^{60}Co in DCAL Source Regions at Various Times after Intake (%)

Time (d)	Lung	BBi	ET1	Stomach	SI	Blood	ULI	LLI	Other	Liver	Retained
					Infant						
0.04	9.49	0.83	20.11	11.93	11.83	2.75	1.45	0.03	0.06	0.01	58.93
0.08	9.40	0.76	19.30	4.72	15.19	3.47	4.72	0.25	0.14	0.02	58.06
0.17	9.27	0.67	17.74	0.72	10.94	4.68	10.36	1.37	0.35	0.04	56.25
0.33	9.07	0.59	15.03	0.07	3.57	5.18	13.34	4.62	0.87	0.10	52.55
0.50	8.92	0.54	12.72	0.04	1.14	4.58	11.73	7.42	1.37	0.15	48.71
1.00	8.65	0.48	7.71	0.02	0.10	2.48	5.49	10.24	2.38	0.26	37.86
2.00	8.43	0.44	2.84	0.01	0.02	0.67	1.06	6.44	3.05	0.34	23.32
4.00	8.18	0.41	0.38	0.00	0.01	0.08	0.09	1.23	2.97	0.33	13.70
8.00	7.74	0.35	0.01	0.00	0.01	0.04	0.05	0.11	2.47	0.27	11.07
					1-y-old						
0.04	10.16	0.82	20.20	11.97	12.06	2.63	1.47	0.03	0.06	0.01	59.87
0.08	10.09	0.75	19.39	4.74	15.81	2.89	4.84	0.26	0.13	0.01	59.00
0.17	9.98	0.65	17.83	0.72	12.01	3.33	10.88	1.42	0.29	0.03	57.22
0.33	9.81	0.57	15.10	0.07	4.41	3.40	14.57	4.92	0.64	0.07	53.64
0.50	9.68	0.53	12.78	0.04	1.56	2.97	13.14	8.04	0.96	0.11	49.88
1.00	9.44	0.48	7.75	0.02	0.12	1.61	6.26	11.39	1.62	0.18	38.92
2.00	9.23	0.44	2.85	0.01	0.02	0.44	1.18	7.21	2.05	0.23	23.68
4.00	8.97	0.41	0.39	0.00	0.01	0.07	0.09	1.35	2.00	0.22	13.53
8.00	8.51	0.35	0.01	0.00	0.01	0.04	0.05	0.12	1.69	0.19	10.98
					5-y-old						
0.04	10.48	0.82	16.67	9.81	9.87	2.39	1.20	0.03	0.05	0.01	51.73
0.08	10.40	0.75	16.00	3.90	12.95	2.60	3.97	0.21	0.11	0.01	51.02
0.17	10.28	0.65	14.72	0.61	9.87	2.94	8.92	1.16	0.26	0.03	49.58
0.33	10.10	0.56	12.46	0.07	3.66	2.96	11.98	4.04	0.57	0.06	46.63
0.50	9.96	0.52	10.55	0.04	1.32	2.58	10.84	6.61	0.85	0.09	43.52
1.00	9.70	0.47	6.40	0.02	0.12	1.40	5.22	9.41	1.41	0.16	34.41
2.00	9.48	0.43	2.35	0.01	0.02	0.39	1.01	6.00	1.79	0.20	21.72
4.00	9.21	0.40	0.32	0.00	0.01	0.06	0.09	1.15	1.75	0.19	13.22
8.00	8.73	0.35	0.01	0.00	0.01	0.04	0.05	0.11	1.49	0.17	10.98
					10-y-old						
0.04	10.05	0.92	17.02	10.05	10.12	2.39	1.23	0.03	0.05	0.01	52.25
0.08	9.97	0.82	16.34	4.00	13.28	2.60	4.06	0.22	0.11	0.01	51.54
0.17	9.86	0.71	15.02	0.63	10.12	2.96	9.14	1.19	0.26	0.03	50.07
0.33	9.69	0.62	12.72	0.07	3.75	2.99	12.29	4.14	0.57	0.06	47.06
0.50	9.56	0.58	10.76	0.04	1.34	2.61	11.11	6.78	0.85	0.09	43.88
1.00	9.32	0.52	6.53	0.02	0.12	1.42	5.33	9.64	1.43	0.16	34.58
2.00	9.11	0.48	2.40	0.01	0.02	0.39	1.02	6.13	1.81	0.20	21.62
4.00	8.86	0.45	0.32	0.00	0.01	0.06	0.09	1.17	1.77	0.20	12.95
8.00	8.40	0.39	0.01	0.00	0.01	0.04	0.05	0.11	1.50	0.17	10.69
					15-y-old						
0.04	11.32	1.30	13.34	8.04	8.05	2.32	0.98	0.02	0.05	0.01	45.79
0.08	11.23	1.16	12.80	3.26	10.63	2.47	3.24	0.17	0.11	0.01	45.22
0.17	11.11	0.98	11.77	0.56	8.21	2.72	7.34	0.95	0.25	0.03	44.06
0.33	10.90	0.84	9.97	0.08	3.13	2.69	9.97	3.33	0.53	0.06	41.65
0.50	10.75	0.79	8.44	0.05	1.16	2.33	9.09	5.49	0.78	0.09	39.11
1.00	10.47	0.72	5.12	0.02	0.12	1.27	4.45	7.90	1.29	0.14	31.60
2.00	10.23	0.67	1.88	0.01	0.03	0.36	0.89	5.10	1.64	0.18	21.02
4.00	9.94	0.62	0.25	0.00	0.02	0.07	0.09	1.00	1.61	0.18	13.81
8.00	9.42	0.54	0.00	0.00	0.01	0.04	0.05	0.12	1.39	0.15	11.77
					Adult						
0.04	13.04		14.28	8.37	8.41	2.40	1.02	0.02	0.05		47.95
0.08	12.85		13.70	3.36	11.06	2.56	3.38	0.18	0.11		47.26
0.17	12.60		12.60	0.55	8.48	2.82	7.63	0.99	0.25		45.95
0.33	12.29		10.67	0.07	3.20	2.78	10.31	3.46	0.54		43.34
0.50	12.10		9.03	0.04	1.18	2.41	9.37	5.69	0.81		40.63
1.00	11.76		5.48	0.02	0.12	1.31	4.57	8.14	1.34		32.74
2.00	11.47		2.01	0.01	0.03	0.38	0.90	5.24	1.69		21.73
4.00	11.12		0.27	0.00	0.02	0.07	0.09	1.03	1.67		14.27
8.00	10.51		0.00	0.00	0.01	0.04	0.05	0.12	1.44		12.19

Table A-3. Activity of Type S ^{60}Co in DCAL Source Regions at Various Times after Intake (%)

Time (d)	Lung	BBi	ET1	Stomach	SI	Blood	ULI	LLI	Other	Liver	Retained
Infant											
0.04	10.51	0.93	20.11	12.62	12.71	0.06	1.52	0.04	0.00	0.00	58.96
0.08	10.44	0.85	19.30	5.01	16.98	0.13	5.11	0.27	0.00	0.00	58.14
0.17	10.30	0.74	17.74	0.77	13.40	0.27	11.71	1.51	0.01	0.00	56.51
0.33	10.09	0.65	15.03	0.08	5.37	0.37	16.18	5.35	0.05	0.01	53.20
0.50	9.93	0.60	12.72	0.05	2.08	0.36	14.90	8.89	0.09	0.01	49.65
1.00	9.65	0.54	7.71	0.02	0.19	0.21	7.29	12.90	0.17	0.02	38.72
2.00	9.45	0.49	2.84	0.01	0.03	0.06	1.36	8.25	0.23	0.03	22.74
4.00	9.26	0.46	0.38	0.00	0.02	0.01	0.09	1.53	0.22	0.02	12.01
8.00	8.94	0.41	0.01	0.00	0.01	0.00	0.05	0.12	0.18	0.02	9.75
1-y-old											
0.04	11.26	0.91	20.20	12.67	12.77	0.04	1.53	0.04	0.00	0.00	59.89
0.08	11.20	0.83	19.39	5.03	17.09	0.08	5.14	0.27	0.00	0.00	59.07
0.17	11.08	0.72	17.83	0.76	13.53	0.14	11.79	1.52	0.01	0.00	57.43
0.33	10.90	0.63	15.10	0.07	5.45	0.19	16.32	5.39	0.03	0.00	54.12
0.50	10.77	0.59	12.78	0.04	2.11	0.18	15.06	8.97	0.05	0.01	50.57
1.00	10.53	0.53	7.75	0.02	0.18	0.11	7.35	13.02	0.09	0.01	39.61
2.00	10.35	0.49	2.85	0.01	0.03	0.03	1.35	8.31	0.12	0.01	23.56
4.00	10.15	0.46	0.39	0.00	0.02	0.00	0.09	1.53	0.12	0.01	12.79
8.00	9.82	0.41	0.01	0.00	0.01	0.00	0.05	0.12	0.10	0.01	10.54
5-y-old											
0.04	11.62	0.91	16.67	10.38	10.45	0.04	1.25	0.03	0.00	0.00	51.74
0.08	11.55	0.83	16.00	4.14	14.00	0.06	4.20	0.22	0.00	0.00	51.06
0.17	11.42	0.72	14.72	0.65	11.12	0.12	9.67	1.24	0.01	0.00	49.71
0.33	11.23	0.63	12.46	0.08	4.53	0.16	13.42	4.42	0.02	0.00	46.98
0.50	11.08	0.58	10.55	0.04	1.78	0.15	12.42	7.37	0.04	0.00	44.05
1.00	10.82	0.52	6.40	0.02	0.18	0.09	6.13	10.76	0.07	0.01	35.01
2.00	10.62	0.48	2.35	0.01	0.03	0.02	1.15	6.92	0.10	0.01	21.71
4.00	10.42	0.45	0.32	0.00	0.02	0.00	0.09	1.30	0.10	0.01	12.73
8.00	10.08	0.40	0.01	0.00	0.01	0.00	0.05	0.12	0.08	0.01	10.78
10-y-old											
0.04	11.13	1.02	17.02	10.64	10.71	0.04	1.28	0.03	0.00	0.00	52.26
0.08	11.07	0.91	16.34	4.25	14.35	0.07	4.31	0.23	0.00	0.00	51.57
0.17	10.95	0.79	15.02	0.67	11.41	0.12	9.91	1.28	0.01	0.00	50.20
0.33	10.77	0.68	12.72	0.07	4.64	0.16	13.76	4.53	0.02	0.00	47.41
0.50	10.64	0.64	10.76	0.04	1.81	0.16	12.73	7.56	0.04	0.00	44.41
1.00	10.40	0.58	6.53	0.02	0.17	0.09	6.26	11.02	0.08	0.01	35.17
2.00	10.21	0.54	2.40	0.01	0.03	0.03	1.17	7.06	0.10	0.01	21.57
4.00	10.02	0.51	0.32	0.00	0.02	0.00	0.09	1.32	0.10	0.01	12.41
8.00	9.69	0.45	0.01	0.00	0.01	0.00	0.05	0.11	0.08	0.01	10.44
15-y-old											
0.04	12.55	1.44	13.34	8.51	8.53	0.03	1.02	0.02	0.00	0.00	45.80
0.08	12.47	1.28	12.80	3.47	11.49	0.06	3.44	0.18	0.00	0.00	45.26
0.17	12.34	1.09	11.77	0.60	9.25	0.10	7.95	1.02	0.01	0.00	44.18
0.33	12.12	0.94	9.97	0.09	3.86	0.14	11.16	3.65	0.02	0.00	41.98
0.50	11.96	0.88	8.44	0.05	1.56	0.13	10.41	6.12	0.03	0.00	39.61
1.00	11.68	0.80	5.12	0.02	0.17	0.08	5.22	9.02	0.06	0.01	32.21
2.00	11.47	0.75	1.88	0.01	0.03	0.02	1.02	5.87	0.08	0.01	21.16
4.00	11.25	0.71	0.25	0.00	0.02	0.00	0.09	1.14	0.08	0.01	13.57
8.00	10.88	0.63	0.00	0.00	0.02	0.00	0.06	0.13	0.07	0.01	11.81
Adult											
0.04	14.45		14.28	8.86	8.90	0.03	1.06	0.02	0.00		47.96
0.08	14.27		13.70	3.57	11.96	0.06	3.58	0.19	0.00		47.37
0.17	13.99		12.60	0.59	9.56	0.11	8.27	1.06	0.01		46.22
0.33	13.67		10.67	0.08	3.95	0.14	11.54	3.79	0.02		43.88
0.50	13.46		9.03	0.05	1.58	0.13	10.73	6.33	0.03		41.36
1.00	13.12		5.48	0.02	0.17	0.08	5.35	9.30	0.07		33.59
2.00	12.85		2.01	0.01	0.03	0.02	1.04	6.03	0.09		22.09
4.00	12.59		0.27	0.00	0.02	0.00	0.09	1.16	0.09		14.23
8.00	12.14		0.00	0.00	0.02	0.00	0.06	0.13	0.07		12.42

Table A-4. Activity of Type F ^{137}Cs in DCAL Source Regions at Various Times after Intake (%)

Time (d)	ET1	Stomach	Blood	LLI	Body tissues	Retained
			Infant			
0.04	20.11	5.65	29.98	0.00	2.73	58.96
0.08	19.30	2.11	30.33	0.01	6.19	58.15
0.17	17.74	0.28	25.66	0.03	12.72	56.57
0.33	15.03	0.01	16.39	0.05	22.14	53.75
0.50	12.72	0.00	10.32	0.07	28.04	51.29
1.00	7.71	0.00	2.58	0.14	35.07	45.67
2.00	2.84	0.00	0.16	0.23	35.93	39.36
4.00	0.38	0.00	0.00	0.29	33.08	33.95
8.00	0.01	0.00	0.00	0.26	27.79	28.22
			1-y-old			
0.04	20.20	5.67	30.71	0.00	2.80	59.89
0.08	19.39	2.12	31.01	0.01	6.34	59.08
0.17	17.83	0.28	26.20	0.03	13.00	57.48
0.33	15.10	0.01	16.74	0.05	22.59	54.64
0.50	12.78	0.00	10.54	0.08	28.57	52.13
1.00	7.75	0.00	2.63	0.15	35.59	46.34
2.00	2.85	0.00	0.16	0.28	36.12	39.67
4.00	0.39	0.00	0.00	0.36	32.61	33.60
8.00	0.01	0.00	0.00	0.31	26.34	26.85
			5-y-old			
0.04	16.68	4.64	27.46	0.00	2.51	51.74
0.08	16.00	1.74	27.49	0.01	5.66	51.06
0.17	14.72	0.23	23.11	0.02	11.55	49.76
0.33	12.46	0.00	14.75	0.04	20.02	47.43
0.50	10.55	0.00	9.29	0.06	25.31	45.38
1.00	6.40	0.00	2.32	0.12	31.60	40.66
2.00	2.35	0.00	0.15	0.22	32.27	35.25
4.00	0.32	0.00	0.00	0.27	29.62	30.45
8.00	0.01	0.00	0.00	0.23	24.91	25.33
			10-y-old			
0.04	17.02	4.75	27.52	0.00	2.52	52.26
0.08	16.34	1.78	27.61	0.01	5.67	51.58
0.17	15.02	0.24	23.24	0.02	11.60	50.25
0.33	12.72	0.00	14.84	0.04	20.12	47.88
0.50	10.77	0.00	9.34	0.06	25.45	45.79
1.00	6.53	0.00	2.34	0.12	31.80	41.01
2.00	2.40	0.00	0.15	0.21	32.58	35.58
4.00	0.33	0.00	0.00	0.25	30.22	31.00
8.00	0.01	0.00	0.00	0.19	26.35	26.69
			15-y-old			
0.04	13.34	3.78	25.88	0.00	2.38	45.80
0.08	12.80	1.41	25.58	0.01	5.32	45.26
0.17	11.77	0.19	21.35	0.02	10.78	44.22
0.33	9.97	0.00	13.61	0.04	18.60	42.35
0.50	8.44	0.00	8.57	0.05	23.49	40.70
1.00	5.12	0.00	2.14	0.10	29.34	36.89
2.00	1.88	0.00	0.13	0.17	30.23	32.61
4.00	0.25	0.00	0.00	0.17	28.76	29.31
8.00	0.00	0.00	0.00	0.08	26.98	27.13
			Adult			
0.04	14.28	3.95	26.83		2.46	47.74
0.08	13.70	1.48	26.54		5.52	47.24
0.17	12.60	0.20	22.16		11.19	46.15
0.33	10.67	0.00	14.13		19.32	44.12
0.50	9.03	0.00	8.89		24.42	42.34
1.00	5.48	0.00	2.22		30.59	38.29
2.00	2.01	0.00	0.14		31.71	33.87
4.00	0.27	0.00	0.00		30.51	30.78
8.00	0.00	0.00	0.00		29.04	29.05

Table A-5. Activity of Type F ^{192}Ir in DCAL Source Regions at Various Times after Intake (%)

Time	Lung	BBi	ET1	Stomach	SI	Blood	ULI	LLI	Liver	Kidneys	Spleen	Other	Retained
Infant													
0.04	0.16	0.01	20.10	5.65	7.00	22.75	1.15	0.03	0.46	0.09	0.05	1.25	58.82
0.08	0.00	0.00	19.28	2.11	8.51	20.50	3.22	0.19	0.95	0.19	0.10	2.58	57.77
0.17	0.00	0.00	17.72	0.28	6.40	16.30	6.73	0.92	1.80	0.36	0.18	4.87	55.67
0.33	0.00	0.00	14.98	0.01	2.44	10.33	9.00	3.06	3.00	0.60	0.30	8.09	51.89
0.50	0.00	0.00	12.66	0.00	0.88	6.52	8.29	5.01	3.75	0.75	0.37	10.12	48.40
1.00	0.00	0.00	7.64	0.00	0.04	1.63	4.14	7.23	4.66	0.93	0.47	12.59	39.35
2.00	0.00	0.00	2.79	0.00	0.00	0.10	0.82	4.66	4.83	0.97	0.48	13.05	27.69
4.00	0.00	0.00	0.37	0.00	0.00	0.00	0.11	0.94	4.60	0.92	0.46	12.42	19.81
8.00	0.00	0.00	0.01	0.00	0.00	0.00	0.06	0.14	4.18	0.84	0.42	11.28	16.92
1-y-old													
0.04	0.17	0.01	20.20	5.67	7.03	23.45	1.16	0.03	0.48	0.10	0.05	1.28	59.77
0.08	0.00	0.00	19.38	2.12	8.56	21.11	3.25	0.19	0.98	0.20	0.10	2.65	58.72
0.17	0.00	0.00	17.80	0.28	6.47	16.75	6.79	0.93	1.86	0.37	0.19	5.01	56.60
0.33	0.00	0.00	15.06	0.01	2.49	10.59	9.12	3.09	3.08	0.62	0.31	8.32	52.78
0.50	0.00	0.00	12.72	0.00	0.91	6.66	8.42	5.07	3.85	0.77	0.38	10.39	49.24
1.00	0.00	0.00	7.68	0.00	0.04	1.66	4.22	7.34	4.78	0.96	0.48	12.92	40.10
2.00	0.00	0.00	2.80	0.00	0.00	0.10	0.83	4.74	4.96	0.99	0.50	13.38	28.30
4.00	0.00	0.00	0.37	0.00	0.00	0.00	0.11	0.95	4.72	0.94	0.47	12.74	20.31
8.00	0.00	0.00	0.01	0.00	0.00	0.00	0.07	0.14	4.28	0.86	0.43	11.56	17.35
5-y-old													
0.04	0.17	0.01	16.67	4.64	5.75	21.52	0.97	0.03	0.43	0.09	0.04	1.17	51.67
0.08	0.00	0.00	15.99	1.73	7.00	19.39	2.70	0.16	0.90	0.18	0.09	2.43	50.86
0.17	0.00	0.00	14.69	0.23	5.29	15.38	5.63	0.77	1.70	0.34	0.17	4.59	49.16
0.33	0.00	0.00	12.43	0.00	2.04	9.72	7.57	2.57	2.83	0.57	0.28	7.63	45.91
0.50	0.00	0.00	10.50	0.00	0.74	6.12	7.00	4.21	3.53	0.71	0.35	9.53	42.89
1.00	0.00	0.00	6.34	0.00	0.04	1.52	3.53	6.12	4.39	0.88	0.44	11.85	35.16
2.00	0.00	0.00	2.31	0.00	0.00	0.09	0.71	3.97	4.55	0.91	0.45	12.27	25.28
4.00	0.00	0.00	0.31	0.00	0.00	0.00	0.10	0.81	4.33	0.87	0.43	11.68	18.54
8.00	0.00	0.00	0.01	0.00	0.00	0.00	0.06	0.13	3.93	0.79	0.39	10.61	15.92
10-y-old													
0.04	0.17	0.02	17.01	4.75	5.89	21.44	0.99	0.03	0.43	0.09	0.04	1.17	52.20
0.08	0.00	0.00	16.32	1.78	7.17	19.31	2.76	0.16	0.90	0.18	0.09	2.42	51.38
0.17	0.00	0.00	15.00	0.24	5.42	15.32	5.75	0.78	1.70	0.34	0.17	4.58	49.65
0.33	0.00	0.00	12.68	0.00	2.09	9.68	7.73	2.62	2.82	0.56	0.28	7.60	46.35
0.50	0.00	0.00	10.72	0.00	0.76	6.09	7.14	4.30	3.52	0.70	0.35	9.50	43.27
1.00	0.00	0.00	6.47	0.00	0.04	1.52	3.60	6.24	4.37	0.87	0.44	11.80	35.40
2.00	0.00	0.00	2.36	0.00	0.00	0.09	0.72	4.04	4.53	0.91	0.45	12.23	25.34
4.00	0.00	0.00	0.31	0.00	0.00	0.00	0.10	0.82	4.31	0.86	0.43	11.64	18.49
8.00	0.00	0.00	0.01	0.00	0.00	0.00	0.06	0.13	3.91	0.78	0.39	10.57	15.86
15-y-old													
0.04	0.19	0.02	13.33	3.78	4.68	21.05	0.82	0.02	0.42	0.08	0.04	1.13	45.74
0.08	0.00	0.00	12.79	1.41	5.70	18.98	2.27	0.13	0.87	0.17	0.09	2.36	45.07
0.17	0.00	0.00	11.75	0.19	4.31	15.05	4.71	0.64	1.66	0.33	0.17	4.48	43.64
0.33	0.00	0.00	9.94	0.00	1.66	9.51	6.33	2.15	2.76	0.55	0.28	7.45	40.91
0.50	0.00	0.00	8.40	0.00	0.60	5.98	5.88	3.53	3.45	0.69	0.34	9.32	38.38
1.00	0.00	0.00	5.07	0.00	0.03	1.49	3.00	5.15	4.29	0.86	0.43	11.58	31.95
2.00	0.00	0.00	1.85	0.00	0.00	0.09	0.62	3.37	4.44	0.89	0.44	12.00	23.72
4.00	0.00	0.00	0.25	0.00	0.00	0.00	0.10	0.71	4.23	0.85	0.42	11.42	17.98
8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.12	3.84	0.77	0.38	10.37	15.56
Adult													
0.04	0.22		14.27	3.95	4.89	21.78	0.86	0.02	0.43	0.09	0.04	1.17	47.90
0.08	0.00		13.69	1.48	5.96	19.64	2.36	0.14	0.91	0.18	0.09	2.44	47.19
0.17	0.00		12.58	0.20	4.50	15.58	4.91	0.67	1.72	0.34	0.17	4.64	45.68
0.33	0.00		10.64	0.00	1.73	9.84	6.61	2.24	2.86	0.57	0.29	7.71	42.78
0.50	0.00		8.99	0.00	0.63	6.19	6.14	3.68	3.57	0.71	0.36	9.64	40.10
1.00	0.00		5.43	0.00	0.03	1.54	3.13	5.37	4.44	0.89	0.44	11.98	33.31
2.00	0.00		1.98	0.00	0.00	0.10	0.64	3.51	4.60	0.92	0.46	12.42	24.64
4.00	0.00		0.26	0.00	0.00	0.00	0.10	0.74	4.38	0.88	0.44	11.82	18.62
8.00	0.00		0.00	0.00	0.00	0.00	0.06	0.13	3.97	0.79	0.40	10.73	16.10

Table A-6. Activity of Type M ^{192}Ir in DCAL Source Regions at Various Times after Intake (%)

Time	Lung	BBi	ET1	Stomach	SI	Blood	ULI	LLI	Liver	Kidneys	Spleen	Other	Retained
Infant													
0.04	9.48	0.83	20.10	11.92	12.14	2.31	1.48	0.04	0.05	0.01	0.00	0.13	58.92
0.08	9.39	0.76	19.28	4.72	16.13	2.14	4.92	0.26	0.10	0.02	0.01	0.26	58.07
0.17	9.26	0.67	17.72	0.72	12.69	1.84	11.20	1.45	0.19	0.04	0.02	0.51	56.35
0.33	9.05	0.58	14.98	0.07	5.07	1.30	15.43	5.11	0.33	0.07	0.03	0.90	52.95
0.50	8.88	0.54	12.66	0.04	1.95	0.87	14.20	8.47	0.43	0.09	0.04	1.16	49.36
1.00	8.58	0.48	7.64	0.02	0.18	0.25	6.93	12.24	0.56	0.11	0.06	1.51	38.57
2.00	8.28	0.43	2.79	0.01	0.02	0.03	1.28	7.77	0.60	0.12	0.06	1.61	23.01
4.00	7.89	0.39	0.37	0.00	0.01	0.02	0.09	1.43	0.59	0.12	0.06	1.58	12.56
8.00	7.20	0.33	0.01	0.00	0.01	0.01	0.05	0.12	0.56	0.11	0.06	1.52	9.99
1-y-old													
0.04	10.16	0.82	20.20	11.97	12.20	2.36	1.49	0.04	0.05	0.01	0.00	0.13	59.86
0.08	10.08	0.75	19.38	4.73	16.23	2.16	4.94	0.26	0.10	0.02	0.01	0.27	59.00
0.17	9.96	0.65	17.80	0.72	12.81	1.78	11.28	1.46	0.19	0.04	0.02	0.51	57.28
0.33	9.78	0.56	15.06	0.07	5.14	1.20	15.57	5.15	0.32	0.06	0.03	0.88	53.86
0.50	9.64	0.53	12.72	0.04	1.98	0.78	14.34	8.55	0.41	0.08	0.04	1.12	50.25
1.00	9.36	0.47	7.68	0.02	0.17	0.22	6.99	12.36	0.53	0.11	0.05	1.43	39.39
2.00	9.07	0.43	2.80	0.01	0.02	0.03	1.28	7.82	0.56	0.11	0.06	1.51	23.72
4.00	8.65	0.39	0.37	0.00	0.01	0.02	0.09	1.43	0.55	0.11	0.06	1.49	13.20
8.00	7.92	0.33	0.01	0.00	0.01	0.02	0.05	0.12	0.53	0.11	0.05	1.44	10.60
5-y-old													
0.04	10.48	0.82	16.67	9.80	9.98	2.17	1.22	0.03	0.04	0.01	0.00	0.12	51.71
0.08	10.39	0.74	15.99	3.90	13.30	1.98	4.05	0.22	0.09	0.02	0.01	0.24	51.01
0.17	10.27	0.65	14.69	0.61	10.53	1.63	9.25	1.20	0.17	0.03	0.02	0.47	49.59
0.33	10.07	0.56	12.43	0.07	4.27	1.09	12.81	4.23	0.30	0.06	0.03	0.80	46.76
0.50	9.91	0.52	10.50	0.04	1.67	0.71	11.84	7.03	0.38	0.08	0.04	1.02	43.77
1.00	9.62	0.46	6.34	0.02	0.16	0.20	5.83	10.22	0.48	0.10	0.05	1.30	34.78
2.00	9.31	0.42	2.31	0.01	0.02	0.03	1.09	6.52	0.51	0.10	0.05	1.38	21.77
4.00	8.88	0.38	0.31	0.00	0.01	0.02	0.09	1.22	0.51	0.10	0.05	1.37	12.95
8.00	8.12	0.32	0.01	0.00	0.01	0.02	0.05	0.11	0.49	0.10	0.05	1.33	10.63
10-y-old													
0.04	10.04	0.92	17.01	10.05	10.23	2.16	1.25	0.03	0.04	0.01	0.00	0.12	52.24
0.08	9.96	0.82	16.32	4.00	13.63	1.97	4.15	0.22	0.09	0.02	0.01	0.24	51.52
0.17	9.85	0.71	15.00	0.62	10.80	1.62	9.49	1.23	0.17	0.03	0.02	0.47	50.07
0.33	9.66	0.61	12.68	0.07	4.37	1.09	13.13	4.33	0.30	0.06	0.03	0.80	47.18
0.50	9.52	0.57	10.72	0.04	1.70	0.71	12.13	7.20	0.38	0.08	0.04	1.02	44.14
1.00	9.24	0.52	6.47	0.02	0.16	0.20	5.95	10.46	0.48	0.10	0.05	1.30	34.94
2.00	8.95	0.47	2.36	0.01	0.02	0.03	1.11	6.66	0.51	0.10	0.05	1.38	21.66
4.00	8.54	0.43	0.31	0.00	0.01	0.02	0.09	1.23	0.50	0.10	0.05	1.36	12.67
8.00	7.81	0.36	0.01	0.00	0.01	0.02	0.05	0.11	0.49	0.10	0.05	1.33	10.35
15-y-old													
0.04	11.32	1.30	13.33	8.04	8.14	2.12	1.00	0.02	0.04	0.01	0.00	0.11	45.78
0.08	11.23	1.15	12.79	3.26	10.91	1.93	3.32	0.18	0.09	0.02	0.01	0.24	45.21
0.17	11.09	0.98	11.75	0.56	8.75	1.58	7.62	0.98	0.17	0.03	0.02	0.46	44.07
0.33	10.87	0.84	9.94	0.08	3.63	1.05	10.66	3.49	0.29	0.06	0.03	0.78	41.77
0.50	10.70	0.79	8.40	0.05	1.46	0.69	9.92	5.84	0.37	0.07	0.04	0.99	39.34
1.00	10.38	0.71	5.07	0.02	0.16	0.19	4.96	8.57	0.47	0.09	0.05	1.26	31.95
2.00	10.05	0.66	1.85	0.01	0.03	0.03	0.96	5.54	0.50	0.10	0.05	1.34	21.12
4.00	9.59	0.60	0.25	0.00	0.02	0.02	0.09	1.06	0.49	0.10	0.05	1.33	13.62
8.00	8.77	0.50	0.00	0.00	0.01	0.02	0.06	0.12	0.49	0.10	0.05	1.31	11.44
Adult													
0.04	13.04		14.27	8.37	8.50	2.19	1.04	0.02	0.04	0.01	0.00	0.12	47.94
0.08	12.84		13.69	3.36	11.35	2.00	3.46	0.18	0.09	0.02	0.01	0.25	47.33
0.17	12.58		12.58	0.55	9.05	1.64	7.92	1.02	0.18	0.04	0.02	0.47	46.11
0.33	12.26		10.64	0.07	3.72	1.09	11.03	3.63	0.30	0.06	0.03	0.80	43.67
0.50	12.04		8.99	0.04	1.48	0.71	10.24	6.05	0.38	0.08	0.04	1.02	41.10
1.00	11.65		5.43	0.02	0.16	0.20	5.09	8.84	0.48	0.10	0.05	1.30	33.34
2.00	11.26		1.98	0.01	0.03	0.03	0.98	5.69	0.51	0.10	0.05	1.39	22.05
4.00	10.73		0.26	0.00	0.02	0.02	0.09	1.09	0.51	0.10	0.05	1.38	14.27
8.00	9.78		0.00	0.00	0.01	0.02	0.06	0.12	0.50	0.10	0.05	1.36	12.03

Table A-7. Activity of Type S ^{192}Ir in DCAL Source Regions at Various Times after Intake (%)

Time	Lung	BBi	ET1	Stomach	SI	Blood	ULI	LLI	Liver	Kidneys	Spleen	Other	Retained
Infant													
0.04	10.51	0.93	20.10	12.62	12.71	0.05	1.52	0.04	0.00	0.00	0.00	0.00	58.94
0.08	10.43	0.85	19.28	5.01	16.97	0.12	5.11	0.27	0.00	0.00	0.00	0.01	58.10
0.17	10.29	0.74	17.72	0.77	13.38	0.24	11.70	1.51	0.01	0.00	0.00	0.03	56.43
0.33	10.06	0.65	14.98	0.08	5.35	0.29	16.14	5.33	0.04	0.01	0.00	0.10	53.06
0.50	9.88	0.60	12.66	0.05	2.07	0.24	14.85	8.85	0.06	0.01	0.01	0.17	49.47
1.00	9.57	0.53	7.64	0.02	0.19	0.08	7.24	12.80	0.10	0.02	0.01	0.27	38.48
2.00	9.28	0.48	2.79	0.01	0.03	0.01	1.33	8.11	0.11	0.02	0.01	0.31	22.50
4.00	8.93	0.44	0.37	0.00	0.02	0.00	0.09	1.48	0.11	0.02	0.01	0.30	11.79
8.00	8.31	0.38	0.01	0.00	0.01	0.00	0.05	0.11	0.10	0.02	0.01	0.28	9.30
1-y-old													
0.04	11.26	0.91	20.20	12.66	12.77	0.04	1.53	0.04	0.00	0.00	0.00	0.00	59.87
0.08	11.19	0.83	19.38	5.02	17.07	0.07	5.13	0.27	0.00	0.00	0.00	0.00	59.03
0.17	11.07	0.72	17.80	0.76	13.51	0.13	11.78	1.52	0.01	0.00	0.00	0.02	57.35
0.33	10.87	0.63	15.06	0.07	5.43	0.15	16.28	5.37	0.02	0.00	0.00	0.05	53.97
0.50	10.72	0.58	12.72	0.04	2.10	0.12	15.00	8.93	0.03	0.01	0.00	0.09	50.36
1.00	10.44	0.53	7.68	0.02	0.18	0.04	7.29	12.91	0.05	0.01	0.01	0.14	39.31
2.00	10.16	0.48	2.80	0.01	0.03	0.00	1.33	8.16	0.06	0.01	0.01	0.16	23.22
4.00	9.79	0.44	0.37	0.00	0.02	0.00	0.09	1.48	0.06	0.01	0.01	0.16	12.45
8.00	9.14	0.38	0.01	0.00	0.01	0.00	0.05	0.11	0.05	0.01	0.01	0.15	9.93
5-y-old													
0.04	11.61	0.91	16.67	10.37	10.45	0.03	1.25	0.03	0.00	0.00	0.00	0.00	51.72
0.08	11.54	0.83	15.99	4.13	13.99	0.06	4.20	0.22	0.00	0.00	0.00	0.00	51.02
0.17	11.41	0.72	14.69	0.65	11.11	0.11	9.65	1.24	0.01	0.00	0.00	0.02	49.64
0.33	11.19	0.63	12.43	0.08	4.51	0.13	13.39	4.41	0.02	0.00	0.00	0.05	46.85
0.50	11.03	0.58	10.50	0.04	1.77	0.10	12.37	7.34	0.03	0.01	0.00	0.07	43.87
1.00	10.73	0.52	6.34	0.02	0.17	0.03	6.08	10.67	0.04	0.01	0.00	0.12	34.74
2.00	10.43	0.47	2.31	0.01	0.03	0.00	1.13	6.80	0.05	0.01	0.00	0.13	21.40
4.00	10.06	0.43	0.31	0.00	0.02	0.00	0.09	1.26	0.05	0.01	0.00	0.13	12.37
8.00	9.38	0.37	0.01	0.00	0.01	0.00	0.05	0.11	0.05	0.01	0.00	0.12	10.12
10-y-old													
0.04	11.13	1.01	17.01	10.63	10.70	0.03	1.28	0.03	0.00	0.00	0.00	0.00	52.24
0.08	11.06	0.91	16.32	4.24	14.34	0.06	4.30	0.23	0.00	0.00	0.00	0.00	51.54
0.17	10.94	0.79	15.00	0.67	11.39	0.11	9.90	1.27	0.01	0.00	0.00	0.02	50.12
0.33	10.74	0.68	12.68	0.07	4.62	0.13	13.73	4.52	0.02	0.00	0.00	0.05	47.28
0.50	10.59	0.64	10.72	0.04	1.81	0.10	12.68	7.52	0.03	0.01	0.00	0.08	44.23
1.00	10.31	0.58	6.47	0.02	0.17	0.03	6.21	10.92	0.05	0.01	0.00	0.12	34.90
2.00	10.03	0.53	2.36	0.01	0.03	0.00	1.15	6.94	0.05	0.01	0.01	0.14	21.26
4.00	9.67	0.49	0.31	0.00	0.02	0.00	0.08	1.28	0.05	0.01	0.00	0.13	12.06
8.00	9.02	0.42	0.01	0.00	0.01	0.00	0.05	0.11	0.05	0.01	0.00	0.13	9.81
15-y-old													
0.04	12.54	1.44	13.33	8.51	8.53	0.03	1.02	0.02	0.00	0.00	0.00	0.00	45.78
0.08	12.46	1.28	12.79	3.46	11.48	0.05	3.43	0.18	0.00	0.00	0.00	0.00	45.23
0.17	12.32	1.09	11.75	0.60	9.24	0.09	7.94	1.02	0.00	0.00	0.00	0.01	44.11
0.33	12.09	0.93	9.94	0.09	3.85	0.11	11.13	3.64	0.01	0.00	0.00	0.04	41.87
0.50	11.91	0.87	8.40	0.05	1.55	0.09	10.37	6.10	0.02	0.00	0.00	0.06	39.45
1.00	11.58	0.80	5.07	0.02	0.17	0.03	5.18	8.95	0.04	0.01	0.00	0.10	31.96
2.00	11.26	0.74	1.85	0.01	0.03	0.00	1.00	5.77	0.04	0.01	0.00	0.12	20.84
4.00	10.85	0.68	0.25	0.00	0.02	0.00	0.09	1.10	0.04	0.01	0.00	0.11	13.17
8.00	10.12	0.58	0.00	0.00	0.02	0.00	0.05	0.12	0.04	0.01	0.00	0.11	11.07
Adult													
0.04	14.45		14.27	8.86	8.90	0.03	1.06	0.02	0.00	0.00	0.00	0.00	47.94
0.08	14.26		13.69	3.57	11.95	0.05	3.58	0.19	0.00	0.00	0.00	0.00	47.35
0.17	13.97		12.58	0.59	9.55	0.09	8.25	1.06	0.01	0.00	0.00	0.01	46.16
0.33	13.63		10.64	0.08	3.94	0.11	11.51	3.78	0.01	0.00	0.00	0.04	43.77
0.50	13.40		8.99	0.05	1.58	0.09	10.69	6.31	0.02	0.00	0.00	0.06	41.21
1.00	13.00		5.43	0.02	0.17	0.03	5.31	9.22	0.04	0.01	0.00	0.11	33.35
2.00	12.62		1.98	0.01	0.03	0.00	1.02	5.93	0.04	0.01	0.00	0.12	21.78
4.00	12.15		0.26	0.00	0.02	0.00	0.09	1.12	0.04	0.01	0.00	0.12	13.83
8.00	11.29		0.00	0.00	0.02	0.00	0.05	0.12	0.04	0.01	0.00	0.11	11.67

Table A-8. Activity of Type M ^{241}Am in DCAL Source Regions at Various Times after Intake (%)

Time	Lung	BBi	ET1	Stomach	SI	Blood	ULI	LLI	Liver	Other	C_Bone	T_Bone	Retained
						Infant							
0.04	9.49	0.83	20.11	11.93	12.17	0.82	1.48	0.03	0.12	0.61	0.42	0.42	58.91
0.08	9.40	0.76	19.30	4.72	16.21	0.25	4.91	0.26	0.16	0.81	0.58	0.58	58.05
0.17	9.27	0.67	17.74	0.72	12.84	0.06	11.22	1.45	0.19	0.84	0.65	0.65	56.40
0.33	9.07	0.59	15.03	0.07	5.20	0.03	15.53	5.13	0.20	0.78	0.71	0.71	53.13
0.50	8.92	0.54	12.72	0.04	2.03	0.03	14.34	8.53	0.21	0.71	0.75	0.74	49.66
1.00	8.66	0.48	7.71	0.02	0.19	0.02	7.04	12.42	0.24	0.54	0.83	0.82	39.03
2.00	8.44	0.44	2.84	0.01	0.03	0.01	1.30	7.94	0.26	0.37	0.91	0.90	23.53
4.00	8.19	0.41	0.38	0.00	0.01	0.00	0.08	1.46	0.28	0.28	0.99	0.96	13.15
8.00	7.76	0.35	0.01	0.00	0.01	0.00	0.04	0.10	0.30	0.27	1.06	1.00	11.03
						1-y-old							
0.04	10.16	0.82	20.20	11.97	12.22	0.85	1.49	0.04	0.12	0.62	0.43	0.43	59.85
0.08	10.09	0.75	19.39	4.74	16.28	0.24	4.93	0.26	0.17	0.83	0.59	0.59	58.98
0.17	9.98	0.65	17.83	0.72	12.92	0.04	11.27	1.46	0.19	0.85	0.66	0.66	57.32
0.33	9.81	0.57	15.10	0.07	5.24	0.03	15.62	5.16	0.20	0.77	0.71	0.70	54.04
0.50	9.68	0.53	12.78	0.04	2.04	0.02	14.42	8.58	0.21	0.70	0.74	0.74	50.55
1.00	9.45	0.48	7.75	0.02	0.18	0.02	7.05	12.48	0.23	0.53	0.82	0.82	39.87
2.00	9.24	0.44	2.85	0.01	0.02	0.01	1.29	7.96	0.26	0.36	0.90	0.90	24.31
4.00	8.98	0.41	0.39	0.00	0.01	0.00	0.08	1.46	0.28	0.28	0.98	0.97	13.92
8.00	8.53	0.35	0.01	0.00	0.01	0.00	0.04	0.11	0.30	0.27	1.05	1.03	11.79
						5-y-old							
0.04	10.48	0.82	16.68	9.81	10.00	0.78	1.22	0.03	0.34	0.57	0.28	0.28	51.72
0.08	10.40	0.75	16.00	3.90	13.34	0.23	4.04	0.21	0.46	0.76	0.39	0.39	51.01
0.17	10.28	0.65	14.72	0.61	10.61	0.04	9.24	1.19	0.52	0.78	0.43	0.43	49.62
0.33	10.10	0.56	12.46	0.07	4.34	0.03	12.84	4.23	0.55	0.71	0.46	0.46	46.90
0.50	9.96	0.52	10.55	0.04	1.72	0.02	11.89	7.05	0.58	0.64	0.49	0.48	44.02
1.00	9.71	0.47	6.40	0.02	0.17	0.01	5.87	10.30	0.64	0.49	0.54	0.54	35.22
2.00	9.49	0.43	2.35	0.01	0.03	0.01	1.10	6.62	0.71	0.34	0.59	0.59	22.33
4.00	9.22	0.40	0.32	0.00	0.01	0.00	0.08	1.24	0.77	0.26	0.64	0.64	13.66
8.00	8.76	0.35	0.01	0.00	0.01	0.00	0.04	0.10	0.83	0.25	0.70	0.69	11.81
						10-y-old							
0.04	10.05	0.92	17.02	10.05	10.24	0.78	1.25	0.03	0.34	0.57	0.28	0.28	52.25
0.08	9.97	0.82	16.34	4.00	13.67	0.23	4.14	0.22	0.46	0.76	0.39	0.39	51.53
0.17	9.86	0.71	15.02	0.63	10.89	0.04	9.47	1.22	0.52	0.78	0.43	0.43	50.11
0.33	9.69	0.62	12.72	0.07	4.45	0.03	13.16	4.34	0.55	0.71	0.46	0.46	47.33
0.50	9.56	0.58	10.77	0.04	1.75	0.02	12.19	7.23	0.58	0.64	0.48	0.48	44.39
1.00	9.33	0.52	6.53	0.02	0.16	0.01	6.00	10.55	0.64	0.49	0.53	0.53	35.38
2.00	9.12	0.48	2.40	0.01	0.02	0.01	1.12	6.76	0.71	0.34	0.59	0.59	22.21
4.00	8.87	0.45	0.33	0.00	0.01	0.00	0.08	1.26	0.76	0.26	0.64	0.64	13.37
8.00	8.42	0.39	0.01	0.00	0.01	0.00	0.04	0.10	0.82	0.25	0.69	0.69	11.50
						15-y-old							
0.04	11.32	1.30	13.34	8.04	8.16	0.78	0.99	0.02	0.33	0.55	0.27	0.27	45.78
0.08	11.23	1.16	12.80	3.26	10.94	0.23	3.30	0.18	0.45	0.74	0.38	0.38	45.21
0.17	11.11	0.98	11.77	0.56	8.82	0.04	7.60	0.98	0.51	0.77	0.42	0.42	44.09
0.33	10.90	0.84	9.97	0.08	3.70	0.02	10.67	3.49	0.54	0.69	0.45	0.45	41.90
0.50	10.75	0.79	8.44	0.05	1.50	0.02	9.95	5.85	0.57	0.63	0.47	0.47	39.57
1.00	10.48	0.72	5.12	0.02	0.16	0.01	4.99	8.63	0.63	0.48	0.53	0.53	32.36
2.00	10.24	0.67	1.88	0.01	0.03	0.01	0.96	5.61	0.70	0.33	0.58	0.58	21.67
4.00	9.95	0.62	0.25	0.00	0.02	0.00	0.08	1.08	0.76	0.26	0.64	0.63	14.37
8.00	9.45	0.54	0.00	0.00	0.01	0.00	0.05	0.11	0.82	0.25	0.70	0.69	12.71
						Adult							
0.04	13.04		14.28	8.37	8.51	0.80	1.04	0.02	0.56	0.57	0.17	0.17	47.95
0.08	12.85		13.70	3.36	11.39	0.23	3.44	0.18	0.78	0.77	0.23	0.23	47.34
0.17	12.60		12.60	0.55	9.12	0.04	7.90	1.02	0.88	0.80	0.26	0.26	46.14
0.33	12.29		10.67	0.07	3.78	0.03	11.04	3.62	0.93	0.72	0.28	0.28	43.80
0.50	12.10		9.03	0.04	1.52	0.02	10.27	6.06	0.98	0.65	0.30	0.30	41.34
1.00	11.77		5.48	0.02	0.16	0.01	5.12	8.90	1.08	0.50	0.33	0.33	33.77
2.00	11.48		2.02	0.01	0.03	0.01	0.98	5.77	1.20	0.35	0.36	0.36	22.63
4.00	11.14		0.27	0.00	0.02	0.00	0.09	1.11	1.31	0.27	0.40	0.40	15.06
8.00	10.54		0.00	0.00	0.01	0.00	0.05	0.11	1.42	0.27	0.43	0.43	13.35

APPENDIX B

POSITIONS OF PHANTOMS WITH RESPECT TO GAMMA CAMERAS

Appendix B

POSITION OF PHANTOMS WITH RESPECT TO GAMMA CAMERAS

The position of each phantom with respect to the Siemens e.cam and the Philips SKYLight cameras is illustrated in Figures B-1 to B-14. These figures are sagittal sections in the median plane of each phantom-camera combination, produced by MCNPX. In each case, a distance of 5 cm is maintained between the camera and the nearest portion of the body.[1] The position of the infant was adjusted so that the entire body was centered on the field of view (FOV) of each camera.[2] The one-year-old was positioned with the top of the head at the top of the FOV, which encompassed all but the lower legs.[3] The 5-year-old was positioned with the base of the trunk at the bottom edge of the FOV. The detector of the Siemens camera was centered on the region of the 10-year-old extending from the nose[4] to the base of the trunk. The two heads of the Philips SKYLight were positioned so that the nasal cavity of the 10-year-old fell into the anterior FOV, while posterior camera viewed all the major organs in the trunk. The 15-year-old and the adult phantoms were placed in typical positions of adults undergoing lung scans, as discussed in Section 3.1.3.

The apparent anomaly of the NORMAN nose touching the camera in Figures B-11 and B-12 is due to the rigidity of the phantom model. The real patient would tilt his head back. In the sagittal sections of NAOMI shown in Figures B-13 and B-14, the buttocks are flattened due to the supine position of the subject during the MRI scan (NORMAN had been adjusted to correct this artifact). In addition, the breasts do not appear in this medial view. The spacing of the camera heads maintains a 5-cm distance from the natural shape of the body in a patient standing erect. Because the median plane lies between the lower legs of both phantoms, only the upper portions of the legs are shown in Figures B-11–B-14.

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[1] 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.

[2] The field of view of each camera is described in Parts II and III of the present series (Anigstein et al. 2007b, Section 2.1.3; Anigstein et al. 2007c, Section 2.1.2), respectively.

[3] Note that with the collimator removed, counts are registered from regions of the body outside the normal field of view, but with reduced efficiencies.

[4] As shown in Appendix A, a significant fraction of the inhaled activity is contained in the anterior nasal cavity during the first day following exposure.

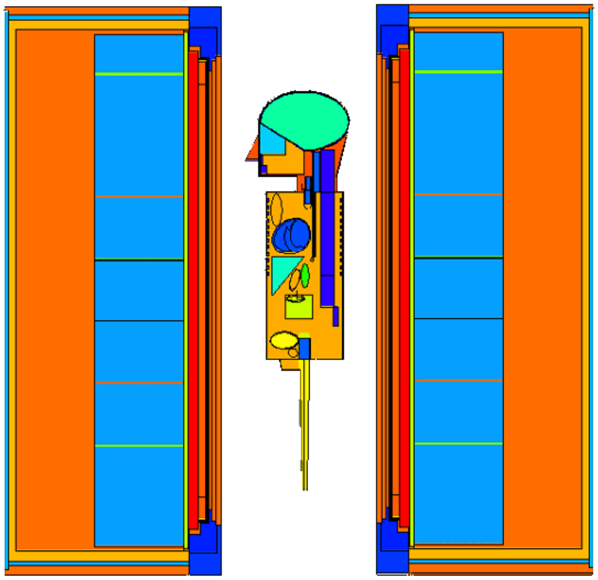

Figure B-1. Infant–Siemens e.cam

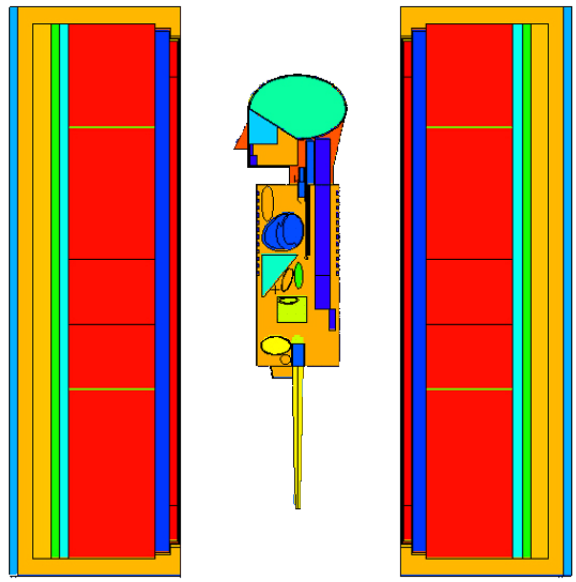

Figure B-2. Infant–Philips SKYLight

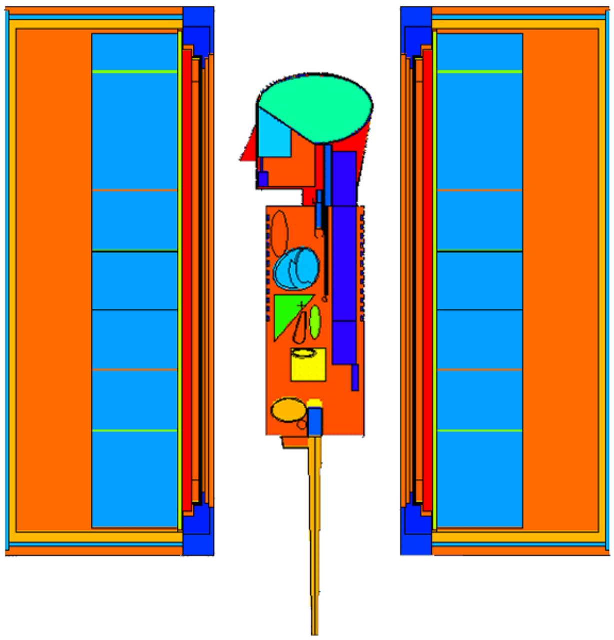

Figure B-3. 1-y-old–Siemens e.cam

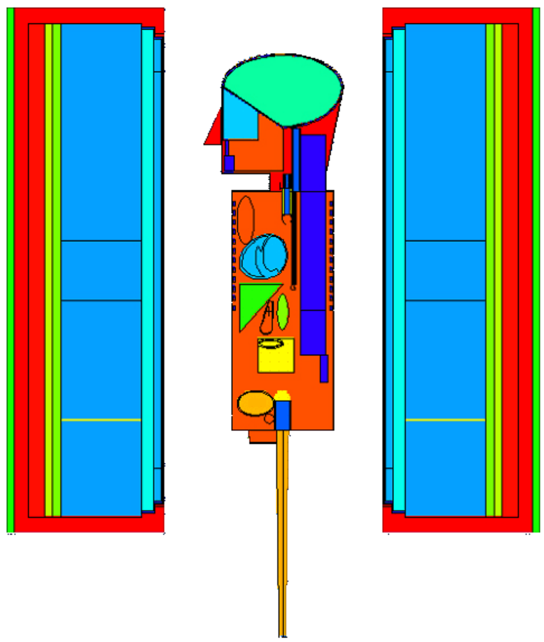

Figure B-4. 1-y-old–Philips SKYLight

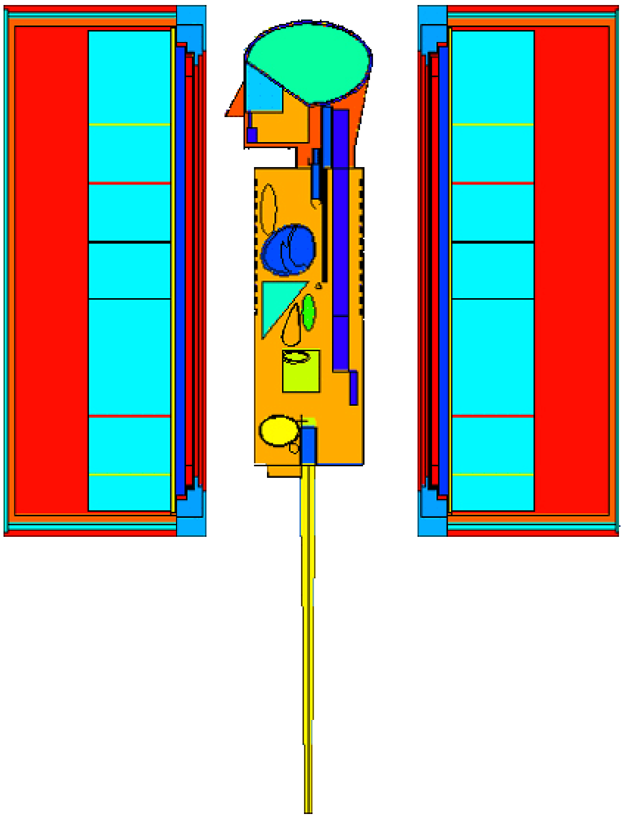

Figure B-5. 5-y-old–Siemens e.cam

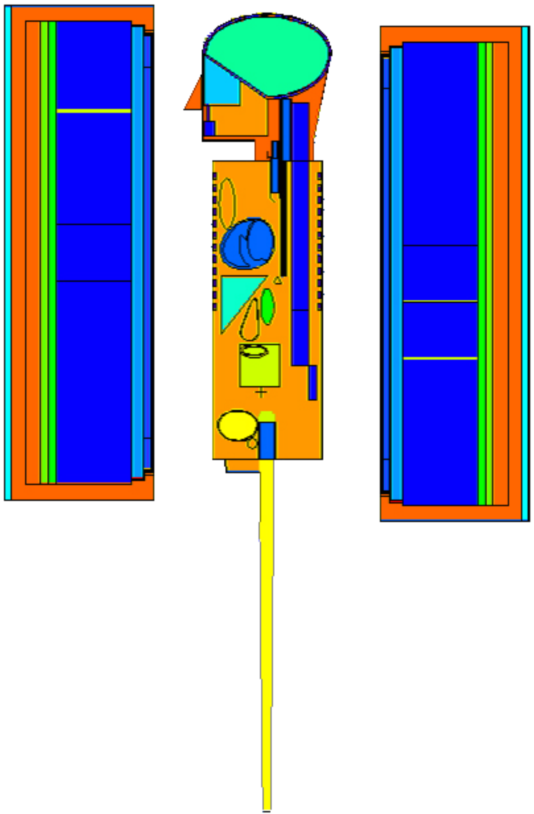

Figure B-6. 5-y-old–Philips SKYLight

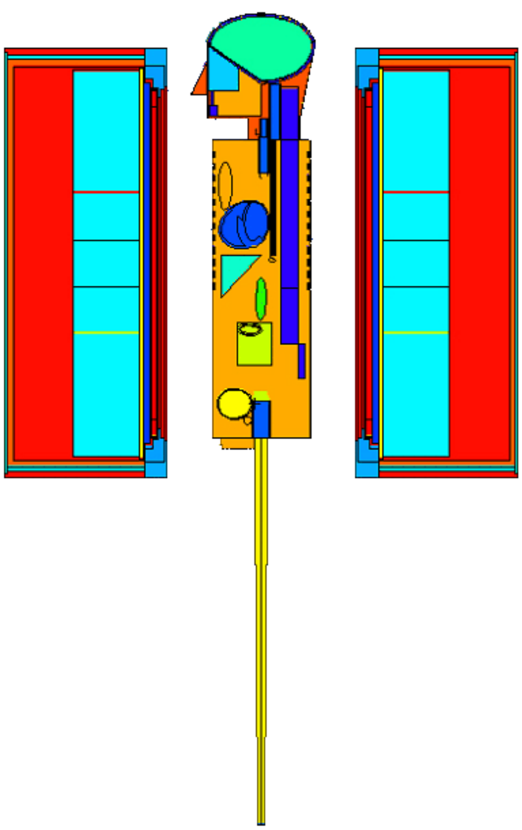

Figure B-7. 10-y-old–Siemens e.cam

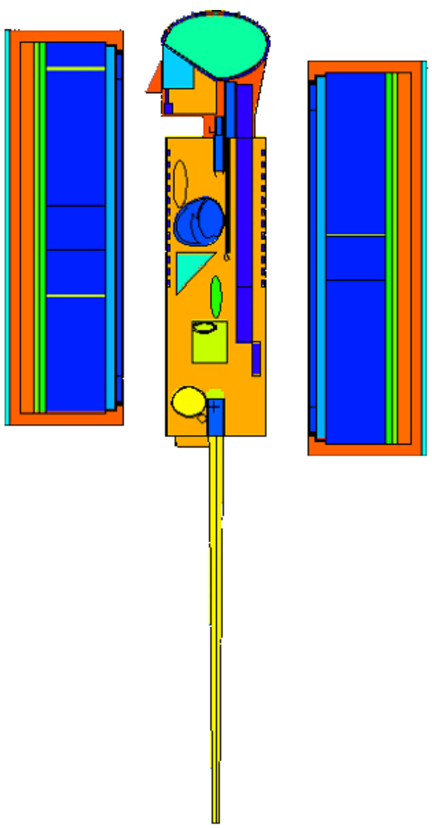

Figure B-8. 10-y-old–Philips SKYLight

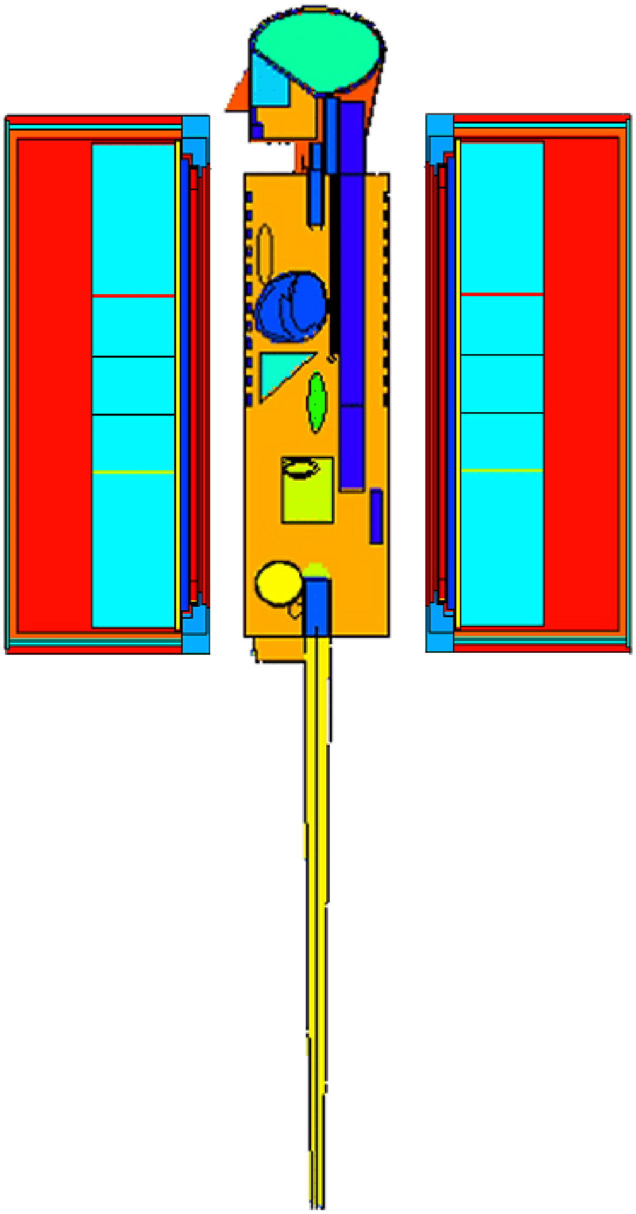

Figure B-9. 15-y-old–Siemens e.cam

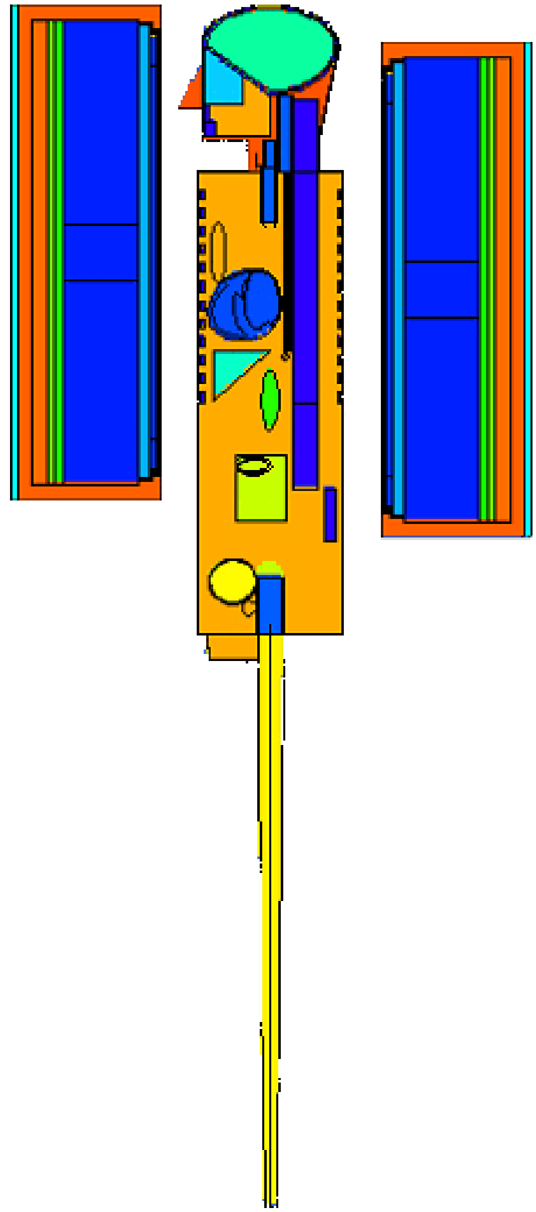

Figure B-10. 15-y-old–Philips SKYLight

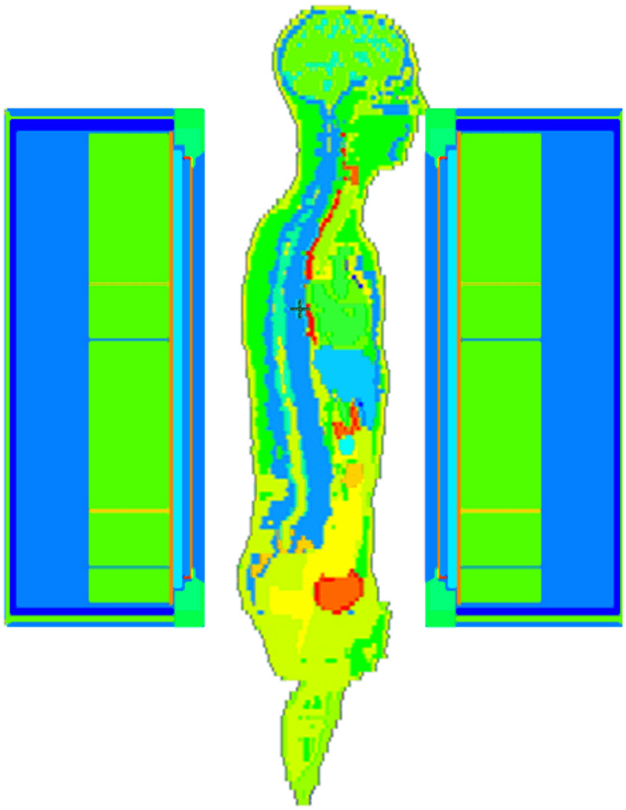

Figure B-11. NORMAN–Siemens e.cam

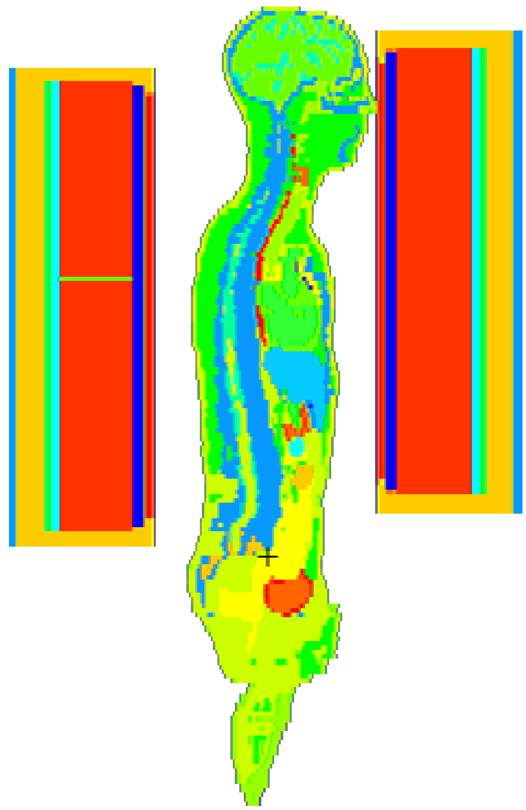

Figure B-12. NORMAN–Philips SKYLight

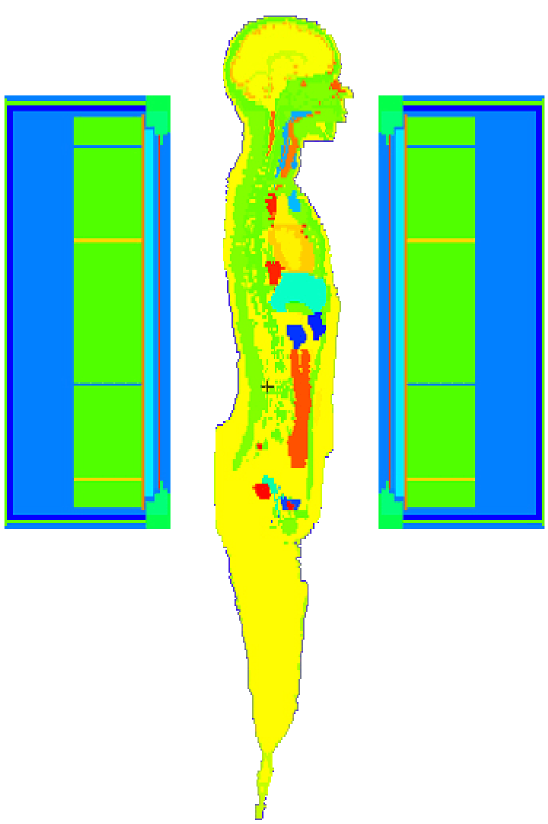

Figure B-13. NAOMI–Siemens e.cam

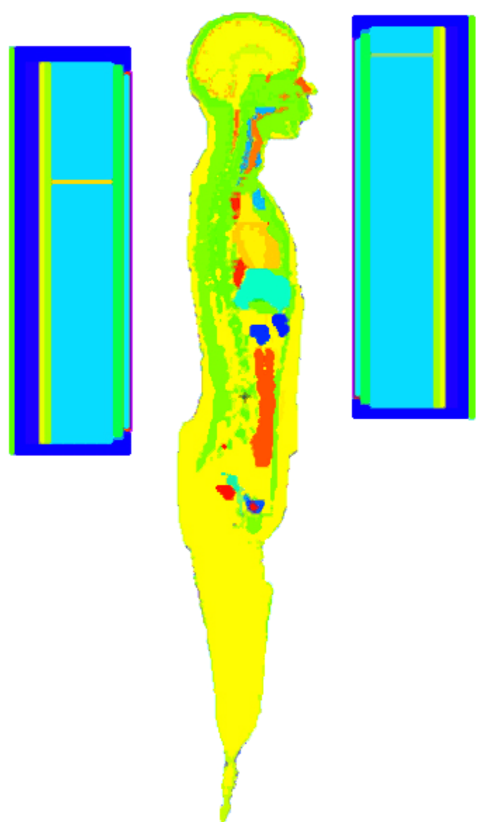

Figure B-14. NAOMI–Philips SKYLight

APPENDIX C

NORMALIZED COUNT RATES IN GAMMA CAMERAS FROM RADIONUCLIDES IN VARIOUS ANATOMICAL REGIONS

Appendix C

NORMALIZED COUNT RATES FROM RADIONUCLIDES IN VARIOUS ANATOMICAL REGIONS

Tables C-1–C-4 list the calculated count rates from each of four radionuclides in various anatomical regions of each of the seven anthropomorphic phantoms used in the present analysis. These regions are identified by the same names as the corresponding source regions in the DCAL model, described in Table A-1. All count rates are normalized to a total activity of 1 Bq uniformly distributed in each region.

As discussed in Section 3.1.4, the simulated count rates from ^{60}Co, ^{137}Cs, and ^{192}Ir in the Siemens e.cam camera were summed over two sets of energy windows: one set consisted of six 50% windows, while the second, narrower set consisted of three such windows. The count rates from these three nuclides in the first set of windows are listed in Tables C-1–C-3 under the column heading "6 Windows," while those using the second set are under the heading "3 Windows." A single set of two 50% windows was used to sum the count rates in the Siemens camera from ^{241}Am, which are listed in Table C-4. Count rates in the two detectors, one in the anterior position, facing the phantom, the other in the posterior position, were calculated separately.

Table C-1. Normalized Count Rates from ^{60}Co in Various Anatomical Regions (cps/Bq)

Anatomical region	Camera					
	Siemens e.cam				Philips SKYLight	
	6 Windows		3 Windows			
	AP	Posterior	Anterior	Posterior	Anterior	Posterior
Infant						
Lung	1.44e-01	1.62e-01	1.02e-01	1.14e-01	1.03e-01	1.17e-01
BBi	1.45e-01	1.67e-01	1.04e-01	1.19e-01	1.04e-01	1.21e-01
ET1	1.64e-01	7.80e-02	1.11e-01	5.51e-02	1.10e-01	5.36e-02
Stomach	1.88e-01	1.53e-01	1.36e-01	1.10e-01	1.37e-01	1.12e-01
SI	1.77e-01	1.77e-01	1.28e-01	1.27e-01	1.29e-01	1.30e-01
Blood	1.54e-01	1.59e-01	1.10e-01	1.13e-01	1.11e-01	1.15e-01
ULI	1.82e-01	1.68e-01	1.32e-01	1.20e-01	1.33e-01	1.23e-01
LLI	1.69e-01	1.74e-01	1.22e-01	1.25e-01	1.23e-01	1.27e-01
Other	1.39e-01	1.51e-01	9.86e-02	1.07e-01	9.82e-02	1.08e-01
Liver	1.77e-01	1.61e-01	1.27e-01	1.15e-01	1.29e-01	1.17e-01
1-y-old						
Lung	1.38e-01	1.59e-01	9.97e-02	1.14e-01	1.10e-01	1.29e-01
BBi	1.42e-01	1.70e-01	1.04e-01	1.23e-01	1.14e-01	1.38e-01
ET1	1.69e-01	6.52e-02	1.16e-01	4.67e-02	1.29e-01	5.09e-02
Stomach	1.86e-01	1.44e-01	1.37e-01	1.05e-01	1.50e-01	1.17e-01
SI	1.64e-01	1.65e-01	1.20e-01	1.21e-01	1.30e-01	1.33e-01
Blood	1.44e-01	1.49e-01	1.05e-01	1.08e-01	1.14e-01	1.20e-01
ULI	1.71e-01	1.53e-01	1.25e-01	1.12e-01	1.37e-01	1.23e-01
LLI	1.47e-01	1.52e-01	1.08e-01	1.11e-01	1.16e-01	1.21e-01
Other	1.19e-01	1.34e-01	8.58e-02	9.62e-02	9.29e-02	1.06e-01
Liver	1.71e-01	1.54e-01	1.25e-01	1.12e-01	1.37e-01	1.25e-01
5-y-old						
Lung	1.44e-01	1.42e-01	1.04e-01	1.03e-01	1.16e-01	1.20e-01
BBi	1.45e-01	1.56e-01	1.06e-01	1.15e-01	1.18e-01	1.32e-01
ET1	1.55e-01	4.84e-02	1.07e-01	3.48e-02	1.25e-01	3.76e-02
Stomach	2.03e-01	1.28e-01	1.49e-01	9.41e-02	1.62e-01	1.08e-01
SI	1.70e-01	1.45e-01	1.25e-01	1.07e-01	1.29e-01	1.23e-01
Blood	1.42e-01	1.27e-01	1.04e-01	9.30e-02	1.13e-01	1.07e-01
ULI	1.79e-01	1.35e-01	1.32e-01	9.88e-02	1.38e-01	1.14e-01
LLI	1.44e-01	1.26e-01	1.06e-01	9.28e-02	1.06e-01	1.07e-01
Other	1.04e-01	1.02e-01	7.51e-02	7.42e-02	8.00e-02	8.43e-02
Liver	1.83e-01	1.41e-01	1.34e-01	1.03e-01	1.46e-01	1.19e-01

Table C-1 (continued)

Anatomical region	Camera					
	Siemens e.cam				Philips SKYLight	
	6 Windows		3 Windows			
	AP	Posterior	Anterior	Posterior	Anterior	Posterior
			10-y-old			
Lung	1.34e-01	1.39e-01	9.75e-02	1.01e-01	1.21e-01	1.21e-01
BBi	1.36e-01	1.43e-01	1.00e-01	1.06e-01	1.27e-01	1.26e-01
ET1	9.46e-02	3.67e-02	6.53e-02	2.62e-02	1.08e-01	3.07e-02
Stomach	2.01e-01	1.29e-01	1.47e-01	9.40e-02	1.67e-01	1.11e-01
SI	1.66e-01	1.48e-01	1.22e-01	1.08e-01	1.20e-01	1.24e-01
Blood	1.31e-01	1.21e-01	9.57e-02	8.85e-02	1.11e-01	1.04e-01
ULI	1.76e-01	1.35e-01	1.29e-01	9.85e-02	1.30e-01	1.13e-01
LLI	1.37e-01	1.23e-01	9.99e-02	8.96e-02	8.85e-02	1.00e-01
Other	8.76e-02	9.02e-02	6.32e-02	6.55e-02	6.83e-02	7.49e-02
Liver	1.76e-01	1.43e-01	1.29e-01	1.05e-01	1.47e-01	1.24e-01
			15-y-old			
Lung	1.45e-01	1.50e-01	1.05e-01	1.08e-01	1.32e-01	1.39e-01
BBi	1.47e-01	1.43e-01	1.06e-01	1.04e-01	1.54e-01	1.47e-01
ET1	5.57e-02	2.78e-02	3.77e-02	1.95e-02	1.44e-01	3.76e-02
Stomach	2.33e-01	1.43e-01	1.69e-01	1.03e-01	1.43e-01	1.01e-01
SI	1.86e-01	1.62e-01	1.34e-01	1.17e-01	6.47e-02	8.12e-02
Blood	1.42e-01	1.30e-01	1.02e-01	9.36e-02	1.04e-01	1.01e-01
ULI	2.00e-01	1.46e-01	1.45e-01	1.05e-01	7.36e-02	7.69e-02
LLI	1.42e-01	1.24e-01	1.02e-01	8.87e-02	3.76e-02	4.79e-02
Other	8.95e-02	9.17e-02	6.40e-02	6.61e-02	5.71e-02	6.44e-02
			Adult male			
Lung	1.44e-01	1.48e-01	1.05e-01	1.08e-01	1.28e-01	1.31e-01
ET1	4.79e-02	2.60e-02	3.38e-02	1.88e-02	1.68e-01	3.13e-02
Stomach	2.09e-01	1.48e-01	1.53e-01	1.08e-01	1.40e-01	1.11e-01
SI	1.73e-01	1.24e-01	1.27e-01	9.05e-02	7.04e-02	7.11e-02
Blood	1.15e-01	1.01e-01	8.68e-02	7.20e-02	8.62e-02	7.93e-02
ULI	1.83e-01	1.29e-01	1.34e-01	9.41e-02	8.58e-02	8.04e-02
LLI	1.14e-01	1.20e-01	8.30e-02	8.75e-02	4.06e-02	6.13e-02
Other	6.83e-02	7.62e-02	4.93e-02	5.53e-02	4.66e-02	5.44e-02
			Adult female			
Lung	1.33e-01	1.37e-01	9.67e-02	1.00e-01	1.14e-01	1.22e-01
ET1	6.12e-02	2.99e-02	4.25e-02	2.14e-02	1.15e-01	3.32e-02
Stomach	1.83e-01	1.48e-01	1.34e-01	1.09e-01	1.35e-01	1.22e-01
SI	1.81e-01	1.25e-01	1.32e-01	9.07e-02	7.80e-02	7.62e-02
Blood	1.24e-01	1.08e-01	9.05e-02	7.88e-02	8.80e-02	8.46e-02
ULI	2.18e-01	1.15e-01	1.60e-01	8.36e-02	1.28e-01	8.13e-02
LLI	1.51e-01	1.13e-01	1.10e-01	8.16e-02	6.87e-02	7.13e-02
Other	7.35e-02	7.53e-02	5.31e-02	5.45e-02	4.62e-02	5.30e-02

Table C-2. Normalized Count Rates from ^{137}Cs in Various Anatomical Regions (cps/Bq)

Anatomical region	Camera					
	Siemens e.cam				Philips SKYLight	
	6 Windows		3 Windows			
	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
			Infant			
ET1	1.52e-01	5.24e-02	8.11e-02	3.34e-02	1.09e-01	3.80e-02
Stomach	1.47e-01	1.09e-01	9.29e-02	7.19e-02	1.09e-01	8.14e-02
Blood	1.19e-01	1.21e-01	7.47e-02	7.61e-02	8.76e-02	9.08e-02
Body tissue	1.08e-01	1.19e-01	6.70e-02	7.33e-02	7.90e-02	8.89e-02
			1-y-old			
ET1	1.52e-01	3.98e-02	8.40e-02	2.67e-02	1.22e-01	3.08e-02
Stomach	1.39e-01	9.55e-02	9.19e-02	6.59e-02	1.09e-01	7.44e-02
Blood	1.05e-01	1.07e-01	6.89e-02	7.05e-02	8.18e-02	8.52e-02
LLI	1.03e-01	1.04e-01	7.01e-02	7.15e-02	7.73e-02	7.98e-02
Body tissue	8.76e-02	9.98e-02	5.71e-02	6.44e-02	6.72e-02	7.90e-02
			5-y-old			
ET1	1.37e-01	2.81e-02	7.65e-02	1.93e-02	1.17e-01	2.08e-02
Stomach	1.45e-01	8.12e-02	9.81e-02	5.74e-02	1.10e-01	6.25e-02
Blood	9.95e-02	8.68e-02	6.68e-02	5.90e-02	7.53e-02	6.94e-02
LLI	9.59e-02	8.23e-02	6.63e-02	5.79e-02	6.49e-02	6.38e-02
Body tissue	7.49e-02	7.35e-02	4.98e-02	4.89e-02	5.55e-02	5.85e-02
			10-y-old			
ET1	7.77e-02	2.03e-02	4.48e-02	1.40e-02	9.78e-02	1.59e-02
Stomach	1.39e-01	7.84e-02	9.55e-02	5.56e-02	1.08e-01	5.94e-02
Blood	8.87e-02	8.02e-02	6.04e-02	5.51e-02	6.99e-02	6.39e-02
Body tissue	6.24e-02	6.34e-02	4.20e-02	4.27e-02	4.61e-02	4.98e-02
			15-y-old			
ET1	4.00e-02	1.41e-02	2.36e-02	9.70e-03	1.31e-01	1.85e-02
Stomach	1.54e-01	8.26e-02	1.06e-01	5.85e-02	8.54e-02	4.92e-02
Blood	9.16e-02	8.09e-02	6.27e-02	5.60e-02	6.17e-02	5.77e-02
Body tissue	6.09e-02	6.19e-02	4.12e-02	4.20e-02	3.60e-02	4.01e-02
			Adult male			
ET1	3.00e-02	1.32e-02	1.97e-02	9.39e-03	1.56e-01	1.46e-02
Stomach	1.35e-01	8.71e-02	9.40e-02	6.25e-02	8.06e-02	5.57e-02
Blood	7.58e-02	6.39e-02	5.24e-02	4.49e-02	5.22e-02	4.52e-02
Body tissue	4.57e-02	5.00e-02	3.11e-02	3.40e-02	2.96e-02	3.35e-02
			Adult female			
ET1	4.40e-02	1.60e-02	2.71e-02	1.12e-02	9.69e-02	1.69e-02
Stomach	1.17e-01	9.14e-02	8.26e-02	6.54e-02	7.76e-02	6.65e-02
Blood	8.23e-02	6.95e-02	5.65e-02	4.85e-02	5.37e-02	4.93e-02
Body tissue	4.91e-02	5.05e-02	3.31e-02	3.41e-02	2.90e-02	3.30e-02

Table C-3. Normalized Count Rates from ^{192}Ir in Various Anatomical Regions (cps/Bq)

Anatomical region	Camera					
	Siemens e.cam				Philips SKYLight	
	6 Windows		3 Windows			
	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Infant						
Lung	4.01e-01	4.61e-01	3.25e-01	3.74e-01	3.17e-01	3.70e-01
BBi	3.85e-01	4.57e-01	3.15e-01	3.73e-01	3.01e-01	3.63e-01
ET1	5.52e-01	1.66e-01	4.38e-01	1.37e-01	4.15e-01	1.24e-01
Stomach	5.34e-01	3.77e-01	4.34e-01	3.09e-01	4.29e-01	3.04e-01
SI	4.71e-01	4.50e-01	3.84e-01	3.68e-01	3.78e-01	3.66e-01
Blood	4.27e-01	4.31e-01	3.47e-01	3.51e-01	3.37e-01	3.45e-01
ULI	4.99e-01	4.16e-01	4.07e-01	3.40e-01	4.02e-01	3.36e-01
LLI	4.53e-01	4.52e-01	3.70e-01	3.70e-01	3.62e-01	3.63e-01
Liver	4.96e-01	4.10e-01	4.04e-01	3.35e-01	3.98e-01	3.31e-01
Kidneys	3.07e-01	6.32e-01	2.52e-01	5.12e-01	2.43e-01	5.16e-01
Spleen	3.63e-01	5.35e-01	2.98e-01	4.36e-01	2.90e-01	4.35e-01
Other	3.82e-01	4.20e-01	3.10e-01	3.41e-01	2.98e-01	3.32e-01
1-y-old						
Lung	3.66e-01	4.28e-01	2.97e-01	3.48e-01	3.17e-01	3.78e-01
BBi	3.51e-01	4.30e-01	2.86e-01	3.51e-01	3.03e-01	3.81e-01
ET1	5.53e-01	1.18e-01	4.40e-01	9.73e-02	4.67e-01	9.89e-02
Stomach	5.00e-01	3.19e-01	4.05e-01	2.60e-01	4.35e-01	2.81e-01
SI	4.05e-01	3.84e-01	3.27e-01	3.12e-01	3.48e-01	3.36e-01
Blood	3.70e-01	3.72e-01	3.01e-01	3.03e-01	3.19e-01	3.26e-01
ULI	4.37e-01	3.47e-01	3.54e-01	2.81e-01	3.77e-01	3.04e-01
LLI	3.63e-01	3.56e-01	2.93e-01	2.89e-01	3.07e-01	3.08e-01
Liver	4.51e-01	3.64e-01	3.65e-01	2.96e-01	3.92e-01	3.22e-01
Kidneys	2.49e-01	6.17e-01	2.03e-01	5.00e-01	2.15e-01	5.49e-01
Spleen	3.09e-01	4.99e-01	2.52e-01	4.06e-01	2.67e-01	4.43e-01
Other	3.02e-01	3.40e-01	2.45e-01	2.76e-01	2.54e-01	2.93e-01
5-y-old						
Lung	3.59e-01	3.65e-01	2.89e-01	2.95e-01	3.17e-01	3.32e-01
BBi	3.31e-01	3.75e-01	2.68e-01	3.05e-01	2.94e-01	3.42e-01
ET1	4.94e-01	7.99e-02	3.93e-01	6.55e-02	4.43e-01	6.55e-02
Stomach	5.15e-01	2.65e-01	4.14e-01	2.12e-01	4.46e-01	2.43e-01
SI	3.94e-01	3.17e-01	3.14e-01	2.54e-01	3.24e-01	2.93e-01
Blood	3.46e-01	2.98e-01	2.78e-01	2.41e-01	2.98e-01	2.71e-01
ULI	4.30e-01	2.83e-01	3.44e-01	2.26e-01	3.56e-01	2.60e-01
LLI	3.27e-01	2.73e-01	2.61e-01	2.19e-01	2.57e-01	2.50e-01
Liver	4.53e-01	3.10e-01	3.63e-01	2.49e-01	3.92e-01	2.86e-01
Kidneys	2.32e-01	5.45e-01	1.85e-01	4.40e-01	1.95e-01	5.10e-01
Spleen	3.01e-01	4.33e-01	2.41e-01	3.49e-01	2.57e-01	4.01e-01
Other	2.44e-01	2.41e-01	1.96e-01	1.95e-01	2.03e-01	2.15e-01

Table C-3 (continued)

Anatomical region	Camera					
	Siemens e.cam				Philips SKYLight	
	6 Windows		3 Windows			
	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
10-y-old						
Lung	3.24e-01	3.40e-01	2.59e-01	2.73e-01	3.18e-01	3.22e-01
BBi	2.99e-01	3.22e-01	2.39e-01	2.60e-01	3.06e-01	3.06e-01
ET1	2.69e-01	5.63e-02	2.15e-01	4.58e-02	3.64e-01	4.93e-02
Stomach	4.90e-01	2.49e-01	3.90e-01	1.97e-01	4.42e-01	2.32e-01
SI	3.67e-01	3.03e-01	2.89e-01	2.39e-01	2.82e-01	2.76e-01
Blood	3.19e-01	2.73e-01	2.69e-01	2.24e-01	2.78e-01	2.50e-01
ULI	4.02e-01	2.67e-01	3.18e-01	2.10e-01	3.17e-01	2.44e-01
LLI	2.93e-01	2.48e-01	2.31e-01	1.96e-01	1.97e-01	2.15e-01
Liver	4.13e-01	3.03e-01	3.30e-01	2.41e-01	3.76e-01	2.85e-01
Kidneys	2.10e-01	5.53e-01	1.64e-01	4.43e-01	1.81e-01	5.28e-01
Spleen	2.66e-01	4.29e-01	2.11e-01	3.44e-01	2.38e-01	4.08e-01
Other	1.95e-01	2.01e-01	1.55e-01	1.61e-01	1.65e-01	1.80e-01
15-y-old						
Lung	3.21e-01	3.35e-01	2.52e-01	2.66e-01	3.24e-01	3.42e-01
BBi	2.98e-01	2.84e-01	2.32e-01	2.24e-01	3.49e-01	3.25e-01
ET1	1.26e-01	3.53e-02	1.00e-01	2.81e-02	4.93e-01	5.85e-02
Stomach	5.24e-01	2.48e-01	4.12e-01	1.91e-01	3.43e-01	1.91e-01
SI	3.77e-01	3.01e-01	2.91e-01	2.33e-01	1.19e-01	1.52e-01
Blood	3.02e-01	2.61e-01	2.37e-01	2.05e-01	2.44e-01	2.26e-01
ULI	4.18e-01	2.63e-01	3.25e-01	2.02e-01	1.45e-01	1.42e-01
LLI	2.76e-01	2.25e-01	2.13e-01	1.74e-01	5.97e-02	7.98e-02
Liver	4.28e-01	3.07e-01	3.36e-01	2.40e-01	3.04e-01	2.53e-01
Kidneys	2.06e-01	6.17e-01	1.56e-01	4.91e-01	1.21e-01	4.73e-01
Spleen	2.62e-01	4.49e-01	2.02e-01	3.55e-01	1.81e-01	3.71e-01
Other	1.81e-01	1.87e-01	1.43e-01	1.48e-01	1.30e-01	1.44e-01
Adult male						
Lung	3.23e-01	3.26e-01	2.58e-01	2.62e-01	3.22e-01	3.21e-01
ET1	8.85e-02	3.41e-02	7.19e-02	2.78e-02	5.61e-01	4.61e-02
Stomach	4.47e-01	2.67e-01	3.54e-01	2.09e-01	3.20e-01	2.18e-01
SI	3.80e-01	2.13e-01	2.99e-01	1.67e-01	1.41e-01	1.26e-01
Blood	2.77e-01	1.80e-01	2.15e-01	1.47e-01	2.26e-01	1.58e-01
ULI	4.09e-01	2.30e-01	3.24e-01	1.80e-01	1.81e-01	1.51e-01
LLI	2.18e-01	2.27e-01	1.71e-01	1.79e-01	6.78e-02	1.17e-01
Liver	4.34e-01	2.69e-01	3.45e-01	2.12e-01	3.37e-01	2.30e-01
Kidneys	2.66e-01	4.46e-01	2.07e-01	3.54e-01	1.78e-01	3.61e-01
Spleen	2.75e-01	3.77e-01	2.17e-01	3.00e-01	2.01e-01	3.16e-01
Other	1.39e-01	1.57e-01	1.11e-01	1.25e-01	1.00e-01	1.18e-01
Adult female						
Lung	2.93e-01	3.18e-01	2.33e-01	2.54e-01	2.84e-01	3.13e-01
ET1	1.41e-01	4.33e-02	1.14e-01	3.51e-02	3.75e-01	5.54e-02
Stomach	3.89e-01	3.01e-01	3.07e-01	2.37e-01	3.16e-01	2.72e-01
SI	4.09e-01	2.35e-01	3.22e-01	1.82e-01	1.73e-01	1.53e-01
Blood	2.76e-01	2.28e-01	2.19e-01	1.81e-01	2.14e-01	1.97e-01
ULI	5.32e-01	2.11e-01	4.22e-01	1.64e-01	3.33e-01	1.60e-01
LLI	3.35e-01	2.16e-01	2.64e-01	1.68e-01	1.50e-01	1.46e-01
Liver	4.24e-01	2.87e-01	3.36e-01	2.25e-01	3.15e-01	2.39e-01
Kidneys	2.92e-01	4.22e-01	2.27e-01	3.34e-01	1.81e-01	3.32e-01
Spleen	2.62e-01	3.81e-01	2.06e-01	3.04e-01	2.08e-01	3.40e-01
Other	1.55e-01	1.61e-01	1.23e-01	1.27e-01	1.09e-01	1.26e-01

Table C-4. Normalized Count Rates from ^{241}Am in Various Anatomical Regions (cps/Bq)

Anatomical region	Camera			
	Siemens e.cam		Philips SKYLight	
	Anterior	Posterior	Anterior	Posterior
Infant				
Lung	6.84e-02	7.89e-02	6.05e-02	7.06e-02
BBi	6.04e-02	7.12e-02	5.25e-02	6.30e-02
ET1	1.17e-01	1.81e-02	9.88e-02	1.44e-02
Stomach	9.18e-02	4.99e-02	8.28e-02	4.47e-02
SI	7.29e-02	6.26e-02	6.57e-02	5.68e-02
Blood	7.14e-02	6.86e-02	6.30e-02	6.10e-02
ULI	8.07e-02	5.58e-02	7.26e-02	5.04e-02
LLI	7.06e-02	6.51e-02	6.33e-02	5.86e-02
Liver	8.38e-02	5.86e-02	7.52e-02	5.26e-02
Other	6.56e-02	7.10e-02	5.68e-02	6.22e-02
Bone	7.82e-02	5.81e-02	6.84e-02	5.09e-02
1-y-old				
Lung	5.61e-02	6.46e-02	5.33e-02	6.22e-02
BBi	4.60e-02	5.55e-02	4.37e-02	5.37e-02
ET1	1.14e-01	8.27e-03	1.05e-01	7.27e-03
Stomach	7.75e-02	3.28e-02	7.41e-02	3.16e-02
SI	5.38e-02	4.25e-02	5.09e-02	4.09e-02
Blood	5.39e-02	5.01e-02	5.08e-02	4.78e-02
ULI	6.15e-02	3.67e-02	5.82e-02	3.50e-02
LLI	4.77e-02	4.08e-02	4.43e-02	3.84e-02
Liver	6.77e-02	4.33e-02	6.46e-02	4.19e-02
Other	4.46e-02	5.00e-02	4.09e-02	4.65e-02
Bone	3.96e-02	4.41e-02	3.59e-02	4.13e-02
5-y-old				
Lung	4.98e-02	5.11e-02	4.82e-02	5.04e-02
BBi	3.68e-02	4.24e-02	3.59e-02	4.21e-02
ET1	9.92e-02	4.43e-03	9.74e-02	3.78e-03
Stomach	7.27e-02	2.24e-02	6.95e-02	2.24e-02
SI	4.64e-02	3.01e-02	4.20e-02	3.04e-02
Blood	4.47e-02	3.58e-02	4.22e-02	3.53e-02
ULI	5.40e-02	2.48e-02	4.94e-02	2.50e-02
LLI	3.73e-02	2.63e-02	3.18e-02	2.63e-02
Liver	6.06e-02	3.23e-02	5.79e-02	3.24e-02
Other	3.30e-02	3.20e-02	2.96e-02	3.07e-02
Bone	2.46e-02	2.92e-02	2.29e-02	2.79e-02

Table C-4 (continued)

Anatomical region	Camera			
	Siemens e.cam		Philips SKYLight	
	Anterior	Posterior	Anterior	Posterior
	10-y-old			
Lung	4.24e-02	4.45e-02	4.50e-02	4.54e-02
BBi	3.07e-02	3.12e-02	3.43e-02	3.24e-02
ET1	4.58e-02	2.56e-03	7.53e-02	2.36e-03
Stomach	6.49e-02	1.80e-02	6.40e-02	1.84e-02
SI	3.91e-02	2.47e-02	3.24e-02	2.47e-02
Blood	3.66e-02	2.95e-02	2.30e-02	2.90e-02
ULI	4.60e-02	2.00e-02	3.93e-02	1.99e-02
LLI	2.96e-02	2.03e-02	2.06e-02	1.90e-02
Liver	5.10e-02	2.90e-02	5.07e-02	2.98e-02
Other	2.51e-02	2.43e-02	2.26e-02	2.33e-02
Bone	1.51e-02	2.21e-02	1.57e-02	2.16e-02
	15-y-old			
Lung	3.58e-02	3.73e-02	3.95e-02	4.11e-02
BBi	2.53e-02	2.10e-02	3.28e-02	2.64e-02
ET1	1.49e-02	1.04e-03	1.05e-01	2.57e-03
Stomach	5.89e-02	1.40e-02	4.22e-02	1.22e-02
SI	3.41e-02	1.98e-02	8.14e-03	9.72e-03
Blood	3.13e-02	2.42e-02	2.80e-02	2.30e-02
ULI	4.13e-02	1.53e-02	1.17e-02	8.33e-03
LLI	2.34e-02	1.41e-02	3.41e-03	3.95e-03
Liver	4.48e-02	2.46e-02	3.52e-02	2.27e-02
Other	2.08e-02	1.98e-02	1.57e-02	1.65e-02
Bone	1.06e-02	1.77e-02	1.30e-02	1.71e-02
	Adult male			
Lung	3.47e-02	3.13e-02	3.80e-02	3.32e-02
ET1	6.52e-03	9.42e-04	1.10e-01	1.70e-03
Stomach	4.25e-02	1.60e-02	3.22e-02	1.44e-02
SI	4.35e-02	1.08e-02	1.21e-02	6.69e-03
Blood	3.41e-02	1.56e-02	3.08e-02	1.48e-02
ULI	4.96e-02	1.51e-02	1.81e-02	1.03e-02
LLI	1.92e-02	1.69e-02	4.07e-03	8.92e-03
Liver	4.23e-02	1.75e-02	3.56e-02	1.62e-02
Other	1.46e-02	1.71e-02	1.21e-02	1.48e-02
Bone	7.05e-03	9.78e-03	5.82e-03	7.15e-03
	Adult female			
Lung	3.02e-02	3.47e-02	3.38e-02	3.77e-02
ET1	1.53e-02	1.34e-03	7.24e-02	2.16e-03
Stomach	3.49e-02	2.33e-02	3.23e-02	2.38e-02
SI	4.77e-02	1.59e-02	1.84e-02	1.11e-02
Blood	3.85e-02	2.71e-02	3.63e-02	2.80e-02
ULI	7.08e-02	1.39e-02	4.72e-02	1.13e-02
LLI	4.00e-02	1.73e-02	1.58e-02	1.30e-02
Liver	4.53e-02	2.46e-02	3.69e-02	2.21e-02
Other	1.88e-02	1.99e-02	1.38e-02	1.62e-02
Bone	8.83e-03	8.55e-03	9.61e-03	8.48e-03

APPENDIX D

CALIBRATION FACTORS FOR CONVERTING COUNT RATES TO INTAKES

Appendix D

CALIBRATION FACTORS FOR CONVERTING COUNT RATES TO INTAKES

Tables D-1 to D-7 list calibration factors for assessing activities inhaled by children and adults at several different times after intake. These factors relate the count rate measured by a gamma camera to the intake of a given radionuclide with a given Lung Absorption Type.

Calibration factors for assessing ^{60}Co, ^{137}Cs, and ^{192}Ir 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. The calibration factors for these three nuclides using the first set of windows with the Siemens camera are listed in Tables D-1 to D-6 under the column heading "6 Windows," while those using the second set are under the heading "3 Windows." Calibration factors for assessing ^{241}Am with the Siemens camera, listed in Table D-7, 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. Section 3.1.4 presents a discussion of the calculation of count rates using various energy windows, which form a basis for these calibration factors, as discussed in Chapter 4. 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.

To assess the initial activity inhaled by an exposed individual, determine the Lung Absorption Type of the radionuclide. The Lung Absorption Types of different chemical forms of radionuclides in the present analysis are discussed in Section 2.1. When assessing a child, use the calibration factors for an age nearest to that of the exposed individual (assume that the adult male and female factors are for individuals 21-years old or older). Use the calibration factors appropriate to the sex of an adult. Next, in the column corresponding to the gamma camera and set of energy windows used in measuring the count rate, find the factor for the time since intake closest to the time elapsed between the peak exposure and the time the counts were taken. The time steps are listed in both days and hours for the convenience of the user. (Linear interpolation may be used for times between two consecutive time steps.) Multiply the count rate, in thousands of counts per minute (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). Calculate the activity separately for the detectors with anterior and posterior views, using the count rates and corresponding calibration factors for the two detectors, and take the average of the two values.

Note that this is the total inhaled activity, and includes a fraction, ranging from about 40% to 50% in the case of 1 µm AMAD particles, that was promptly expelled. The total inhaled activity is the relevant quantity for estimating prospective doses.

Table D-1. Intake 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	292
0.083	2	172	209	244	293	243	289
0.167	4	179	213	253	298	252	295
0.333	8	193	226	272	316	271	312
0.5	12	209	240	296	337	295	332
1	24	275	300	388	420	387	414
2	48	468	472	659	663	657	652
4	96	854	787	1199	1112	1195	1090
8	192	1078	967	1513	1369	1508	1339
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	282
0.333	8	196	239	273	330	249	299
0.5	12	213	254	297	351	271	318
1	24	284	316	394	436	360	395
2	48	491	496	681	686	623	619
4	96	911	822	1262	1142	1149	1019
8	192	1139	994	1578	1382	1434	1229
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	318	315	435	289	380
0.5	12	247	338	342	463	315	403
1	24	325	416	449	569	416	496
2	48	540	625	746	857	689	745
4	96	922	960	1271	1318	1154	1142
8	192	1114	1127	1537	1550	1384	1341
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	260	330	359	453	306	388
0.5	12	281	351	389	482	335	415
1	24	367	434	507	596	447	514
2	48	606	659	835	905	733	775
4	96	1027	1022	1413	1405	1181	1182
8	192	1240	1204	1705	1655	1397	1385

Table D-1 (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	369	442	322	424
0.167	4	273	325	381	451	346	442
0.333	8	288	345	402	478	378	473
0.5	12	309	366	431	508	415	507
1	24	391	443	546	615	541	616
2	48	595	629	829	872	786	812
4	96	890	883	1237	1223	1045	1008
8	192	1033	1009	1433	1396	1169	1113
Adult male							
0.042	1	265	334	363	458	270	417
0.083	2	274	343	375	471	290	441
0.167	4	284	351	388	482	310	458
0.333	8	302	363	414	499	339	477
0.5	12	326	379	447	521	373	502
1	24	415	447	569	615	496	597
2	48	617	620	847	851	745	790
4	96	877	856	1205	1174	1022	1002
8	192	1000	972	1373	1334	1148	1112
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	775	810
4	96	912	919	1252	1256	1120	1065
8	192	1067	1046	1465	1429	1277	1192

Table D-2. Intake 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	650	649
4	96	939	865	1318	1222	1312	1195
8	192	1186	1058	1665	1497	1655	1462
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	668	674	611	607
4	96	929	837	1286	1162	1169	1035
8	192	1142	993	1582	1381	1434	1225
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	402	477
2	48	523	606	722	831	668	721
4	96	910	947	1255	1301	1135	1125
8	192	1078	1089	1486	1497	1333	1293
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	379
0.5	12	271	340	375	467	326	401
1	24	351	416	484	571	431	492
2	48	582	635	802	872	707	746
4	96	1008	1003	1385	1378	1148	1155
8	192	1192	1157	1638	1589	1326	1324

Table D-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	252	317	351	440	293	404
0.083	2	261	314	364	435	320	420
0.167	4	268	319	373	442	346	438
0.333	8	279	335	389	465	377	467
0.5	12	297	353	414	490	411	497
1	24	372	423	518	588	528	595
2	48	567	601	789	833	754	776
4	96	856	849	1188	1175	986	953
8	192	971	949	1347	1312	1074	1026
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	583	481	570
2	48	586	590	806	810	715	751
4	96	839	821	1151	1126	967	951
8	192	935	913	1283	1252	1058	1031
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	1206	1210	1063	1012
8	192	1007	987	1382	1347	1183	1108

Table D-3. Intake 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	395
0.083	2	221	293	374	467	303	394
0.167	4	232	297	393	475	319	400
0.333	8	251	307	423	493	345	413
0.5	12	268	316	452	509	369	425
1	24	315	339	524	549	433	455
2	48	382	372	626	605	524	500
4	96	455	418	737	679	624	561
8	192	551	500	890	813	754	671
1-y-old							
0.042	1	226	336	368	507	286	426
0.083	2	236	337	384	511	299	426
0.167	4	251	343	408	523	318	434
0.333	8	276	357	447	546	351	451
0.5	12	299	370	484	567	382	467
1	24	362	399	577	615	465	505
2	48	455	440	710	680	589	556
4	96	561	501	862	775	730	632
8	192	707	622	1084	963	921	786
5-y-old							
0.042	1	281	484	448	709	354	614
0.083	2	296	489	473	720	374	620
0.167	4	319	505	508	747	403	639
0.333	8	355	535	565	794	451	676
0.5	12	389	559	617	833	497	707
1	24	476	611	745	915	617	771
2	48	596	670	914	1006	791	844
4	96	723	749	1090	1125	973	941
8	192	876	895	1317	1344	1182	1124
10-y-old							
0.042	1	360	535	554	778	391	678
0.083	2	384	545	592	795	417	689
0.167	4	417	568	643	832	455	718
0.333	8	467	610	719	896	518	772
0.5	12	510	643	785	948	577	816
1	24	614	710	937	1050	731	903
2	48	741	779	1114	1155	948	991
4	96	866	861	1289	1278	1162	1096
8	192	1007	992	1497	1472	1365	1263

Table D-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	455	602	677	869	440	817
0.083	2	489	616	730	892	466	833
0.167	4	534	645	799	937	510	879
0.333	8	598	694	896	1013	590	969
0.5	12	651	733	975	1073	670	1043
1	24	758	804	1133	1184	892	1188
2	48	859	868	1277	1280	1233	1320
4	96	942	930	1394	1372	1551	1432
8	192	1012	996	1497	1469	1709	1536
Adult male							
0.042	1	532	696	773	990	411	958
0.083	2	578	728	843	1039	437	997
0.167	4	641	770	936	1104	480	1058
0.333	8	730	826	1071	1193	559	1152
0.5	12	805	869	1183	1262	640	1227
1	24	956	950	1409	1388	883	1374
2	48	1086	1019	1600	1495	1311	1505
4	96	1179	1082	1736	1589	1750	1612
8	192	1251	1144	1841	1679	1930	1707
Adult female							
0.042	1	483	640	714	916	516	865
0.083	2	513	670	762	962	548	912
0.167	4	560	713	834	1029	603	984
0.333	8	636	776	950	1128	703	1094
0.5	12	702	825	1049	1205	800	1185
1	24	840	917	1255	1348	1065	1361
2	48	969	993	1441	1465	1449	1511
4	96	1064	1057	1575	1561	1783	1627
8	192	1130	1118	1673	1651	1934	1723

Table D-4. Intake 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	108
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	178	185
4	96	204	197	252	242	260	247
8	192	242	229	298	281	307	287
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	133	87	124
0.5	12	81	114	100	140	95	131
1	24	105	132	130	163	124	153
2	48	161	174	199	215	189	201
4	96	240	229	296	282	281	263
8	192	285	264	351	325	334	304
5-y-old							
0.042	1	78	143	97	177	89	158
0.083	2	81	143	101	178	93	159
0.167	4	85	148	106	183	98	164
0.333	8	93	157	117	195	109	174
0.5	12	103	167	128	207	120	184
1	24	134	195	168	242	158	216
2	48	204	254	254	315	242	280
4	96	297	327	370	406	352	361
8	192	351	376	437	467	416	415
10-y-old							
0.042	1	99	158	121	195	100	172
0.083	2	103	158	127	196	105	173
0.167	4	108	163	134	203	112	179
0.333	8	118	174	147	217	124	191
0.5	12	130	185	162	231	138	203
1	24	168	217	211	272	185	240
2	48	248	284	313	356	282	312
4	96	354	366	444	458	405	400
8	192	416	421	522	527	476	459

Table D-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	132	184	168	236	118	222
0.083	2	137	185	175	236	127	231
0.167	4	143	190	183	243	139	244
0.333	8	155	202	198	259	159	267
0.5	12	167	214	214	273	181	290
1	24	208	247	266	316	252	347
2	48	286	311	366	395	386	424
4	96	376	384	480	488	533	496
8	192	434	438	553	555	618	557
Adult male							
0.042	1	141	233	180	290	108	273
0.083	2	145	237	185	296	114	286
0.167	4	151	239	193	298	124	295
0.333	8	164	241	208	302	142	307
0.5	12	179	247	227	310	162	321
1	24	227	275	287	346	229	370
2	48	313	347	394	437	367	460
4	96	404	440	509	553	535	561
8	192	463	505	584	635	627	636
Adult female							
0.042	1	133	194	168	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	236	189	299	170	288
1	24	190	271	240	344	233	339
2	48	275	343	347	435	366	432
4	96	381	431	481	546	531	537
8	192	445	493	563	625	624	613

Table D-5. Intake 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
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	389	400	359
8	192	436	380	538	468	505	431
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	197
2	48	212	259	264	322	249	285
4	96	368	384	458	475	424	421
8	192	452	451	561	559	516	496
10-y-old							
0.042	1	92	147	115	185	92	159
0.083	2	96	145	121	182	98	157
0.167	4	100	147	126	185	104	160
0.333	8	107	155	135	195	113	169
0.5	12	116	164	146	206	124	179
1	24	152	197	191	248	168	216
2	48	252	287	317	360	279	312
4	96	427	427	536	532	452	455
8	192	521	502	652	626	541	533

Table D-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	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
Adult male							
0.042	1	122	175	154	220	99	200
0.083	2	125	180	158	226	106	212
0.167	4	129	183	162	230	114	220
0.333	8	136	186	172	233	127	226
0.5	12	147	191	185	240	141	235
1	24	189	218	238	274	191	270
2	48	281	292	353	366	295	342
4	96	393	396	493	494	412	423
8	192	453	456	568	568	474	476
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	379	304	334
4	96	408	405	515	508	451	427
8	192	488	465	614	583	526	485

Table D-6. Intake 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
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
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-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

Table D-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	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
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	287	348	359	287	331
4	96	389	388	488	484	398	407
8	192	445	442	557	551	451	453
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

Table D-7. Intake 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	1116	1052	1251
4	96	1767	1773	2006	1988
8	192	2144	2050	2433	2299
1-y-old					
0.042	1	352	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	471	906	504	954
1	24	645	1049	691	1105
2	48	1162	1474	1242	1549
4	96	2206	2121	2343	2215
8	192	2673	2379	2833	2482
5-y-old					
0.042	1	467	1302	486	1319
0.083	2	497	1281	519	1295
0.167	4	527	1300	553	1313
0.333	8	574	1358	605	1373
0.5	12	633	1412	669	1427
1	24	863	1609	919	1627
2	48	1492	2119	1588	2146
4	96	2574	2786	2695	2826
8	192	3015	3059	3137	3105
10-y-old					
0.042	1	685	1593	580	1577
0.083	2	739	1563	632	1552
0.167	4	782	1587	680	1580
0.333	8	838	1666	747	1665
0.5	12	913	1735	829	1741
1	24	1216	1980	1148	1995
2	48	2008	2589	1946	2590
4	96	3241	3362	3110	3312
8	192	3728	3680	3554	3612

Table D-7 (continued)

Time post intake		Camera			
		Siemens e.cam		Philips SKYLight	
d	h	Anterior	Posterior	Anterior	Posterior
15-y-old					
0.042	1	1111	2064	703	2165
0.083	2	1204	2035	780	2245
0.167	4	1262	2070	861	2336
0.333	8	1317	2175	971	2464
0.5	12	1408	2264	1090	2578
1	24	1781	2533	1503	2865
2	48	2619	3095	2375	3226
4	96	3622	3705	3366	3498
8	192	4004	3982	3733	3684
Adult male					
0.042	1	1193	2363	659	2439
0.083	2	1184	2436	707	2585
0.167	4	1184	2428	762	2641
0.333	8	1246	2379	854	2645
0.5	12	1355	2391	963	2693
1	24	1780	2611	1354	2952
2	48	2623	3274	2213	3488
4	96	3461	4107	3225	4025
8	192	3756	4478	3588	4307
Adult female					
0.042	1	1136	1907	821	1888
0.083	2	1057	2027	847	2072
0.167	4	985	2125	847	2197
0.333	8	976	2185	880	2250
0.5	12	1034	2227	965	2293
1	24	1352	2425	1348	2488
2	48	2226	2980	2281	2959
4	96	3586	3673	3475	3487
8	192	4103	3983	3897	3748