DOE Review Release 10/28/2011

Document Title:	Document Number:	ORAUT-TKBS-0029-3
Pinellas Plant – Occupational Medical Dose	Revision:	01
	Effective Date:	10/13/2011
	Type of Document:	TBD
	Supersedes:	Revision 00 PC-1

Subject Expert(s): Elyse M. Thomas and Brian P. Gleckler

Approval:	Signature on File Brian P. Gleckler, Document Owner	Approval Date:	10/11/2011
Concurrence:	Signature on File John M. Byrne, Objective 1 Manager	Concurrence Date:	10/12/2011
Concurrence:	Signature on File Edward F. Maher, Objective 3 Manager	Concurrence Date:	10/11/2011
Concurrence:	Vickie S. Short Signature on File for Kate Kimpan, Project Director	Concurrence Date:	10/12/2011
Approval:	Signature on File James W. Neton, Associate Director for Science	Approval Date:	10/13/2011

☐ New ☒ Total Rewrite ☐ Revision ☐ Page Change

FOR DOCUMENTS MARKED AS A TOTAL REWRITE, REVISION, OR PAGE CHANGE, REPLACE THE PRIOR REVISION AND DISCARD / DESTROY ALL COPIES OF THE PRIOR REVISION.

PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
05/06/2005	00	New technical basis document for the Pinellas Plant – Occupational Medical Dose. First approved issue. Initiated by Mark D. Notich.
07/04/2006	00 PC-1	Page change revision to incorporate introductory language from NIOSH on pages 5 and 6 in Section 3.0. Deletes the uterus as an analogue/surrogate organ in Table 3.3.3-1 on page 13 in Section 3.3.3 as per Task 5 comment. No changes occurred as a result of formal internal review. Incorporates NIOSH formal and DOL review comments. No sections were deleted. This revision results in a reduction in assigned dose and no PER is required. Training required: As determined by the Task Manager. Initiated by Paul J. Demopoulos. Approval: Signature on File 05/25/2006 Paul J. Demopoulos, TBD Team Leader Signature on File 05/25/2006 John M. Byrne, Task 3 Manager Signature on File 05/25/2006 Edward F. Maher, Task 5 Manager Signature on File 06/20/2006 Kate Kimpan, Project Director Signature on File 07/04/2006 James W. Neton, Associate Director for Science
10/13/2011	01	Revised to address comments from Sanford Cohen & Associates as identified in SCA-TR-TASK1-0015. Added skin doses for all projections. Includes editorial changes. Incorporates formal internal and NIOSH review comments. Constitutes a total rewrite of the document. Training required: As determined by the Objective Manager. Initiated by Brian P. Gleckler.

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

Abd/KUB	abdomen or KUB
AEC	U.S. Atomic Energy Commission
AP	anterior-posterior
CFR	Code of Federal Regulations
cGy	centigray
cm	centimeter
DCF	dose conversion factor
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
EEOICPA	Energy Employees Occupational Illness Compensation Program Act of 2000
ENSD	entrance skin dose
EXSD	exit skin dose
FDA	Food and Drug Administration
GE	General Electric Company
GEND	GE Neutron Devices
GENDD	GE Neutron Devices Department
GEPP	GE Pinellas Plant
GEXF	GE X-Ray Division-Florida
Gy	gray
HVL	half-value layer
ICRP	International Commission of Radiological Protection
in.	inch
IREP	Interactive RadioEpidemiological Program
KUB	kidneys, ureters, bladder
kVp	kilovolts-peak
LAT	lateral
m	meter
mA	milliampere
mAs	milliampere-second
mGy	milligray
mm	millimeter
mR	milliRoentgen
NIOSH	National Institute for Occupational Safety and Health
OBL	oblique
PA	posterior-anterior
PFG	photofluorography
POC	probability of causation

R	Roentgen
RAO	right anterior oblique
RSD	remote skin dose
SID	source-to-image distance
SRDB Ref ID	Site Research Database Reference Identification (number)
SSD	source-to-skin distance
TBD	technical basis document
U.S.C.	United States Code
§	section or sections

3.1 INTRODUCTION

Technical basis documents and site profile documents are not official determinations made by the National Institute for Occupational Safety and Health (NIOSH) but are rather general working documents that provide historic background information and guidance to assist in the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). These documents may be used to assist NIOSH staff in the completion of the individual work required for each dose reconstruction.

In this document the word "facility" is used as a general term for an area, building, or group of buildings that served a specific purpose at a site. It does not necessarily connote an "atomic weapons employer facility" or a "Department of Energy [DOE] facility" as defined in the Energy Employees Occupational Illness Compensation Program Act [EEOICPA; 42 U.S.C. § 7384l(5) and (12)]. EEOICPA defines a DOE facility as "any building, structure, or premise, including the grounds upon which such building, structure, or premise is located … in which operations are, or have been, conducted by, or on behalf of, the Department of Energy (except for buildings, structures, premises, grounds, or operations … pertaining to the Naval Nuclear Propulsion Program)" [42 U.S.C. § 7384l(12)]. Accordingly, except for the exclusion for the Naval Nuclear Propulsion Program noted above, any facility that performs or performed DOE operations of any nature whatsoever is a DOE facility encompassed by EEOICPA.

For employees of DOE or its contractors with cancer, the DOE facility definition only determines eligibility for a dose reconstruction, which is a prerequisite to a compensation decision (except for members of the Special Exposure Cohort). The compensation decision for cancer claimants is based on a section of the statute entitled "Exposure in the Performance of Duty." That provision [42 U.S.C. § 7384n(b)] says that an individual with cancer "shall be determined to have sustained that cancer in the performance of duty for purposes of the compensation program if, and only if, the cancer … was at least as likely as not related to employment at the facility [where the employee worked], as determined in accordance with the POC [probability of causation[1]] guidelines established under subsection (c) …" [42 U.S.C. § 7384n(b)]. Neither the statute nor the probability of causation guidelines (nor the dose reconstruction regulation, 42 C.F.R. Pt. 82) define "performance of duty" for DOE employees with a covered cancer or restrict the "duty" to nuclear weapons work (NIOSH 2010).

The statute also includes a definition of a DOE facility that excludes "buildings, structures, premises, grounds, or operations covered by Executive Order No. 12344, dated February 1, 1982 (42 U.S.C. 7158 note), pertaining to the Naval Nuclear Propulsion Program" [42 U.S.C. § 7384l(12)]. While this definition excludes Naval Nuclear Propulsion Facilities from being covered under the Act, the section of EEOICPA that deals with the compensation decision for covered employees with cancer [i.e., 42 U.S.C. § 7384n(b), entitled "Exposure in the Performance of Duty"] does not contain such an exclusion. Therefore, the statute requires NIOSH to include all occupationally-derived radiation exposures at covered facilities in its dose reconstructions for employees at DOE facilities, including radiation exposures related to the Naval Nuclear Propulsion Program. As a result, all internal and external occupational radiation exposures are considered valid for inclusion in a dose reconstruction. No efforts are made to determine the eligibility of any fraction of total measured exposure for inclusion in dose reconstruction. NIOSH, however, does not consider the following exposures to be occupationally derived (NIOSH 2010):

- Background radiation, including radiation from naturally occurring radon present in conventional structures
- Radiation from X-rays received in the diagnosis of injuries or illnesses or for therapeutic reasons

[1] The U.S. Department of Labor (DOL) is ultimately responsible under the EEOICPA for determining the POC.

3.1.1 Purpose

This technical basis document (TBD) provides the basis for assessing occupational medical doses at the Pinellas Plant. The information in this TBD can be used in dose reconstructions for the EEOICPA.

3.1.2 Scope

This document provides supporting technical data to evaluate the total occupational radiation dose that can reasonably be associated with a Pinellas Plant worker's radiation exposure. Occupational medical doses result from X-ray procedures that were performed on energy employees for occupational health screening and as a condition of employment. Under the EEOICPA program, doses from occupational medical X-ray procedures that were performed on energy employees for occupational health screening and as a condition of employment must be included in the EEOICPA dose reconstructions. The doses from those X-ray procedures were not measured, considered, or included as part of the employees' occupational doses that are reported by the site. Therefore, the worker's doses from those X-ray procedures are estimated based on the best available information, which is documented in this TBD and, when available, a worker's occupational medical records.

The Pinellas Plant operations contractors required preemployment and routine medical examinations as part of their occupational health and safety programs. The preemployment examinations and some of the periodic medical examinations typically required X-ray screening examinations. At the Pinellas Plant, the screening X-ray procedures typically included posterior-anterior (PA) and infrequent lateral (LAT) chest X-rays. For some years, these medical examinations might have included X-rays of the abdomen or lumbar spine. At the Pinellas Plant, the terms "Abdomen X-ray" and "KUB X-ray" were synonymous and the records use them interchangeably. (KUB indicates "kidneys, ureters, bladder"). Therefore, this TBD refers to these procedures as "Abd/KUB X-rays." For this site, the Abd/KUB X-rays and the lumbar spine X-rays are considered to be screening X-rays because they were performed on so many Pinellas Plant workers.

A wide variety of other X-ray procedures (e.g., cervical spine, dorsal spine, hand, ankle, foot, sinuses, wrist, etc.) were performed on Pinellas Plant workers. These X-rays are not known to have been performed for screening. The available information, including general medical literature, indicates that these X-ray procedures were performed solely for diagnostic purposes. Therefore, the doses associated with these X-ray procedures are not included in dose reconstruction under EEOICPA.

X-ray equipment and the techniques that were used for taking X-rays changed over the years that are covered by this TBD. This analysis took these factors into account in estimating the dose a worker would have received from each type of X-ray exposure that might have been received. The considered parameters include the tube current and voltage, exposure time, filtration, source-to-skin distance (SSD), the projection [PA, anterior-posterior (AP), or LAT], and any other factor that could affect the dose that was received by the worker.

Doses are calculated to exposed organs from the X-ray procedures. The calculated doses take into account the uncertainty that is associated with some of the parameters that are mentioned above. Tables in Attachment A list these doses for convenient reference for dose reconstruction.

3.1.3 Overview

The Pinellas Plant records reflect that it has been known by several names throughout its history. Those names include the 908 Plant, Pinellas Peninsula Plant, General Electric Company (GE) X-Ray Division-Florida (GEXF), GE Neutron Devices Department (GENDD), GE Neutron Devices (GEND), GE Pinellas Plant (GEPP), and the Pinellas Plant. This document refers to the Pinellas Plant or simply Pinellas throughout.

GE built and operated the Pinellas Plant for the U.S. Atomic Energy Commission (AEC) from its initial startup in January 1957 until June 1992. In June 1992, Martin Marietta Specialty Components (MMSC) took over as the management and operating contractor for the Pinellas Plant. In 1994, Lockheed merged with Martin Marietta, and the management and operating contractor for the Pinellas Plant was renamed Lockheed Martin Specialty Components (LMSC). The Pinellas Plant completed its war reserve fabrication of neutron generators at the end of September 1994 and began the transition from a defense mission to an environmental management mission. That transition included a number of decontamination and decommissioning activities that allowed the Plant to be turned over for commercial uses. LMSC continued as the management and operating contractor until decontamination and decommissioning activities ended in 1997 (ORAUT 2011a).

The Pinellas Plant was built to manufacture neutron generators, a principal component in nuclear weapons. The neutron generators consisted of a miniaturized linear ion accelerator assembled with pulsed electric power supplies. The ion accelerator, or neutron tube, required ultraclean, high-vacuum technology; hermetic seals between glass, ceramic, glass-ceramic, and metal materials; and high-voltage generation and measurement technology. The Plant manufactured only neutron generators for its first 10 years of operation. It later manufactured other products including neutron detectors, radioisotopic thermoelectric generators, high-vacuum switch tubes, specialty capacitors, and specialty batteries (Weaver 1990). As part of its program to promote commercial uses of the site, DOE sold most of the Pinellas Plant to the Pinellas County Industry Council in March 1995 and leased back a portion through September 1997 to complete safe shutdown and transition activities (LMSC 1996).

3.2 EXAMINATION FREQUENCIES

The energy employee's medical X-ray file contains information about the X-rays that were taken including the numbers and types of projections and the frequencies at which they occurred. A review of the submitted claim file records for the Pinellas Plant workers indicated that throughout the Plant's history PA chest X-rays were administered on an up-to-annual basis with infrequent LAT or oblique (OBL) chest X-rays.

The submitted medical records also show that it was relatively common for an energy employee to have received a lumbar spine X-ray, an Abd/KUB X-ray, or both, along with the chest X-rays, especially between 1969 and 1974. Specifically, one of the most common combinations of X-ray examinations during the years from 1969 through 1974 included an AP Abd/KUB, LAT lumbar spine, and PA chest X-rays. A former nurse at Pinellas, who took many of the X-rays of the energy employees, stated in a 2007 interview that she did not recall taking any Abd/KUB X-rays and that she recalled only a few lumbar spine X-rays (Gleckler 2007). However, a December 1972 report from the Pinellas County Health Department indicated that Abd/KUB X-rays and "lateral lumbar radiographs" were being performed as frequently as the chest X-rays (McCall 1973). Because of this report, and because the Abd/KUB and lumbar spine X-rays appear so often in the energy employee records for 1969 through 1974, dose reconstructors should assume that these X-rays were performed for screening and include the dose in dose reconstruction under EEOICPA. Exceptions should be made (i.e., not including the dose) when the energy employee's records clearly indicate that the X-rays were performed for individual diagnostic reasons or for work-related injuries. For best estimate cases and in accordance with the recommendations in ORAUT-PROC-0061, *Occupational Medical X-Ray Dose Reconstruction for DOE Sites* (ORAUT 2010), the dose from Abd/KUB or lumbar spine X-rays should only be included when they were performed in conjunction with a chest X-ray.

Dose should be assigned based on individual X-ray examinations that are recorded in the submitted medical records. When no X-ray examination records are available for an individual, the dose reconstructor should assume that an annual PA chest X-ray was administered. This is in accordance with the recommendations in ORAUT-OTIB-0006, *Dose Reconstruction from Occupational Medical X-*

Ray Procedures (ORAUT 2011b). Unless otherwise indicated in the energy employee's medical records, LAT chest projections should be assumed to be left LAT, and OBL chest projections should be assumed to be right anterior OBL (RAO).

3.3 EQUIPMENT AND TECHNIQUES

A summary description of the medical X-ray equipment that was used at the Pinellas plant is included in Table 3-1.

Table 3-1. Medical X-ray equipment that was used at the Pinellas Plant.

Period	Equipment
1957–1959	Photofluorography (PFG). No information available.
1960–1971	Conventional radiography. No information available.
1972–1987[a]	GE Model 11CK-1
1988–1997[b]	GE DXS-650, single phase, 2 pulse, 200 mA, 125 kVp, automated collimator, AFP 14XL automatic film processor

a. McCall (1973).
b. Jones (1988).

3.3.1 Photofluorography, 1957 through 1959

Chest photofluorography (PFG), which resulted in much greater doses per chest examination than conventional 14- by 17-inch film, was used throughout the AEC complex until the 1960s. PFG used a smaller film (4 by 5 in.), a smaller source-to-image distance (SID) of 42 in., and both a higher kVp and a several-fold higher exposure in mAs (ORAUT 2011b).

No evidence was found that indicates that PFG was used at the Pinellas Plant after reviewing submitted claim file records. This is consistent with information that was provided by a former Pinellas Plant nurse who was employed at the site between 1958 and 1986 (Gleckler 2007). The former nurse indicated that PFG X-rays were never performed at the Pinellas Plant (Gleckler 2007). However, a 2005 program evaluation report, OCAS-PER-004, indicates that there was at least one occasion where PFG was recorded in one energy employee's files (NIOSH 2005). Therefore, the use of PFG should be assumed to ensure conservative dose reconstructions from X-ray examinations during the period from 1957 through 1959 (NIOSH 2005).

Because no historical information about site-specific parameters for PFG at Pinellas has been found, the default PFG doses from Table A-7 in ORAUT-OTIB-0006 (ORAUT 2011b) should be used in dose reconstruction. They are reproduced in Table A-1 for convenience.

3.3.2 Chest Radiography, 1960 through 1971

The X-ray machine information and techniques used before 1972 at Pinellas are not available. Therefore, the incident air kerma values for the PA, LAT, and OBL chest projections for years before 1972 are from ORAUT-OTIB-0006 (ORAUT 2011b). Incident air kerma of 0.2 cGy for the PA chest X-rays and 0.5 cGy for the LAT and OBL chest X-rays were used in the organ dose calculations. All X-ray procedures from this time period are assumed to be poorly collimated, and organ doses determined accordingly per ORAUT-OTIB-0006 (ORAUT 2011b). Organ doses from all chest X-rays for all periods are in Table A-1.

3.3.3 Chest Radiography, 1972 through 1987

The X-ray machine information for 1972 through 1987 is available from the following surveys:

- One survey conducted by the Pinellas County Health Department in 1972 (McCall 1973), and

- Several surveys conducted by the Pinellas health physics department from 1975-1984 (Holliday 1975–1984).

All of these surveys contain half-value layer (HVL) measurements and measured X-ray exposure output values that are typically reported in units of R/mA-min at 12 in. When these measurements were normalized to units of mR/mAs at an SSD of 155 cm for a PA chest X-ray, the highest value for this period was1.66 mR/mAs at 155 cm. This value, multiplied by 20 mAs for a PA chest X-ray (Name Redacted 1984), yielded about 32 mR at the skin of a reference worker. The incident air kerma for the LAT and OBL chest projections was estimated by assuming it was 2.5 times that of the PA chest (ORAUT 2011b). The HVL was reported to be 3.2 mm Al and rounded up to 3.5 mm Al for the dose calculations (McCall 1973).

3.3.4 Chest Radiography, 1988 through 1997

The X-ray machine information for 1988 through 1997 is available from surveys that were conducted by the Food and Drug Administration (FDA) in 1988 and 1992 (Halvorsen 1988; Collins 1992). The HVL was reported to be 3.1 mm Al at 90 kVp in the 1988 survey (Halvorsen 1988), which was rounded up to 3.5 mm Al for the dose calculations, because the kVp used for chests in 1992 was at least 97 kVp (Collins, 1992).

3.3.5 Abd/KUB Examinations, 1969 through 1971

Abd/KUB X-rays are included in many claim file records; therefore, they might have been performed as part of the routine or periodic physicals at the Pinellas Plant. Other than from 1969 through 1974, Abd/KUB X-rays do not appear to have been a frequent examination based on the review of numerous energy employee medical records. Typically, an AP Abd/KUB projection was administered in conjunction with a LAT lumbar spine projection.

The organ doses from the AP Abd/KUB examinations for 1969 through 1971 are based on measured data that were reported in Table VII of Lincoln and Gupton (1958) – including the HVL of 2.0 mm Al; ovary, testes, and skin doses; and a derived incident air kerma of 818 mR for the AP Abd/KUB – because no information is available about the X-ray machine at Pinellas before 1972 (Section 3.3.2). The organ doses are also based on information in ORAUT-OTIB-0006 (ORAUT 2011b) for the X-ray beam location in relation to organs for the AP lumbar spine (a very similarly positioned examination to the AP Abd/KUB examination). However, the dose conversion factors (DCFs) from International Commission on Radiological Protection (ICRP) Publication 34 (ICRP 1982) for the abdomen rather than lumbar spine were used. Because Publication 34 does not list a DCF for the breast from this examination, the dose to the breast from the Abd/KUB projection was determined using the method in ORAUT-OTIB-0006 (ORAUT 2011b) for determining dose to the breast from the AP lumbar spine.

Organ doses from the Abd/KUB examinations for all periods are in Table A-2.

3.3.6 Abd/KUB Examinations, 1972 through 1974

For 1972 through 1974, the incident air kerma value at the SSD for the Abd/KUB X-ray was calculated from the measured 4 mR/mAs value at 1 m (Name Redacted 1984) multiplied by the 100 mAs technique factor as listed in Table 3-2 (Section 3.3.9) and corrected for the thickness of the abdomen of 23 cm, tabletop-to-film distance of 5 cm, and an SID of 102 cm. This resulted in an incident air kerma of about 750 mR. The HVL on this machine was reported to be 3.2 mm Al at 85 kVp (McCall 1973). Therefore, at the 70 kVp used for the Abd/KUB examination (Name Redacted 1984), the HVL was assumed to be around 2.8 mm Al, which was rounded up to 3.0 mm Al HVL for the dose calculations. As mentioned previously for the Abd/KUB examinations for 1969 through 1971, the organ doses were based on information in ORAUT-OTIB-0006 (ORAUT 2011b) for the X-ray beam

location in relation to organs for the AP lumbar spine (a very similarly positioned examination to the AP Abd/KUB examination). However, the DCFs from ICRP Publication 34 (ICRP 1982) for the abdomen rather than lumbar spine were used. Because Publication 34 does not list a DCF for the breast for this examination, the dose to the breast from the Abd/KUB examination was determined using the method in ORAUT-OTIB-0006 for determining dose to the breast from the AP lumbar spine examination.

3.3.7 Lumbar Spine Examinations, 1969 through 1971

Lumbar spine examinations appear in the medical records throughout Pinellas Plant operations. However, other than during 1969 through 1974, it does not appear to have been a frequent examination based on the review of numerous energy employee medical records. A LAT lumbar spine projection was typically administered in conjunction with an AP Abd/KUB projection. It has already been mentioned that the AP Abd/KUB and the AP lumbar spine projections were positioned very similarly. Because of the common occurrence in the claim files of the AP Abd/KUB and LAT lumbar spine projections from 1969 through 1974, dose reconstructors should only include dose from these two projections as screening during this period. At other times, the Abd/KUB and lumbar spine examinations were probably not performed for screening, and they are therefore ineligible for inclusion in total dose under EEOICPA.

Because no information is available about the X-ray equipment that was used at Pinellas before 1972, the lumbar spine X-ray doses are from ORAUT-OTIB-0006 (ORAUT 2011b). The doses are reproduced in Table A-3 for convenience.

3.3.8 Lumbar Spine Examinations, 1972 through 1974

The incident air kerma value at the SSD for the AP Lumbar spine projection for 1972 through 1974 was calculated from the measured 5.0 mR/mAs value at 1 m (Name Redacted 1984) multiplied by the 100 mAs technique factor as listed in Table 3-2 (Section 3.3.9) and corrected for the thickness of the abdomen of 23 cm, tabletop-to-film distance of 5 cm, and an SID of 102 cm. This resulted in an incident air kerma value of 940 mR. The measured HVL in 1972 was 3.2 at 85 kVp (McCall 1973), which was rounded to 3.5 mm Al for the 90 kVp that was reportedly used for this projection (Name Redacted 1984).

The incident air kerma value at the SSD for the LAT lumbar spine projection for 1972 through 1974 was calculated from the measured 7.0 mR/mAs value at 1 m (Name Redacted 1984) multiplied by the 70 mAs technique factor (Name Redacted 1984) as listed in Table 3-2 (Section 3.3.9) and corrected for the thickness of the abdomen of 23 cm, tabletop-to-film distance of 5 cm, and an SID of 102 cm. This resulted in an incident air kerma value of 1,235 mR. The measured HVL in 1972 was 3.2 at 85 kVp (McCall 1973), which is equivalent to 3.0 mm Al for the 80 kVp that was reportedly used for this projection (Name Redacted 1984). Note that different HVLs are used to determine organ doses from the AP and LAT lumbar spine projections, because of different kVp values used for each of these two projections.

Except for the breast, doses were determined using the DCFs for the lumbar spine from ICRP Publication 34 (ICRP 1982). Because Publication 34 does not list a DCF for the breast for this examination, the dose to the breast from the AP and LAT lumbar spine examinations was determined using the method in ORAUT-OTIB-0006 (ORAUT 2011b) for determining dose to the breast from the lumbar spine projections. Organ doses from the lumbar spine X-rays are in Table A-3.

3.3.9 Summary of Technical Parameters

A summary of the technical parameters for all X-ray projections and periods is presented in Table 3-2.

Table 3-2. Summary of technical parameters for X-ray projections.

Date	X-ray projection	kVp	mAs	mR/mAs at SSD	HVL	Incident air kerma (mR)
1957–1959	PFG chest	--	--	--	2.5[a]	2,270[a,b]
1960–1971	PA chest	--	--	--	2.5[a]	200[a]
	LAT chest	--	--	--	2.5[a]	500[a]
1972–1987	PA chest	90[c]	20[c]	1.6[d]	3.5[d]	32[d]
	LAT chest	--	--	--	3.5	80
1988–1997	PA chest	97[e]	6.6[e]	--	3.5[e,f]	16.3[e]
1969–1971	KUB	--	--	--	2.0[a]	818[g]
	AP lumbar	--	--	--	2.0[a]	1,440[a]
	LAT lumbar	--	--	--	2.0[a]	3,790[a]
1972–1974	KUB	70[c]	100[c]	7.5[c]	3.0[d]	750
	AP lumbar	90[c]	100[c]	9.4[c]	3.5[d]	940
	LAT lumbar	80[c]	70[c]	17.6[c]	3.0[d]	1,235

a. From ORAUT-OTIB-0006 (ORAUT 2011b).
b. Stereo views.
c. Name Redacted 1984.
d. Based on McCall 1973.
e. Collins 1992.
f. Based on Halvorsen 1988.
g. Based on Table VII Lincoln and Gupton (1958).

3.4 ORGAN DOSE CALCULATIONS

ICRP Publication 34 (ICRP 1982) provides tables of average absorbed dose (in mGy) in selected organs for selected X-ray projections at 1 Gy entrance kerma (i.e., entrance air kerma without backscatter, more recently referred to as incident air kerma) and for selected beam qualities (i.e., various HVLs). These organ DCFs are used for converting incident air kerma to organ dose for all organs except skin. Selection of DCFs for organs that are not listed in Publication 34 but are specified in the Interactive RadioEpidemiological Program (IREP) was made according to the scheme in ORAUT-OTIB-0006 (ORAUT 2011b). Skin doses were calculated according to the method in that document.

Because site-specific information was not found for PFG and radiographic equipment at Pinellas before 1972, organ doses for this period came from ORAUT-OTIB-0006 (ORAUT 2011b). Organ doses for 1972 and after were based on actual measurements of the X-ray machine at Pinellas. The HVLs assumed for dose reconstruction are listed in Table 3-2.

Since at least 1972, the collimator with positive beam limitation was checked and found adequate in annual surveys from about 1972 though 1985 that were verified by a FDA survey in 1992. However, poor collimation was assumed before about 1970 in accordance with ORAUT-OTIB-0006 (ORAUT 2011b). This means that for before 1972 at Pinellas, because nothing is known about the X-ray equipment before then, some organs should be considered to be in the primary beam that would not normally be if the beam were properly collimated. ICRP Publication 34 (ICRP 1982) does not provide DCFs for the breast from lumbar spine or Abd/KUB projections because the DCFs are “small” in comparison with other organs. Therefore, the breast dose for these projections was estimated using the method in ORAUT-OTIB-0006 for breast dose from the lumbar spine examination.

The resultant organ doses for all projections and all years are in Tables A-1 through A-3. Skin dose guidance and skin dose equivalents in rem for all projections and periods are in Tables A-4 and A-8. The doses are shown in units of dose equivalent or rem with an assumed radiation weighting factor of 1 for X-rays.

3.5 UNCERTAINTY

ORAUT-OTIB-0006 (ORAUT 2011b) lists the major sources of uncertainty in X-ray output intensity and subsequent effect on dose to the worker. The five sources of uncertainty are:

1. X-ray beam measurement error (±2%),
2. Variation in peak kilovoltage (±9%),
3. Variation in X-ray beam current (±5%),
4. Variation in exposure time (±25%), and
5. Variation in SSD as a result of worker size (±10%).

The 10% uncertainty in output intensity as a result of worker size was based on an inverse square correction of output intensity changes from differences of standard chest thickness of ±7.5 cm.

These uncertainties are assumed to be random; therefore, the combined statistical uncertainty was calculated as the square root of the sum of the squares of all the uncertainties, which is ±28.9%. Rounding this up to ±30% provides an adequate and suitably conservative indication of uncertainty. Therefore, for a derived dose equivalent to an individual organ, a total combined standard uncertainty of ±30% can be assumed. Dose reconstructors should therefore input the organ dose equivalent as the mean of a normal distribution with a standard uncertainty of ±30%.

3.6 ATTRIBUTIONS AND ANNOTATIONS

All information requiring identification was addressed via references integrated into the reference section of this document.

REFERENCES

[Name Redacted], 1984, "Medical X-rays at Pinellas". [SRDB Ref ID 13215, p. 5-6]

Collins, B. B., 1992, untitled letter to M. Stone (General Electric Company), U.S. Department of Health and Human Services, Food and Drug Administration, Atlanta, Georgia, March 9. [SRDB Ref ID: 14710]

Gleckler, B. P., 2007, "Technical Basis Document (TBD), Pinellas Plant – Occupational Medical Dose," documented communication with Name Redacted, (former Pinellas Plant worker), Oak Ridge Associated Universities Team, Oak Ridge, Tennessee, November 13. [SRDB Ref ID: 37343]

Halvorsen, Janis, V., 1988, untitled letter to D. Ingle (General Electric Company), U.S. Department of Health and Human Services, Food and Drug Administration, Orlando, Florida, February 5. [SRDB Ref ID: 13215, p. 108]

Holliday, J. N., 1975–1984, collection of letters, reports, and handwritten notes on surveys of medical X-ray unit, General Electric Company, St. Petersburg, Florida. [SRDB Ref ID: 14713]

ICRP (International Commission on Radiological Protection), 1982, *Protection of the Patient in Diagnostic Radiology*, Publication 34, Pergamon Press, Oxford, England.

Jones, R. F., 1988, "PMS Data Record - Generator I," October 3. [SRDB Ref ID: 13215, p. 82]

Jones, R. F., 1989, "PMS Data Record - Generator I," April 11. [SRDB Ref ID: 13215, p. 87]

Lincoln, T. A., and E. D. Gupton, 1958, "Radiation Doses in Diagnostic X-Ray Procedures," *Radiology*, volume 71, pp. 208–215. [SRDB Ref ID: 11099]

LMSC (Lockheed Martin Specialty Components), 1996, *Pinellas Plant Annual Site Environmental Report for Calendar Year 1995*, MMSC-EM-96010, Lockheed Martin Specialty Components, Largo, Florida, May. [SRDB Ref ID: 23003]

McCall, G. R., 1973, "Report of Radiation Protection Survey at General Electric Co., Bryan Dairy Road, Pinellas Co., Fla., December 15, 1972," attachment to untitled letter to J. N. Holliday (General Electric Company), Pinellas County Health Department, St. Petersburg, Florida, January 4. [SRDB Ref ID: 13215, p. 60]

NCRP (National Council on Radiation Protection and Measurements), 1989, *Medical X-Ray, Electron Beam and Gamma-Ray Protection for Energies Up To 50 MeV*, Report 102, Bethesda, Maryland. [SRDB Ref ID: 32467]

NIOSH (National Institute for Occupational Safety and Health), 2005, *Application of Photofluorography at the Pinellas Plant*, OCAS-PER-004, Rev. 0, Office of Compensation Analysis and Support, Cincinnati, Ohio, February 15.

NIOSH (National Institute for Occupational Safety and Health), 2010, *Radiation Exposures Covered for Dose Reconstructions Under Part B of the Energy Employees Occupational Illness Compensation Program Act*, DCAS-IG-003, Rev. 01, Division of Compensation Analysis and Support, Cincinnati, Ohio, October 5.

ORAUT (Oak Ridge Associated Universities Team), 2010, *Occupational Medical X-Ray Dose Reconstruction for DOE Sites*, ORAUT-PROC-0061, Rev. 03, Oak Ridge Associated Universities, Oak Ridge, Tennessee, March 3.

ORAUT (Oak Ridge Associated Universities Team), 2011b, *Dose Reconstruction from Occupational Medical X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 04, Oak Ridge, Tennessee, June 20.

ORAUT (Oak Ridge Associated Universities Team), 2011a, *Pinellas Plant – Site Description,* ORAUT-TKBS-0029-2, Rev. 02, Oak Ridge, Tennessee, April 1.

Weaver, A. S., 1990, *External Dosimetry*, HP03, Rev. 4.0, General Electric Company, St. Petersburg, Florida, May 30. [SRDB Ref ID: 12989, p. 2]

GLOSSARY

absorbed dose
Amount of energy (ergs or joules) deposited in a substance by ionizing radiation per unit mass (grams or kilograms) of the substance and measured in units of rads or grays.

ampere (A)
International System unit of electrical current equal to 1 coulomb per second.

dose equivalent
In units of rem or sievert, product of absorbed dose in tissue multiplied by a weighting factor and sometimes by other modifying factors to account for the potential for a biological effect from the absorbed dose.

exposure
(1) In general, the act of being exposed to ionizing radiation. (2) Measure of the ionization produced by X- and gamma-ray photons in air in units of roentgens.

film
(1) In the context of external dosimetry, radiation-sensitive photographic film in a light-tight wrapping. (2) X-ray film.

filtration
The process of filtering an X-ray beam, usually with millimeter thicknesses of aluminum material between the X-ray source and the film that preferentially absorbs photons from the beam. Usually measured in equivalent millimeters of aluminum. See *half-value layer*.

gray (Gy)
International System unit of absorbed radiation dose, which is the amount of energy from any type of ionizing radiation deposited in any medium; 1 Gy equals 1 joule per kilogram or 100 rads.

half-value layer (HVL)
Thickness of a specified substance, usually specified in equivalent millimeters of aluminum, which, when introduced in the path of a given beam of radiation, reduces the kerma rate by one-half. See *filtration*.

kerma
Measure in units of absorbed dose (usually grays but sometimes rads) of the energy released by radiation from a given amount of a substance. Kerma is the sum of the initial kinetic energies of all the charged ionizing particles liberated by uncharged ionizing particles (neutrons and photons) per unit mass of a specified material. Free-in-air kerma refers to the amount of radiation at a location before adjustment for any external shielding from structures or terrain. The word derives from kinetic energy released per unit mass.

rad
Traditional unit for expressing absorbed radiation dose, which is the amount of energy from any type of ionizing radiation deposited in any medium. A dose of 1 rad is equivalent to the absorption of 100 ergs per gram (0.01 joules per kilogram) of absorbing tissue. The rad has been replaced by the gray in the International System of Units (100 rads = 1 gray). The word derives from radiation absorbed dose.

radiography

The process of producing images on film (or other media) with radiation.

roentgen (R, sometimes r)

Unit of photon (gamma or X-ray) exposure for which the resultant ionization liberates a positive or negative charge equal to 2.58×10^{-4} coulombs per kilogram (or 1 electrostatic unit of electricity per cubic centimeter) of dry air at 0°C and standard atmospheric pressure. An exposure of 1 R is approximately equivalent to an absorbed dose of 1 rad in soft tissue for higher energy photons (generally greater than 100 kiloelectron-volts).

rem

Traditional unit of radiation dose equivalent that indicates the biological damage caused by radiation equivalent to that caused by 1 rad of high-penetration X-rays multiplied by a quality factor. The sievert is the International System unit; 1 rem equals 0.01 sievert. The word derives from roentgen equivalent in man; rem is also the plural.

sievert (Sv)

International System unit for dose equivalent, which indicates the biological damage caused by radiation. The unit is the radiation value in gray (equal to 1 joule per kilogram) multiplied by a weighting factor for the type of radiation and a weighting factor for the tissue; 1 Sv equals 100 rem.

source-to-image distance (SID)

Distance from the X-ray machine target (anode) to the plane of the image receptor (film). This distance is standardized for typical radiographic procedures. Chest X-rays, for example, are performed at a 72-inch SID.

source-to-skin distance (SSD)

Distance from the X-ray machine target (anode) to the skin of the person being X-rayed. This distance varies with the size of the person being radiographed.

technique

Combination of X-ray machine settings (technique factors) used to produce radiographs, which consists of the kilovoltage, tube current (milliamperes), and exposure time (seconds). The last two parameters are often multiplied to yield the electric charge that has crossed the X-ray tube during the exposure in units of milliampere-seconds. Any combination of time and tube current that produces a given product in milliampere-seconds produces the same exposure for a fixed peak kilovoltage. Also called technic.

ATTACHMENT A
ORGAN DOSE TABLES
Page 1 of 13

LIST OF TABLES

This attachment refers to entrance skin dose as ENSD, exit skin dose as EXSD, and remote skin dose as RSD.

ATTACHMENT A
ORGAN DOSE TABLES
Page 2 of 13

Table A-1. Organ dose equivalents (rem) for chest projections for all periods.

Organ	Projection	PFG, 1957–1959[a]	14- by 17-in., 1960–1971[b]	14- by 17-in., 1972–1987	14- by 17-in., 1988–1997
Thyroid	PA	3.94E–01	3.48E–02	1.98E–03	1.01E–03
	LAT/OBL	--[c]	6.85E–02	1.21E–02	6.16E–03
Eye/brain	PA	7.25E–02	6.40E–03	1.98E–03	1.01E–03
	LAT/OBL	--	6.85E–02	1.21E–02	6.16E–03
Ovaries	PA	2.50E–02	2.50E–02	1.02E–04	5.22E–05
	LAT/OBL	--	1.30E–02	1.28E–04	6.53E–05
Urinary bladder/prostate	PA	2.50E–02	2.50E–02	1.02E–04	5.22E–05
	LAT/OBL	--	1.30E–02	1.28E–04	6.53E–05
Colon/rectum	PA	2.50E–02	2.50E–02	1.02E–04	5.22E–05
	LAT/OBL	--	1.30E–02	1.28E–04	6.53E–05
Testes	PA	5.00E–03	5.00E–03	3.20E–07	1.63E–07
	LAT/OBL	--	2.50E–03	8.00E–06	4.08E–06
Lungs (male)	PA	9.50E–01	8.38E–02	1.81E–02	9.21E–03
	LAT/OBL	--	9.65E–02	2.21E–02	1.13E–02
Lungs (female)	PA	1.02E+00	9.02E–02	1.95E–02	9.94E–03
	LAT/OBL	--	1.10E–01	2.48E–02	1.26E–02
Thymus	PA	1.02E+00	9.02E–02	1.95E–02	9.94E–03
	LAT/OBL	--	1.10E–01	2.48E–02	1.26E–02
Esophagus	PA	1.02E+00	9.02E–02	1.95E–02	9.94E–03
	LAT/OBL	--	1.10E–01	2.48E–02	1.26E–02
Stomach	PA	1.02E+00	9.02E–02	1.95E–02	9.94E–03
	LAT/OBL	--	1.10E–01	2.48E–02	1.26E–02
Bone surface	PA	1.02E+00	9.02E–02	1.95E–02	9.94E–03
	LAT/OBL	--	1.10E–01	2.48E–02	1.26E–02
Liver/gall bladder/spleen	PA	1.02E+00	9.02E–02	1.95E–02	9.94E–03
	LAT/OBL	--	1.10E–01	2.48E–02	1.26E–02
Remainder organs	PA	1.02E+00	9.02E–02	1.95E–02	9.94E–03
	LAT/OBL	--	1.10E–01	2.48E–02	1.26E–02
Breast	PA	1.11E–01	9.80E–03	2.91E–03	1.48E–03
	LAT/OBL	--	1.28E–01	2.53E–02	1.29E–02
Uterus	PA	2.50E–02	2.50E–02	9.60E–05	4.89E–05
	LAT/OBL	--	1.30E–02	1.12E–04	5.71E–05
Bone marrow (male)	PA	2.09E–01	1.84E–02	4.67E–03	2.38E–03
	LAT/OBL	--	1.85E–02	4.88E–03	2.49E–03
Bone marrow (female)	PA	1.95E–01	1.72E–02	4.51E–03	2.30E–03
	LAT/OBL	--	1.45E–02	3.84E–03	1.96E–03
Entrance skin[d]	PA	3.06E+00	2.70E–01	4.48E–02	2.28E–02
	LAT/OBL	--	6.75E–01	1.12E–01	5.71E–02

a. Doses for PFG are from ORAUT-OTIB-0006 (ORAUT 2011b) and assumed to be stereo views.
b. Doses before 1972 are based on values in ORAUT-OTIB-0006 (ORAUT 2011b).
c. -- = not applicable.
d. ENSD is determined by multiplying the incident air kerma by the backscatter factors of 1.35 and 1.4 for HVL of 2.5 and 3.5 mm Al, respectively, from NCRP Report 102 (NCRP 1989, Table B-8). Skin doses for all areas of skin are provided in Table A-4 through A-6.

ATTACHMENT A
ORGAN DOSE TABLES
Page 3 of 13

Table A-2. Organ dose equivalents (rem) for Abd/KUB projections.

Organ	AP Abd/KUB, 1969–1971[a]	AP Abd/KUB, 1972–1974
Thyroid	8.18E–06	7.50E–06
Eye/brain	8.18E–06	7.50E–06
Ovaries	2.90E–01[b]	2.23E–01
Urinary bladder/prostate	1.40E–01	2.23E–01
Colon/rectum	1.40E–01	2.23E–01
Testes	4.40E–02[b]	1.88E–02
Lungs male	7.28E–03	1.28E–02
Lungs female	7.28E–03	1.28E–02
Thymus	7.28E–03	1.28E–02
Esophagus	7.28E–03	1.28E–02
Stomach	1.40E–01	2.23E–01
Bone surfaces	1.40E–01	2.23E–01
Liver/gall bladder/spleen	1.40E–01	2.23E–01
Remainder	1.40E–01	2.23E–01
Breast	2.25E–03[c]	5.21E–04[c]
Uterus	1.87E–01	2.84E–01
Bone marrow male	2.05E–02	4.13E–02
Bone marrow female	2.05E–02	4.13E–02
Entrance skin	1.080E+00[b]	1.043E+00

a. From Lincoln and Gupton (1958, Table VII) and ORAUT-OTIB-0006 (ORAUT 2011b).
b. Ovary, testes, and entrance skin doses are measured values from Lincoln and Gupton (1958, Table VII).
c. ICRP 34 does not have a DCF for dose to the breast from an AP abdomen projection. The dose to the breast was determined according to the method described in ORAUT-OTIB-0006 for dose to the breast from the lumbar spine examinations.

ATTACHMENT A
ORGAN DOSE TABLES
Page 4 of 13

Table A-3. Organ dose equivalents (rem) for lumbar spine projections for all periods.

Organ	AP lumbar spine projection, 1969–1971[a]	LAT lumbar spine projection, 1969–1971[a]	AP lumbar spine projection, 1972–1974	LAT lumbar spine projection, 1972–1974
Thyroid	2.88E–04	3.79E–05	8.46E–04	1.24E–05
Eye/brain	2.88E–04	3.79E–05	8.46E–04	1.24E–05
Ovaries	5.60E–01[b]	7.10E–01[b]	3.11E–01	8.27E–02
Urinary bladder/prostate	2.30E–01	1.17E–01	3.11E–01	8.27E–02
Colon/rectum	2.30E–01	1.17E–01	3.11E–01	8.27E–02
Testes	2.70E–02[b]	5.60E–02[b]	8.46E–03	1.48E–03
Lungs male	8.93E–02	3.79E–02	1.02E–01	2.10E–02
Lungs female	8.93E–02	3.79E–02	1.02E–01	2.10E–02
Thymus	8.93E–02	3.79E–02	1.02E–01	2.10E–02
Esophagus	8.93E–02	3.79E–02	1.02E–01	2.10E–02
Stomach	2.30E–01	1.17E–01	3.11E–01	8.27E–02
Bone surfaces	2.30E–01	1.17E–01	3.11E–01	8.27E–02
Liver/gall bladder/spleen	2.30E–01	1.17E–01	3.11E–01	8.27E–02
Remainder	2.30E–01	1.17E–01	3.11E–01	8.27E–02
Breast	4.78E–03[c]	7.58E–03[c]	5.39E–04[c]	3.74E–04[c]
Uterus	3.12E–01	7.58E–02	3.96E–01	5.56E–02
Bone marrow male	3.46E–02	5.69E–02	6.67E–02	3.83E–02
Bone marrow female	3.46E–02	5.69E–02	6.67E–02	3.83E–02
Entrance skin	1.900E+00[b]	5.00E+00[b]	1.32E+00	1.74E+00

a. From ORAUT-OTIB-0006 (ORAUT 2011b).
b. Ovary, testes, and entrance skin doses are measured values from Lincoln and Gupton (1958, Table VII).
c. ICRP 34 does not have a DCF for dose to the breast from an AP lumbar spine projection. The dose to the breast was determined according to the method described in ORAUT-OTIB-0006 for dose to the breast from the lumbar spine examinations.

Table A-4. Skin dose guidance and skin dose equivalents (rem) for chest projections, 1957 through 1971.

Area of skin	PFG 1957–1959		PA chest 1960–1971		LAT chest 1960–1971		RAO chest 1960–1971	
	Guidance	Dose	Guidance	Dose	Guidance	Dose	Guidance	Dose
Right front shoulder	EXSD	6.67E–02	EXSD	5.9E–03	ENSD	6.75E–01	EXSD	3.0E–03
Right back shoulder	ENSD	3.06E+00	ENSD	2.70E–01	ENSD	6.75E–01	ENSD	6.75E–01
Left front shoulder	EXSD	6.67E–02	EXSD	5.9E–03	EXSD	3.0E–03	EXSD	3.0E–03
Left back shoulder	ENSD	3.06E+00	ENSD	2.70E–01	EXSD	3.0E–03	ENSD	6.75E–01
Right upper arm to elbow	10% ENSD	3.06E–01	ENSD	2.70E–01	ENSD	6.75E–01	ENSD	6.75E–01
Left upper arm to elbow	10% ENSD	3.06E–01	ENSD	2.70E–01	EXSD	3.0E–03	ENSD	6.75E–01
Left hand	ENSD	3.06E+00	ENSD	2.70E–01	10% ENSD	6.75E–02	10% ENSD	6.75E–02
Right hand	ENSD	3.06E+00	ENSD	2.70E–01	10% ENSD	6.75E–02	10% ENSD	6.75E–02
Left elbow, forearm, wrist	10% ENSD	3.06E–01	ENSD	2.70E–01	10% ENSD	6.75E–02	10% ENSD	6.75E–02
Right elbow, forearm, wrist	10% ENSD	3.06E–01	ENSD	2.70E–01	10% ENSD	6.75E–02	10% ENSD	6.75E–02
Right side of head (including ear and temple)	10% ENSD	3.06E–01	10% ENSD	2.70E–02	Eye/brain	6.85E–02	10% EXSD	3.E–04
Left side of head (including ear and temple)	10% ENSD	3.06E–01	10% ENSD	2.70E–02	Eye/brain	6.85E–02	10% ENSD	6.75E–02
Front left thigh	RSD (0.52 m)	9.E–04	RSD (0.52 m)	8.E–05	RSD (0.52 m)	9.E-05	RSD (0.52 m)	9.E-05
Back left thigh	RSD (0.52 m)	9.E–04	RSD (0.52 m)	8.E–05	RSD (0.52 m)	9.E-05	RSD (0.52 m)	9.E-05
Front right thigh	RSD (0.52 m)	9.E–04	RSD (0.52 m)	8.E–05	RSD (0.52 m)	9.E-05	RSD (0.52 m)	9.E-05
Back right thigh	RSD (0.52 m)	9.E–04	RSD (0.52 m)	8.E–05	RSD (0.52 m)	9.E-05	RSD (0.52 m)	9.E-05
Left knee and below	RSD (0.86 m)	3.E–04	RSD (0.86 m)	3.E–05	RSD (0.86 m)	3.E-05	RSD (0.86 m)	3.E-05
Right knee and below	RSD (0.86 m)	3.E–04	RSD (0.86 m)	3.E–05	RSD (0.86 m)	3.E-05	RSD (0.86 m)	3.E-05
Left side of face	Eye/brain	7.25E–02	Eye/brain	6.4E–03	Eye/brain	6.85E–02	ENSD	6.75E–01
Right side of face	Eye/brain	7.25E–02	Eye/brain	6.4E–03	Eye/brain	6.85E–02	EXSD	3.0E–03
Left side of neck	10% ENSD	3.06E–01	ENSD	2.70E–01	Eye/brain	6.85E–02	ENSD	6.75E–01
Right side of neck	10% ENSD	3.06E–01	ENSD	2.70E–01	Eye/brain	6.85E–02	EXSD	3.0E–03
Back of head	10% ENSD	3.06E–01	10% ENSD	2.70E–02	Eye/brain	6.85E–02	10% ENSD	6.75E–02
Front of neck	Eye/brain	7.25E–02	Eye/brain	6.4E–03	Eye/brain	6.85E–02	Eye/Brain	6.85E–02
Back of neck	10% ENSD	3.06E–01	ENSD	2.70E–01	Eye/brain	6.85E–02	ENSD	6.75E–01
Front torso: base of neck to end of sternum	EXSD	6.67E–02	EXSD	5.9E–03	Lung	1.10E–01	EXSD	3.0E–03
Front torso: end of sternum to lowest rib	EXSD	6.67E–02	EXSD	5.9E–03	Lung	1.10E–01	EXSD	3.0E–03
Front torso: lowest rib to iliac crest	EXSD	6.67E–02	EXSD	5.9E–03	Lung	1.10E–01	EXSD	3.0E–03

Area of skin	PFG, 1957–1959		PA chest, 1960–1971		LAT chest, 1960–1971		RAO chest, 1960–1971	
	Guidance	Dose	Guidance	Dose	Guidance	Dose	Guidance	Dose
Front torso: iliac crest to pubis	10% EXSD	6.7E–03	10% EXSD	6.E–04	10% lung	1.10E–02	10% EXSD	3.E–04
Back torso: base of neck to mid–back	ENSD	3.06E+00	ENSD	2.70E–01	Lung	1.10E–01	ENSD	6.75E–01
Back torso: mid–back to lowest rib	ENSD	3.06E+00	ENSD	2.70E–01	Lung	1.10E–01	ENSD	6.75E–01
Back torso: lowest rib to iliac crest	ENSD	3.06E+00	ENSD	2.70E–01	Lung	1.10E–01	ENSD	6.75E–01
Back torso: buttocks (Iliac crest and below)	10% ENSD	3.06E–01	10% ENSD	2.70E–02	10% Lung	1.10E–02	10% ENSD	6.75E–02
Right torso: base of neck to end of sternum	ENSD	3.06E+00	ENSD	2.70E–01	ENSD	6.75E–01	EXSD	3.0E–03
Right torso: end of sternum to lowest rib	ENSD	3.06E+00	ENSD	2.70E–01	ENSD	6.75E–01	EXSD	3.0E–03
Right torso: lowest rib to iliac crest	ENSD	3.06E+00	ENSD	2.70E–01	ENSD	6.75E–01	EXSD	3.0E–03
Right torso: iliac crest to pubis (right hip)	10% ENSD	3.06E–01	10% ENSD	2.70E–02	10% ENSD	6.75E–02	10% EXSD	3.E–04
Left torso: base of neck to end of sternum	ENSD	3.06E+00	ENSD	2.70E–01	EXSD	3.0E–03	ENSD	6.75E–01
Left torso: end of sternum to lowest rib	ENSD	3.06E+00	ENSD	2.70E–01	EXSD	3.0E–03	ENSD	6.75E–01
Left torso: lowest rib to iliac crest	ENSD	3.06E+00	ENSD	2.70E–01	EXSD	3.0E–03	ENSD	6.75E–01
Left torso: iliac crest to pubis (left hip)	10% ENSD	3.06E–01	10% ENSD	2.70E–02	10% EXSD	3.E–04	10% ENSD	6.75E–02

Table A-5. Skin dose guidance and skin dose equivalents (rem) for chest projections, 1972 through 1987.

Area of skin	PA chest, 1972–1987		LAT chest, 1972–1987		RAO chest, 1972–1987	
	Guidance	Dose	Guidance	Dose	Guidance	Dose
Right front shoulder	EXSD	1.3E–03	ENSD	1.12E–01	EXSD	7.E–04
Right back shoulder	ENSD	4.48E–02	ENSD	1.12E–01	ENSD	1.12E–01
Left front shoulder	EXSD	1.3E–03	EXSD	7.E–04	EXSD	7.E–04
Left back shoulder	ENSD	4.48E–02	EXSD	7.E–04	ENSD	1.12E–01
Right upper arm to elbow	10% ENSD	4.5E–03	ENSD	1.12E–01	10% ENSD	1.12E–02
Left upper arm to elbow	10% ENSD	4.5E–03	EXSD	7.E–04	10% ENSD	1.12E–02
Left hand	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Right hand	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Left elbow, forearm, wrist	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Right elbow, forearm, wrist	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Right side of head (including ear and temple)	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% EXSD	7.E–05
Left side of head (including ear and temple)	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Front left thigh	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05
Back left thigh	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05
Front right thigh	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05
Back right thigh	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05	RSD (0.52 m)	2.E–05
Left knee and below	RSD (0.86 m)	6.E–06	RSD (0.86 m)	7.E-06	RSD (0.86 m)	7.E-06
Right knee and below	RSD (0.86 m)	6.E–06	RSD (0.86 m)	7.E-06	RSD (0.86 m)	7.E-06
Left side of face	Eye/brain	2.0E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Right side of face	Eye/brain	2.0E–03	10% ENSD	1.12E–02	10% EXSD	7.E–05
Left side of neck	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Right side of neck	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% EXSD	7.E–05
Back of head	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Front of neck	Thyroid	2.0E–03	10% ENSD	1.12E–02	Thyroid	1.21E–02
Back of neck	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% ENSD	1.12E–02
Front torso: base of neck to end of sternum	EXSD	1.3E–03	Lung	2.48E–02	EXSD	7.E–04
Front torso: end of sternum to lowest rib	EXSD	1.3E–03	Lung	2.48E–02	EXSD	7.E–04
Front torso: lowest rib to iliac crest	10% EXSD	1.E–04	10% Lung	2.5E–03	10% EXSD	7.E–05
Front torso: iliac crest to pubis	10% EXSD	1.E–04	10% Lung	2.5E–03	10% EXSD	7.E–05
Back torso: base of neck to mid–back	ENSD	4.48E–02	Lung	2.48E–02	ENSD	1.12E–01
Back torso: mid–back to lowest rib	ENSD	4.48E–02	Lung	2.48E–02	ENSD	1.12E–01
Back torso: lowest rib to iliac crest	10% ENSD	4.5E–03	10% lung	2.5E–03	10% ENSD	1.12E–02
Back torso: buttocks (Iliac crest and below)	10% ENSD	4.5E–03	10% lung	2.5E–03	10% ENSD	1.12E–02

Area of skin	PA chest, 1972–1987		LAT chest, 1972–1987		RAO chest, 1972–1987	
	Guidance	Dose	Guidance	Dose	Guidance	Dose
Right torso: base of neck to end of sternum	ENSD	4.48E–02	ENSD	1.12E–01	EXSD	7.E–04
Right torso: end of sternum to lowest rib	ENSD	4.48E–02	ENSD	1.12E–01	EXSD	7.E–04
Right torso: lowest rib to iliac crest	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% EXSD	7.E–05
Right torso: iliac crest to pubis (right hip)	10% ENSD	4.5E–03	10% ENSD	1.12E–02	10% EXSD	7.E–05
Left torso: base of neck to end of sternum	ENSD	4.48E–02	EXSD	7.E–04	ENSD	1.12E–01
Left torso: end of sternum to lowest rib	ENSD	4.48E–02	EXSD	7.E–04	ENSD	1.12E–01
Left torso: lowest rib to iliac crest	10% ENSD	4.5E–03	10% EXSD	7.E–05	10% ENSD	1.12E–02
Left torso: iliac crest to pubis (left hip)	10% ENSD	4.5E–03	10% EXSD	7.E–05	10% ENSD	1.12E–02

Table A-6. Skin dose guidance and skin dose equivalents (rem) for chest projections, 1988 through 1997.

Area of skin	PA chest, 1988–1997		LAT chest, 1988–1997		RAO chest, 1988–1997	
	Guidance	Dose	Guidance	Dose	Guidance	Dose
Right front shoulder	EXSD	7.E–04	ENSD	5.71E–02	EXSD	4.E–04
Right back shoulder	ENSD	2.28E–02	ENSD	5.71E–02	ENSD	5.71E–02
Left front shoulder	EXSD	7.E–04	EXSD	4.E–04	EXSD	4.E–04
Left back shoulder	ENSD	2.28E–02	EXSD	4.E–04	ENSD	5.71E–02
Right upper arm to elbow	10% ENSD	2.3E–03	ENSD	5.71E–02	10% ENSD	5.7E–03
Left upper arm to elbow	10% ENSD	2.3E–03	EXSD	4.E–04	10% ENSD	5.7E–03
Left hand	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Right hand	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Left elbow, forearm, wrist	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Right elbow, forearm, wrist	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Right side of head (including ear and temple)	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% EXSD	4.E–05
Left side of head (including ear and temple)	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Front left thigh	RSD (0.52 m)	8.E–06	RSD (0.52 m)	1.E–05	RSD (0.52 m)	1.E–05
Back left thigh	RSD (0.52 m)	8.E–06	RSD (0.52 m)	1.E–05	RSD (0.52 m)	1.E–05
Front right thigh	RSD (0.52 m)	8.E–06	RSD (0.52 m)	1.E–05	RSD (0.52 m)	1.E–05
Back right thigh	RSD (0.52 m)	8.E–06	RSD (0.52 m)	1.E–05	RSD (0.52 m)	1.E–05
Left knee and below	RSD (0.86 m)	3.E–06	RSD (0.86 m)	4.E–06	RSD (0.86 m)	4.E–06
Right knee and below	RSD (0.86 m)	3.E–06	RSD (0.86 m)	4.E–06	RSD (0.86 m)	4.E–06
Left side of face	Eye/brain	1.0E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Right side of face	Eye/brain	1.0E–03	10% ENSD	5.7E–03	10% EXSD	4.E–05

Area of skin	PA chest, 1988–1997		LAT chest, 1988–1997		RAO chest, 1988–1997	
	Guidance	Dose	Guidance	Dose	Guidance	Dose
Left side of neck	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Right side of neck	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% EXSD	4.E–05
Back of head	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Front of neck	Thyroid	1.0E–03	10% ENSD	5.7E–03	Thyroid	6.2E–03
Back of neck	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% ENSD	5.7E–03
Front torso: base of neck to end of sternum	EXSD	7.E–04	Lung	1.26E–02	EXSD	4.E–04
Front torso: end of sternum to lowest rib	EXSD	7.E–04	Lung	1.26E–02	EXSD	4.E–04
Front torso: lowest rib to iliac crest	10% EXSD	7.E–05	10% lung	1.3E–03	10% EXSD	4.E–05
Front torso: iliac crest to pubis	10% EXSD	7.E–05	10% lung	1.3E–03	10% EXSD	4.E–05
Back torso: base of neck to mid–back	ENSD	2.28E–02	Lung	1.26E–02	ENSD	5.71E–02
Back torso: mid–back to lowest rib	ENSD	2.28E–02	Lung	1.26E–02	ENSD	5.71E–02
Back torso: lowest rib to iliac crest	10% ENSD	2.3E–03	10% lung	1.3E–03	10% ENSD	5.7E–03
Back torso: buttocks (Iliac crest and below)	10% ENSD	2.3E–03	10% lung	1.3E–03	10% ENSD	5.7E–03
Right torso: base of neck to end of sternum	ENSD	2.28E–02	ENSD	5.71E–02	EXSD	4.E–04
Right torso: end of sternum to lowest rib	ENSD	2.28E–02	ENSD	5.71E–02	EXSD	4.E–04
Right torso: lowest rib to iliac crest	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% EXSD	4.E–05
Right torso: iliac crest to pubis (right hip)	10% ENSD	2.3E–03	10% ENSD	5.7E–03	10% EXSD	4.E–05
Left torso: base of neck to end of sternum	ENSD	2.28E–02	EXSD	4.E–04	ENSD	5.71E–02
Left torso: end of sternum to lowest rib	ENSD	2.28E–02	EXSD	4.E–04	ENSD	5.71E–02
Left torso: lowest rib to iliac crest	10% ENSD	2.3E–03	10% EXSD	4.E–05	10% ENSD	5.7E–03
Left torso: iliac crest to pubis (left hip)	10% ENSD	2.3E–03	10% EXSD	4.E–05	10% ENSD	5.7E–03

Table A-7. Skin dose guidance and skin dose equivalents (rem) for Abd/KUB projections, 1969 through 1974.[a]

Area of skin	Abd/KUB, 1969-1971		Abd/KUB, 1972-1974	
	Guidance[a]	Dose	Guidance[a]	Dose
Right front shoulder	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Right back shoulder	10% EXSD	2.1E–03	10% EXSD	2.6E–03
Left front shoulder	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Left back shoulder	10% EXSD	2.1E–03	10% EXSD	2.6E–03
Right upper arm to elbow	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Left upper arm to elbow	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Left hand	ENSD	1.08E+00	10% ENSD	1.04E–01
Right hand	ENSD	1.08E+00	10% ENSD	1.04E–01
Left elbow, forearm, wrist	ENSD	1.08E+00	10% ENSD	1.04E–01
Right elbow, forearm, wrist	ENSD	1.08E+00	10% ENSD	1.04E–01
Right side of head (including ear and temple)	Eye/brain	8.E–06	Eye/brain	8.E–06
Left side of head (including ear and temple)	Eye/brain	8.E–06	Eye/brain	8.E–06
Front left thigh	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Back left thigh	10% EXSD	2.1E–03	10% EXSD	2.6E–03
Front right thigh	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Back right thigh	10% EXSD	2.1E–03	10% EXSD	2.6E–03
Left knee and below	RSD (0.60 m)	2.E–04	RSD (0.60 m)	3.E–04
Right knee and below	RSD (0.60 m)	2.E–04	RSD (0.60 m)	3.E–04
Left side of face	Eye/brain	8.E–06	Eye/brain	8.E–06
Right side of face	Eye/brain	8.E–06	Eye/brain	8.E–06
Left side of neck	Eye/brain	8.E–06	Eye/brain	8.E–06
Right side of neck	Eye/brain	8.E–06	Eye/brain	8.E–06
Back of head	Eye/brain	8.E–06	Eye/brain	8.E–06
Front of neck	Eye/brain	8.E–06	Eye/brain	8.E–06
Back of neck	Eye/brain	8.E–06	Eye/brain	8.E–06
Front torso: base of neck to end of sternum	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Front torso: end of sternum to lowest rib	ENSD	1.08E+00	ENSD	1.04E+00
Front torso: lowest rib to iliac crest	ENSD	1.08E+00	ENSD	1.04E+00
Front torso: iliac crest to pubis	ENSD	1.08E+00	ENSD	1.04E+00
Back torso: base of neck to mid–back	10% EXSD	2.1E–03	10% EXSD	2.6E–03
Back torso: mid–back to lowest rib	EXSD	2.07E–02	EXSD	2.63E–02
Back torso: lowest rib to iliac crest	EXSD	2.07E–02	EXSD	2.63E–02

Area of skin	Abd/KUB, 1969-1971		Abd/KUB, 1972-1974	
	Guidance[a]	Dose	Guidance[a]	Dose
Back torso: buttocks (Iliac crest and below)	EXSD	2.07E–02	EXSD	2.63E–02
Right torso: base of neck to end of sternum	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Right torso: end of sternum to lowest rib	ENSD	1.08E+00	ENSD	1.04E+00
Right torso: lowest rib to iliac crest	ENSD	1.08E+00	ENSD	1.04E+00
Right torso: iliac crest to pubis (right hip)	ENSD	1.08E+00	ENSD	1.04E+00
Left torso: base of neck to end of sternum	10% ENSD	1.08E–01	10% ENSD	1.04E–01
Left torso: end of sternum to lowest rib	ENSD	1.08E+00	ENSD	1.04E+00
Left torso: lowest rib to iliac crest	ENSD	1.08E+00	ENSD	1.04E+00
Left torso: iliac crest to pubis (left hip)	ENSD	1.08E+00	ENSD	1.04E+00

a. Skin dose guidance for the Abd/KUB is assumed to be the same as the AP lumbar spine for the same period because the two procedures are very similarly positioned.

Table A-8. Skin dose guidance and skin dose equivalents (rem) for lumbar spine projections, 1969 through 1974.

Area of skin	AP lumbar spine, 1969–1971		LAT lumbar spine, 1969–1971		AP lumbar spine, 1972–1974		LAT lumbar spine, 1972–1974	
	Guidance	Dose	Guidance	Dose	Guidance	Dose	Guidance	Dose
Right front shoulder	10% ENSD	1.90E–01	10% ENSD	5.00E–01	10% ENSD	1.32E–01	10% ENSD	1.74E–01
Right back shoulder	10% EXSD	3.6E–03	10% ENSD	5.00E–01	10% EXSD	3.9E–03	10% ENSD	1.74E–01
Left front shoulder	10% ENSD	1.90E–01	10% EXSD	1.90E–03	10% ENSD	1.32E–01	10% EXSD	1.8E–03
Left back shoulder	10% EXSD	3.6E–03	10% EXSD	1.90E–03	10% EXSD	3.9E–03	10% EXSD	1.8E–03
Right upper arm to elbow	10% ENSD	1.90E–01	10% ENSD	5.00E–01	10% ENSD	1.32E–01	10% ENSD	1.74E–01
Left upper arm to elbow	10% ENSD	1.90E–01	10% EXSD	1.90E–03	10% ENSD	1.32E–01	10% EXSD	1.8E–03
Left hand	ENSD	1.90E+00	10% EXSD	1.90E–03	10% ENSD	1.32E–01	10% EXSD	1.8E–03
Right hand	ENSD	1.90E+00	10% ENSD	5.00E–01	10% ENSD	1.32E–01	10% ENSD	1.74E–01
Left elbow, forearm, wrist	ENSD	1.90E+00	10% EXSD	1.90E–03	10% ENSD	1.32E–01	10% EXSD	1.8E–03
Right elbow, forearm, wrist	ENSD	1.90E+00	10% ENSD	5.00E–01	10% ENSD	1.32E–01	10% ENSD	1.74E–01
Right side of head (including ear and temple)	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Left side of head (including ear and temple)	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Front left thigh	10% ENSD	1.90E–01	10% EXSD	1.90E–03	10% ENSD	1.32E–01	10% EXSD	1.8E–03
Back left thigh	10% EXSD	3.6E–03	10% EXSD	1.90E–03	10% EXSD	3.9E–03	10% EXSD	1.8E–03
Front right thigh	10% ENSD	1.90E–01	10% ENSD	5.00E–01	10% ENSD	1.32E–01	10% ENSD	1.74E–01
Back right thigh	10% EXSD	3.6E–03	10% ENSD	5.00E–01	10% EXSD	3.9E–03	10% ENSD	1.74E–01
Left knee and below	RSD (0.60 m)	4.E–04	RSD (0.60 m)	4.E–04	RSD (0.60 m)	4.E–04	RSD (0.60m)	2.E–04
Right knee and below	RSD (0.60 m)	4.E–04	RSD (0.60 m)	4.E–04	RSD (0.60 m)	4.E–04	RSD (0.60 m)	2.E–04
Left side of face	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Right side of face	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Left side of neck	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Right side of neck	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Back of head	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Front of neck	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Back of neck	Eye/brain	3.E–04	Eye/brain	3.E–05	Eye/brain	8.E–04	Eye/brain	1.E–05
Front torso: base of neck to end of sternum	10% ENSD	1.90E–01	Lung	3.32E–02	10% ENSD	1.32E–01	Lung	2.10E–02
Front torso: end of sternum to lowest rib	ENSD	1.90E+00	Lung	3.32E–02	ENSD	1.32E+00	Lung	2.10E–02

Area of skin	AP lumbar spine, 1969–1971		LAT lumbar spine, 1969–1971		AP lumbar spine, 1972–1974		LAT lumbar spine, 1972–1974	
	Guidance	**Dose**	**Guidance**	**Dose**	**Guidance**	**Dose**	**Guidance**	**Dose**
Front torso: lowest rib to iliac crest	ENSD	1.90E+00	Lung	3.32E–02	ENSD	1.32E+00	Lung	2.10E–02
Front torso: iliac crest to pubis	ENSD	1.90E+00	Lung	3.32E–02	ENSD	1.32E+00	Lung	2.10E–02
Back torso: base of neck to mid–back	10% EXSD	3.6E–03	Lung	3.32E–02	10% EXSD	3.9E–03	Lung	2.10E–02
Back torso: mid–back to lowest rib	EXSD	3.64E–02	Lung	3.32E–02	EXSD	3.86E–02	Lung	2.10E–02
Back torso: lowest rib to iliac crest	EXSD	3.64E–02	Lung	3.32E–02	EXSD	3.86E–02	Lung	2.10E–02
Back torso: buttocks (Iliac crest and below)	EXSD	3.64E–02	Lung	3.32E–02	EXSD	3.86E–02	Lung	2.10E–02
Right torso: base of neck to end of sternum	10% ENSD	1.90E–01	10% ENSD	5.00E–01	10% ENSD	1.32E–01	10% ENSD	1.74E–01
Right torso: end of sternum to lowest rib	ENSD	1.90E+00	ENSD	5.00E+00	ENSD	1.32E+00	ENSD	1.74E+00
Right torso: lowest rib to iliac crest	ENSD	1.90E+00	ENSD	5.00E+00	ENSD	1.32E+00	ENSD	1.74E+00
Right torso: iliac crest to pubis (right hip)	ENSD	1.90E+00	ENSD	5.00E+00	ENSD	1.32E+00	ENSD	1.74E+00
Left torso: base of neck to end of sternum	10% ENSD	1.90E–01	10% EXSD	1.90E–03	10% ENSD	1.32E–01	10% EXSD	1.8E–03
Left torso: end of sternum to lowest rib	ENSD	1.90E+00	EXSD	1.90E–02	ENSD	1.32E+00	EXSD	1.82E–02
Left torso: lowest rib to iliac crest	ENSD	1.90E+00	EXSD	1.90E–02	ENSD	1.32E+00	EXSD	1.82E–02
Left torso: iliac crest to pubis (left hip)	ENSD	1.90E+00	EXSD	1.90E–02	ENSD	1.32E+00	EXSD	1.82E–02