

SEC Petition Evaluation Report

Petition SEC-00139

Report Rev #: 1

Report Submittal Date: September 23, 2010

Subject Expert(s):		Robert Coblantz, Mike Domal		
Site Expert(s):		N/A		
Petition Administrative Summary				
Petition Under Evaluation				
Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00139	83.13	February 27, 2009	September 8, 2009	Hangar 481, Kirtland Air Force Base (AFB)
Petitioner Class Definition				
All employees who worked at Hangar 481, Kirtland Air Force Base, from March 1, 1989 through February 29, 1996.				
Class Evaluated by NIOSH				
All employees who worked at Hangar 481, Kirtland Air Force Base (AFB), from March 1, 1989 through February 29, 1996.				
NIOSH-Proposed Class(es) to be Added to the SEC				
None				
Related Petition Summary Information				
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ORAU Lead Technical Evaluator: Robert Coblantz		ORAU Peer Review Completed By: Daniel Stempfley		
Peer Review Completed By:	_____		_____	
	<i>Samuel E. Glover</i>		<i>9/28/10</i>	
	<i>Date</i>			
SEC Petition Evaluation Reviewed By:	_____		_____	
	<i>J. W. Neton</i>		<i>10/4/2010</i>	
	<i>Date</i>			
SEC Evaluation Approved By:	_____		_____	
	<i>Stuart L. Hinnefeld</i>		<i>10/4/2010</i>	
	<i>Date</i>			

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Evaluation Report Summary: SEC-00139, Hangar 481, Kirtland AFB

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) addresses a class of employees proposed for addition to the Special Exposure Cohort (SEC) per the *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 U.S.C. § 7384 *et seq.* (EEOICPA) and 42 C.F.R. pt. 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*.

Petitioner-Requested Class Definition

Petition SEC-00139 was received on February 27, 2009, and qualified on September 8, 2009. The petitioner requested that NIOSH consider the following class: *All employees who worked at Hangar 481, Kirtland Air Force Base, from March 1, 1989 through February 29, 1996.*

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class for review. NIOSH evaluated the following class: All employees who worked at Hangar 481, Kirtland Air Force Base, from March 1, 1989 through February 29, 1996.

NIOSH-Proposed Class(es) to be Added to the SEC

Based on its full research of the class under evaluation, NIOSH has obtained exposure monitoring data for the specified worker class. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.13(c)(1), NIOSH has established that it has access to sufficient information to: (1) estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class; or (2) estimate radiation doses of members of the class more precisely than an estimate of maximum dose. 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 evaluated class under plausible circumstances during the specified period.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is not required because NIOSH has determined that it has sufficient information to estimate dose for the members of the evaluated class.

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SEC Petition Evaluation Report for SEC-00139

ATTRIBUTION AND ANNOTATION: This is a single-author document. All conclusions drawn from the data presented in this evaluation were made by the ORAU Team Lead Technical Evaluator: Robert Coblentz, Quantaflux, LLC. The rationales for all conclusions in this document are explained in the associated text.

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all employees who worked at Hangar 481, Kirtland Air Force Base, from March 1, 1989 through February 29, 1996. It provides information and analyses germane to considering a petition for adding a class of employees to the congressionally-created SEC.

This report does not make any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH. This report also does not contain the final determination as to whether the proposed class will be added to the SEC (see Section 2.0).

This evaluation was conducted in accordance with the requirements of EEOICPA, 42 C.F.R. pt. 83, and the guidance contained in the Office of Compensation Analysis and Support's (OCAS) *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, OCAS-PR-004.

2.0 Introduction

Both EEOICPA and 42 C.F.R. pt. 83 require NIOSH to evaluate qualified petitions requesting that the Department of Health and Human Services (HHS) add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether it is feasible to estimate with sufficient accuracy the radiation doses of the class of employees through NIOSH dose reconstructions.¹

42 C.F.R. § 83.13(c)(1) states: *Radiation doses can be estimated with sufficient accuracy if NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class, or if NIOSH has established that it has access to sufficient information to estimate the radiation doses of members of the class more precisely than an estimate of the maximum radiation dose.*

¹ NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 C.F.R. pt. 82 and the detailed implementation guidelines available at <http://www.cdc.gov/niosh/ocas>.

Under 42 C.F.R. § 83.13(c)(3), if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, then NIOSH must 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 at least 250 aggregated work days within the parameters established for the class or in combination with work days within the parameters established for other SEC classes (excluding aggregate work day requirements).

NIOSH is required to document its evaluation in a report, and to do so, relies upon both its own dose reconstruction expertise as well as technical support from its contractor, Oak Ridge Associated Universities (ORAU). Once completed, NIOSH provides the report to both the petitioner(s) and to the Advisory Board on Radiation and Worker Health (Board). The Board will consider the NIOSH evaluation report, together with the petition, petitioner(s) comments, and other information the Board considers appropriate, in order 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 a decision on behalf of HHS. The Secretary of HHS will make the final decision, taking into account the NIOSH evaluation, the advice of the Board, and the proposed decision issued by NIOSH. As part of this decision process, petitioners may seek a review of certain types of final decisions issued by the Secretary of HHS.²

3.0 SEC-00139, Hangar 481, Kirtland AFB Class Definitions

The following subsections address the evolution of the class definition for SEC-00139, Hangar 481, Kirtland Air Force Base. When a petition is submitted, the requested class definition is reviewed as submitted. Based on its review of the available site information and data, NIOSH will make a determination whether to qualify for full evaluation all, some, or no part of the petitioner-requested class. If some portion of the petitioner-requested class is qualified, NIOSH will specify that class along with a justification for any modification of petitioner's class. After a full evaluation of the qualified class, NIOSH will determine whether to propose a class for addition to the SEC and will specify that proposed class definition.

3.1 Petitioner-Requested Class Definition and Basis

Petition SEC-00139 was submitted by the surviving spouse of a deceased former Ross Aviation employee at Hangar 481. The petition was received on February 27, 2009, and qualified on September 8, 2009. The petitioner requested that NIOSH consider the following class: *All employees who worked at Hangar 481, Kirtland Air Force Base, from March 1, 1989 through February 29, 1996.*

² See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available at <http://www.cdc.gov/niosh/ocas>.

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Hangar 481 workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00139 for evaluation:

The petition under evaluation was submitted on the basis that there is a lack of personnel monitoring for certain individuals who were employed at Hangar 481. The petitioner (also a former employee at Hangar 481) asserts that the deceased former Ross Aviation employee at Hangar 481 *“did not wear dose monitoring badges,”* and to the best of his knowledge, *“there was no monitoring of any kind at Hangar 481 or adjacent there to [sic].”* The petitioner also states that *“shipments of substances and items were delivered to the hangar in guarded shipments from Sandia National Labs and loaded into planes at Hangar 481 for further delivery by personnel wearing dose badges.”* (Petition, 2009)

The petitioner also submitted a statement from another former Hangar 481 employee, who stated by affidavit, *“...I recall that pilots, flight engineers and flight mechanics who were present at the time of loading on the ramp would be wearing radiation dose badges. I was not required to wear radiation badges during times that I assisted in loading cargo into the planes, or while cleaning the planes.”* He also stated that *“[evaluated employee - name redacted] would have been working in the offices in the hanger [sic] building, and on occasions when the cargo would have been loaded into airplanes parked on the ramp that was located near to the Ross Aviation hanger [sic].”* (Affidavit, 2009)

Based on its Hangar 481 research and data capture efforts, NIOSH determined that it has access to summary reports containing personnel monitoring data for Hangar 481 workers during the time period under evaluation, as well as area monitoring data (radiological surveys) for radioactive material shipments transported by planes based at Hangar 481. However, NIOSH identified a lack of individual dosimetry results for the evaluated period. Based on this information, NIOSH found support for the petition basis regarding lost (or otherwise unavailable) personnel monitoring data. The information and statements provided by the petitioner qualified the petition for further consideration by NIOSH, the Board, and HHS. The details of the petition basis are addressed in Section 7.4.

3.2 Class Evaluated by NIOSH

Based on its preliminary research, NIOSH accepted the petitioner-requested class employee description. Therefore, NIOSH defined the following class for further evaluation: all employees who worked at Hangar 481, Kirtland Air Force Base (AFB), from March 1, 1989 through February 29, 1996.

3.3 NIOSH-Proposed Class(es) to be Added to the SEC

Based on its research, NIOSH has obtained Hangar 481 summary reports containing personnel monitoring data for the time period specified in the class under evaluation. NIOSH has also obtained documents pertaining to Ross Aviation radiation protection programs, radiological surveys, and radioactive material shipment records. Based on its analysis of these available resources, NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As a standard practice, NIOSH completed an extensive database and Internet search for information regarding Hangar 481, Kirtland Air Force Base. The database search included the DOE Legacy Management Considered Sites database, the DOE Office of Scientific and Technical Information (OSTI) database, the Energy Citations database, the Atomic Energy Technical Report database, and the Hanford Declassified Document Retrieval System. In addition to general Internet searches, the NIOSH Internet search included OSTI OpenNet Advanced searches, OSTI Information Bridge Fielded searches, Nuclear Regulatory Commission (NRC) Agency-wide Documents Access and Management (ADAMS) web searches, the DOE Office of Human Radiation Experiments website, and the DOE-National Nuclear Security Administration-Nevada Site Office-search. Attachment 1 contains a summary of Hangar 481 documents. The summary specifically identifies data capture details and general descriptions of the documents retrieved.

In addition to the database and Internet searches listed above, NIOSH identified and reviewed numerous data sources to determine information relevant to determining the feasibility of dose reconstruction for the class of employees under evaluation. This included determining the availability of information on personal monitoring, area monitoring, industrial processes, and radiation source materials. The following subsections summarize the data sources identified and reviewed by NIOSH.

4.1 Site Profile Technical Basis Documents (TBDs)

A Site Profile provides specific information concerning the documentation of historical practices at the specified site. Dose reconstructors can use the Site Profile to evaluate internal and external dosimetry data for monitored and unmonitored workers, and to supplement, or substitute for, individual monitoring data. A Site Profile consists of an Introduction and five Technical Basis Documents (TBDs) that provide process history information, information on personal and area monitoring, radiation source descriptions, and references to primary documents relevant to the radiological operations at the site. The Site Profile for a small site may consist of a single document.

As part of NIOSH's evaluation detailed herein, it examined the following TBDs for insights into Hangar 481 operations or related topics/operations at other sites:

- *TBD: Nevada Test Site – Occupational External Dose*; ORAUT-TKBS-0008-6, Revision 01 PC-1; Oak Ridge Associated Universities; May 28, 2008; SRDB Ref ID: 34013
- *TBD: Site Profile for Sandia National Laboratories in Albuquerque, New Mexico, and the Tonopah Test Range, Nevada*; ORAUT-TKBS-0037, Revision 00; Oak Ridge Associated Universities; June 22, 2007; SRDB Ref ID: 32531

4.2 ORAU Technical Information Bulletins (OTIBs) and Procedures

An ORAU Technical Information Bulletin (OTIB) is a general working document that provides guidance for preparing dose reconstructions at particular sites or categories of sites. An ORAU Procedure provides specific requirements and guidance regarding EEOICPA project-level activities, including preparation of dose reconstructions at particular sites or categories of sites. NIOSH reviewed the following OTIB as part of its evaluation:

- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*; ORAUT-OTIB-0006, Rev 3 PC-1; Oak Ridge Associated Universities; December 21, 2005; SRDB Ref ID: 20220

4.3 Facility Employees and Experts

To obtain additional information, NIOSH conducted eight interviews with seven individuals that included: two individuals who are currently or formerly with the Department of Energy-Albuquerque; two individuals with the National Nuclear Security Administration Office of Secure Transportation; and three former Ross Aviation-Hangar 481 employees:

- Personal Communication, 2009a, *Personal Communication with Employee at Sandia National Laboratory, DOE-Albuquerque*; Telephone Interview by ORAU Team; June 10, 2009; SRDB Ref ID: 69631
- Personal Communication, 2009b, *Personal Communication with Employee at Sandia National Laboratory, DOE-Albuquerque*; Telephone Interview by ORAU Team; June 3, 2009; SRDB Ref ID: 69633
- Personal Communication, 2009c, *Personal Communication with former Director of Safety and General Manager at Ross Aviation, Hangar 481*; Telephone Interview by ORAU Team; June 2, 2009; SRDB Ref ID: 69638
- Personal Communication, 2009d, *Personal Communication with the ES&H Division Director, and a Nuclear Engineer at the Office of Secure Transportation*; Telephone Interview by ORAU Team; June 17, 2009; SRDB Ref ID: 70643

- Personal Communication, 2009e, *Personal Communication with former Director of Safety and Security at Ross Aviation, Hangar 481*; Telephone Interview by ORAU Team; August 25, 2009; SRDB Ref ID: 72792
- Personal Communication, 2009f, *Personal Communication with Director of Safety and Security at Ross Aviation, Hangar 481*; Telephone Interview by ORAU Team; November 6, 2009; SRDB Ref ID: 76358
- Personal Communication, 2009g, *Personal Communication with Director of Safety and Security at Ross Aviation, Hangar 481*; Telephone Interview by ORAU Team; December 7, 2009; SRDB Ref ID: 77272
- Personal Communication, 2009h, *Personal Communication with former Ross Aviation General Manager and former Ross Aviation Personnel Director*; Telephone Interview by ORAU Team; December 7, 2009; SRDB Ref ID: 77273

4.4 Previous Dose Reconstructions

NIOSH reviewed its NIOSH OCAS Claims Tracking System (NOCTS) to locate EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation. Table 4-1 summarizes the results of this review. (NOCTS data available as of October 22, 2009)

Table 4-1: No. of Hangar 481 Claims Submitted Under the Dose Reconstruction Rule	
Description	Totals
Total number of claims submitted for dose reconstruction	1
Total number of claims submitted for energy employees who meet the definition criteria for the class under evaluation (March 1, 1989 through February 29, 1996)	1
Number of dose reconstructions completed for energy employees who meet the definition criteria for the class under evaluation (i.e., the number of such claims completed by NIOSH and submitted to the Department of Labor for final approval).	0
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	0
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	0

NIOSH reviewed the current Hangar 481, Kirtland AFB claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. The claim is for the same employee represented in this SEC00139 Hangar 481 petition.

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. One hundred ninety four (194) documents in this database were identified as pertaining to Hangar 481, Kirtland Air Force Base. These documents were evaluated for their relevance to this petition. The documents include historical background on contracts between the U.S. Atomic Energy Commission and Ross Aviation, contracts between the DOE and Ross Aviation, DOE Occupational Radiation Exposure Reports, periodic regulatory site inspection reports, radiological surveys of facilities and aircraft, shipping records, and site drawings and photos.

4.6 Other Technical Sources

NIOSH found personnel radiation exposure summary data for Ross Aviation employees located in the Nuclear Regulatory Commission (NRC) Radiation Exposure Information Recording System (REIRS) database (Ross, 2009), and the DOE Occupational Radiation Exposure Report for 1996 (DOE, 1996) that, together, cover the timeframe specified in the worker class description.

NIOSH also reviewed the following DOE document, which provided the basis for exempting Ross Aviation from performing worker internal exposure monitoring for Hangar 481 activities:

- *Transportation Safeguards Division Technical Basis for Radioactive Material Intake Potential*, Transportation Safeguards Division, Albuquerque Operations Office, U.S. Department of Energy; August 7, 1997; SRDB Ref ID: 71009

Although the date of the above report is subsequent to the timeframe specified in the class definition, the document describes reviews of data and information regarding historical Hangar 481 activities and is, therefore, considered relevant to this evaluation.

4.7 Documentation and/or Affidavits Provided by Petitioners

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

- *Special Exposure Cohort Petition, Form B and supporting documents*; received February 27, 2009; OSA Ref ID: 108306
- *Employment History Affidavit from Co-worker*; received April 9, 2009; OSA Ref ID: 108623

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

The following subsections summarize both radiological operations at the Hangar 481, Kirtland AFB from March 1, 1989 to February 29, 1996 and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of each radionuclide of concern, and information describing processes through which radiation exposures may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is intended only to be a summary of the available information.

5.1 Hangar 481, Kirtland AFB Plant and Process Descriptions

Hangar 481 is located at Kirtland Air Force Base in Albuquerque, New Mexico, as shown in Figures 5-1 and 5-2. Ross Aviation, with operations based at Hangar 481, was under contractual agreement with the DOE to provide air transport of personnel and equipment associated with DOE operations at the Sandia National Laboratory in Albuquerque, New Mexico. Ross Aviation maintained air transport services for government-owned aircraft at government-owned facilities, which included: Kirtland AFB; Las Vegas, Nevada; Tonopah Test Range, Nevada; Los Alamos, New Mexico; and Desert Rock, Nevada (Contract, 1989). The transported equipment included packages containing radioactive materials associated with atomic weapons programs.

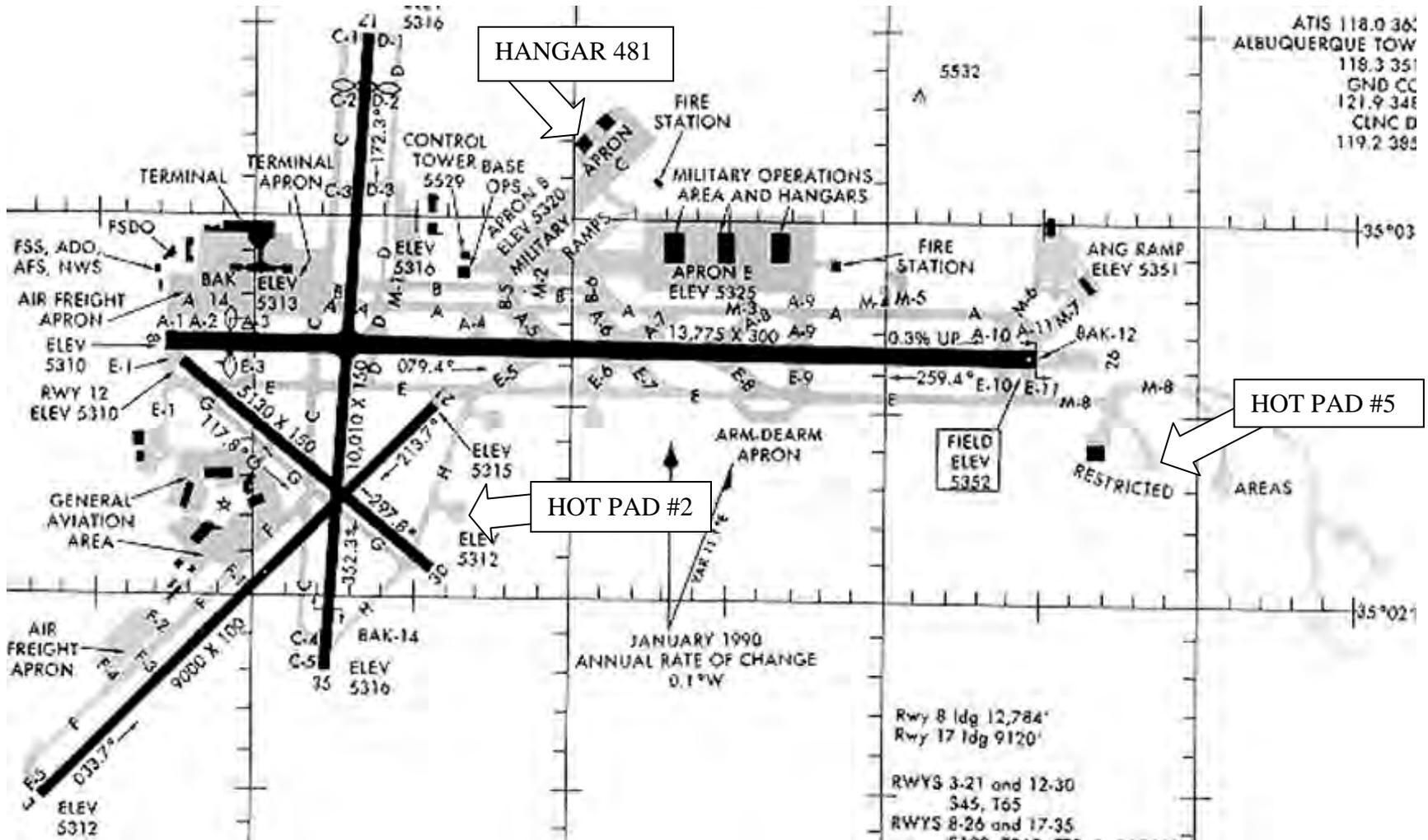


Figure 5-1: Diagram of Kirtland AFB Showing Hangar 481



Figure 5-2: Hangar 481, Kirtland Air Force Base

According to the contract (Contract, 1989), the government-owned aircraft that were operated and maintained by Ross Aviation at Kirtland AFB consisted of the following:

- Douglas DC-9-15F (3 total)
- DeHavilland DHC-7 (3 total)
- DeHavilland DHC-6 (2 total)
- Beech BE 200 (2 total)

Radioactive materials were transported in sealed containers in accordance with Department of Transportation (DOT) requirements (Contract, 1989). By former Ross employee accounts, radioactive shipment loading activities took place at specific loading areas, called “hot pads,” that were located at least 6,000 feet from the Hangar 481 building. Cleaning and servicing of unloaded aircraft took place at Hangar 481 (Personal Communication, 2009e; Personal Communication, 2009h). Based on Ross Aviation shipment records, radioactive material shipments predominantly consisted of tritium, depleted uranium, and mixed fission products (Checklist, 1988a; Checklist, 1988b; Shipping Record, 1988; Shipping Record, 1989; Shipping Record, 1992).

During the majority of the covered period at the site, aircraft non-destructive testing (NDT) was performed at Hangar 481 via X-ray analysis. This work was performed for short durations at night during off-shift hours (Personal Communication, 2009e).

A December 2, 1992, Occupational Safety and Health Inspection report (Ross, 1992) regarding health physics practices at Ross Aviation states:

Ross does not handle, store, or use radioactive materials in the Albuquerque facilities. There is an x-ray machine used in one building. Most people wear external dosimetry to support other Ross activities involving loading and unloading aircraft, as well as flight operations.

Ross uses a Baltograph IV X-ray unit and control console. This unit is operated for nondestructive testing and inspections, approximately ten minutes per month. There are only two qualified operators, who are the only current Radiological Workers at Ross. Inspection records, operator training records, and device records/interlocks were inspected, and no discrepancies noted.

The Ross External Dosimetry Program is contracted through Eberline, Inc., and is DOE Laboratory Accreditation Program accredited. The highest recorded exposure for 1991 was approximately 45 millirem. No discrepancies were identified in the dosimetry records from Eberline to Ross.

A Health Protection Division appraisal document dated April, 1994 states that the X-ray operations at Hangar 481 had been curtailed (HPD, 1994). Information gained through personal interviews with a former Ross Aviation Safety Director indicates that the X-ray testing was outsourced sometime around 1992 or early 1993, but the interviewee was unsure of the exact date. After that time, X-ray testing was no longer performed at Hangar 481; the planes were taken to a facility in Arizona for testing (Personal Communication, 2009g). Only the NDT operations performed at the covered facility evaluated in this report (Hangar 481) are addressed in this evaluation; the NDT operations and associated exposures associated with X-ray work at other contractor facilities outside of this covered facility location (after testing was outsourced), are not covered under this evaluation.

5.2 Radiological Exposure Sources from Hangar 481 Operations

The following subsections provide an overview of the internal and external exposure sources for the Hangar 481 class under evaluation.

5.2.1 Internal Radiological Exposure Sources from Hangar 481 Operations

On August 7, 1997, the Transportation Safety Division (TSD) of DOE's Albuquerque Operations Office issued the *Technical Basis for Radioactive Material Intake Potential* regarding activities performed by Ross Aviation at Hangar 481 (TSD, 1997). The document stated:

Based on: (1) the TSD Special Agents tasks (i.e., no contact with package contents); (2) TSD's operational history with confirmatory surveys (i.e., no package breach or leakage); and (3) the use of DOT compliant shipping packages and programs, there is no credible path for an intake of radioactive materials during normal operations.

Based on the available information on the radiological program and potential for internal exposure sources, NIOSH concludes that internal radiological exposures to Ross Aviation employees resulting from services rendered for the DOE at Hangar 481 are unlikely to have occurred. Radioactive materials handled by workers at Hangar 481 were in sealed DOT-compliant containers and monitored

in accordance with DOT regulations to verify radiation and contamination levels on package exteriors. Results of available radiological surveys performed on the packages and in the transport aircraft support this premise.

Since Kirtland AFB and Hangar 481 are directly adjacent to the Sandia National Laboratory-Albuquerque (SNL-A), it is conceivable that internal dose to individuals working at Hangar 481 could have occurred from ambient environmental sources at SNL-A moving across the site boundary.

5.2.2 External Radiological Exposure Sources from Hangar 481 Operations

External radiological exposures to employees at Hangar 481 occurred as a result of handling packages containing radioactive materials. Those radioactive materials emit photon and particle radiation (i.e., gamma and beta). However, since the materials were in sealed packages, photon radiation was the dominant external exposure source for Hangar 481 personnel.

Non-destructive testing was performed at Hangar 481 via X-ray analysis. This work was performed at night (Personal Communication, 2009e) for approximately ten minutes per month by trained Radiological Workers (Ross, 1992). In a personal interview, a former Ross Aviation Safety Director stated the names of two individuals involved in X-ray activities at Hangar 481. The names provided are listed in the personnel monitoring summary data available to NIOSH. Therefore, NIOSH concludes that the personnel dose from these operations would be accounted for in the personnel exposure summary data available to NIOSH.

5.2.2.1 Photon

According to available radioactive material shipping documents associated with Hangar 481, the principal photon-emitting radioactive materials were predominantly depleted uranium and mixed fission products (Checklist, 1988a; Checklist, 1988b; Shipping Record, 1988; Shipping Record, 1989; Shipping Record, 1992).

Photon exposures from depleted uranium are primarily from the Th-234 daughter of U-238 (Radiological Health, 1970).

Photon exposures were also possible from radioactive material shipments containing mixed fission products; shipping documents indicated that such shipments consisted of samples taken from weapons-test tunnels.

As stated in Section 5.1, non-destructive X-ray testing was performed at Hangar 481 and served as a potential external photon (X-ray) exposure source for those personnel involved in the NDT activities. This work was performed on the evening/night shift for about 10 minutes per month by trained Radiological Workers.

Bremstrahlung effects (excluding that from tritium beta emissions) could also be considered as a photon source, but are accounted for in the exposure summary data.

5.2.2.2 Beta

Due to the fact that the radioactive materials were transported in sealed DOT-compliant containers (TSD, 1997), beta exposure was not likely. However, as recorded in the personnel dosimetry data, some shallow exposure to either beta or non-penetrating photon radiation did occur.

5.2.2.3 Neutron

Neutron generators were frequently transported by aircraft at Hangar 481. These devices emit neutron radiation only when powered and energized (Procedure, 1990). Since these devices were only being transported, neutron exposure was infeasible. This statement is backed up by neutron monitoring data which indicated that no positive neutron doses were ever recorded for any individual at Hangar 481. Based on this information, neutron exposure is not considered a factor for this site and the topic will not be discussed further in this report.

5.2.3 Incidents

The petitioner did not file a claim on the basis of exposure incidents and did not indicate knowledge of any having occurred at Hangar 481. The former Director of Safety and Security at Ross Aviation, Hangar 481, stated there were no incidents involving radioactive material shipments at Ross that he was aware of (Personal Communication, 2009e). A NIOSH review of all Ross Aviation/Hangar 481 documents contained in the Site Research Database (SRDB) has found no information regarding any radiological incidents occurring at Hangar 481. Therefore, incidents are not considered a factor for this site and the topic will not be discussed further in this report.

6.0 Summary of Available Monitoring Data for the Class Evaluated by NIOSH

The following subsections provide an overview of the state of the available internal and external monitoring data for the Hangar 481 class under evaluation.

6.1 Available Hangar 481 Internal Monitoring Data

For the reasons stated in Section 5.2.1, internal monitoring was not needed or performed at Hangar 481 (TSD, 1997); therefore, there are no internal monitoring data associated with the operations for this site.

However, since it is conceivable that internal dose to individuals working at Hangar 481 could have occurred from ambient environmental sources at SNL-A moving across the site boundary, NIOSH intends to use the method defined in the SNL-A ambient environmental methods defined in the SNL-A Site Profile document to assess and bound any internal dose for the Hangar 481 class under evaluation (ORAUT-TKBS-0037).

6.2 Available Hangar 481 External Monitoring Data

Summary external personnel monitoring data (TLD data) are available for Hangar 481 personnel during the covered period at the site, with the exception of 1996. For 1996, external personnel monitoring was not performed because operations requiring external monitoring and reporting had ceased (DOE/EH-0575). NIOSH is working with Landauer (which has the Eberline data for this time period) to obtain the raw data represented in the summary reports. However, as of the date of this evaluation report, NIOSH has not been able to coordinate (via Landauer) the review and release of the applicable Eberline dosimetry data. It should be noted that the 1996 portion of the covered period consists of two months, January and February.

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determination for the class of employees under evaluation in this report is governed by both EEOICPA and 42 C.F.R. § 83.13(c)(1). Under that Act and rule, NIOSH must establish whether or not it has access to sufficient information either to 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 to members of the class more precisely than a maximum dose estimate. If NIOSH has access to sufficient information for either case, NIOSH would then determine that it would be feasible to conduct dose reconstructions.

In determining 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. If the conclusion is one of infeasibility, NIOSH systematically evaluates the sufficiency of different types of monitoring data, process and source or source term data, which together or individually might assure that NIOSH can estimate either the maximum doses that 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 as summarized in Section 7.5. This approach is discussed in OCAS's SEC Petition Evaluation Internal Procedures which are available at <http://www.cdc.gov/niosh/ocas>. The next four major subsections of this Evaluation Report examine:

- The sufficiency and reliability of the available data. (Section 7.1)
- The feasibility of reconstructing internal radiation doses. (Section 7.2)
- The feasibility of reconstructing external radiation doses. (Section 7.3)
- The bases for petition SEC-00139 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Hangar 481 Data

This subsection answers questions that need to be asked before performing a feasibility evaluation. Data Pedigree addresses the background, history, and origin of the data. It requires looking at site methodologies that may have changed over time; primary versus secondary data sources and whether they match; and whether data are internally consistent. All these issues form the bedrock of the researcher's confidence and later conclusions about the data's quality, credibility, reliability, representativeness, and sufficiency for determining the feasibility of dose reconstruction. The feasibility evaluation presupposes that data pedigree issues have been settled.

7.1.1 Internal Monitoring Data Pedigree Review

As stated in section 5.2.1, internal monitoring was not needed or performed (TSD, 1997); therefore, there are no internal monitoring data associated with site operations available for, or requiring, a pedigree review. Available radiological monitoring data, from surveys performed on shipment packages and the transport aircraft, agree with and support the position stated in the *Technical Basis for Radioactive Material Intake Potential* issued by the Transportation Safety Division (TSD) of DOE's Albuquerque Operations Office (TSD, 1997).

7.1.2 External Monitoring Data Pedigree Review

External monitoring data from thermoluminescent dosimeter (TLD) results are available for individuals who were monitored at Kirtland AFB, Hangar 481. The data are annual summaries for each individual who was monitored for all years of the evaluation period except for 1996. Eberline was the TLD processor throughout the covered period except for 1996. Those monitored included mechanics, pilots, and personnel involved with handling or securing packages (Personal Communication, 2009b; Personal Communication, 2009e). These individuals were expected to have received the highest exposures because their work activities frequently put them in close proximity to the source (radioactive packages). Monitored individuals were issued TLDs that were changed out on a quarterly basis. This level of personnel monitoring was robust given the low levels of exposure at the site (no individual received over 200 mrem annual exposure from 1989 through 1995). The data appear to be complete and accurate. In 1996, no external monitoring results were recorded because operations requiring external monitoring and reporting had ceased (DOE/EH-0575).

NIOSH is working with Landauer to obtain (from Eberline) the raw data represented in the summary reports to permit data validation for the pedigree review in this report. However, as of the date of this evaluation, NIOSH has not been able to coordinate (via Landauer) the review and release of applicable Eberline dosimetry data to support the validation review.

7.2 Evaluation of Bounding Internal Radiation Doses at Hangar 481

As stated in Section 5.2.1, internal monitoring was not needed or performed. Therefore, an evaluation of the ability to bound operationally-related internal doses at Hangar 481 for the evaluated worker class is not required in this report.

7.2.1 Evaluation of Bounding Ambient Environmental Internal Doses

As discussed in the Sections 5 and 6 of this report, the primary radiological hazard at Hangar 481 was external exposure from radioactive packages; therefore, internal monitoring to assess potential internal exposures from Hangar 481 operations was not needed or performed (TSD, 1997). However, low-level ambient environmental internal exposures were conceivable from sources on the boundary of Kirtland AFB and Hangar 481. Because Kirtland AFB is located immediately adjacent to Sandia National Laboratory-Albuquerque (SNL-A), it might have been possible for individuals at Kirtland, and therefore Hangar 481, to receive low-level ambient environmental internal exposure from SNL's radioactive effluent releases. Ambient environmental doses for individuals who worked at SNL-A have been researched and assessed (ORAUT-TKBS-0037). Considering the effect that the additional distance beyond the SNL-A boundary would have had on the dispersion of airborne radiological contaminants, the ambient environmental exposures assessed for workers in the SNL-A Site Profile document would have been considerably higher than those for individuals working at an off-site location. Therefore, the ambient environmental internal exposure assessment method defined for SNL-A workers in the environmental section of the SNL-A Site Profile will serve to bound any ambient internal doses for individuals at Kirtland AFB and Hangar 481.

7.2.2 Internal Dose Reconstruction Feasibility Conclusion

Based on NIOSH's evaluation, there is no potential for internal exposures (or the need to assess dose) associated with Hangar 481 operations. However, NIOSH has identified a potential source of ambient environmental exposures from a source external to the Hangar 481 site/location, which can be assessed using the boundary site's ambient environmental monitoring data and dose assessment approach (ORAUT-TKBS-0037). Considering this information, and the methods to assign ambient environmental dose defined in the environmental section of the SNL-A Site Profile, NIOSH concludes that it can bound any potential internal dose for the Hangar 481 class under evaluation.

7.3 Evaluation of Bounding External Radiation Doses at Hangar 481

The principal sources of external radiation doses for members of the evaluated class were the packages containing radioactive materials. The following subsections address the ability to bound external doses, methods for bounding doses, and the feasibility of external dose reconstruction.

7.3.1 Evaluation of Bounding Process-Related External Doses

The following subsections summarize the extent and limitations of information available for reconstructing the process-related external doses of members of the class under evaluation.

7.3.1.1 Personnel Dosimetry Data

As stated in Section 7.1, many employees at Kirtland AFB, Hangar 481, were monitored for external radiation exposure by TLDs. The available dosimetry data are annual summaries for each individual who was monitored for all years of the evaluation period except for 1996. Those monitored included mechanics, pilots, and personnel involved with handling or securing packages (Personal Communication, 2009b; Personal Communication, 2009e). These individuals were expected to have received the highest exposures because their work activities frequently put them in close proximity to the source (radioactive packages). Monitored individuals were issued TLDs that were changed out on a quarterly basis. The data appear to be complete and accurate. In 1996, no external monitoring results were recorded because operations requiring external monitoring and reporting had ceased (DOE/EH-0575).

The annual dose summaries list the total number of individuals monitored, the site collective dose, and the maximum individual dose. The maximum individual doses can be used to bound all other doses since they included data from the maximally-exposed individuals.

Photon

Personnel most likely to receive external dose at Kirtland AFB were pilots and mechanics. The mechanics were involved in handling the packages. The pilots likely had the opportunity to come in close proximity to the packages depending on the package locations in the aircraft.

Non-destructive X-ray testing also took place at Hangar 481, providing an additional photon source. These activities took place on night shift with minimal personnel on site (Ross, 1992). TLDs would have provided adequate personnel monitoring data for these photon sources.

Beta

Beta radiation emanating from shipped radioactive materials is not likely to have penetrated the packaging containers. Therefore, it is not considered to be a likely source of external exposures to workers. However, TLD data indicate personnel shallow dose, which is most likely caused by non-penetrating photon radiation. In either case, the TLD data are adequate to assess personnel shallow/beta dose.

7.3.1.2 Area Monitoring Data

No records of perimeter or fixed area monitors were found. Given that the primary radiological hazard was transporting packages with limited exposure fields, fixed area or perimeter monitoring likely would not have provided much usable data

Area monitoring focused on surveys for contamination in areas where it was possible for contamination to spread from damaged or improper packaging. Records found included shipping records and surveys of empty aircraft, Hangar 481, and other areas. Source term data could be obtained by reviewing radioactive shipping records and receipt surveys. Shipping surveys were reviewed and were found to contain isotope data as well as surface and one-meter dose rates (SRDB 70776). External dose rates from the packages and time estimates could be used to estimate maximum doses for those who handled radioactive packages. However, based on the hierarchy established in OCAS guidance documents, personal dosimetry information is the preferred data source over area monitoring results for use in dose reconstruction.

The available area monitoring data support that there was no spread of contamination. These data also provide information about the program and plane conditions. However, the data do not provide a reasonable means for bounding external doses and are, thus, not supportive of external dose reconstruction. Bounding of external doses will rely on the available TLD data.

7.3.2 Evaluation of Bounding Ambient Environmental External Doses

Ambient environmental doses are accounted for in the personnel monitoring data. Therefore, further assessment of ambient environmental external doses is not required in this evaluation report.

7.3.3 Hangar 481 Occupational Examinations

Interviews with former Hangar 481 workers indicate that annual occupational X-ray examinations were not performed at Hangar 481. Sufficient data and references are available regarding annual X-ray exams at DOE facilities to bound occupational X-ray doses during the covered years (ORAUT-OTIB -0006).

7.3.4 Methods for Bounding External Dose at Hangar 481

There is an established protocol for assessing external exposure when performing dose reconstructions (these protocol steps are discussed in the following subsections):

- Photon Dose
- Beta Dose
- Medical X-ray Dose

7.3.4.1 Methods for Bounding Operational Period External Dose

Photon Dose

Given the availability of TLD data for the period under evaluation, external photon doses for Kirtland AFB, Hangar 481, can be bounded.

From the years 1989 through 1995, individual annual doses are available and summarized in Table 7-1. Site collective dose and individual maximum doses are also available for those years. An average of 76 Hangar 481 employees was monitored each year from 1989 through 1995. The maximum number of personnel monitored was 98 in 1989 and the minimum was 56 in 1995. The maximum annual individual dose recorded during this timeframe was 172 mrem in 1994, which was about two times higher than any other year. Those who were monitored included the mechanics and pilots. These individuals were believed to have been the most likely to have received external photon exposure due to the nature of their jobs and the likelihood of being in close proximity to radioactive packages. The TLD data available from 1989 through 1995 is believed to accurately assess exposures at Hangar 481 for that time period and is acceptable for bounding external exposures.

Table 7-1: Annual Dose Summaries for Kirtland AFB, Hangar 481				
Year	Total Monitored	Maximum Individual Shallow Dose (mrem)	Maximum Individual Deep Dose (mrem)	Total Person-mrem
1989	95	77	58	246
1990	89	89	89	201
1991	87	61	44	207
1992	70	51	48	203
1993	67	47	37	163
1994	66	83	172	1501
1995	56	77	54	445

In 1996, no external monitoring results were recorded because operations requiring external monitoring and reporting had ceased (DOE/EH-0575). Although it is likely that no occupational dose was received during the covered period in 1996, it is possible to use the data from the previous years to support bounding any potential dose at the facility for 1996. Any possible external photon dose from operations or ambient environmental sources can be bounded by using the highest recorded individual external dose for any of the previous covered years, which is 172 mrem in 1994.

Beta Dose

Given the availability of TLD data for the period under evaluation, external beta doses for Kirtland AFB, Hangar 481, can be bounded.

From the years 1989 through 1995, individual annual shallow dose equivalent (SDE) and deep dose equivalent (DDE) doses are available. These data can be used to determine the contribution to SDE from beta radiation. Those who were monitored included the mechanics and pilots. These individuals were believed to have been the most likely to have received external beta exposure due to the nature of their jobs and the likelihood of being in close proximity to radioactive packages. The TLD data available from 1989 through 1995 are believed to accurately assess exposures at Hangar 481 for that time period and are acceptable for bounding external beta/shallow exposures.

In 1996, no external monitoring results were recorded because operations requiring external monitoring and reporting had ceased (DOE/EH-0575). Any possible external beta/shallow exposures for 1996 can be bounded by using the highest recorded individual external beta dose for any of the previous covered years. This approach is also bounding because the evaluated period in 1996 consists of two months, and any assessed exposure will assume exposure for the entire year.

Medical X-ray Dose

Interviews with former Hangar 481 workers indicate that annual occupational X-ray examinations were not performed at Hangar 481. Based on this information, the bounding approach for assessing medical X-ray doses for the class under evaluation is to assume annual X-ray examinations. Sufficient data and references are available regarding annual X-ray exams at DOE facilities to bound occupational X-ray doses during the covered years (ORAUT-OTIB -0006).

7.3.5 External Dose Reconstruction Feasibility Conclusion

Given the availability of TLD data for the covered years of employment, it is feasible to bound the evaluated worker class external dose (reconstruct external doses with sufficient accuracy). The primary radiological hazard was external photon dose from radioactive packages. A shallow dose component was also present, but to a much lesser extent. From 1989 through 1995, individual annual TLD data was available for all monitored individuals. Those that were monitored included individuals such as mechanics and pilots. These individuals were believed to have been the most likely to have received external exposures due to the nature of the jobs. The TLD data from 1989 through 1995 is believed to adequately assess the radiological exposures at Kirtland AFB Hangar 481 during this timeframe and is therefore adequate for performing dose reconstructions. Dose from 1996 can be over-estimated for dose reconstructions by using the highest individual dosimetry data for all previous covered years (1989 through 1995).

7.4 Evaluation of Petition Basis for SEC-00139

The following subsections evaluate the assertions made on behalf of petition SEC-00139 for Hangar 481, Kirtland AFB.

7.4.1 Lost (or Otherwise Unavailable) Personnel Monitoring Data

SEC-00139: The petition under evaluation was submitted on the basis of a lack of personnel monitoring for certain individuals employed at Hangar 481. The petitioner (also a former employee at Hangar 481) asserts that the deceased former Ross Aviation employee at Hangar 481 “*did not wear dose monitoring badges,*” and to the best of his knowledge, “*there was no monitoring of any kind at Hangar 481 or adjacent there to [sic]*”. He also stated that “*shipments of substances and items were delivered to the hangar in guarded shipments from Sandia National Labs and loaded into planes at Hangar 481 for further delivery by personnel wearing dose badges.*” (Petition, 2009)

The petitioner also submitted a statement from another former Hangar 481 employee, who stated by affidavit, “*...I recall that pilots, flight engineers and flight mechanics who were present at the time of loading on the ramp would be wearing radiation dose badges. I was not required to wear radiation badges during times that I assisted in loading cargo into the planes, or while cleaning the planes.*” He also stated that “[evaluated employee - name redacted] *would have been working in the offices in the hanger [sic] building, and on occasions when the cargo would have been loaded into airplanes parked on the ramp that was located near to the Ross Aviation hanger [sic].*” (Affidavit, 2009)

Not all employees who worked at Hangar 481 were monitored for radiation exposure. However, not all Hangar 481 employees worked near radioactive materials, and as such, were not required to having monitoring. Ross Aviation was required to monitor personnel who were directly involved in radioactive material shipments, and NIOSH has located personnel exposure data for the applicable Ross Aviation employees for the time class period under evaluation.

While it may not be feasible to determine which individuals were directly involved in radioactive material shipments and those who were not, the available data are adequate for determining upper bound dose estimates for all members of the class under evaluation.

The bounding scenario for this evaluation is based on the Hangar 481 worker who handled packages containing radioactive materials. Because NIOSH has the monitoring data for that exposure scenario/worker group, NIOSH concludes that it can bound the dose for the worker class under evaluation in this report.

7.5 Summary of Feasibility Findings for Petition SEC-00139

This report evaluates the feasibility for completing dose reconstructions for employees at the Hangar 481, Kirtland AFB from March 1, 1989 through February 29, 1996. NIOSH found that the available monitoring records, process descriptions and source term data available are sufficient to complete dose reconstructions for the evaluated class of employees.

Table 7-2 summarizes the results of the feasibility findings at Hangar 481 for each exposure source during the time period March 1, 1989 through February 29, 1996.

Table 7-2: Summary of Feasibility Findings for SEC-00139 March 1, 1989 through February 29, 1996		
Source of Exposure	Reconstruction Feasible	Reconstruction Not Feasible
Internal	X	
External	X	
- Gamma	X	
- Beta	X	
- Neutron	N/A	N/A
- Occupational Medical X-ray	X	

As of October 22, 2009, a total of one claim has been submitted to NIOSH for an individual who worked at Hangar 481 and is covered by the class definition evaluated in this report. This individual claim is currently with NIOSH for dose reconstruction.

8.0 Evaluation of Health Endangerment for Petition SEC-00139

The health endangerment determination for the class of employees covered by this evaluation report is governed by both 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. Section 83.13 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.

NIOSH evaluated Petition SEC-00139 on the basis of lost (or otherwise unavailable) personnel monitoring data. Through research and data capture activities, NIOSH has located radiation exposure summary data for Hangar 481 workers for the time period under evaluation. NIOSH's evaluation determined that it is feasible to estimate radiation dose for members of the NIOSH-evaluated class with sufficient accuracy based on the sum of information available from available resources. Modification of the class definition regarding health endangerment and minimum required employment periods, therefore, is not required.

9.0 Class Conclusion for Petition SEC-00139

Based on its full research of the class under evaluation, NIOSH found no part of said class for which it cannot estimate radiation doses with sufficient accuracy. This class includes all employees who worked at Hangar 481, Kirtland Air Force Base, from March 1, 1989 through February 29, 1996.

NIOSH has carefully reviewed all material sent in by the petitioner, including the specific assertions stated in the petition, and has responded herein (see Section 7.4). NIOSH has also reviewed available technical resources and many other references, including the Site Research Database (SRDB), for information relevant to SEC-00139. In addition, NIOSH reviewed its NOCTS dose reconstruction database to identify EEOICPA-related dose reconstructions that might provide information relevant to the petition evaluation.

These actions are based on existing, approved NIOSH processes used in dose reconstruction for claims under EEOICPA. NIOSH's guiding principle in conducting these dose reconstructions is to ensure that the assumptions used are fair, consistent, and well-grounded in the best available science. Simultaneously, uncertainties in the science and data must be handled to the advantage, rather than to the detriment, of the petitioners. When adequate personal dose monitoring information is not available, or is very limited, NIOSH may use the highest reasonably possible radiation dose, based on reliable science, documented experience, and relevant data to determine the feasibility of reconstructing the dose of an SEC petition class. NIOSH contends that it has complied with these standards of performance in determining the feasibility or infeasibility of reconstructing dose for the class under evaluation.

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10.0 References

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42 C.F.R. pt. 82, *Methods for Radiation Dose Reconstruction Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule; May 2, 2002; SRDB Ref ID: 19392

42 C.F.R. pt. 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*; Final Rule; May 28, 2004; SRDB Ref ID: 22001

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ORAUT-TKBS-0037, *Site Profile for Sandia National Laboratories in Albuquerque, New Mexico, and the Tonopah Test Range, Nevada*; Rev 00; Oak Ridge Associated Universities; June 22, 2007; SRDB Ref ID: 32531

Personal Communication, 2009a, *Personal Communication with Employee at Sandia National Laboratory, DOE-Albuquerque*; Telephone interview by ORAU Team; June 10, 2009; SRDB Ref ID: 69631

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Personal Communication, 2009c, *Personal Communication with former Director of Safety and General Manager at Ross Aviation, Hangar 481*; Telephone interview by ORAU Team; June 2, 2009; SRDB Ref ID: 69638

Personal Communication, 2009d, *Personal Communication with the ES&H Division Director, and a Nuclear Engineer at the Office of Secure Transportation*; Telephone interview by ORAU Team; June 17, 2009; SRDB Ref ID: 70643

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Attachment 1: Data Capture Synopsis

Table A1-1: Data Capture Synopsis for Hangar 481, Kirtland AFB			
Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded
<p><u>Primary Site/Company Name:</u> Hangar 481 March 1, 1989 - February 29, 1996; DOE</p> <p><u>Other Site Names:</u> Ross Aviation, Inc. Pierce Air Pierce Enterprises, Inc.</p>	<p>On 06/03/2009 the ORAU Team confirmed with a former Ross Aviation Director of Safety and General Manager that dosimetry records are in the possession of the DOE. Radiological surveys were performed by Sandia National Lab.</p> <p>On 08/25/2009 the ORAU Team confirmed with a former Ross Aviation Director of Safety and Security that Ross Aviation went out of business in 2008.</p>	08/25/2009	0
State Contacted: John Parker, Chief, New Mexico Radiation Control Bureau 505-827-2855	No relevant data identified. The New Mexico Radiation Control Bureau does not hold records for Hangar 481 or Ross Aviation.	10/12/2009	0
DOE Albuquerque Office (DOE AL)	Contract documents from Ross Aviation contracts with the AEC and DOE.	04/16/2009	20
DOE Office of Secure Transportation (OST)	The Transportation Safeguards Division technical basis for eliminating intakes as a credible source of exposure.	07/28/2009	1
Idaho National Engineering Laboratory	1988 DOELAP application and 1988 and 1993 DOELAP accreditations.	06/11/2009	3
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	10/23/2009	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	10/23/2009	0
Internet - DOE OpenNet	No relevant data identified.	10/23/2009	0
Internet - DOE OSTI Energy Citations	No relevant data identified.	10/23/2009	0
Internet - DOE OSTI Information Bridge	No relevant data identified.	10/23/2009	0
Internet - Google	Occupational radiation exposure reports, an audit of aircraft activities, fire protection review, and brief mentions of Ross Aviation as a transporter of weapons components.	10/23/2009	13
Internet - National Academies Press (NAP)	No relevant data identified.	10/23/2009	0
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	10/23/2009	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	No relevant data identified.	10/23/2009	0
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	10/23/2009	0
NARA Atlanta	Results of the DOE Indoor Radon Study. Hangar 481 was included in the study.	08/09/2004	1

Table A1-1: Data Capture Synopsis for Hangar 481, Kirtland AFB			
Data Capture Information	General Description of Documents Captured	Date Completed	Uploaded
National Nuclear Security Administration (NNSA) - Service Center	1997 Ross Aviation Safety Manual.	08/10/2009	1
Nevada Test Site Records Center	Radioactive material shipping records, checklists, and documentation.	07/16/2009	61
ORAU Team	The seventh through eleventh annual reports of contractor radiation exposures, process knowledge interviews with former Ross Aviation, DOE AL, NNSA, and OST personnel.	09/17/2009	10
ORISE	Ross Aviation external dosimetry data from the REM/REIRS Database.	09/30/2009	1
SAIC	Radiation exposure summaries from 1970 and 1972.	09/02/2004	2
Sandia National Laboratory (SNL)	Contamination surveys of aircraft and associated equipment, a computed exposure report, documents regarding annual environmental reports, statement of work for providing external dosimetry services and the associated NEPA determination, DOE appraisals, occupational radiation exposure reports, drawings and photos of Hangar 481, drawings of pads 2 and 5, Ross Aviation organizational chart, and requirements for TLD storage and use.	07/31/2009	80
Unknown	DOE Occupational Exposure Report 1992-1994.	N/A	1
TOTAL			194

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
DOE CEDR http://cedr.lbl.gov/ COMPLETED 10/23/2009	"Ross Aviation" in Title "Pierce Air" in Title "Hangar 481" "Hanger 481"	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 10/23/2009	"Ross Aviation" in any field (simple search mode) "Pierce Air" in any field (simple search mode) "Hangar 481" "Hanger 481"	0	0

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 10/23/2009	"Ross Aviation" in any field "Pierce Air" in any field "Hangar 481" "Hanger 481"	1	0
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 10/23/2009	"Ross Aviation" in any field "Pierce Air" in any field "Hangar 481" "Hanger 481"	52	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 10/23/2009	"Ross Aviation" in any field "Pierce Air" in any field "Hangar 481" "Hanger 481"	52	0
Google http://www.google.com COMPLETED 10/23/2009	"Ross Aviation" "Ross Aviation" americium OR Am241 OR Am-241 OR Am 241 OR 241Am OR 241-Am OR 241 Am "Ross Aviation" ionium OR Th230 OR Th-230 OR Th 230 OR 230Th OR 230-Th OR 230 Th "Ross Aviation" neptunium OR Np237 OR Np-237 OR Np 237 OR 237Np OR 237-Np OR 237 Np OR palm OR palmolive "Ross Aviation" polonium OR Po210 OR Po-210 OR Po 210 OR 210Po OR 210-Po OR 210 Po "Ross Aviation" thorium OR thoria OR Th232 OR Th-232 OR Th 232 OR 232Th OR 232-Th OR 232 Th OR Z metal OR Z-metal OR myrnalloy OR chemical 10-66 OR chemical 1066 OR chemical 10 66 OR chemical 18-12 OR chemical 1812 OR chemical 18 12 OR chemical 10-12 OR chemical 1012 OR chemical 10 12 OR UX1 OR UX2 OR Th-234 OR Th234 OR Th 234 OR 234-Th OR 234Th OR 234 Th "Ross Aviation" tritium OR H3 OR H-3 OR mint OR HTO	47,437	13

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>"Ross Aviation" uranium OR U233 OR U-233 OR U 233 OR 233U OR 233-U OR 233 U OR U234 OR U 234 OR U-234 OR 234U OR 234-U OR 234 U OR U235 OR U 235 OR U-235 OR 235-U OR 235U OR 235 U OR U238 OR U 238 OR U-238 OR 238-U OR 238U OR 238 U OR U308 OR U 308 OR U-308 OR 308-U OR 308U OR 308 U OR black oxide OR brown oxide OR green salt OR orange oxide OR yellow cake OR UO2 OR UO3 OR UF4 OR UF6 OR C-216 OR C-616 OR C-65 OR C-211 OR U3O8 (uranium extraction OR uranium dioxide OR uranium hexafluoride OR uranium tetrafluoride OR uranium trioxide)</p> <p>"Ross Aviation" plutonium OR Pu-238 OR Pu238 OR Pu 238 OR 238Pu OR 238-Pu OR 238 Pu OR Pu-239 OR Pu239 OR Pu 239 OR 239Pu OR 239-Pu OR 239 Pu OR Pu-240 OR Pu240 OR Pu 240 OR 240Pu OR 240-Pu OR 240 Pu OR Pu-241 OR Pu241 OR Pu 241 OR 241Pu OR 241-Pu OR 241 Pu</p> <p>"Ross Aviation" radium OR Ra-226 OR Ra226 OR Ra 226 OR 226-Ra OR 226Ra OR 226 Ra OR Ra-228 OR Ra228 OR Ra 228 OR 228Ra OR 228-Ra OR 228 Ra</p> <p>"Ross Aviation" radon OR Rn-222 OR Rn222 OR Rn 222 OR 222Rn OR 222-Rn OR 222 Rn</p> <p>"Ross Aviation" thoron OR Rn-220 OR Rn220 OR Rn 220 OR 220Rn OR 220-Rn OR 220 Rn</p> <p>Ross Aviation" protactinium OR Pa-234m OR Pa234m OR Pa 234m OR 234mPa OR 234m-Pa OR 234m Pa</p> <p>"Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" or alloy</p> <p>"Ross Aviation" strontium OR Sr-90 OR Sr90 OR Sr 90 OR 90-Sr OR 90Sr OR 90 Sr</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	"Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" postum "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" tuballoy "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "uranyl nitrate hexahydrate" OR UNH "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "K-65" "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "Accident" "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "Sump Cake" "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "air count" "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "air dust" "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "air filter" "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "airborne test" "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" alpha		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "belgian congo ore"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” beta</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” bioassay OR bio-assay</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” breath OR "breathing zone" OR BZ</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "body burden"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” calibration</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "chest count"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” columnation</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” contamination</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” curie</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” denitration OR "denitration pot"</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” derby OR regulus</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "derived air concentration" OR DAC</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” dose</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” dosimeter</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” dosimetric</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” dosimetry</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” electron</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” environment</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "Ether-Water Project"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” exposure OR "exposure investigation" OR "radiation exposure"</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB

Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” external</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "F machine"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” fecal</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "feed material"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” femptocurie</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” film</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” fission</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” fluoroscopy</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "Formerly Utilized Sites Remedial Action Program" OR FUSRAP</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "gamma-ray" OR "gamma ray"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "gas proportional"</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "gaseous diffusion"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” health OR "health instrument" OR "health physics"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "highly enriched uranium" OR HEU</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” hydrofluorination</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "in vitro"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” in vivo</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” incident</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” ingestion</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” inhalation</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” internal</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB

Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” investigation</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” isotope</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” isotopic</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "isotopic enrichment"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "JS Project"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” Landauer</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "liquid scintillation"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” log OR "log sheet" OR "log book"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "low enriched uranium" OR LEU</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "lung count"</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "maximum permissible concentration" OR MPC</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” metallurgy</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” microcurie</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” millicurie</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "mixed fission product" OR MFP</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” monitor OR "air monitoring"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” nanocurie</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "nasal wipe"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” neutron</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "nose wipe"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” nuclear OR "Chicago-Nuclear" OR "nuclear fuels"</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "nuclear track emulsion type A" OR NTA</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "occupational radiation exposure"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” occurrence</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "ore concentrate"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "PC Project"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” permit OR "radiation work permit" OR "safe work permit" OR "special work permit" OR RWP OR SWP</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "phosphate research"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” photon</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” picocurie</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” pitchblende</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "pocket ion chamber" OR PIC</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” problem</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” procedure</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” radeco</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” radiation</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” radioactive</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” radioactivity</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” radiograph</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” radiological</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "Radiological Survey Data Sheet" OR RSDS</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” radionuclide</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” raffinate</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” reactor</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” respiratory</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "retention schedules"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” roentgen</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” sample OR "air sample" OR "dust sample" OR "general area air sample"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” sampling OR "air sampling" OR "dust sampling" OR "general area air sampling"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "solvent extraction"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” source OR "sealed source"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” spectra</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	<p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” spectrograph</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” spectroscopy</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” spectrum</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "standard operating"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” survey OR "building survey" OR routine OR special</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "technical basis"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "thermal diffusion"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "thermoluminescent dosimeter" OR TLD</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "Tiger Team"</p> <p>“Ross Aviation” OR “Ross Aviation, Inc” OR “Ross Aviation Angel Fire” OR “Pierce Air, Inc” OR “Pierce Enterprises, Inc” "tolerance dose"</p>		

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
	"Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" urinalysis "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" urine "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" "whole body count" OR WBC "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" working level OR WL "Ross Aviation" OR "Ross Aviation, Inc" OR "Ross Aviation Angel Fire" OR "Pierce Air, Inc" OR "Pierce Enterprises, Inc" X-ray OR X ray OR Xray "Ross Aviation" "Hangar 481" "Hangar 481" "Hanger 481"		
National Academies Press http://www.nap.edu/ COMPLETED 10/23/2009	"Ross Aviation" "Pierce Air" "Hangar 481" "Hanger 481"	31	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 10/23/2009	"Ross Aviation" "Pierce Air" "Hangar 481" "Hanger 481"	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 10/23/2009	"Ross Aviation" in any field "Pierce Air" in any field "Hangar 481" "Hanger 481"	6	0

Table A1-2: Database Searches for Hangar 481, Kirtland AFB			
Database/Source	Keywords / Phrases	Hits	Uploaded
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 10/23/2009	"Ross Aviation" "Pierce Air" "Hangar 481" "Hanger 481"	0	0

OSTI Documents Requested			
Document Number	Document Title	Requested	Received
No documents ordered.			