Office of Compensation Analysis and Support Technical Basis Document for Atomic Energy Operations at the Iowa Army Ammunition Plant (IAAP)	Document Number: OCAS-TKBS-0001 Effective Date: 12/21/2005 Revision No.:0 Controlled Copy No.: ________ Page 1 of 19
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RECORD OF ISSUE / REVISIONS

ISSUE AUTHORIZATION DATE	EFFECTIVE DATE	REV. NO.	DESCRIPTION
12/21/2005	12/21/2005	00	Significant changes to ORAUT-TKBS-0018 Rev 01 based upon the feasibility determination by the Secretary of Health and Human Services. Incorporated comments received from OGC pertaining to reconstruction of medical X-ray procedures.

ACRONYMS AND ABBREVIATIONS

AEC	US Atomic Energy Commission
AP	Anterior-posterior (or front-to-back) irradiation of the body
BAECP	Burlington Atomic Energy Commission Plant
DCF	dose conversion factor
DOE	U. S. Department of Energy
DU	depleted uranium
EDA	Explosives Disposal Area
FS	Firing Site
GSD	geometric standard deviation
Hp(d)	personnel dose equivalent at depth d in tissue
IAAP	Iowa Army Ammunition Plant (also sometimes IAAAP)
ICRP	International Commission on Radiological Protection
ICRU	International Commission on Radiation Units and Measurements
IREP	Interactive RadioEpidemiological Program
keV	kilo (thousand) electron volts, a unit of energy
MED	Manhattan Engineer District
MeV	million electron volts, a unit of energy
MDL	minimum detectable level
mrem	millirem one-thousandth of a rem
NCRP	National Commission on Radiological Protection and Measurements
NIOSH	National Institute for Occupational Safety and Health
NTA	Eastman Kodak Nuclear Track Emulsion type A
OCAS	Office of Compensation Analysis and Support
ORAU	Oak Ridge Associated Universities
R	roentgen, unit of exposure to ionizing photons in air
SRS	Savannah River Site
TBD	technical basis document
TLD	thermoluminescent dosimeter

1.0 INTRODUCTION

Technical basis documents are general working documents that provide guidance concerning 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 the National Institute for Occupational Safety and Health (NIOSH) 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 IAAP. It does not necessarily connote an “atomic weapons employer facility” or a “Department of Energy facility” as defined in the Energy Employee Occupational Illness Compensation Program Act of 2000 (42 U.S.C. § 7384I (5) and (12)).

This document provides information on interpretation of dosimetry records to estimate external doses for workers at the Iowa Army Ammunition Plant in Burlington, Iowa. The Iowa Army Ammunition Plant was responsible for high explosive (HE) fabrication, assembly of non-nuclear and nuclear components, retrofits, modifications, surveillance, and disassembly of nuclear weapons.

The Secretary of Health and Human Services determined that it is not feasible for NIOSH to estimate with sufficient accuracy, the radiation exposures for Line 1 Iowa Army Ammunition Plant workers, from March 1949 through December 1974. As a result of this determination, NIOSH is only able to conduct dose reconstructions using actual measured radiation exposure data for an individual whose dose is being reconstructed (USDOL 2005). Correspondence received by NIOSH from the U.S. Department of Labor concerning dose reconstruction for members of the designated Special Exposure Cohort can be found in Appendix A of this document.

2.0 SITE DESCRIPTION, OPERATIONAL HISTORY, AND PROCESS

The Iowa Army Ammunition Plant (IAAP) is a load, assemble, and pack munitions facility that began production in 1941 and continues to operate as a Government-owned, contractor-operated installation. IAAP is in the southeastern part of Iowa, near the town of Middletown in Des Moines County. It is about 10 miles west of the Mississippi River and the town of Burlington (U. S. Army 1988). Less than a third of the IAAP’s 19,015-acre (30-square-mile) property is occupied by active or formerly active production or storage facilities. The remaining land is evenly divided between leased agricultural acreage and woodlands (JAYCOR 1996).

Since operations began in 1941, IAAP has used explosives and lead-based initiating compounds to produce a wide variety of ordnance items. The Line 1 area, portions of the Firing Site (FS) area, the Explosive Disposal Area (EDA) sites, and Yards C, G, and L came under the jurisdiction of the Atomic Energy Commission [AEC; now the U. S. Department of Energy (DOE)]. In addition, the Security Command Center, the Emergency Response Command Post, the Deactivation furnace, Line 3 Warehouse 301, and the North Burn Pads Landfill might have been utilized. This area, totaling around 1,630 acres, became known as the Burlington Atomic Energy Commission Plant (BAECP). The site was officially renamed the Iowa Army

Ammunition Plant in 1965. The site has also been referred to as the Iowa Ordnance Plant. Specific buildings and the functions of various radiological buildings can be found in Appendix B of this report.

During the summer of 1947, Silas Mason Company entered into a contract with the Ordnance Department to assist in the design and engineering to perform the construction and to operate a facility for the purpose of supplying the Atomic Energy Commission (AEC) with explosive components for nuclear weapons. In May 1948, Silas and Mason Company supervisor personnel entered a training program at the Naval Ordnance Test Station (China Lake, California). Upon returning from training, these supervisors trained other IAAP personnel. By the spring of 1949, IAAP was at full production for HE fabrication (Mitchell 2003). In March 1949, it was decided that certain weapon assembly operations (non-nuclear components) would also be conducted at IAAP (Poole and Harrison, 1954, Mitchell, 2003). Until March 1949, all of the initial work at IAAP focused solely on high explosive manufacturing. Based on a review of IAAP Project History reports (Poole and Harrison, 1954), NIOSH has concluded that the first nuclear weapon assembly operations began in 1949 with the Mark IV.

Based on the review conducted during the development of the initial site profile, NIOSH felt certain that fissile materials were onsite from at least 1958 forward. The concern for these materials is that they are generally the most radioactive component of a nuclear weapon and result in the largest external dose. NIOSH has uncovered considerable evidence that indicated fissile materials were not onsite at IAAP until 1955. This evidence considers IAAP's mission, early weapon design and the development of a Rad-Safe (Radiation Safety) program.

According to the IAAP History of Line 1 Operations (Ahlstrand, 1956a, 1956b, 1957b), with the planned assembly of new sealed pit weapon designs, IAAP instituted a radiological monitoring program which included the routine external dose monitoring for some workers using film badges. A chronology of significant events can be found in Table 2.1.

Table 2.1 Significant Radiation Safety Program Events

Time	Event	Reference
November 1955	Selected workers issued film dosimetry on an intermittent basis. Badge exchange frequency was weekly.	TracerLab Reports (1955)
March 1956	Safety Manager attends Rad-Safe training at LASL.	Ahlstrand (1956a)
July 1956	Formal establishment of a Rad-Safe program • Training of all Division B Personnel • Acquirement of Rad-Safe Equipment • Continuous Air Monitoring	Ahlstrand (1956b)
July 1957	The following excerpt is from the IAAP Project History Report in 1957. *Continued emphasis on Rad-Safe Training for the safe handling of radioactive materials in order to prepare all workers for the new phases of work in division "B". Even though this material is received at this installation in sealed containers and is low energy radiation, employees are trained in all phases of safe handling of these materials.*	Ahlstrand (1957b)
September 1957	Establishment of a team for Off-site Emergency Radiological Monitoring	Ahlstrand (1957b)
January – June 1958	Extensive Rad-Safe training conducted including training on urinalysis. • 72 Employees attended Primer Course 2T • 7 employees spent a week in April at the Nevada Test Site for special Rad-safe training • The Plant's Registered nurses and certain members of the Safety, Mechanical and Chemical Laboratory departments spent approximately 200 hours special training on urinalysis procedures and the operation and maintenance of monitoring equipment.	Ahlstrand (1958a)
July 1959	Radiation Safety inspector visits Pantex and LASL to discuss radiological and health problems.	Ahlstrand (1959b)
1962	First instance of AEC Form 191 documenting no internal exposures at IAAP during the year.	AEC Report 191 (1962-1974)
September 1962	Routine issuance of film dosimeter badges to personnel. Badge exchange frequency was weekly. First routine area dosimeters in buildings 1-11 and 1-77.	Landauer Reports (1962)
January 1963	Badge exchange frequency changed to bi-weekly.	Landauer Reports (1963)
January 1964	Badge exchange frequency changed to 4 weeks. A total of 13 cycles per year. Some highly exposed workers continued on bi-weekly basis.	
1968	Significant increase (doubling) in the issuance of dosimeters to personnel.	Landauer Reports (1968)
October 1969	IAAP establishes hand monitoring program following an AEC recommendation in 1969: *Hand exposure studies have been made in the past, with results that indicate only nominal exposure. However, no hand monitoring has been done within the past year. With new items that are coming into production, and the strong possibility of a reduced exposure guide for extremities, a program of hand monitoring should be provided for those employees who work directly with the radioactive units that have significant surface dose rates.*	Davis (1969)

3.0 OCCUPATIONAL MEDICAL RADIATION EXPOSURE

Medical examinations at the IAAP were required as a condition of employment. Generally a chest X-ray was given to each IAAP employee annually. During the worker outreach meeting in July 2004, some workers indicated that they received chest X-rays on a semi-annual basis, while others indicated that it was more frequent on a quarterly basis. Assuming medical monitoring practices were similar between IAAP and Pantex, there is evidence that male employees in certain job categories (heavy lifters, perhaps) received lumbar spine examinations, the frequency of which was not available. At Pantex, lumbar spine examinations were given to men when they were hired to check for pre-existing back conditions. Even though measured X-ray exposure data does not exist for every IAAP employee, some records of X-ray machine exposures do exist as described below. Therefore, the claimant favorable assumption was made to include this source of occupational radiation exposure, consistent with NIOSH guidance (2002, 2005 communication via email).

Background information on X-ray doses can be found in *Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures* (NIOSH 2003). Only limited data was found concerning X-ray exposures. The exposure information was located within the dosimetry records indicating chest exposures at the hospital. During a study, several Landauer film badges were exposed to select X-ray machine settings. Table 3.1 below summarizes the X-ray settings and measured film badge dose for the special study.

Table 3.1 Hospital Exposure Settings

#	Amperage (mA)	Voltage (kVp)	Duration (sec)	Dosimeter Reading (mR)
1	200 mA	85 kVp	0.1 s	20
2	100 mA	95 kVp	0.6 s	690
3	100 mA	70 kVp	0.4 s	300
4	100 mA	45 kVp	0.05 s	0

A chest exposure of 20 mAs (200mA x 0.1s) is fairly common for typical chest exposures as indicated in exposure #1. Since this exposure was first in the series, it is expected that these were the default values for the common chest X-ray. As indicated in ORAUT-OTIB-0006, X-ray measurements with films results in large uncertainty, and great care is needed to properly evaluate the dose. This study likely did not consider the calibration of the commercial film badge nor the effects that filtration has on the resulting spectral energy. As a result, the 20 mR could be either an underestimate or an overestimate depending on a multitude of variables. As a result, the claimant favorable default values provided in ORAUT-OTIB-0006 should be used for chest X-rays (Tables 3.3-1 and 4.0-1).

The dose reconstructor should by default assume an annual posterior-anterior (PA) chest X-ray for all employees applicable from 1947 through 1975. Semiannual chest X-rays should be assumed for all assembly workers, and quarterly chest X-rays should be assumed for workers involved in radiography. Do not apply X-ray dose for years other than 1947 through 1975, regardless if the worker was employed at IAAP during other years.

NIOSH (2003) does not provide default values for lumbar spine examinations. The Occupational Medical Dose TBD for the Rocky Flats site (ORAU 2004b) provides a method for calculating organ doses from lumbar spine examinations. Estimated median entrance skin exposures were 1.79 R for the PA view and 5.79 R for the lateral view based on information in Lincoln and Gupton (1958). Distributions of entrance skin exposures were created using the Crystal Ball® computer program (Decisioneering Inc. 2000) for different filtration half-value layers (HVL) as presented in Lincoln and Gupton. Tables A2 through A8 in ICRP Publication 34 provide organ doses in units of mGy per Gray entrance skin exposure for the thyroid, ovaries, testes, lungs, female breast, uterus, and active bone marrow (ICRP 1982). For practical purposes, the units can be considered mrem per R. Multiplying the entrance skin exposure to the kerma-to-organ dose factors in ICRP Publication 34 results in the organ doses and geometric standard deviations listed in Table 3.2, varying the HVL from 1.5 to 3.0 mm AL. NIOSH (2003) provides guidance for dose to organs not provided in ICRP 34 by relating their proximity to organs that are listed in ICRP 34. To account for a field of direct exposure larger than that used by ICRP 34 (as might have happened in the 1940s and 50s), additional organs were added to the ovary category, including stomach, kidneys, adrenals, and pancreas. Organs not listed by ICRP 34 added to the modeled organ based on proximity to the ICRP 34 organ (Table 3.2).

Table 3.2 Organ doses from lumbar spine X-rays at IAAP

Organ	View	Organ Dose Geometric Mean mrem Geo. Std. Dev. (GSD)
Thyroid, eye, brain	PA LAT	0.50 (3.0) 0.10 (1.9)
Ovaries, liver, gall bladder, stomach, intestines, colon, rectum, kidneys, adrenals, pancreas, spleen	PA LAT	330 (2.6) 230 (2.1)
Lungs, thymus, esophagus, bone surfaces	PA LAT	120 (2.5) 64 (2.0)
Active bone marrow	PA LAT	58 (2.6) 110 (2.1)
Testes[a]	PA LAT	26 (3.1) 40 (1.5)
Skin[a]	PA LAT	1,800 (2.4) 5,800 (1.8)

a. Calculated from information in Lincoln and Gupton (1958) as presented in the Rocky Flats site TBD (ORAU 2004b).

For skin and testes, consistent with the approach taken in the Rocky Flats Occupational Medical Dose TBD, the values measured in the Lincoln and Gupton paper were used directly to account for the difference in collimation in the Lincoln and Gupton measurements versus ICRP 34 factors.

The PA view should be used unless person-specific information is found indicating otherwise. The lumbar spine organ dose should be assigned to males in the year of hire from 1947 through July 1975. The dose is assigned in the year of hire and is assumed to be lognormally distributed.

4.0 ESTIMATION OF INTERNAL RADIATION EXPOSURE

Internal radiation exposures result from the inhalation, ingestion, and transdermal absorption of radioactive materials. Intakes of radioactive materials could have occurred and probably did occur to a certain extent during weapons assembly and disassembly procedures. No actual internal exposure data could be located for any given individual worker involved in Line 1 operations. Based upon the recommendations of the Secretary of Health and Human Services, it was determined that internal exposures cannot be estimated with sufficient accuracy to complete dose reconstructions (USDOL 2005); thus, no internal dose should be assigned for Iowa Army Ammunition Plant employment.

5.0 ESTIMATION OF EXTERNAL RADIATION EXPOSURE

External radiation exposures are received from sources of ionizing radiation and radioactive materials located outside of the body. The radiation dose received from working with radioactive materials can be measured using a radiation sensitive film badge, ionization chamber, or thermoluminescent dosimeter.

5.1 Photon Radiation

The external dose contribution for photon exposures at the IAAP was predominately from 30-250 keV photons. For the purposes of dose reconstruction, a claimant-favorable photon energy distribution of 100% 30 – 250 keV photons should be assumed, with an anterior to posterior radiation exposure geometry. Exposure dose conversion factors should be used to translate recorded whole body photon dose to target organ dose (NIOSH 2002). A missed photon dose value may be assigned (NIOSH 2002) for each reported non-positive dosimetry result (represented by “0” or “M”) recorded in an employee’s exposure history. Information on the detection sensitivity of the dosimetry used at the IAAP can be found in Table 5.1 below. A claimant-favorable limit of detection value equal to 20 mrem should be used for missed dose calculations from the years 1955 through 1960, and 10 mrem from 1962 through 1974, if there are records of monitoring with reported zeroes in an individual’s exposure records. Missed dose should not be assigned unless a reported “0” or “M” exists in the individual’s exposure history records.

5.2 Neutron Radiation

Recorded neutron dose as reported in an individual’s dosimetry records must be adjusted with an ICRP Publication 60 neutron weighting factor of 1.91 for dose input into the Interactive RadioEpidemiological Program (IREP) (ICRP 1994). A neutron energy spectrum of 100% 100 keV to 2 MeV (Fission Spectrum) should be assumed. Recorded neutron dose should be converted to organ dose using deep dose equivalent to organ dose equivalent dose conversion factors (NIOSH 2002). Missed dose may be assigned for neutron badge cycles when a “zero” reported dose is documented in an individual’s exposure records provided to NIOSH. Non-positive neutron dosimetry results may have been reported as either “0” or as “M”.

Based on a review of the neutron dosimetry information for Line 1 workers, the lowest reported detectable neutron dose observed for an employee was 20 mrem, during a monitoring cycle in 1974. Neutron dose reported during weekly cycles in 1962 was as low as 24 mrem. These reported values are likely below the actual limit of detection for the NTA film employed; therefore, a claimant-favorable limit of detection value of 50 mrem should be assumed for missed dose calculations based on known detection sensitivities for similar NTA films (ORAUT 2005).

5.3 Electron Radiation

The primary source of electron exposures at the IAAP on Line 1 was from depleted uranium metal. Electron exposures as recorded by an employee’s film badge should be assigned using a dose conversion factor of unity and an energy distribution of 100% greater than 15 keV electrons. A review of the dosimetry exposure data at the IAAP indicates a limit of detection for electron exposures of 40 mrem. A missed dose of 40 mrem may be assigned for each reported "zero" dose result documented in an energy employee's exposure history record.

5.4 Extremities Exposures

Recorded positive extremity dose results should be assigned only for target organs of the extremities, and missed dose for each reported non-positive dosimetry result may be assigned using the limit of detection values documented above for the whole body badge. Extremity exposures should be assigned using a photon energy distribution of 100% 30 – 250 keV or electrons with energies greater than 15 keV, whichever is more claimant favorable for calculating dose to the target organ.

5.5 Uncertainty

Recorded positive external photon, neutron, and electron exposures should be assigned as point estimates (constant values) in the Interactive RadioEpidemiological Program. Missed doses calculated using the nLOD / 2 method (NIOSH 2002) should be assigned using a lognormal distribution where nLOD / 2 is the median value of the distribution, and nLOD is the 95th percentile.

Table 5.1 Summary of Photon Dosimetry Data

Year	Exchange Frequency	First Badge Date	End Date for last cycle	Minimum Reported Dose
1955	Weekly	November 14, 1955	January 1, 1956	20
1956	Weekly	January 2, 1956	February 13, 1956	20
1957	Weekly	May 6, 1957	August 4, 1957	10[a]
1958	Weekly	July 28, 1958	November 2, 1958	5[a]
1959	Weekly	June 29, 1958	October 4 1958	5[a]
1960	Weekly	March 7, 1960	June 19, 1960	5[a]
1961[b]				
1962	Weekly	September 3, 1962	December 3, 1962	10
1963	Bi-Weekly	January 7, 1963	January 5, 1964	10
1964	4 Week	January 6, 1964	January 3, 1965	10
1965	4 Week	January 4, 1965	January 2, 1966	10
1966	4 Week	January 3, 1966	January 1, 1967	10
1967	4 Week	January 2, 1967	December 31, 1967	10
1968	4 Week	January 1, 1968	December 29, 1968	10
1969	4 Week	December 30, 1968	December 28, 1969	10
1970	4 Week	December 29, 1969	December 27, 1970	10
1971	4 Week	December 28, 1970	January 23, 1972	10
1972	4 Week	January 24, 1972	January 21, 1973	10
1973	4 Week	January 22, 1973	January 20, 1974	10
1974	4 Week	January 21, 1974	January 19, 1975	10

[a] Given the dosimeter designs of this time period, it is highly unlikely that the film dosimeter could measure this level. For this early time period, a detection level of 20 mR is more credible.

[b] Note that no film badge exposure data for IAAP workers could be located prior to 1955 or for the year of 1961.

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GLOSSARY

Atomic Energy Commission

Original agency established for nuclear weapons and power production; a predecessor to the U. S. Department of Energy.

beta radiation

Radiation consisting of charged particles of very small mass (i.e. the electron) emitted spontaneously from the nuclei of certain radioactive elements. Physically, the beta particle is identical to an electron moving at high velocity.

curie

A special unit of activity. One curie (1 Ci) exactly equals 3.7×10^{10} nuclear transitions per second.

deep absorbed dose (D_d)

The absorbed dose at the depth of 1.0 cm in a material of specified geometry and composition.

deep dose equivalent (H_d)

The dose equivalent at the respective depth of 1.0 cm in tissue.

detection limit (lower)

The minimum quantifiable exposure or neutron flux that can be detected.

dose equivalent (H)

The product of the absorbed dose (D), the quality factor (Q), and any other modifying factors.
The special unit is the rem. When D is expressed in Gy, H is in sieverts (Sv).
(1 Sv = 100 rem).

dose of record

The dose files provided by DOE to NIOSH as part of the individual worker files.

dosimeter

A device used to measure the quantity of radiation received. A holder with radiation-absorbing element (filters) and an insert with radiation-sensitive elements packaged to provide a record of absorbed dose or dose equivalent received by an individual. (See *film dosimeter, neutron film dosimeter, thermoluminescent dosimeter).*

dosimetry

The science of assessing absorbed dose, dose equivalent, effective dose equivalent, etc., from external or internal sources of radiation.

dosimetry system

A system used to assess dose equivalent from external radiation to the whole body, skin, and extremities. This includes the fabrication, assignment, and processing of dosimeters as well as interpretation and documentation of the results.

DU

Depleted uranium; uranium having less than the natural mass of ^{235}U; used as components in nuclear weapons or as a surrogate for enriched uranium or plutonium in testing.

exchange period (frequency)

Period (weekly, biweekly, monthly, quarterly, etc.) for routine exchange of dosimeters.

exposure

As used in the technical sense, a measure expressed in roentgens (R) of the ionization produced by photons (i.e., gamma and X-rays) in air.

extremity

That portion of the arm extending from and including the elbow through the fingertips, and that portion of the leg extending from and including the knee and patella through the tips of the toes.

field calibration

Dosimeter calibration based on radiation types, intensity and energies present in the work environment.

film

Generally means a “film packet” that contains one or more pieces of film in a light-tight wrapping. The film when developed has an image caused by radiation that can be measured using an optical densitometer. (See *Dupont 552, Dupont 558, Eastman Kodak, Nuclear Emulsions).*

film density

See optical density.

film dosimeter

A small packet of film in a holder that attaches to a wearer.

gamma rays (γ)

Electromagnetic radiation (photons) originating in atomic nuclei and accompanying many nuclear reactions (e.g. fission, radioactive decay, and neutron capture). Physically, gamma rays are identical to X-rays but with higher energy; the only essential differences is that X-rays do not originate in the nucleus.

Gertie

A facility covered with crushed gravel used to suppress the potential radioactive contamination from the accidental explosion of a nuclear weapon during assembly. Also referred to as a Gravel Gertie.

Gray

SI unit of absorbed dose. Unit symbol, Gy. 1 Gy = 100 rad.

hydroshot

Detonation of a mixture of explosives and DU used as a quality control technique for measuring the performance of plastic-bonded explosives.

ionizing radiation

Electromagnetic or particulate radiation capable of producing charged particles through interactions with matter.

Line 1

Facilities and operations taken over by the AEC in 1947 for casting of baratols and processes related to the assembly of nuclear weapons.

Minimum Detectable Level (MDL)

A term used in this document and other NIOSH documents to refer to a statistically determined minimum detection level, Lower Limit of Detectability (L_D), and related quantities.

Minimum Reportable Dose (MRD)

A general term used to identify the minimum dose recorded and reported, normally based on site-specific policy.

neutron

A basic particle that is electrically neutral weighing nearly the same as the hydrogen atom.

neutron, fast

Neutrons with energy equal or greater than 10 keV.

neutron, intermediate

Neutrons with energy between 0.5 eV and 10 keV.

neutron, thermal

Strictly, neutrons in thermal equilibrium with surroundings. Generally, neutrons with energy less than about 0.5 eV.

neutron film dosimeter

A film dosimeter that contains a Neutron Track Emulsion, type A, film packet.

nuclear emulsion

Often referred to as “NTA” film and used to measure personnel dose from neutron radiation.

nuclear track emulsion, type A (NTA)

A film that is sensitive to fast neutrons. The developed image has tracks caused by neutrons that can be seen by using an appropriate imaging capability such as oil immersion and a 1000X power microscope or a projection capability.

open window

Designation on film dosimeter reports that implies the use of little shielding. It commonly is used to label the film response corresponding to the open window area.

optical density

The quantitative measurement of photographic blackening with the density defined as D = Log_{10} (I_o/I).

personal dose equivalent H_p(d)

Represents the dose equivalent in soft tissue below a specified point on the body at an appropriate depth d. The depths selected for personnel dosimetry are 0.07 mm and 10 mm, respectively, for the skin and body. These are noted as H_p(0.07) and Hp(10), respectively.

photon

A unit or "particle" of electromagnetic radiation consisting of X- or gamma rays.

photon – X-ray

Electromagnetic radiation of energies between 10 keV and 100 keV whose source can be an X-ray machine or radioisotope.

quality factor, Q

A modifying factor used to derive dose equivalent from absorbed dose.

radiation

Alpha, beta, neutron, and photon radiation with sufficient energy to ionize atoms. See also ionizing radiation.

radioactivity

The spontaneous emission of radiation, generally alpha or beta particles, gamma rays, and neutrons from unstable nuclei.

rem

A special unit of dose equivalent, which is equal to the product of the number of rad absorbed and the "quality factor."

roentgen (R)

A unit of exposure to gamma (or X-ray) radiation. It is defined precisely as the quantity of gamma (or x) rays that will produce a total charge of 2.58 x 10^{-4} coulomb in 1 kg of dry air. An exposure of 1 R is approximately equivalent to an absorbed dose of 1 rad in soft tissue for higher (>100 keV) energy photons.

shallow absorbed dose (D_s)

The absorbed dose at a depth of 0.007 cm in a material of specified geometry and composition.

shallow dose equivalent (H_s)

Dose equivalent at a depth of 0.007 cm in tissue.

shielding

Any material or obstruction that absorbs (or attenuates) radiation and thus tends to protect personnel or materials from radiation.

skin dose

Absorbed dose at a tissue depth of 7 mg/cm^2.

thermoluminescent

Property of a material that causes it to emit light as a result of being excited by heat.

thermoluminescent dosimeter (TLD)

A holder containing solid chips of material that when heated will release the stored energy as light. The measurement of this light provides a measurement of absorbed dose.

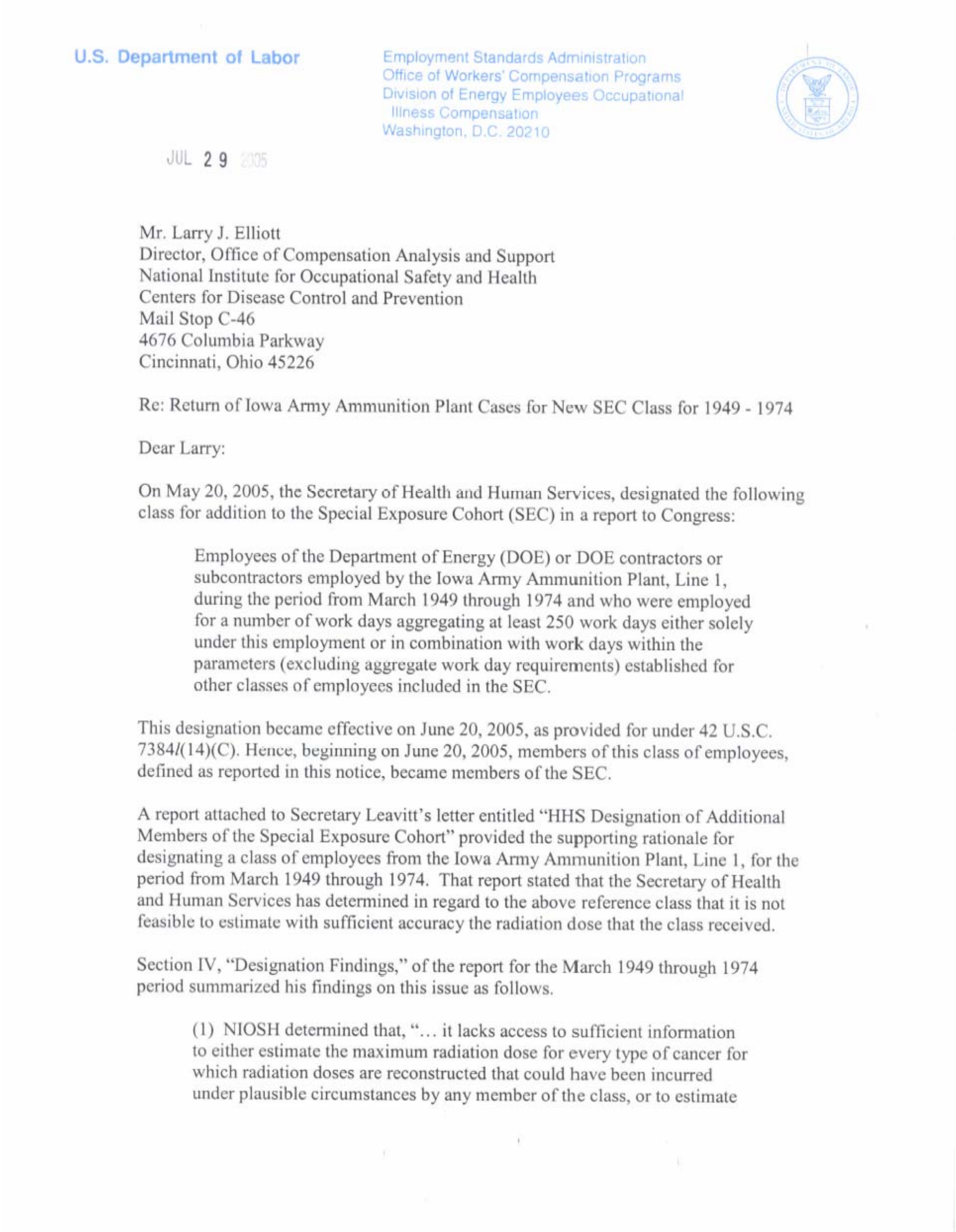
whole-body dose

Commonly defined as the absorbed dose at a tissue depth of 1.0 cm (1000 mg/cm^2); however, this term is also used to refer to the recorded dose.

X-ray

Ionizing electromagnetic radiation that originates external to the nucleus of an atom.

Appendix A—U.S. Department of Labor Correspondence



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Re: Return of Iowa Army Ammunition Plant Cases for New SEC Class for 1949 - 1974

Dear Larry:

On May 20, 2005, the Secretary of Health and Human Services, designated the following class for addition to the Special Exposure Cohort (SEC) in a report to Congress:

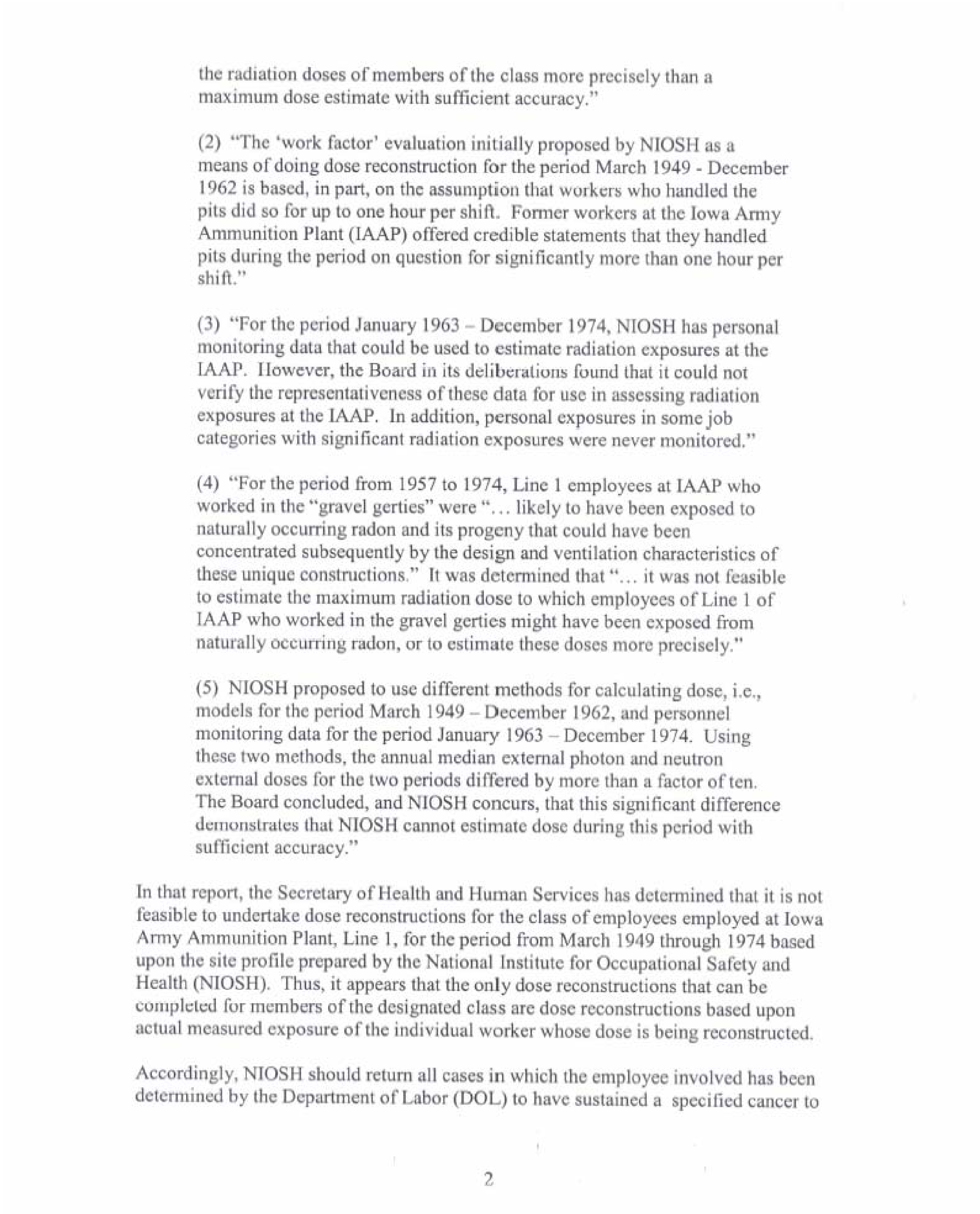
> Employees of the Department of Energy (DOE) or DOE contractors or subcontractors employed by the Iowa Army Ammunition Plant, Line 1, during the period from March 1949 through 1974 and who were employed for a number of work days aggregating at least 250 work days either solely under this employment or in combination with work days within the parameters (excluding aggregate work day requirements) established for other classes of employees included in the SEC.

This designation became effective on June 20, 2005, as provided for under 42 U.S.C. 7384*l*(14)(C). Hence, beginning on June 20, 2005, members of this class of employees, defined as reported in this notice, became members of the SEC.

A report attached to Secretary Leavitt's letter entitled "HHS Designation of Additional Members of the Special Exposure Cohort" provided the supporting rationale for designating a class of employees from the Iowa Army Ammunition Plant, Line 1, for the period from March 1949 through 1974. That report stated that the Secretary of Health and Human Services has determined in regard to the above reference class that it is not feasible to estimate with sufficient accuracy the radiation dose that the class received.

Section IV, "Designation Findings," of the report for the March 1949 through 1974 period summarized his findings on this issue as follows.

> (1) NIOSH determined that, "… it lacks access to sufficient information to either estimate the maximum radiation dose for every type of cancer for which radiation doses are reconstructed that could have been incurred under plausible circumstances by any member of the class, or to estimate



> the radiation doses of members of the class more precisely than a maximum dose estimate with sufficient accuracy."
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> (2) "The 'work factor' evaluation initially proposed by NIOSH as a means of doing dose reconstruction for the period March 1949 - December 1962 is based, in part, on the assumption that workers who handled the pits did so for up to one hour per shift. Former workers at the Iowa Army Ammunition Plant (IAAP) offered credible statements that they handled pits during the period on question for significantly more than one hour per shift."
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> (3) "For the period January 1963 – December 1974, NIOSH has personal monitoring data that could be used to estimate radiation exposures at the IAAP. However, the Board in its deliberations found that it could not verify the representativeness of these data for use in assessing radiation exposures at the IAAP. In addition, personal exposures in some job categories with significant radiation exposures were never monitored."
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> (4) "For the period from 1957 to 1974, Line 1 employees at IAAP who worked in the "gravel gerties" were "… likely to have been exposed to naturally occurring radon and its progeny that could have been concentrated subsequently by the design and ventilation characteristics of these unique constructions." It was determined that "… it was not feasible to estimate the maximum radiation dose to which employees of Line 1 of IAAP who worked in the gravel gerties might have been exposed from naturally occurring radon, or to estimate these doses more precisely."
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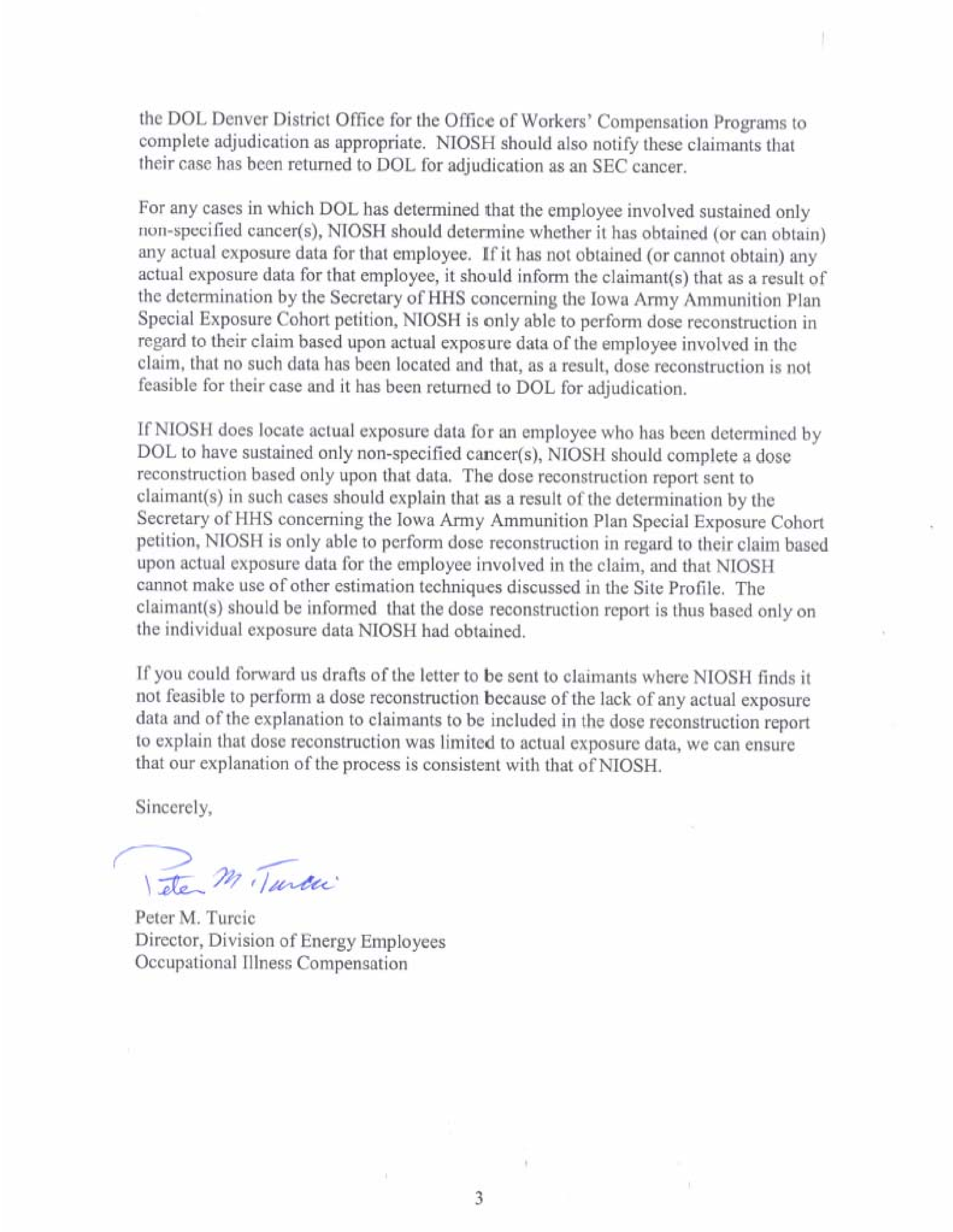
> (5) NIOSH proposed to use different methods for calculating dose, i.e., models for the period March 1949 – December 1962, and personnel monitoring data for the period January 1963 – December 1974. Using these two methods, the annual median external photon and neutron external doses for the two periods differed by more than a factor of ten. The Board concluded, and NIOSH concurs, that this significant difference demonstrates that NIOSH cannot estimate dose during this period with sufficient accuracy."

In that report, the Secretary of Health and Human Services has determined that it is not feasible to undertake dose reconstructions for the class of employees employed at Iowa Army Ammunition Plant, Line 1, for the period from March 1949 through 1974 based upon the site profile prepared by the National Institute for Occupational Safety and Health (NIOSH). Thus, it appears that the only dose reconstructions that can be completed for members of the designated class are dose reconstructions based upon actual measured exposure of the individual worker whose dose is being reconstructed.

Accordingly, NIOSH should return all cases in which the employee involved has been determined by the Department of Labor (DOL) to have sustained a specified cancer to



the DOL Denver District Office for the Office of Workers' Compensation Programs to complete adjudication as appropriate. NIOSH should also notify these claimants that their case has been returned to DOL for adjudication as an SEC cancer.

For any cases in which DOL has determined that the employee involved sustained only non-specified cancer(s), NIOSH should determine whether it has obtained (or can obtain) any actual exposure data for that employee. If it has not obtained (or cannot obtain) any actual exposure data for that employee, it should inform the claimant(s) that as a result of the determination by the Secretary of HHS concerning the Iowa Army Ammunition Plan Special Exposure Cohort petition, NIOSH is only able to perform dose reconstruction in regard to their claim based upon actual exposure data of the employee involved in the claim, that no such data has been located and that, as a result, dose reconstruction is not feasible for their case and it has been returned to DOL for adjudication.

If NIOSH does locate actual exposure data for an employee who has been determined by DOL to have sustained only non-specified cancer(s), NIOSH should complete a dose reconstruction based only upon that data. The dose reconstruction report sent to claimant(s) in such cases should explain that as a result of the determination by the Secretary of HHS concerning the Iowa Army Ammunition Plan Special Exposure Cohort petition, NIOSH is only able to perform dose reconstruction in regard to their claim based upon actual exposure data for the employee involved in the claim, and that NIOSH cannot make use of other estimation techniques discussed in the Site Profile. The claimant(s) should be informed that the dose reconstruction report is thus based only on the individual exposure data NIOSH had obtained.

If you could forward us drafts of the letter to be sent to claimants where NIOSH finds it not feasible to perform a dose reconstruction because of the lack of any actual exposure data and of the explanation to claimants to be included in the dose reconstruction report to explain that dose reconstruction was limited to actual exposure data, we can ensure that our explanation of the process is consistent with that of NIOSH.

Sincerely,

Peter M. Turcic

Peter M. Turcic
Director, Division of Energy Employees
Occupational Illness Compensation