SEC Petition Evaluation Report
Petition SEC-0006-1

Report Rev # Draft   Report Submittal Date ________

Petition Administrative Summary			
Petition Under Evaluation			
Petition #	Petition Type	Submittal Date	DOE/AWE Facility Name
SEC-00006	83.13	06-15-2004	Iowa Army Ammunition Plant

Feasible to Estimate Doses with Sufficient Accuracy?											
Single class				Multiple classes				Determination Established for All Classes?			
Yes		No		Yes		No	X	Yes		No	X

Initial Class Definition
Facility: Iowa Ordnance Plant (also known as the Iowa Army Ammunition Plant), Burlington, Iowa *Locations:* Line 1 (which includes Yard C, Yard G, Yard L, Firing Site Area, Burning Field “B” and Storage Sites for Pits and Weapons including Buildings 73 and 77) *Job Titles and/or Job Duties:* All Technicians (Laboratory, Health Physics, Chemical, X-ray, etc.), Production Personnel, Physical Security Personnel (hourly and salaried), Engineers, Inspectors, Safety Personnel, Physical Security Personnel, and Maintenance Persons. *Period of Employment:* 1947-1974

Proposed Class Definition
NA

Related Petition Summary Information			
SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
SEC-00007	83.13	Iowa Army Ammunition Plant	Merged with SEC-00006
SEC-00014	83.13	Iowa Army Ammunition Plant	Merged with SEC-00006
SEC-00015	83.13	Iowa Army Ammunition Plant	Merged with SEC-00006

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Peer Review Completed By:	**Signature on file** *James W. Neton*	*Date*
SEC Petition Evaluation Approved By:	**Signature on file** *Larry J. Elliott*	*Date*

Evaluation Summary

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) covers all employees proposed as a class for addition to the Special Exposure Cohort (SEC) in SEC Petition SEC00006, which was qualified for evaluation on October 20, 2004. The petition was submitted on behalf of all technicians (laboratory, HP, chemical, X-ray, etc.), production personnel (hourly and salary), engineers, inspectors, safety personnel, physical security personnel, and maintenance persons working at the Iowa Army Ammunition Plant (IAAP) Line 1, which includes Yard C, Yard G, Yard L, Firing Site Area, Burning Field "B" and Storage Sites for Pits and Weapons including Buildings 73 and 77 from 1947-1974. Subsequently, 3 additional petitions (SEC00007, SEC00014, and SEC00015) on behalf of this class of workers were received and qualified for evaluation, and were merged into SEC00006.

The evaluation report addresses the feasibility of estimating radiation doses of members of this class with sufficient accuracy (i.e., the feasibility of dose reconstruction). As discussed below, the feasibility of dose reconstruction is the primary factor in the decision by the Department of Health and Human Services (HHS) as to whether or not to designate a class of employees for addition to the SEC and the definition of such classes.

Feasibility of Dose Reconstruction

The feasibility determination for the class of employees covered by this evaluation report is governed by 42 CFR § 83.13 (c) (1). Under this regulation, NIOSH must establish whether or not it has access to sufficient information to either estimate the maximum radiation dose 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. If NIOSH were to have access to the information sufficient for either case, then dose reconstruction would be feasible.

NIOSH has established in this evaluation that there are three separate classes of employees covered by the petition: one class who worked from June 1947-May 1948, during which existing documentation indicates there were not any radioactive materials at the facility, nor any radiological exposures associated with the Atomic Energy Commission (AEC) work at the site; a second class composed of industrial radiographers who may have conducted radiography on non-radiological high explosive weapons components from May 1948-March 1949; and a third class comprising all employees at Line 1 of the facility from March 1949-1974.

With respect to the class of employees who worked from June 1947-May 1948, no evaluation of feasibility is necessary because available documentation indicates there were not any radioactive materials at the facility, nor any radiological exposures.

With respect to the class of employees composed of industrial radiographers who may have conducted radiography on non-radiological high explosive weapons components from May 1948-March 1949, NIOSH will issue a separate evaluation report as soon as possible. The potential existence of this limited class was determined late in the preparation of this report and NIOSH has not completed research to verify the existence of this class and evaluate the feasibility of dose reconstructions for any members of the class.

With respect to the class of employees comprising all employees at Line 1 of the facility from March 1949-1974, NIOSH has determined that it has access to sufficient information to estimate either the maximum radiation dose incurred by any member of the class being evaluated, or to estimate such radiation doses more precisely than a maximum dose estimate. The sum of information available from the site profile and additional resources is sufficient to document or estimate the maximum internal and external potential exposure to members of the class, under plausible circumstances during the period of radiological operations at IAAP; 1949-1974.

However, NIOSH also established that it would have to rely on security-classified information to conduct dose reconstructions for employees at IAAP, and has determined that such data may not provide a viable basis for conducting dose reconstructions. The classified information that NIOSH could not release to the public, for the protection of national security, includes source-term and process information needed to reconstruct radiation doses for employees. This limitation on the transparency of NIOSH dose reconstructions for IAAP employees would be likely to undermine the credibility of such dose reconstructions among the IAAP claimant population.

Consequently, while NIOSH finds that it is scientifically and technically feasible to estimate doses with sufficient accuracy for employees working on Line 1 AEC operations at the IAAP in Burlington, Iowa during the years from March 1949-1974, such estimates could not be substantiated by the transparent, publicly available facts. Hence, NIOSH finds that, in terms of maintaining a policy of transparency with respect to its dose reconstruction program, it may not be feasible to estimate doses with sufficient accuracy for employees working on Line 1 AEC operations at the IAAP in Burlington, Iowa during the years from March 1949-1974.

Health Endangerment

The health endangerment determination for the class of employees covered by this evaluation report is governed by 42 CFR § 83.13(c)(3). Under this regulation, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high level exposure has not been established and it is not feasible to estimate radiation doses for members of the class, then NIOSH is required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

The NIOSH evaluation did not identify any evidence from the petitioners or from other resources that would establish that the class was exposed to radiation during a discrete incident likely to have involved exceptionally high level exposures, as described above. NIOSH is not aware of any report of such an occurrence at the facility. Evidence presented by the petitioner and obtained by NIOSH indicates that some workers in the class may have accumulated substantial doses through chronic exposure to external sources of radiation. Consequently, NIOSH is specifying that health was endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

Proposed Class Definitions

This evaluation defines a single class of employees for which NIOSH has established that it cannot estimate radiation doses with sufficient accuracy and whose health may have been endangered by such radiation doses. The class includes all employees working at the IAAP Line 1, which includes Yard C, Yard G, Yard L, Firing Site Area, Burning Field "B" and Storage Sites for Pits and Weapons including Buildings 73 and 77, from March, 1949-1974, and whom were employed for a number of work days aggregating at least 250 work days, occurring either solely under this employment, or in combination with work days of employment occurring within the parameters (excluding aggregate work day requirements) established for other classes of employees included in the SEC.

In addition, this evaluation defines a class of employees who worked from June 1947-May 1948, prior to the introduction of any radioactive materials or radiological processes at Line 1 of IAAP. For this class, NIOSH has determined that no feasibility determination is necessary because members of the class received no radiation doses, as covered by EEOICPA.

Finally, this evaluation identifies a potential class of employees composed of industrial radiographers who may have conducted radiography on non-radiological high explosive weapons components from May 1948-March 1949. NIOSH will issue a separate evaluation report addressing this potential class as soon as possible. Presently, NIOSH does not have any claims which would be included in this potential class.

1.0 Purpose

The purpose of this report for SEC Petition SEC00006 is to provide an evaluation of the feasibility of reconstructing the dose for the defined worker class at the Iowa Army Ammunition Plant in Des Moines County, near Middletown, Iowa from 1947-1974.

This evaluation was conducted in accordance with the requirements of 42 CFR Part 83 and the guidance contained in NIOSH's Internal Procedures for SEC Evaluations, OCAS-PR-004. It provides information and analyses germane to considering a petition for adding a class of employees to the SEC. It does not provide any determinations concerning the feasibility of dose reconstruction that necessarily apply in the particular case of any individual energy employee who might require a dose reconstruction from NIOSH.

2.0 Introduction

Title 42 of the Code of Federal Regulations (CFR), Part 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*, requires NIOSH to evaluate qualified petitions requesting HHS to add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether or not it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions[1]. If it is not feasible, the evaluation is further required to make a determination with respect to the health endangerment of the class of employees.

NIOSH is required to document the evaluation in a report, which is provided to the petitioners and to the President's Advisory Board on Radiation and Worker Health (the Board). The Board will consider the NIOSH evaluation report, together with the petition and any comments of the petitioners(s), to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose decisions on behalf of HHS. The Secretary of HHS will make final decisions, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this final decision process, the petitioner(s) may seek a review of certain types of proposed decisions issued by NIOSH[2].

In this evaluation, NIOSH reviewed all available process information, radiation monitoring data, and source-term data between 1947-1974 for the IAAP. The data were evaluated to determine if the quality and quantity of the measurements, process, and

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[1] NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 CFR Part 82 and the detailed implementation guidelines available at www.cdc.gov/niosh/ocas.

[2] See 42 CFR Part 83 for a full description of the procedures summarized here. Additional internal procedures are available at www.cdc.gov/niosh/ocas.

source term information are sufficient to support radiation dose reconstruction for this class.

3.0 Initial Class Definition and Petition Basis

The initial class definition specified in SEC Petition SEC00006 is: all technicians (laboratory, HP, chemical, X-ray, etc.), production personnel (hourly and salary), engineers, inspectors, safety personnel, physical security personnel, and maintenance persons at the Iowa Ordnance Plant (also known as the Iowa Army Ammunition Plant), Burlington, Iowa that worked on Line 1 (which includes Yard C, Yard G, Yard L, Firing Site Area, Burning Field "B" and storage sites for pits and weapons including Buildings 73 and 77) from 1947-1974.

The basis cited in the petition is that radiation exposures potentially incurred by members of the petitioning class were not monitored, either through personal monitoring or through area monitoring. The petitioners contend that reconstruction of the radiological exposures received by members of the class with sufficient accuracy is not possible. As the basis for this belief, the petitioners provided affidavits and documents indicating that radiation exposures and doses to members of the proposed class were not monitored, either through personal or area monitoring, and that radiation monitoring records for members of the proposed class have been lost, falsified, or destroyed. One of the affidavits references the IAAP Technical Basis Document (TBD), the Pantex TBD and two technical reports.

4.0 Data Resources

To evaluate the petition, NIOSH reviewed available data sources for the existence of personal monitoring, area monitoring, industrial process, and radiological source information relevant to determining the feasibility of dose reconstruction for the class of employees covered by the petition.

This information was retrieved from existing site profiles, Technical Information Bulletins (TIBs), dose reconstructions, internal databases containing personal and area monitoring data, DOE records, NIOSH documents, other scientific reports, information gained through interviews with former workers, and information provided by the petitioners.

The following sections discuss the resources identified and reviewed.

Site Profile or Technical Basis Documents

A revised site profile exists for the IAAP. The site profile, *Technical Basis Document for Atomic Energy Operations at the Iowa Army Ammunition Plant (IAAP)* was reviewed and found to contain information regarding the site operations, procedures and processes, the occupational medical X-ray program, site radon exposures, estimates of annual intakes, and internal and external radiological exposure estimates relevant to the facility, work locations, job descriptions, and time-frames that make up the worker class defined in the SEC petition.

Information regarding the identity of each radionuclide of concern is presented as well as information describing the process through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. Discussions regarding data availability/limitations are also presented. As such, much of the topic discussion presented here represents summaries of and references to the information in the TBD.

Previous Dose Reconstructions

A review was done of the NIOSH dose reconstruction database, NIOSH OCAS Claims Tracking System (NOCTS), to determine the number of claims submitted under the dose reconstruction rule for energy employees who worked at the IAAP during the covered period.

NOCTS currently indicates that 611 claims (as of January 25, 2005) have been received for the IAAP facility. Of the total number of claims received to date, 5 claims have been pulled, 490 claims are active, and dose reconstructions for 116 claim files (19% of the total claims) have been completed. Of the 116 claims for which dose reconstructions have been completed, the following job titles were noted within the claims records:

> security guards, engineers, supervisors/foremen, production operators (tore down bombs), inspectors, technicians, laborers, firemen, shipping/receiving personnel, machinists, sheet metal workers, line workers, pipefitters, secretaries, iron workers, janitors, railroad brakemen, carpenters, estimators, nurses, welders, millwrights, and electricians.

The above list is not intended to be all inclusive due to differences in job descriptions provided by claimants, but is provided here to indicate the wide range of jobs where dose reconstructions have been completed for the IAAP facility.

The claims submitted for energy employees who meet the petition criteria were searched to determine not only the number of claims, but to identify individual records that could be reviewed for monitoring data and process information.

NIOSH and ORAU Research Documents

A search of the NIOSH and Oak Ridge Associated Universities (ORAU) site research database (SRDB) was conducted for documentation relating to IAAP, and the resulting 162 documents were evaluated for relevance to this petition. These documents contained external dosimetry measurement results (for both IAAP and Pantex), annual Department of Defense (DoD) dosimetry reports, pocket ionization chamber logs, air sample results, survey reports, site incident reports, standing operating procedures, effluent data, and radon measurements. A Needs Assessment conducted by the University of Iowa, College of Public Health, and a significant number of the transcripts of interviews with former site employees are also in the holdings of the SRDB and provided important information concerning the exposure and operational history of the site (UI BAECP 2001).

The information from these documents relevant to the class, as evaluated in this report, is summarized in sections 5.0 and 7.0 of this report.

Personnel Interviews

NIOSH holdings include the transcripts of individual interviews held with former IAAP employees. In addition, as part of the development of the TBD, individuals with specific knowledge of the site health and safety programs were interviewed. Table 4.2 summarizes the information provided during an interview with an individual that worked at IAAP from 1958-1975 and had knowledge of the radiation monitoring program at IAAP. Additional information was obtained from AEC Health and Safety Reviews.

Table 4.2 Radiation Monitoring at IAAP

Monitoring Methods	**Numbers of Surveys/Sampling**
Radiation Surveys	Routine surveys conducted daily throughout Line 1
Contamination Surveys	Routine surveys conducted daily throughout Line 1
Particulate Air Sampling	Intermittent air sampling conducted
Radon Daughter Air Sampling	None obtained during processing or storage
Urinalysis for tritium	Intermittent. Specific individuals were regularly monitored as determined necessary based on potential for exposure.

Documentation and/or Affidavits Provided by the Petitioners

In qualifying and evaluating the petition, NIOSH reviewed the following documents submitted or referenced by the petitioners:

1) Affidavit of petitioner (SEC 00006) received September 22, 2004.
2) NIOSH site profile "Technical Basis Document for Atomic Energy. Operations at the Iowa Army Ammunition Plant (IAAP)" ORAUT-TKBS-0018. April 16, 2004.
3) Sims, C.S., Swja, R.E. "Personnel Dosimetry Intercomparisons Studies at the Health Physics Research Reactor: A Summary (1974-1980)." Health Physics, 42(1):3-18, 1982.
4) Larson, H.V., Unruh, C.M., Beetle, T.M., Keene, A.R. "Factors Involved in Establishing Film Dosimeter Performance Criteria, in Radiation Dose Measurements, Their Purpose, Interpretation, and Required Accuracy in

Radiological Protection.” European Nuclear Energy Agency, pp 191-208, 1967.
5) NIOSH site profile “Technical Basis Document for the Pantex Plant – Site Description” ORAUT-TKBS-0013-2, March 30, 2004.
6) Affidavit of petitioner (SEC 00007) received August 9, 2004.
7) Affidavit of petitioner (SEC 00014) received October 18, 2004.
8) Affidavit of petitioner (SEC 00015) received November 4, 2004.

These documents were reviewed as to their relevance to the petitioning class. The information from these documents relevant to the petitioning class has been summarized in sections 5.0 and 7.0 of this report.

5.0 Summary of Available Monitoring Data

Dosimetry programs were implemented in phases in conjunction with the development of the nuclear weapons work at IAAP. External dosimetry was implemented in 1955. Prior to 1955, a variety of documents suggest that there were no nuclear capsules at the IAAP facility (Poole and Harrison, 1954; Ahlstrand, 1957; Ahlstrand, 1958; and Mitchell, 2003). However, these research and historical documents are not definitive. Based on records retention cycles, documents that provide the definitive tracking of nuclear capsules are likely to have been destroyed. Regardless of whether they have been destroyed, NIOSH has not been able to locate definitive information as to whether nuclear capsule materials were onsite. Because NIOSH does not have definitive evidence, NIOSH has assumed for the purposes of this evaluation that there might have been nuclear capsules as early as March 1949, when AEC authorized the transfer of weapons assembly to Line 1 of IAAP.

Table 5.1 summarizes the development of the dosimetry programs at IAAP and the available monitoring data and data gaps for the period; 1955-1974.

Table 5.1 Summary of Monitoring Data for IAAP; 1955-1974

	Available Data	**Data Gap**
External Dosimetry Data	From 1955-1961, radiation monitoring data on an average of 22 workers. From 1962-1967, monitoring data on an average of 44 workers. From 1968-1974, monitoring data on an average of 226 workers. Extremity exposure records from 1969-1974. IAAP Area Badge measurements from 1962-1975. Pocket ionization chamber measurements from June 18, 1965-November 7, 1974.	No personal radiation monitoring data prior to 1955. No wrist (extremity) dosimeters prior to 1969. No area monitoring was conducted prior to 1962. No results of pocket ionization chamber measurements prior to 1965.
Neutron Dosimetry Data	Neutron monitoring began in 1962 with the increased worker monitoring. At that time, approximately 25% of the badges processed had NTA film. Approximately half of these neutron badges were area badges in the vault and inspection areas where neutron doses were expected to be the highest. Accurate co-worker data is available from dosimetry measurements of Pantex workers during the period of 1993-2003.	No neutron monitoring prior to 1962.
Internal Dosimetry Data	AEC reports summarizing the results of biweekly tritium bioassay monitoring for selected workers. Individual tritium bioassay monitoring results for workers from Pantex, which conducted similar processes involving tritium.	No individual bioassay sample results for any of the radiological materials.
Air Sampling Data	Gate monitoring (Gravel Gerties) air sampling data (DU) from 1971-1974. Air sampling data (DU) from the area adjacent to FS-12 from 1965-1973. Tritium air sample data is available from effluent monitoring reports from 1962-1972. Additional IAAP tritium air sample data was located in the Pantex records holdings; 1959 – 1964.	Depleted uranium air sampling is only available from 1971-1974. No data has been located prior to 1971. Limited air sample data was available for any operation where airborne contaminants may have been present. No Tritium air sampling data from 1954-1959 and from 1964-1974. Radon levels at IAAP were not quantified until all nuclear materials had been removed from the site (e.g., sampling conducted in 1989-1991).

Depleted Uranium (DU)

Workers at IAAP may have had intakes of DU as a result of the disassembly of oxidized bomb components, hydroshot testing, high explosives (HE) testing, and/or the machining of baratols (spherical-shaped, explosive charges that surround the nuclear weapons core). They may have also inhaled DU as a result of burning contaminated scrap explosive components and bagging of the resulting ash.

The disassembly of some nuclear weapons is likely a source of DU intake for some IAAP workers. NIOSH has learned that during the life of a weapons program there is routine surveillance that involves the disassembly, testing, and reassembly. During this surveillance activity, there is some potential for intake of DU contamination, although it is not expected to be as great as when a weapon system is disassembled during retirement or removal from the stockpile. Because surveillance activities were conducted essentially from the start of operations, exposure to low-level DU contamination is estimated in the revised TBD to be a continuous chronic exposure from 1949-1975.

Records indicate 701 hydroshots occurred between 1965-1973; 530 hydroshots between December 2, 1965-March 3, 1969; 3 hydroshots between March 4-July 14, 1969; and 168 hydroshots between July 15, 1969-December 31, 1973. A driver and one or two test fire operators were potentially exposed to airborne DU for some brief period immediately following each of these shots. A limited amount of air sampling was performed after hydroshots in 1971 and 1972 (TKBS-0018, p 11).

In addition to the hydroshots, there was also some potential exposure to DU during regular HE testing. Air sampling data in the 1970s indicate that the depleted uranium air concentration was higher during regular HE tests compared to the hydroshots (Roeder, 1974). This documentation indicates that the increased concentration is likely due to DU particulates deposited on the ground during the hydroshots and subsequently re-suspended during routine HE tests. Because the level of DU contamination increased over time as more hydroshots were conducted, the use of air sampling data from the mid 1970s for dose reconstructions would be claimant-favorable. The first hydroshot was in 1965, thus the start of this exposure potential would be after the first shot in 1965. The exposure potential would have continued until at least April 1974, when the FS-12 area underwent remediation. The revised TBD expands the duration of exposure from an intermittent exposure to a routine exposure because there were approximately 3-4 HE tests per day. These data are used to estimate the chronic exposure to uranium from the HE tests in addition to the hydroshots.

On Line 1, from 1948 through about 1962, the first step of the production process was the casting of baratols. Subsequent machining or grinding on baratols in proximity to DU might have released small quantities of DU. The DU was not machined directly, but unintentional “nicking” of the DU occasionally occurred during machining on the explosive charge.

As shown in Table 5.1, some air sampling data is available for DU operations at IAAP. These air samples were collected in the area of the Gravel Gerties (1971-1974) and the FS-12 area (1965-1973).

Tritium

The technology of tritium usage in nuclear weapons is classified. Canisters of tritium gas arrived in pressurized sealed containers. Gas from these containers was sampled as it was released under an exhaust ventilation system using a T-289 monitor to check for tritium contamination. Containers were purged to ensure the residual radioactivity was less than 90 µCi/m3 (Shaykin, 1969).

Documentation indicates that two urine samples were analyzed biweekly for selected individuals who worked in areas where there was a potential for exposure. AEC conducted reviews, from 1962-1973, of the IAAP tritium urinalysis. As of the 1973 review, the AEC reported there had never been a positive urine result for tritium (Davis, 1969).

NIOSH has obtained tritium bioassay results from Pantex from the 1970s and 1980s. Material and procedures at IAAP were almost the same as those at Pantex. Both facilities were operated under the same corporate management and were assigned the same tasks related to nuclear weapons. The largest internal dose at Pantex from tritium recorded during any year in this period was 122 mrem[3] . It should be noted that this dose level is likely below what the AEC would have considered a positive result in the 1960s.

In addition, from NIOSH records:

- Landauer dosimetry reports indicate that the IAAP site used the K-type badge and that the badge was used for both personal and a fairly extensive area monitoring badge program that included 68 badges placed within buildings.
- A series of documents (located on the site research database) indicate that all exposure records were sent to Pantex. Four hundred and twenty-nine persons at IAAP were monitored at one time or another. The average lifetime dose was approximately 1 rem and a few workers received approximately 5 rem. The documents also indicate that area dosimetry was used sometimes to assign dose to individuals.
- Personnel logs indicate that pocket dosimeters were used by workers when conducting work with the two ^{60}Co (200 and 500 Ci) industrial radiography machines and several X-ray units used as irradiation sources. Multiple pencil dosimeters were sometimes used on workers performing unusual activities and their use (including notation of location on the body) was documented within the logs.

[3] With the exception of a major accident

6.0 Summary of Radiological Operations Relevant to the Initial Class

The IAAP is a government-owned, contractor operated, military-industrial installation that was established initially for the loading, assembly and packing of 75MM and 155MM artillery shells and 100 pound bombs. The IAAP site was historically shared with the DoD. Construction of the plant began in January 1941. On August 5, 1947 the Silas Mason Co. (Mason & Hanger-Silas Mason Co., Inc.) contracted to complete rehabilitation of Line 1 and the construction of new facilities on behalf of the AEC. The phase one construction was completed in late 1948. In May 1948, Silas Mason Company sent supervisors of production personnel to the Naval Ordinance Test Site at China Lake, California for training on the production of high explosives (Poole and Harrison, 1954). Upon completion of the training, these supervisors trained production personnel at the Iowa Ordinance Plant. Within a year, the Burlington Plant was at full production for high explosives fabrications and plans were underway to begin assembly of non-nuclear components, duplicating the assembly capabilities of Sandia (Mitchell, 2003). In March of 1949, AEC decided that certain weapons assembly operations would be conducted at the Iowa Ordinance Plant (Poole and Harrison, 1954). According to DOE's Office of Worker Advocacy, nuclear weapons assembly operations that were performed at Los Alamos and Sandia were transferred to IAAP by 1949 (DOE Website 2005, www.doe.gov). In 1949, Silas Mason accepted responsibility for operation of highly classified facilities, known locally as Division B.

Based on this information, NIOSH concludes that prior to March 1949 the Iowa Ordinance Plant was not authorized to receive radiological nuclear weapons components. The facility was under construction and personnel were being trained to work under the AEC contract. Any production activities occurring after the supervisory training was provided to facility managers in May 1948 could only have involved HE fabrication (i.e. no production involving weapons components containing radioactive materials). This means that only radiographers could have had radiation exposures associated with the AEC activities in the period from May 1948-March 1949. Starting in March 1949, once weapons assembly operations commenced, other IAAP workers might also have begun to be exposed to radiation at the facility.

All AEC/DOE activities at IAAP were transferred to the Pantex plant in Amarillo, Texas in 1975.

Information concerning the early history of IAAP nuclear weapons assembly/disassembly activities still involves classified information and, therefore, a detailed description of certain activities cannot be made publicly available at this time. The following summary process information is releasable.

Weapons operations included assembly, surveillance, maintenance, modification and dismantlement of nuclear weapons stockpile warheads. Assembly is the final process of joining separately manufactured components and major parts into complete, functional and certified nuclear weapon warhead(s) for delivery to the DoD. Dismantlement of retired warheads includes disassembly of weapons and the sanitization, demilitarization, and disposition of their component parts. Warhead modifications and maintenance by DOE are also included in this category (Linking Legacies, 1997).

Operations involving radiological materials at the site, including DU, enriched uranium (EU), plutonium, tritium, ^{210}Po, and radium, included operations to combine containers of fissionable material with explosives, recovery operations following hydroshot testing at the Firing Site area, and operations to assemble uranium packages. Exposure to ^{60}Co and X-ray generating devices, used for industrial radiography, were also potential sources of radiation exposure. The separate locations and operations are summarized below.

Line 1

The Line 1 operations consisted primarily of nuclear weapons final assembly, disassembly, casting, machining, and weapons modifications (possibly), and were functional from late 1948-July 1975. These activities involved assembling and/or modifying components manufactured at other AEC facilities, disassembling weapons as part of the weapon retirement program, and manufacturing and processing large quantities of high explosive materials. The radiographic inspection of the components for quality assurance was also part of the Line 1 Operations and involved two 1,000 kV peak X-ray units housed in Building 1-100.

Yard C

Yard C was an existing igloo storage yard which was designated for the explosive material (Poole and Harrison, 1954). Activities in this yard would entail potential exposure to the pits (encapsulated fissile materials) being stored there.

Yard G

Yard G was used to store finished castings. This yard was accessible by motor vehicles only and required that shipments made by rail had to be handled by truck to the rail loading point. Workers were potentially exposed to the stored components.

Yard L

Yard L has been referred to as the AEC Inert Storage. Battery operated forklift repair, storage, and battery reworking operations took place within the yard. Yard L stored inert materials, solvents, PCB containing boxes, projectiles in containers, and #2 fuel oil (UI Risk Map, 2001). No information has been identified that indicates radiological exposures to workers in Yard L.

Firing Site Area

From 1965-1973, hydroshot testing was performed at the Firing Site Area, specifically at site 12 (FS-12). This involved the detonation of a DU surrogate weapon for testing the effects of explosives on weapon components in lieu of using weapons-grade material. One to two people would occupy the test fire control bunker next to ground zero. Within minutes of the explosion, the driver would enter the restricted area, pick up the workers in the bunker, and drive to the blast area to retrieve instruments. Then the workers would leave the fenced area. The workers would be exposed to a plume from the explosion for several minutes. There are reports of personnel subsequently recovering exploded parts by hand from the area. No respiratory protection was reported to have been worn during these recovery operations (TKBS-0018).

In addition to the hydroshots, there was also potential exposure to depleted uranium during regular HE testing. Air sampling data in the 1970s indicate that the depleted uranium air concentration was higher during regular HE tests compared to the hydroshots (Roeder, 1974). This documentation indicates that the increased concentration is likely due to resuspension of particulates originally deposited on the ground during the hydroshots.

Burning Field B/Yard B "Burn Area"

High explosives contaminated with DU were routinely burned in the AEC Explosive Disposal Area (EDA), which is an irregularly shaped region of slightly less than 1 square mile just north of the "C" Yard. Estimates are that approximately 2,000 grams/yr of DU, as contamination on scrap explosive components, were burned at the EDA. The ash was bagged and shipped off the site for disposal. Potential exposures to DU could have occurred as workers handled the contaminated scrap explosive components and ash.

Building 73

Building 1-73 was used as a gammagraph and radiograph facility. This building was used for inspection operations and necessary for production procedures. The building was designed to provide adequate shielding and safety devices for protection of personnel (Poole and Harrison, 1954). Interlocks and physical barriers were designed to shield workers from radiation exposures associated with the inspection equipment.

Building 77

Building 1-77 was designated as a Special Storage Building (TN & Assoc, 2001) and was one of the receiving buildings. The building was used for pit storage and inspection. Based on interviews with past employees, tritium (i.e. reservoirs) were also stored in this building. The building was built in the mid-1960s. Potential worker exposures could have resulted from material handling, storage, visual inspection, weighing, and swipe testing.

Gravel Gerties

Weapons assembly/disassembly was conducted in bays and special cells called Gravel Gerties that were at ground level, but had an overlay of earth on the roof and part-way up the sides. Potential exposures to naturally-occurring radon could have occurred to workers carrying out activities in these structures.

7.0 Evaluation of Feasibility of Dose Reconstruction

The feasibility of dose reconstruction is addressed in this report for the class of employees including all employees working at the Iowa Army Ammunition Plant Line 1, which includes Yard C, Yard G, Yard L, Firing Site Area, Burning Field "B" and Storage Sites for Pits and Weapons including Buildings 73 and 77, from March 1949-1974. It is not addressed for the class of employees who worked from June 1947-May 1948, prior to the introduction of any radioactive materials or radiological processes at Line 1 of Iowa Army Ammunition Plant. For this class, NIOSH has determined that no feasibility determination is necessary because members of the class received no radiation doses, as covered by EEOICPA. In addition, the feasibility of dose reconstruction is not addressed in this report for a potential class of employees composed of industrial radiographers who may have conducted radiography on non-radiological high explosive weapons components from May 1948-March 1949. NIOSH determined the potential existence of this class of employees late in the development of the report and has not completed the necessary research to verify that such a class exists and to evaluate the feasibility of dose reconstruction, should this class exist. NIOSH will issue a separate evaluation report addressing this potential class as soon as possible. Presently, NIOSH does not have any claims which would be included in this potential class.

The feasibility determination covered by this evaluation report is governed by 42 CFR § 83.13(c) (1). Under this regulation, NIOSH must establish whether or not it has access to sufficient information to either estimate the maximum radiation dose 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. If NIOSH were to have access to the information sufficient for either case, then dose reconstruction would be feasible.

In making determinations of feasibility, NIOSH begins by evaluating whether current or completed NIOSH dose reconstructions demonstrate the feasibility of estimating with sufficient accuracy the potential radiation exposures of the class (identified in section 6.0 of this report). If not, NIOSH systematically evaluates the sufficiency of different types of monitoring data and process and source or source term data, which together or individually might assure NIOSH that it can estimate either the maximum doses members of the class might have incurred, or more precise quantities that reflect the variability of exposures experienced by groups or individual members of the class. This approach is specified in the SEC Petition Evaluation Internal Procedures (OCAS-PR-004) available at www.cdc.gov/niosh/ocas.

Although dose reconstructions have been completed for some IAAP claims, these completed dose reconstructions do not provide sufficient information to assess the feasibility of reconstructing doses for the entire class, in view of additional information provided to NIOSH during worker outreach meetings in July 2004.

The evaluation that follows examines separately the availability of monitoring, process, and source information necessary for reconstructing internal and external radiation doses of members of the class.

7.1 Internal Radiation Doses

The revised TBD describes the assumptions used to estimate the potential intakes at IAAP. As noted in the TBD, weapons components containing EU, plutonium, polonium-210 and thorium sealed these radioactive materials within a non-radioactive protective cladding. As a result, workers handling these components may have received external doses of radiation from the radioactive contents, but they would not have received internal exposures unless the cladding was compromised. NIOSH has received no evidence to suggest the opening or rupture of such cladding, either at IAAP or at Pantex. The use of such cladding and its characteristics are discussed in greater detail under section 7.3 of this report.

The TBD indicates that potential internal exposure to site personnel during weapons assembly operations was minimized primarily by engineering controls. According to all reports and documentation, the tasks conducted during the assembly of weapons were designed to prevent internal exposure. All radiological components handled during assembly arrived at IAAP in a sealed configuration. AEC reports document that shipments of radiological materials were swipe tested on entry to the plant and before being sent to the assembly facilities. Radiological Safety personnel indicated that the presence of contamination was rare. As noted above, there is no documentation indicating that any of the sealed components containing radiological materials was ruptured, a highly unlikely event. Considering the controlled assembly procedures; a rupture would have been documented. Nor have there been reports from employees suggesting such an event.

Workers had potential for internal exposure associated with the disassembly of weapons, explosive testing, machining, and waste disposal. The radionuclides involved in these exposures were DU and tritium. Table 7.1 summarizes the relevant operations and time periods for these exposures.

Limited air sample results from IAAP were typically less than detectable levels and those that were detectable indicated only low level exposure (Gate Monitoring Records D38, 1971-1974; Gate Monitor Information Lab Analysis Sheets, January 1973–August 1974).

Table 7.1 Radionuclides and Operations with Potential Internal Exposure at IAAP

Radionuclide	Operation	Timeframe of Potential Exposure
Tritium	Assembly and disassembly of weapons: inhalation and skin absorption from operation where the pressurized, tritium containing reservoirs were installed or disconnected.	1954-1974
DU	Hydroshot activities: inhalation, as well as ingestion, during and after test shot activities in the Test Fire Area.	1965-1973
DU	Routine HE testing: inhalation and ingestion potential resulting from re-suspension of DU contaminated soil.	1965-1975
DU	Machining baratols: inhalation, as well as ingestion, during machining of high explosives.	1949-1962
DU	Burn Yard disposal: inhalation of slightly contaminated, explosive materials treated by burning operations.	1949-1975
DU	Disassembly of weapon: inhalation of oxidized weapons parts.	1949-1975

Tritium reservoirs came from the Savannah River Site. Workers at IAAP completed the first assembly of a weapon containing tritium in 1955. Considering that some tritium would have been onsite prior to the completion of the first assemblies, NIOSH assumes tritium may have been introduced at the site in 1954.

NIOSH has obtained tritium bioassay results from Pantex from the 1970s and 1980s. Material and procedures at IAAP were almost the same as those at Pantex. Both facilities were operated under the same corporate management and were assigned the same tasks related to nuclear weapons. The largest internal dose at Pantex from tritium recorded during any year in this period was 122 mrem[4]. Allowing for possible different circumstances between Pantex in the 1970-80s and IAAP from the late 1950s, in conjunction with information on the IAAP tritium air samples, it is possible to estimate the maximum plausible internal tritium deposition for any single employee.

The revised TBD incorporates information obtained from the IAAP-specific tritium air sampling data and the tritium bioassay data obtained from the Pantex site to develop an overestimate of employee uptake of tritium. This number is based on the assumption that 10 tritium containers containing the maximum releasable air concentration of 90 µCi/m3 were processed in a cell each day. According to workers, at most 4-5 disassemblies would be completed in a day in a single cell, thus 10 containers is considered claimant favorable. For purposes of this overestimate, the tritium was assumed to be a more biologically-effective form of tritiated water (HTO). Chronic exposure to elevated tritium concentrations at this level results in a maximum whole body internal dose of 207 mrem per year of intake (as compared to the maximum whole body internal dose of 122 mrem at Pantex). Based on the documented detection level of 0.25 µCi/L for tritium urinalysis in 1972 at the Pantex facility, if the IAAP workers' exposures to tritium had

[4] With the exception of a major accident

actually occurred at the levels assumed in the TBD, the deposition would have been detected in the bioassay program discussed above.

From 1965-1973 there was a potential for workers to be exposed to DU oxide-bearing dust in proximity to the North Firing Site (FS-12) immediately following the detonation of a hydroshot. For exposed workers, maximum doses can be estimated through a general exposure model, as included in the revised TBD. This requires the use of air sampling data and the dates of hydroshots, which are available. The revised TBD expands the duration of exposure from an intermittent to a routine exposure in consideration of the fact that there were on average around 3-4 HE tests per day, in addition to the intermittent hydroshots. This data is used to estimate the chronic exposure to uranium from the HE tests in addition to the hydroshots. Based on a field investigation at Los Alamos Scientific Laboratories in November 1974, it was determined that approximately 10% of the total mass of uranium was aerosolized in a hydroshot. Data show that uranium particle sizes were lognormally distributed with an aerodynamic mass median diameter of 0.1 to 1 micron and a standard deviation of 8 for three separate experiments (Dahl and Johnson, 1977). For FS-12 workers, the revised TBD uses an activity median aerodynamic diameter (AMAD) of 1 micron for uranium particles in lieu of the default 5 micron AMAD. This is claimant favorable in that the smaller particle size results in a larger internal dose.

Machining baratols ended in 1962; thus, intakes of DU from that process would have ended at that time as well. There was no actual machining directly on the DU, but there was the potential to "nick" the DU during machining of the explosive charges. An assumption of some intake of DU by the machinists is reasonable, although it would have been intermittent. For workers who machined the baratols, a maximum dose, as included in the current TBD, can be estimated by referring to air samples collected at other sites during machining operations, and the development of an ingestion model (TKBS-0018, p 14).

The source term of DU at the burn yard has been estimated (TN and Assoc, 2001) to have been approximately 2,000 grams/year. The burning of DU-contaminated high explosive components can be assumed to create aerosolized particles of DU. Accounting for the amount of DU present, it is feasible to estimate the amount of DU released into the air during the operations at the burn yard, and hence, it is feasible to estimate maximum doses received by any workers who may have been exposed at this operation, as included in the current TBD (TKBS-0018, p 14, 15).

The disassembly of some nuclear weapons is also likely to be a source of DU intake for some IAAP workers. A review of IAAP DU swipe data indicates that the initial contamination level was very low (< 3 dpm/100cm^2); however, in later time periods, presumably during disassembly, the swipe data increased to approximately 150 dpm/100cm^2 (Meek and Shahan, 1972, Shannon, 1974). The maximum doses from this exposure received by workers involved in disassembly operations can be estimated, as described in the revised TBD. This estimation requires the use of air sample and swipe sampling data, which are available to NIOSH.

Three hundred forty-two radon measurements were taken in various buildings at IAAP by the Army from December 1989-January 1991. No information has been found that associates these measurements with specific buildings. Hence, the information is of marginal value. The average, standard deviation and geometric mean of the IAAP data are all less than the corresponding radon measurements obtained from the Pantex data, which are used as the basis for estimating radon doses at IAAP (TKBS-0018, p 38, 39).

7.2 External Radiation Doses

The primary work activities from which site personnel may have received external radiation exposures were testing nuclear components containing DU, handling sealed nuclear components, storage of materials, and industrial radiography operations (TKBS-0018). There are monitoring data on external exposures to photon emitting radiation at IAAP for workers employed from late 1955 through termination of nuclear operations at IAAP in 1974. The limitations of these data are summarized in section 5.0 and table 5.1. The following are methods, addressed in more detail in the revised TBD, by which the external radiation doses of IAAP workers involved in each of the listed activities can be estimated, taking into account the data limitations.

7.2.1 Photons

During time periods when individual monitoring was not conducted at IAAP (prior to 1955), or was inadequate (1955-1962), the radiation dose can be estimated using dose rate information from the source term with the claimant favorable assumption that the pit was unshielded rather than sealed within cladding (Taulbee, 2004). This dose rate information can be combined with exposure duration and geometry information (ratio methodology) to estimate annual photon doses. The limitation concerning such estimates is that source term information, from which dose rates would be calculated, remains classified for reasons of national security.

Since 1955, personal radiation monitoring at IAAP was conducted using commercial dosimetry vendors. Tracer Lab and R.S. Landauer Company dose reports were found in the archival records (1955-1975). The film badges apparently were assigned to selected IAAP workers based on work activity (potential for exposure) in the early years, thus not all workers were monitored. Starting in 1963, continuous dosimetry monitoring results are available for radiological workers. Of the individual IAAP worker dose records analyzed, several thousand were deemed acceptable records for high energy photon dose reconstruction, spanning 1963-1974 (TKBS-0018). Only records with personal and dosimeter badge identification and contractor affiliation were examined. Annual dose distributions were developed from these dosimetry records. These distributions are used to estimate worker doses for unmonitored workers during this time.

Although Landauer reported that their dosimeter badge had a lower energy threshold of approximately 30 keV, measurement data from the era at Hanford indicate that the dosimeter badge was likely to have had a reduced response to photons less than 70 keV. As a result, the low energy photon dose from IAAP is likely to be underestimated by these measurements. The revised TBD corrects for this underestimate, however the photon spectra upon which these corrections are based are classified for reasons of national security.

In addition to personal dosimeters, IAAP health and safety personnel also routinely assigned and evaluated pocket ionization chamber (PIC) measured doses from at least June 18, 1965-November 7, 1974, for workers at the radiographic facilities.

7.2.2 Neutrons

Only a limited number of dosimeter badges (27 of 215) at IAAP contained Neutron Track Emulsion (NTA) film for neutron monitoring (Davis, 1969). Based on a review of the area badge (building) data, only a few areas at IAAP had significant neutron exposures. In these areas when the neutron dose was detectable, the photon doses were also high.

The neutron dose component of workers with external radiation exposures can be estimated, as included in the current TBD (TKBS-0018, p 25), by using the distribution of neutron-to-photon dose ratio from measured Pantex worker doses during the period of 1993-2003. This application of surrogate data, however, relies on the ability of NIOSH to document the comparability of the radiological exposures, which in turn depends on the comparability of the radiological source-term data on the content of the pits, as well as process data. NIOSH has access to these data, but they remain classified for reasons of national security and, hence, are not available to the public.

The neutron dose could also be estimated by using the IAAP data and deriving a ratio using an established method (MCNP) to calculate the portion of the neutron dose that would not have been detected by the NTA film. The latter method, however, estimates lower neutron doses and was not recommended in the TBD, which discusses the issue in detail. In addition, the latter method would also require NIOSH to rely on source-term data on the content of the pits and certain process data, which remain classified for reasons of national security.

7.2.3 Occupational Medical Dose

Occupational exposures to medical X-rays are also covered in the revised TBD. The claimant-petition favorable assumptions made for the site include: <u>all employees</u> received a pre-placement and annual posterior-anterior (PA) chest X-ray exposure and <u>all male employees</u> received a pre-placement anterior-posterior (AP) and lateral lumbar spine examination. The frequency of examination has been updated with input from the worker outreach program. Limited information on the dose from certain medical X-rays has been found in the dosimetry records. Because these doses are significantly less than the default values obtained from *Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures* (ORAUT-OTIB-0006) and the *Technical Basis Document for Rocky Flats-Occupational Medical Dose* (ORAUT-TKBS-0011-3) which provides a method for calculating organ doses from lumbar spine examinations. There is some uncertainty as to which exposure shot was the standard setting for a typical PA chest exam, therefore the default values are used.

7.3 Evaluation of Specific Petition Assertions Concerning Feasibility of Dose Reconstruction

The following addresses assertions made by the petitioners on behalf of petition SEC00006:

- *"A large fraction of these IAAP workers worked directly with or in very close proximity to hand held radioactive plutonium 'pits' of these weapons. …Many of these workers report holding the pits in their hands with only cotton gloves with rare or no radiation monitoring and little or no shielding from the radiation, (no glove boxes or lead aprons)." (SEC 00006 affidavit)*

According to documentation reviewed, the AEC was also concerned about some work in close proximity to certain components (Davis, 1969). In the September 1969 review, the AEC recommended IAAP Radiation Safety establish a hand monitoring program for employees who may handle or work in close proximity to certain radioactive components during assembly or disassembly operations. Based on NIOSH's review of the records, IAAP responded to the AEC recommendation and implemented a program. NIOSH has obtained the wrist dosimeter data from 1969-1974. These data clearly indicate an increased exposure potential for the extremities. In the revised TBD, NIOSH used these data to correct for geometry among workers who directly handled pits.

Without the shielding mentioned in the assertion, workers were more likely to be exposed to low energy photons. While this exposure was not measured, the NIOSH process of dose reconstruction takes this potential exposure into account and assumes the worker received it. High energy photons were measured through whole-body dosimetry, and with the knowledge of the ratio between high energy photon and low energy photons, the low energy photon dose can be estimated.

- *"In addition, only a small minority (approximately 20 per cent) of the Line 1 work- force were ever issued badges, and there were periods when none or very few individuals were monitored." (SEC 00006 affidavit)*
- *"My dad **************** did not have a monitoring badge issued to him." (SEC 00007 affidavit)*

The practice of monitoring a representative member of a workforce directly, and applying that dose to co-workers, was used during the era addressed by this evaluation report. This practice is valid when applied with adequate information on the work environment and conditions to conclude that the co-workers would not have received a substantially higher exposure than the individual being monitored. NIOSH has access to sufficient information on monitoring practices at IAAP and from area monitoring and process and source information to generally conclude that representative workers were selected for monitoring. Interviews with former workers and site experts, and examination of job titles of monitored workers support the conclusion that the workers selected for monitoring were representative of those most likely to have been exposed. These co-worker data are adequate to support dose reconstruction for co-workers, used in conjunction with allowances for exposures to vary between similarly situated workers. The problem, however, is that the source and process information that NIOSH has reviewed to judge the appropriateness of the representation of workers in the monitoring program, remains classified and, hence, is not available to the public. With respect to low energy photons, the problem extends to all workers who might have been employed on Line 1, because these doses were not adequately monitored at the site. This data limitation also applies to neutron doses among workers in areas of Line 1 where such doses might have been significant. As discussed under Section 7.2.1 and 7.2.2 of this report, NIOSH would have to rely upon classified information for any procedure it could use to reconstruct these doses.

NIOSH has determined that such reliance on classified information that cannot be released to the public maybe unacceptable for the purposes of the EEOICPA compensation program. The ultimate success or failure of this program will rely substantially on the degree to which the basis for claims adjudication, of which dose reconstruction is a substantial part, is transparent to the public. In this case, the intent of NIOSH to be as transparent as possible in the conduct of dose reconstructions may be impeded through the use of security-classified information.

- *"Personal interviews of production workers also indicate that even if badges were provided, they often were not worn by the workers in the bays but were left either in their lockers or on a main storage board so they would not lose them." (SEC 00006 affidavit)*

Workers provided similar information to NIOSH during the IAAP worker outreach meeting in July 2004. The effect of workers not wearing issued badges is to increase the number of zero dosimeter readings or false negatives. With an increased number of false negatives, the quantity of missed dose is underestimated in the annual dose distributions used to assign dose to unmonitored workers. Because this practice has been identified from multiple sources, the annual dose distributions in the IAAP TBD were revised to account for this practice. In addition, the dose reconstruction methodology has been modified in a clamant-favorable manner to assign the higher of either the individual's monitored dose or the new annual dose distribution (unmonitored dose). A more detailed discussion of the methodology can be found in the revised TBD.

- *"The Health Physicists made a variety of assumptions in the site profile process. Where data are non-existent, extrapolations of exposure were made using other facilities from other eras involved in other manufacturing processes." (SEC 00006 affidavit)*

It is standard practice for dose reconstructions to extrapolate from data and to apply data from comparable operations to fill gaps in data, so long as the extrapolations and applications have a reasonable basis. All assumptions provided in the site profile documents are strictly reviewed for validity for one site based on the operations and source information of the surrogate facility by NIOSH before they are approved for use in the dose reconstruction process.

NIOSH recognizes that some of the assumptions in the initial TBD were not claimant-favorable. These errors were identified by former workers during the worker outreach meetings. NIOSH has conducted further research and has revised the TBD to correct these assumptions. NIOSH is currently in the process of re-evaluating formerly completed claims and will issue new dose reconstruction reports as necessary.

- *"According to NIOSH, no records have been located that indicate any individual monitoring of internal doses of radionuclides (i.e. plutonium, uranium or tritium) occurred between 1947 and 1975. No wrist or finger monitor data exist for these workers." (SEC 00006 affidavit)*

As of this evaluation, NIOSH has identified records summarizing the results of internal dosimetry monitoring performed for tritium and has obtained air monitoring data on tritium from which maximum doses can be estimated. NIOSH has also obtained extremity monitoring records for workers at IAAP from which doses can be estimated.

- *"Several area monitoring records have been located that document the potential for high external radiation exposure even though the location of these area measurements were not in proximity of the actual immediate work area where higher exposures took place. Data from area monitoring in this facility documents cases of exposure in excess of OSHA standards." (SEC 00006 affidavit)*

These area monitoring records assist in the dose reconstruction process. The data associated with these monitors are used to calculate and verify the potential exposure of individuals working in the area. While these monitors are located further from the source of exposure than the work force, dose reconstructionists make adjustments to exposure readings based on the knowledge of the facility, duration of the exposure, and the geometry of exposure.

- *"No records have been found that document the radiation sources, source term, uniformity of exposures, potential for airborne dispersion, radiation energy spectrum, particle size distribution, etc. that were in the work area with the employees on a day-to-day basis at the plant. Detailed information of this type with chemical form of the radionuclide would be required to validly reconstruct past radiation exposure." (SEC 00006 affidavit)*

NIOSH does have access to records pertaining to radiation sources and source term. As discussed above, however, this information is classified for the protection of national security and is not available for public release.

- *"A report as recent as 1981 of controlled exposures indicated that film dosimetry lacked both precision and accuracy and yielded underestimates of true neutron exposure approaching 80% in some instances." (SEC 00006 affidavit)*

NTA film underestimates the dose from lower energy neutrons. The relative degree of the underestimation is highly dependent on the incident neutron energy and the calibration methodology. NIOSH has conducted calculations that indicate as much as 40% of the neutron dose could have been underestimated at IAAP. NIOSH has subsequently applied this correction to the recorded NTA film measurement data at IAAP and developed a new neutron to photon ratio. This new ratio was compared to the ratio in the initial TBD, which used modern TLD dosimetry and was found to be smaller (less claimant favorable). As a result, NIOSH is continuing to use the more claimant favorable ratio identified in the initial TBD.

- *The issue of "cladding" or shielding is unsettling. Not all pits were "clad" in Beryllium and/or Depleted Uranium. (SEC 00006 original petition E.5)*

There are two dose components with regards to cladding. The first, internal dose, is important if the pits were not clad. Through further research, NIOSH has learned that all pits manufactured since the late 1940s were clad. From the energy employee viewpoint, the pits could have appeared, and felt through thermal radiance (heat), as if they were bare plutonium or uranium metal. In some instances, this cladding could be a very thin layer of material, thus the pit could be thermally warm and could also look like bare metal. As a result of our analysis, NIOSH has determined that there is no significant potential for internal exposure from pits.

While there is no significant potential for internal exposure from pits, the cladding material and thickness can affect the external dose rate (second dose component). This is particularly problematic for low energy photons (<30 keV). High-Z materials such as uranium greatly reduce the photon dose rate and almost completely shield the worker from low energy photon emissions. Conversely, low-Z materials such as beryllium, do not provide much shielding and allow a relatively large quantity of low energy photons (<30 keV) to pass. Through discussions with DOE, NIOSH has learned that exact information on the cladding material and thickness for each weapon design assembled and disassembled at IAAP remains classified.

The initial TBD assumed a high Z material of sufficient thickness and that the low energy photon dose was negligible. Through further research, NIOSH has learned that while this may be correct for some components, this assumption was not universally accurate. In some instances, low energy photon doses might not have been negligible. As a result of this finding, NIOSH has significantly revised the IAAP TBD to include a low energy photon dose for all workers handling pits.

It is important to note that not all nuclear weapon components had the potential to produce a significant low energy photon dose. However, due to security considerations, NIOSH cannot publicly identify those with and without potential to produce such dose.

As a result, a claimant favorable approach has been adopted in which NIOSH assumes, for low energy photons dose calculations only, that none of the pits were clad. This low energy photon dose is based on a calculated ratio between the low energy photons and higher energy photons that would be measured by the film badges. This assumption maximizes the possible low energy photon dose component. If data on the actual characteristics of the pits were used in the dose reconstruction, the low energy photon dose of dose reconstructions for workers handling pits would be substantially lower.

- *"No data are available to indicate that adjustments were made to account for dosimeter responses to low energy radiation." (SEC 00006 affidavit)*

NIOSH previously had information indicating that low energy photons, predominately from plutonium in some of the IAAP weapons components, were shielded by high Z materials including depleted uranium. Through further research, NIOSH has learned that low energy photons were not always heavily shielded. The revised TBD corrects this underestimation using a low energy to high energy (measured) dose ratio.

- *"Curiously, not one radiation related incident or investigation report was included in the IAAP plant records for the entire period 1945 to 1975." (SEC 00006 affidavit)*

NIOSH has extensive information on incidents at the IAAP. NIOSH has reviewed over 200 incident reports between 1959-1974. NIOSH has identified 15 incidents that involved radioactive materials in which special surveys or precautionary building evacuations were conducted. NIOSH does not typically include incident information in Technical Basis Documents, but does consider these incidents in dose reconstructions on an individual basis.

- *"The adequacy of the badges used is called into question by the lack of available SOPs, QA and validation data." (SEC 00006 original petition E.5)*

Within the dosimetry records, the IAAP radiological safety group intermittently exposed spare badges to known quantities of radiation and submitted them with other dosimeters as a quality assurance check. NIOSH's review of this information indicates that the standard deviation was ± 20%, with an increase to -60% and +40% observed for two of the three low level exposures at 50mR. This greater uncertainty is common with film dosimeter as the exposure approaches the limit of detection. This effect is discussed in NIOSH's External Dose Reconstruction Implementation Guideline (OCAS-IG-001) which provides guidance on how to incorporate this uncertainty in dose reconstructions. Based on NIOSH's review, IAAP did have a reasonable QA and data validation program.

- *"I am sending you this sworn statement that I never in the course of my employment during 1950, 1951 and the first part of 1952 saw any kind of radiation monitoring device, other than GEIGER COUNTERS in each assembly area." (SEC 00014 affidavit)*

"This statement is to confirm that my brother and I, after considerable effort, have not been able to locate or obtain any records with respect to monitoring radiation and other deadly toxins at the I.O.P., in Burlington, Iowa, i.e., (Middletown), during the 1940s and 1950s…" (SEC 00015 affidavit)

NIOSH has not located radiation monitoring data prior to 1955 and based upon a review of the documentation suspects that none was conducted. This absence of monitoring data does not preclude the ability to conduct dose reconstructions. NIOSH has information on the radioactive source terms prior to 1955 and how they were used. In the initial TBD, dose estimation prior to 1958 was reserved primarily because at that time NIOSH could not be certain when fissile materials were first onsite. Through further research, NIOSH has learned that the first sealed pits which contained the fissile materials were introduced in 1955. This directly corresponds with IAAP's implementation of a film badge monitoring program and radiation safety program which included training for all Line 1 workers. However, because NIOSH cannot be certain as to when other fissile materials (such as nuclear capsules) arrived on site, to give the benefit of the uncertainty to the claimant, the revised TBD uses a ratio methodology to estimate the dose to workers starting in 1949.

- *Buildings 1-06-1, 1-06-2, 1-08-1, 1-50, and 1-60 were specifically raised by a petitioner (SEC 00014) as work locations that contributed to the exposure of employees.*

These locations have been researched and there is no reference to or indication of the presence of radiation generating materials in buildings 1-06-1, 1-06-2, 1-08-1, 1-50 and 1-60. These buildings were all buildings containing non-radiological functions and processes for the munitions involved in the AEC products IAAP.

7.4 Summary of Feasibility Findings

This report evaluated the feasibility for completing dose reconstructions for employees working on Line 1 AEC operations at the Iowa Army Ammunitions Plant in Burlington, Iowa during the years of 1947-1974. NIOSH has fully reviewed the publicly available data as well as those data not available to the public for reasons of national security. This report identifies several data gaps and describes how those gaps could be effectively addressed, in accordance with Section 82.2 (a), (b), and (c) of 42 CFR Part 82, through use of default values based on accepted scientific methods and (where possible) stated assumptions, and the use of data from comparable activities and process operations in order to provide dose reconstructions sufficiently accurate for compensation purposes. However, some of the technical bases (i.e., source term information, process information, and photon and neutron dose calculations) for sufficiently accurate dose reconstructions for this petitioned class depend on the use of classified information that is not available to the public for reasons of protecting national security.

As discussed under Section 7.3 of this report, NIOSH has determined this limitation on the transparency of the NIOSH dose reconstruction program, imposed through the use of classified information, may be unacceptable for the purposes of conducting dose reconstructions under EEOICPA. For this reason, NIOSH finds that it is not feasible to estimate doses with sufficient transparency for employees working on Line 1 AEC operations at the Iowa Army Ammunitions Plant in Burlington, Iowa during the years of 1949-1974.

Although NIOSH believes that it has a sufficient scientific and technical basis to estimate radiation doses incurred by employees at IAAP from 1949-1974, NIOSH questions whether this basis for dose reconstruction is viable for the purposes of this compensation program due to the desire for transparency under. NIOSH will, however, seek advice from the Board concerning this finding. Specifically, NIOSH will ask the Board to provide advice on whether NIOSH can and should conduct dose reconstructions under limited transparency conditions due to national security considerations. The Board's advice concerning this transparency issue will also be taken into consideration in light of the potential for this issue to arise in future Cohort petitions.

8.0 Health Endangerment

The health endangerment determination for the class of employees covered by this evaluation report is governed by EEOICPA and 42 C.F.R. § 83.13(c)(3). Under these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must also determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

As discussed in Section 5.0 of this report and as documented in the monitoring results available to NIOSH, IAAP employees generally received low radiation doses. Among 429 employees that were monitored at the facility, the average lifetime dose documented by monitoring was approximately 1 rem and a few workers were documented to have received approximately 5 rem. The NIOSH dose reconstruction program, however, has estimated doses will be higher than 5 rem among IAAP employees. On this basis, NIOSH has determined that it is reasonably likely that such exposures may have endangered the health of the IAAP employees covered by the class definition provided in section 9.0 of this evaluation.

The NIOSH evaluation did not identify any evidence from the petitioners or from other resources that would establish that the classes were exposed to radiation during a discrete incident or similar conditions resulting from the failure of radiation exposure controls and likely to have produced levels of exposure similarly high to those occurring during nuclear criticality incidents. NIOSH is not aware of any report of such an occurrence at the facility. The evidence reviewed in this evaluation indicates that some workers in the classes may have accumulated substantial doses through chronic exposure to external sources of radiation. Consequently, NIOSH is specifying that health was endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

9.0 Proposed Class Definition

This evaluation defines a single class of employees for which NIOSH has established that it may not be able to estimate radiation doses with sufficient accuracy for compensation purposes due to transparency concerns, and whose health may have been endangered by such radiation doses. The class includes all employees working at the Iowa Army Ammunition Plant Line 1, which includes Yard C, Yard G, Yard L, Firing Site Area, Burning Field "B" and Storage Sites for Pits and Weapons including Buildings 73 and 77, from March 1949-1974, and whom were employed for a number of work days aggregating at least 250 work days, occurring either solely under this employment, or in combination with work days of employment occurring within the parameters (excluding aggregate work day requirements) established for other classes of employees included in the SEC.

In addition, this evaluation defines a class of employees who worked from June 1947-May 1948, prior to the introduction of any radioactive materials or radiological processes at Line 1 of Iowa Army Ammunition Plant. For this class, NIOSH has determined that no feasibility determination is necessary because members of the class received no radiation doses, as covered by EEOICPA.

Finally, this evaluation identifies a potential class of employees composed of industrial radiographers who may have conducted radiography on non-radiological high explosive weapons components from May 1948-March 1949. NIOSH will issue a separate evaluation report addressing this potential class as soon as possible. This future evaluation will complete the NIOSH evaluation of SEC Petitions No. 6, 7, 14, and 15.

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