SEC Petition Evaluation Report
Petition SEC-00175

Report Rev #: 0 Report Submittal Date: January 11, 2011

Subject Expert(s):	Ed Scalsky, Eugene Potter, Roger Halsey
Site Expert(s):	N/A

Petition Administrative Summary

Petition Under Evaluation

Petition #	Petition Type	Petition Receipt Date	Qualification Date	DOE/AWE Facility Name
SEC-00175	83.13	June 30, 2010	September 7, 2010	Grand Junction Operations Office

Petitioner Class Definition

All – Laborers, labor supervisors, painters, grounds personnel, and Fire Chief who worked at the Grand Junction Operations Office from 1943 through July 31, 2010.

Class Evaluated by NIOSH

All on-site personnel who worked at the Grand Junction Operations Office from 1943 through July 31, 2010.

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

All employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the Grand Junction Operations Office from March 23, 1943 through January 31, 1975, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
N/A			

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
N/A	

ORAU Lead Technical Evaluator: Ed Scalsky

ORAU Peer Review Completed By: Michael Kubiak

Peer Review Completed By:	[Signature on file] *Thomas Tomes*	1/12/2011 *Date*
SEC Petition Evaluation Reviewed By:	[Signature on file] *J. W. Neton*	1/12/2011 *Date*
SEC Evaluation Approved By:	[Signature on file] *Stuart L. Hinnefeld*	1/12/2011 *Date*

This page intentionally left blank

Evaluation Report Summary: SEC-00175, Grand Junction

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-00175 was received on June 30, 2010, and qualified on September 7, 2010. The petitioner requested that NIOSH consider the following class: All - Laborers, labor supervisors, painters, grounds personnel from 1943 to present. Upon consultation with NIOSH, the petitioner changed the requested class definition to: All - Laborers, labor supervisors, painters, grounds personnel, and Fire Chief from 1943 to July 31, 2010.

Class Evaluated by NIOSH

Based on its preliminary research, NIOSH found insufficient information to evaluate each category of workers in the requested class. Therefore, NIOSH modified the petitioner-requested class and evaluated the following class: All on-site personnel who worked at the Grand Junction Operations Office from 1943 through July 31, 2010.

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

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class includes all employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the Grand Junction Operations Office from March 23, 1943 through January 31, 1975, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

The March 23, 1943 proposed starting date is based on the date that the Army representative arrived at Grand Junction to establish the Colorado Area Engineer Office.

The class under evaluation was divided (see Section 3.0 below) because, for the combined operational periods of the refinery, the Small Pilot Plant, the Large Pilot Plant, and the Sampling Plant (1943-1975), there is a lack of radon data for reconstructing internal dose. There are sufficient data to reconstruct external dose for the period from January 1, 1960 through July 31, 2010. There are also sufficient data to reconstruct internal dose for the period from February 1, 1975 through July 31, 2010.

Feasibility of Dose Reconstruction

NIOSH finds it is not feasible to estimate internal exposures with sufficient accuracy for all workers at the site from March 23, 1943 through January 31, 1975. There is insufficient information to estimate radon exposures from plant operations during this period; however, partial internal dose reconstructions can be performed for workers who were monitored for uranium intakes during this period. There are insufficient data to estimate all external doses prior to 1960.

With the exception of this 1943 through January 31, 1975 class, 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; or (2) estimate radiation doses more precisely than an estimate of maximum dose. Information available to NIOSH 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 from February 1, 1975 through July 31, 2010.

The NIOSH dose reconstruction feasibility findings are based on the following:

- NIOSH finds that it is likely feasible to reconstruct occupational medical dose for the Grand Junction Operations Office workers with sufficient accuracy.

- Principal sources of internal radiation for members of the evaluated class included exposures to natural uranium and its decay products. The modes of exposure were inhalation and ingestion during the processing of ores or ore concentrates or during the subsequent re-suspension of these materials.

- Based on the lack of radon data for Grand Junction workers during the refining, pilot plant, and sampling operations conducted during the period from March 23, 1943 through January 31, 1975, internal dose reconstruction from all potential sources of exposure is not feasible. By February 1, 1975, sampling operations had ended, and the site mission had changed to mainly off-site work. The large quantities of uranium concentrate were removed from the site. Although geological samples were still analyzed on site, the quantities were much smaller than during the uranium procurement program. On site, the workers were mainly exposed to residual contamination until decontamination and decommissioning (D&D) operations began. NIOSH has identified sufficient information and data related to residual contamination in the buildings and air samples during the D&D operations to support bounding internal dose estimates for the February 1, 1975 through July 31, 2010 period using available methodologies.

- Principal sources of external radiation for members of the evaluated class included exposures to uranium progeny, primarily radium-226 for penetrating photon exposures and protactinium-234m for shallow beta exposures.

- Limited external dosimetry data were found for 1952-1953 and 1957-1959. Annual site exposure reports are available starting in 1960.

- External penetrating photon exposure was monitored with film badges and, in later years, with TLD badges. Shallow beta exposure results exist for film badges. These data are available to NIOSH to calculate a ratio against the photon exposure for later years.

- NIOSH concludes that there are sufficient data to estimate bounding levels of external exposure from January 1, 1960 through July 31, 2010. Limited film badge data are available prior to 1960; no film badge or radiation measurements are available for the refinery and pilot plants during their operational periods. Site exposure reports starting in 1960 are available to NIOSH to provide a conservative upper bound for external exposure. For the years 1985 through 2009, many individual annual exposures are available and may be used to bound doses for individuals without individual dosimetry. General information, supported by site-wide surveys performed before and after remediation activities, documents near-background exposure levels. For those years where data are absent, conservative estimates can be developed based on consistent site activity.

- Pursuant to 42 C.F.R. § 83.13(c)(1), NIOSH determined that there is insufficient information for the period from March 23, 1943 through January 31, 1975 to either: (1) 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 (2) estimate the radiation doses of members of the class more precisely than a maximum dose estimate.

- Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Grand Junction Operations Office during the period from March 23, 1943 through January 31, 1975, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Health Endangerment Determination

Per EEOICPA and 42 C.F.R. § 83.13(c)(3), a health endangerment determination is required because NIOSH has determined that it does not have sufficient information to estimate dose for the members of the proposed class from March 23, 1943 through January 31, 1975.

NIOSH did not identify any evidence supplied by the petitioners or from other resources that would establish that the proposed class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, evidence indicates that some workers in the proposed class may have accumulated substantial chronic exposures through episodic intakes of radionuclides, combined with external exposures to gamma, beta, and neutron radiation. Consequently, NIOSH has determined that health was endangered for those workers covered by this evaluation who were employed for at least 250 aggregated work days either solely under their employment at Grand Junction Operations Office or in combination with work days within the parameters established for other SEC classes.

For the period from February 1, 1975 through July 31, 2010, 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.

Table of Contents

Figures

Tables

This page intentionally left blank

SEC Petition Evaluation Report for SEC-00175

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for all on-site personnel who worked at the Grand Junction Operations Office from March 23, 1943 through July 31, 2010. 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 Division of Compensation Analysis and Support's (DCAS) *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, OCAS-PR-004.[1]

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.[2]

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.*

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

[1] DCAS was formerly known as the Office of Compensation Analysis and Support (OCAS).
[2] 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.

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.

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 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.[3]

3.0 SEC-00175 Grand Junction Operations Office Class Definitions

The following subsections address the evolution of the class definition for SEC-00175, Grand Junction Operations Office (GJOO). 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 the 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-00175 was received on June 30, 2010, and qualified on September 7, 2010. The petitioner requested that NIOSH consider the following class: *All – Laborers, labor supervisors, painters, grounds personnel, and Fire Chief who worked at the Grand Junction Operations Office from 1943 through July 31, 2010.*

The petitioner provided information and affidavit statements in support of the petitioner's belief that accurate dose reconstruction over time is impossible for the Grand Junction workers in question. NIOSH deemed the following information and affidavit statements sufficient to qualify SEC-00175 for evaluation:

> I have been working on and researching information related to the claim I filed on behalf of my *[relationship and name redacted]*, since January 2002. In talking to numerous people who were employed at the Grand Junction operations office *[sic]*, working at the facility myself in *[date redacted]*, and looking for records, I found that employees at this facility were never monitored, including laborers (includes my *[relationship redacted]* who was a

[3] 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.

> *[job titles redacted]*) painters and grounds persons. The dose reconstruction sent to me by NIOSH indicates that my *[relationship redacted]* was never monitored during his employment *[dates redacted]* at the Grand Junction operations office *[sic]*.

Based on its Grand Junction research and data capture efforts, NIOSH determined that it has access to bioassay, air monitoring, soil sample, and film badge results for Grand Junction workers during the time period under evaluation. However, NIOSH also determined that film badge and bioassay data records are not complete for all time periods or for all radionuclides. NIOSH concluded that there is sufficient documentation to support, for at least part of the requested time period, the petition basis that internal and external radiation exposures and radiation doses were not adequately monitored at Grand Junction, either through personal monitoring or area monitoring. 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

NIOSH modified the petitioner-requested class because the petitioner later requested the inclusion of Fire Chief in the class definition. The petitioner also replaced “to the present” with July 31, 2010 for the class end date. Based on its preliminary research, NIOSH concluded that specific information was lacking for reconstructing all exposures to the personnel categories requested by the petitioner. Therefore, NIOSH evaluated exposure to all on-site personnel who worked at the Grand Junction Operations Office from 1943 through July 31, 2010.

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

Based on its research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the Grand Junction Operations Office from March 23, 1943 through January 31, 1975, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

4.0 Data Sources Reviewed by NIOSH to Evaluate the Class

As is standard practice, NIOSH completed an extensive database and Internet search for information regarding the Grand Junction Operations Office. 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 2

contains a summary of Grand Junction Operations Office 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 TBD for insights into Grand Junction operations or related topics/operations at other sites:

- *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium*, Battelle-TBD-6001; Rev. F0; December 13, 2006; SRDB Ref ID: 30673

4.2 ORAU Technical Information Bulletins (OTIBs)

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. NIOSH reviewed the following OTIBs as part of its evaluation:

- *OTIB: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, ORAUT-OTIB-0006, Rev. 03 PC-1; December 21, 2005; SRDB Ref ID: 20220

- *OTIB: Internal Dose Overestimates for Facilities with Air Sampling Programs*, ORAUT-OTIB-0018, Rev. 01; August 9, 2005; SRDB Ref ID: 19436

4.3 Facility Employees and Experts

To obtain additional information, NIOSH interviewed eight former Grand Junction Operations Office employees and one former GJOO contractor. Interviews were conducted by telephone by members of the ORAU Team.

- Personal Communication, 2010a, *Personal Communication with a Former Section Head for ORNL Office*; Telephone Interview by ORAU Team; October 12, 2010; SRDB Ref ID: 90652
- Personal Communication, 2010b, *Personal Communication with a Former Physicist*; Telephone Interview by ORAU Team; October 19, 2010; SRDB Ref ID: 90653
- Personal Communication, 2010c, *Personal Communication with a Former Senior HP Technologist*; Telephone Interview by ORAU Team; October 14, 2010; SRDB Ref ID: 90654
- Personal Communication, 2010d, *Personal Communication with a Former Systems Analyst and Programmer*; Telephone Interview by ORAU Team; October 19, 2010; SRDB Ref ID: 90655
- Personal Communication, 2010e, *Personal Communication with a Former Senior Health Physicist in Charge of Internal and External Dosimetry*; Telephone Interview by ORAU Team; August 25, 2010; SRDB Ref ID: 90656
- Personal Communication, 2010f, *Personal Communication with a Former Health Physicist*; Telephone Interview by ORAU Team; August 24, 2010; SRDB Ref ID: 90651
- Personal Communication, 2010g, *Personal Communication with a Former Field Assistant-Geologist*; Telephone Interview by ORAU Team; December 8, 2009: SRDB Ref ID: 82163; follow-up interview on December 2, 2010: SRDB Ref ID: 90997
- Personal Communication, 2010h, *Personal Communication with a Former Analytical Chemistry Manager*; Telephone Interview by ORAU Team; December 2, 2010; SRDB Ref ID: 90999
- Personal Communication, 2010i, *Personal Communication with a Sampling Plant Manager*; Telephone Interview by ORAU Team; December 6, 2010; SRDB Ref ID: 90998

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. NIOSH reviewed each claim to determine whether internal and/or external personal monitoring records could be obtained for the employee. Table 4-1 summarizes the results of this review. (NOCTS data available as of December 22, 2010)

Table 4-1: No. of Grand Junction Claims Submitted Under the Dose Reconstruction Rule

Description	Totals
Total number of claims submitted for dose reconstruction	58
Total number of claims submitted for energy employees who meet the definition criteria for the class under evaluation (1943 through July 31, 2010).	58
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).	48
Number of claims for which internal dosimetry records were obtained for the identified years in the evaluated class definition	8
Number of claims for which external dosimetry records were obtained for the identified years in the evaluated class definition	22

4.5 NIOSH Site Research Database

NIOSH also examined its Site Research Database (SRDB) to locate documents supporting the assessment of the evaluated class. Six hundred and three documents in this database were identified as pertaining to Grand Junction. These documents were evaluated for their relevance to this petition. The documents include historical background on data types, monitoring, dust sampling, air monitoring, urinalysis data, fecal analysis, the radiological control program, medical monitoring, process materials, and process descriptions.

4.6 Documentation and/or Affidavits Provided by Petitioners

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

- *Affidavit from Survivor*; June 25, 2010; OSA Ref ID: 112121 (Affidavit, 2010)

5.0 Radiological Operations Relevant to the Class Evaluated by NIOSH

ATTRIBUTION: Sections 5.0 through 5.2.1.2 were completed by Ed Scalsky, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The following subsections summarize both radiological operations at the Grand Junction Operations Office from 1943 through July 31, 2010 and the information available to NIOSH to characterize particular processes and radioactive source materials. The operations are divided into two periods: (1) March 23, 1943 through January 31, 1975; and (2) February 1, 1975 through July 31, 2010. The first period can be classified as operational while the second period is more resource evaluation and remediation. From available sources NIOSH has gathered process and source descriptions, information regarding the identity and quantities of the radionuclides 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 Grand Junction Operations Office Plant and Process Descriptions

On March 23, 1943, the U.S. Army Corps of Engineers arrived in Grand Junction, Colorado to acquire land, build a uranium refinery, and construct uranium recovery plants in Uravan and Durango, Colorado (Chenoweth, 1997). Land was initially leased. Then on August 14, 1943, the 55.7 acres of leased land were purchased. This tract of land was to become the U.S. Department of Energy's Grand Junction Projects Office (GJPO). The site is on the Gunnison River, two miles south of the City of Grand Junction, and one-half mile off U. S. Highway 50. Within ten months, the recovery plants at Uravan and Durango were constructed and engaged in reprocessing vanadium mill tailings to recover uranium. These mill products were shipped to the refinery at GJPO, which refined the mill product into uranium oxide or "yellow cake." The GJPO became the Grand Junction Operations Office (GJOO) on November 30, 1952; the site will be referred to as the GJOO hereafter in this document (DOE, 1993; Chenoweth, 1997).

5.1.1 Grand Junction General Operations

Since the beginning of GJOO operations, there have been several prime contractors who managed the site and provided services to the uranium mining and milling facilities throughout the western United States. In addition, there were other contractors on the site that provided specific functions (e.g., sampling and analysis). Table 5-1 presents a chronology of the prime and secondary contractors that performed functions at the GJOO.

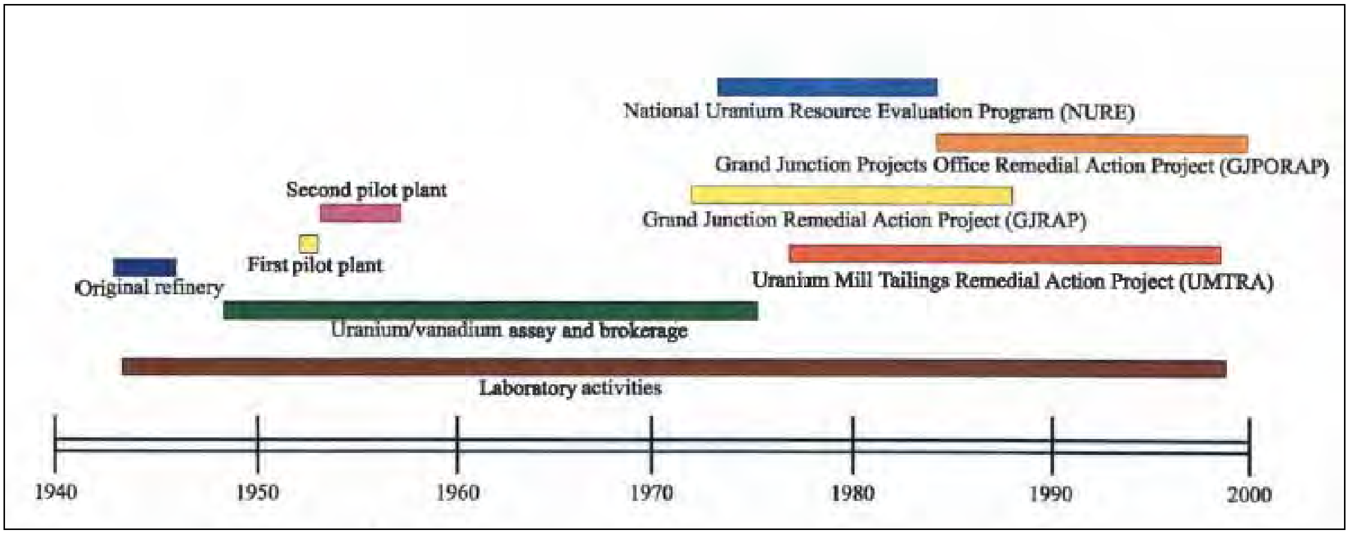
Table 5-1: Grand Junction Contractors, Dates, and Functions
(This table spans two pages)

Contractor	Dates	Functions
U.S. Vanadium Corporation	August 14, 1943 – December 31,1946	Constructed and operated the uranium ore refinery (mill) for the U.S. Army's Manhattan Engineer District (MED).
U.S. Army Manhattan Engineer District	1947	Worked on dismantling outlying mill buildings; disposed of surplus equipment and materials
Ledoux and Company	1948	Performed the initial sampling of uranium concentrate (yellowcake). Analyses performed by the National Bureau of Standards
Walker-Lybarger Construction Company Prime Contractor	1948 - December 31, 1956	GJOO Prime contractor; constructed buildings for the AEC expanding missions; responsible for maintenance and operation of facility; provided support to the AEC exploration, drilling, and geologic studies.
American Smelting and Refining Company	1948-1955	Set up uranium ore buying stations in the western United States; operated the analytical chemistry laboratory at GJOO; had the responsibility for receiving, sampling, analyzing, storing, and shipping uranium ore concentrates. In 1951 a new sampling plant was built at GJOO.
American Cyanamid Company	May, 1953 – June 1954	Operated the first small pilot plant at GJOO (1953); did research to develop the resin-in-pulp uranium extraction process
National Lead Company, Inc.	July, 1954 - June, 1958	Operated the large pilot plant, built in 1954, that consisted of 2 large mill buildings, a crushing and sampling plant, office and laboratory warehouse, maintenance shop, ore stockpiling area, and tailing ponds
Swinerton and Walberg Prime Contractor	January 1, 1957 – April 30, 1959	Assumed the duties of prime contractor
Lucius Pitkin, Inc. Prime Contractor	1956-1965 May 1, 1959 – July 10, 1975	Operated the ore buying stations and the analytical chemistry laboratory and the concentrate sampling plant in 1956. Named prime contractor May 1, 1959; supported the uranium procurement program until it was terminated in 1970; provided technical and engineering support to the National Uranium Resource Evaluation (NURE) program in 1974.
Bendix Field Engineering Corporation Prime Contractor	July 11, 1975 – September 30, 1986	Assumed role of prime contractor on July 11, 1975; prime responsibility was to manage the expanding NURE program; when NURE program was completed in 1984, Bendix administered the Grand Junction Remedial Action Program that began in 1972 (remediated soils in the Grand Junction area)

Table 5-1: Grand Junction Contractors, Dates, and Functions
(This table spans two pages)

Contractor	Dates	Functions
UNC Technical Services, Inc UNC Geotech, Inc Chem Nuclear Geotech, Inc. Rust Geotech, Inc. Prime Contractor	October 1, 1986 – September 30, 1987 October 1, 1987 – August 14, 1990 August 15, 1990 – November 2, 1993 November 3, 1993 – September 4, 1996	UNC Technical Services, Inc., became RUST Geotech, Inc., through a series of corporate mergers and acquisitions. Did remediation work in public areas; managed the Long-Term Surveillance and Maintenance (LTSM) program that was assigned to GJOO in 1989.
MACTEC Environmental Restoration Services	September 5, 1996 – July 21, 2002	Continued the remediation projects; managed cleanup of uranium mill tailings and mill tailings contaminated with material from the former AEC-operated processing mills at Monticello, Utah, etc.
Wastren, Inc. Prime Contractor	September 5, 1996 – July 21, 2002	Wastren, Inc., assumed responsibility to operate the GJOO site in September 1996. Responsibilities included facility management, analytical chemistry laboratory, occupational medical services, technical library, records management, automated data processing systems, publication services, communication systems, security, and remediation of the GJOO site.
Riverview Technology Corporation	September 30, 2001 - Present	On September 30, 2001, DOE transferred ownership of the Grand Junction property to the Riverview Technology Corporation. DOE, however, continues to lease portions of the site and provides some on-going remediation services as well as long-term surveillance and maintenance at the site. (DOE Facility List)
S.M. Stoller Corporation Prime Contractor	July 22, 2002 - Present	S.M. Stoller Corporation assumed the activities of the two previous contractors, MACTEC-ERS and Wastren, Inc., in July 2002. Currently, the GJOO has stewardship responsibility for the Grand Junction (also known as Cheney) Disposal Cell, southeast of Grand Junction, and 28 other remediated sites or disposal cells. The U.S. Department of Energy assigned management of the former uranium ore-processing mill site and the tailings pile at Moab, Utah, to the GJOO on October 1, 2001.

Source: Contractor History, 1943-2002



Source: Rust Geotech, 1996b

Figure 5-1: Timeline of Major GJOO Projects and Operations

Since the Grand Junction site's inception in 1943, the nature of site operations has varied considerably. Figure 5-1 shows a timeline of major projects and operations conducted at the GJOO. The operations can be divided into two major time periods (Note: Some operations overlapped the two time periods defined below):

- March 23, 1943 through January 31, 1975: This period covers early operations, including: refinery operation (1943-1946), small pilot plant (May 15, 1953 through December 24, 1954), the large pilot plant (January 9, 1955 through May 29, 1958) (McGinley, 2000), the sampling plants (1948), a new sampling plant (1951), the analytical chemistry plant (1956), and other related radiological operations that could expose workers to direct radiation and to uranium dust and progeny that posed an inhalation hazard. One of the principal functions during this time frame was the receipt, sampling, and analysis of uranium and vanadium concentrates from the various ore-processing operations in the western United States. Shipments of processed uranium were also made from the GJOO, the last shipment departing in January, 1975 (Albrethsen, 1986). The GJOO also administered programs for the acquisition and production of uranium concentrates and for the acquisition of raw source material throughout the U.S. west of the Mississippi River (O'Rear, 1969). Many of these programs were primarily administrative in nature and may not have been a major source of exposure to GJOO personnel.

- February 1, 1975 through July 31, 2010: During this period, the GJOO was assigned the National Uranium Resource Evaluation (NURE) program (1974-1984) (DOE, 1993). This period also includes the Grand Junction Remedial Action Project (GJRAP) (1972-1988), the Uranium Mill Tailings Action Project (UMTRA) (1978 to late 1990s), the Grand Junction Project Office Remedial Action Project (GJPORAP) (mid-1980s to about 2000), and the Long-Term Surveillance and Maintenance (LTSM) program (1989). The GJOO assisted other DOE facilities and government agencies in the areas of geophysics, geology, hydrology, hazardous and radioactive waste management, and environmental clean-up. In 1993, there were more than 800 employees engaged in these activities (DOE, 1993).

Operational Period (1943 through January 31, 1975)

Ore and Ore Concentrates

The material received and processed at Grand Junction was either uranium ores or ore concentrates, with ore concentrates being the primary material processed though the Sampling Plants. Grand Junction processed ores in the Pilot Plants from 1953 through 1958 to develop the methods being used at other mills. Grand Junction received large quantities of ore concentrates produced at other sites. The ore's uranium content was typically between 0.1 and 0.2 % U (Uranium, 2004). During mill processing of uranium ores, the amount of sludge (tailings) produced is nearly the same as that of the ore milled. Most uranium is mined in open pit or underground mines. In the early years (up until 1960), uranium was mined in open pit mines from ore deposits located near the surface.

A ton of ore typically produces one ton of tailings and four pounds of yellowcake as well as liquid waste. The mills processed crushed ore by either acid leach or alkaline leach. The uranium was precipitated out of the leach solution as yellowcake, dried and packaged, and sent to other facilities for additional refining. The tailings left from the leached ore contained all the material in the ore not dissolved during the leaching process. In addition, the process of precipitating the uranium out of solution in the mill removed additional quantities of radionculides (impurities). The most significant non-uranium radionuclides present in the yellowcake were Th-230 and Ra-226. The concentrations of these radionuclides in the yellowcake varied based on the leaching agent (acid or alkaline) and the precipitation method (ion exchange or solvent extraction). For the alkaline leach process, 2% of the Ra-226 (by activity) and practically none of the Th-230 ended up in the yellowcake; however, alkaline leach was less common. For acid-leached yellowcake, the percentages varied by extraction method. As much as 0.2% of the Ra-226 and 5% of the Th-230 ended up in the yellowcake (Sears, 1976). Over 90% of the uranium in ores was typically recovered in the yellowcake (Uranium, 2004).

The material received and processed at Grand Junction from 1943 through 1945 was similar to the concentrates discussed above. That material is discussed in the following subsection.

Refinery Operations

DOE-GJO facility lands were acquired by the U.S. War Department in 1943 for the Manhattan Engineer District. A refinery was constructed by the MED in 1943 to further process the green sludge produced at Durango and the two Uravan plants. It used a process developed by the U.S. Vanadium Corp (USV) and operated for 26 months from August, 1943 through October 1945.

The mills at Durango and Uravan processed vanadium mill tailings. The tailings processed at Uravan and Durango contained a reported 0.25% uranium and residual vanadium. The vanadium tailings were leached in sulfuric acid to recover the uranium and the vanadium, which were then precipitated out of solution along with some impurities. The precipitate was dried, put into barrels, and shipped to Grand Junction for further processing (Dust Samples, 1945). The material shipped to Grand Junction was called "green sludge."

Green sludge contained 6% to 12% U_3O_8 and 9% to 13% V_2O_5, and 25% to 35% water. It was delivered in 30-gallon steel drums weighing about 700 pounds each. The capacity of the refinery was 20 dry tons of green sludge per day, but it averaged 12.9 tons per day. Ten thousand tons of green sludge were processed at the refinery. The refinery had an estimated 40 employees and three sludge transporters (McGinley, 2000).

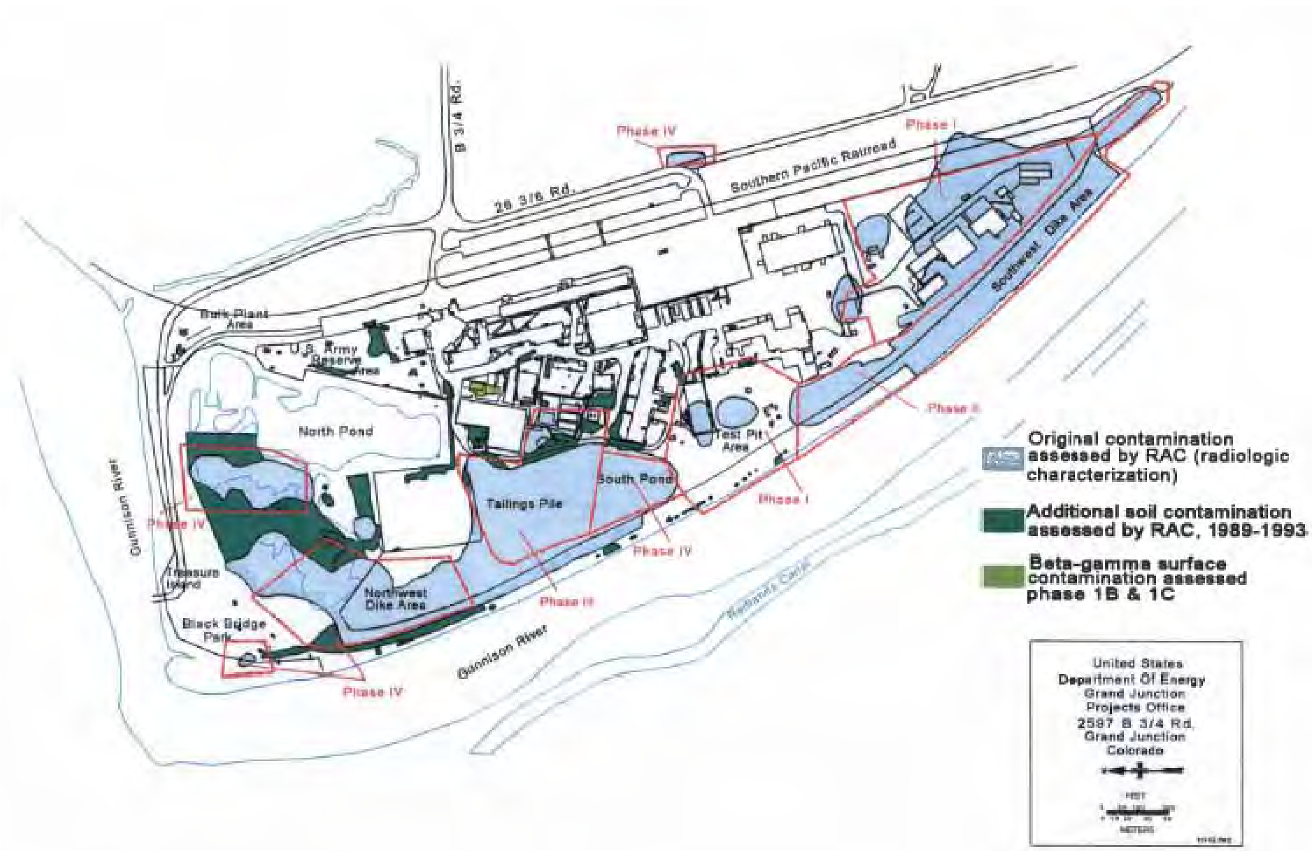
The purpose of the of the Grand Junction refinery mill was to separate the uranium from the vanadium.

The refinery process consisted of roasting the green sludge with sodium carbonate to about 800^o C, quenching with water, and then filtering to remove the soluble sodium vanadate. The residue contained the water insoluble sodium diurinate. The vanadium filtrate went to precipitation with sulfuric acid, first to remove alumina, phosphorus, and arsenic, and then with more acid to form vanadium "red cake." It was washed, dried and fused to make a V_20_5 product. The uranium filter cake was dried to about 4% moisture, barreled, stored, or shipped east for further processing (McGinley, 2000; Dust Samples, 1945).

The resulting refinery products included dried uranium sludge (sodium diuranate) containing about 15% U_30_8 and one percent V_20_5. Fused vanadium averaged 89% V_20_5 and 0.08% U_30_8. Alumina cake was saved for further future treatment because it contained 0.4% to 0.9% U_30_8 and 5% to 10% V_20_5 (McGinley, 2000). Approximately 1,170 tons of uranium oxide and a similar amount of vanadium concentrate were produced.

Pilot Plant Operations

Two pilot-scale uranium ore mills were operated from 1953 to 1958, processing 30,000 tons of ore. The milling processes consisted of the acid leach – resin in pulp (RIP) process, alkaline – RIP process, and other acid-leach processes. The end product of the mills was yellowcake (U_3O_8), about 108,000 pounds of which were produced, all for the AEC. The ore was transported to the pilot plants by truck, except for 2,000 tons of lignite, which was transported by railroad, crushed by a local gravel company plant, and then trucked to the pilot plants (the uranium content of lignite is very low, on average less than 0.005% U_30_8). Lucius Pitkin also used the pilot plant to crush and sample the “richest load of uranium ever mined in the Colorado Plateau” that was delivered to the AEC compound on April 9, 1958. This was 22.25 tons of 22.9 % U_3O_8 ore from the Lisbon Uranium Corporation’s Big Indian Wash mines near Moab, Utah. The pilot plants had 17-18 employees in 1953 and up to 107 employees in 1957 (McGinley, 2000). The pilot plant operations were the primary source of contaminated materials at the DOE-GJO facility. Approximately 247,000 cubic yards of uranium pilot plant products were buried on site. Other potential sources of contamination associated with pilot plant operations included laboratory and vehicle maintenance wastes and by-products, and activities related to sampling and stockpiling uranium concentrates (including yellowcake). Approximately 22 acres of open land and 19 buildings were contaminated (WASTREN, 1997). Figure 5-2 shows the areas originally assessed as being contaminated (Forbes, 1997).



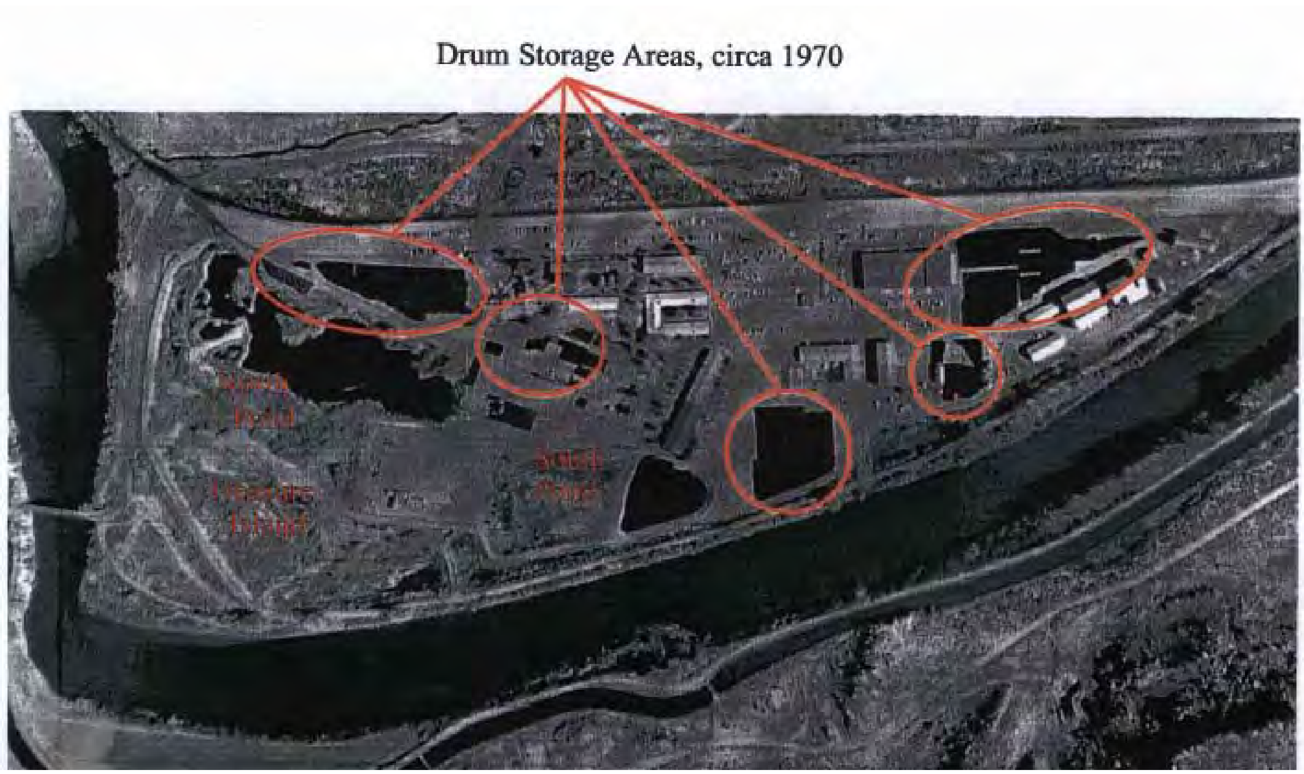
Source: Forbes, 1997

Figure 5-2: Areas Assessed as Contaminated and Original Phase Designations

In 1953, the pilot-plant program was initiated with the construction of a resin-in-pulp milling processing plant. A subsequent pilot-plant program was dedicated to amenability testing of uranium ores and to developing and testing uranium milling processes (DOE, unspecified). During its five years of operation, the pilot uranium mill ran 24 hrs/day, 7 days/week (DOE, 1993).

Concentrate Receiving Depot (Sampling and Analyzing)

From 1948 to 1971, a total of approximately 347 million pounds of uranium oxide and approximately 29 million pounds of vanadium oxide were received and stockpiled in steel drums at the facility. Figure 5-3 shows the drum storage locations circa 1970. As a result of past uranium-related activities, surface and near-surface soils, buildings (wood, concrete/brick, and metal), and related equipment were contaminated with uranium mill tailings and ore (DOE, unspecified).



Source: Forbes, 1997

Figure 5-3: Aerial View of Facility Showing Drum Storage Areas, circa 1970

As noted in Table 5-1, American Smelting and Refining Company and Lucius Pitkin, Inc., performed sampling and analysis work at GJOO. During the period from 1948-1966, the AEC purchased 145,379 tons of U_3O_8. With the exception of 1960-1965, when portions of the sampling and analysis were done at Weldon Spring, all of the sampling and analysis was done at GJOO. As noted in a later section, GJOO also sampled several thousand tons of U_3O_8 shipped by private industry between 1966 and 1968.

Table 5-2 shows the quantities of U_3O_8 purchased by the AEC from 1948-1966.

Table 5-2: AEC Domestic Uranium Concentrate Purchases, 1948-1966			
Fiscal Year	**Tons U_3O_8**	**Fiscal Year**	**Tons U_3O_8**
1948	116	1958	10,250
1949	115	1959	15,160
1950	323	1960	16,403
1951	659	1961	17,671
1952	822	1962	17,248
1953	984	1963	15,760
1954	1453	1964	12,283
1955	2142	1965	11,819
1956	4204	1966	10,109
1957	7578		
Total Purchases: 145,099			

Source: O'Rear, 1966, pdf p. 70

The AEC operated a uranium-concentrate sampling plant and assay laboratory on the site until 1974. January 1, 1967 marked the beginning of the government's final four years (under the then-current program) of purchasing uranium concentrates from privately-owned and operated uranium processing mills. By the terms of the AEC's program announcement of November 17, 1962, existing purchase contracts would extend through December 31, 1970 (O'Rear, 1969). This 1963-1970 program, known generally as the "stretch-out" program, provided for a voluntary deferral of delivery until 1967 and 1968 of a portion of the U_30_8 previously scheduled for delivery prior to 1967. In return, the AEC offered to purchase in 1969 and 1970 additional U_30_8 equal to the quantity deferred and delivered in 1967 and 1968. The additional purchases totaled approximately 32,500 tons, or about 8,000 tons per year from 1967 through 1970.

The uranium concentrates produced by processing mills operating in 1967-1970 under the stretch-out program were delivered in steel drums to the AEC at Grand Junction. They were received, weighed, sampled, and analyzed as a basis for payment to the mills (O'Rear, 1969). Three large buildings at the AEC compound housed the sampling and analytical facilities that were operated for the AEC by the contractor Lucius Pitkin, Inc. About 35 people were employed in this activity (O'Rear, 1969).

Because of the value of uranium concentrates, the sampling and analyzing were performed in a careful manner. The quality of the concentrate delivered to the AEC was governed by a set of specifications included in all milling contracts. They included a minimum of 75% U_30_8 and maximum limitations for some 15 impurities such as vanadium, molybdenum, chlorides, and sulfate. Most of the drums of concentrate arrived via commercial truck, but some came by rail on a spur line that runs into the compound (O'Rear, 1969).

The drums were weighed and then the tops removed; the drums averaged about 700 pounds each. Two sampling methods were employed. One was the closed auger method in which an electrically-operated drill or auger was run down into the open drum of concentrate in predetermined positions, bringing up samples for subsequent preparation and assaying. In the falling stream method used for sampling some concentrates, the drum was hoisted to the top of the sampling unit and the contents were allowed to flow down through sample cutters which took representative samples. At Grand Junction, one building housed the auger method of sampling and another building the falling stream sampling method (O'Rear, 1969).

Although every drum received was opened and sampled, the assays were made on drum lots rather than on each drum. For instance, if a lot of 20 drums was received from one mill, a sample from each drum was blended into one large sample that represented the entire lot (O'Rear, 1969).

After the samples were taken and blended, the lot sample was "prepared" for analysis. This preparation was done in the sampling plant and involved grinding the sample to a fine powder and placing the sample in drying ovens to remove all moisture. Afterward, the sample went to the analytical laboratory.

Analytical Laboratory

The Analytical Laboratory, also operated for the AEC by Lucius Pitkin, Inc., was housed in a large modern building. The operation was conducted by a Chief Chemist and a staff of Analytical Chemists.

In the early days of the uranium procurement program, only chemical assays were made of all the concentrate samples prepared in the sampling plants. In later years, the laboratory acquired an X-ray spectrometer and an emission spectrograph to supplement the chemical assay work. Some samples were assayed chemically and some with these instruments in order to assure a complete and accurate analysis. This laboratory also analyzed uranium ore samples and other special samples, as requested by the AEC (O'Rear, 1969). The laboratory continued to operate during the remediation period.

Custom Sampling

In 1966, several processing mills contracted to deliver uranium concentrates to private domestic concerns and to friendly foreign governments and companies (O'Rear, 1969). To facilitate these shipments, the Grand Junction Office began a new service for the uranium industry: that of offering, through its contractor, custom weighing and sampling of uranium concentrates produced and sold by privately-owned processing mills.

Between late 1966 and June 1968, the Grand Junction Office sampled several thousand tons of U_30_8 shipped in by private industry. The producer of the concentrates was provided weights and samples and paid the AEC contractor, Lucius Pitkin, Inc., for this service on the basis of an established schedule of charges.

The Grand Junction Office discontinued this service after June 1968 when Allied Chemical Corp., began operating an independent UF_6 conversion facility at Metropolis, Illinois, equipped with a sampling plant to provide this service for industry.

Raw Materials Program

In 1947, the site became the Colorado Raw Materials Office for the AEC and administered the U.S. defense-related uranium exploration and purchasing programs through 1970.

In July 1969, when the GJOO had responsibility for administering the raw materials program in the western United States, GJOO had a staff of 137 AEC personnel and 132 Lucius Pitkin personnel (O'Rear, 1969).

Resource Evaluation and Remediation Period (1974 - July 31, 2010)

From 1974 through 1984, the site managed the National Uranium Resource Evaluation (NURE) program. The NURE program was a massive data-gathering and research effort that resulted in a comprehensive assessment of the nation's uranium resources. At the height of the NURE program, 94 Federal employees and 558 contract employees performed primarily geosciences work. This work included taking 750,000 hydro-chemical samples throughout the nation, drilling about 435,000 feet of new boreholes, gathering data from 3,000,000 feet of boreholes drilled for purposes other than uranium, and flying about 1,000,000 flight-line miles to map the distribution of the natural radioactive elements uranium, thorium, and potassium (DOE, 1993).

Today, the primary mission of the Grand Junction Projects Office site is to support Environmental Management in completing environmental restoration and waste management activities, particularly in the areas of site characterization, project integration and coordination, remedial design, remedial action, decommissioning, independent verification, long-term surveillance and maintenance, technology development and demonstration, geosciences, and analytical chemistry.

In 1972, the GJOO assisted the Colorado Department of Health in managing the Grand Junction Remedial Action Project (GJRAP), the first remedial action program in Mesa County. The program cleaned up 594 homes or business structures that were contaminated with mill tailings from the Climax Uranium Company processing mill, which operated in Grand Junction from 1951 to 1970. The purpose was to reduce or eliminate the potential health hazard from long-term exposure to radon emitted from the radium left in the mill tailings after the uranium was extracted (DOE, 1993). This action is included for historical completeness; however, exposures to these off-site remedial action personnel or the public are not germane to this current evaluation.

The Department of Health began the Grand Junction Projects Office Remedial Action Project (GJPORAP) for the site in FY 1988. The approach has been to remediate the open spaces of the GJPO facility from south to north. Since 1988, 414,000 tons of radioactive-contaminated materials at the GJPO facility have been excavated and transported to the Cheney disposal cell. Following removal of tailings and other contaminated material, affected areas of the GJPO facility have been re-contoured, reconstructed, and re-vegetated, as appropriate.

As part of the remedial action projects, DOE restored some of the contaminated buildings at the Grand Junction Projects Office for unrestricted use. These activities began in 1989. Following completion of the decommissioning process, 17 facility buildings were demolished or decontaminated and restored for unrestricted use (resulting in an estimated 4,700 cubic yards of contaminated material). Table 5-3 lists the buildings on the GJOO site, their radiological status before remediation, the dates they were built and demolished (if applicable), and the operations conducted in them. Not all information has been identified for some of the buildings.

In 1997, there were approximately 30 buildings on site. The site also included two bodies of water, the North Pond (13,500 m^2) and the South Pond (15,200 m^2). The area west of the North Pond was a former landfill which, since remediation, has become a wetlands area (Forbes, 1997).

Most of the contaminated materials at the GJOO are from pilot-plant milling research operations, which involved testing and processing uranium ores at the site. The materials consist of uranium mill tailings, contaminated soil, ore-process-related slimes and equipment, heavy metals, and PCBs. In addition, laboratory debris and trash were disposed of onsite (Rust Geotech, 1996b).

The analytical laboratory continued to operate during the remediation period. The lab performed analyses of tailings for Grand Junction as well as analyses for other sites (e.g., LANL, INEEL). Analyses were performed for radium, thorium, uranium, heavy metals, and organics. The lab analyzed thousands of soil, air, and urine samples per year. However, no urine samples were analyzed for Grand Junction Operations Office workers. Only low-level radioactive work was done during this period. The lab had a guideline that they would not accept samples that were above about 2,000 pCi/g (Personal Communication, 2010h)

Table 5-3: Grand Junction Site Building Information
(This table spans five pages)

Bldg. No.	Contaminated? (Y/N)		Date Built	Date Demolished	Building Function (SRDB Ref ID)
	Building	Underlying or Adjacent Soil			
1	Y	Y	1943	1996	Part of the larger refinery structure to house boilers. All other portions of the refinery were removed during the 1950s. Subsequently, contained the steam boilers and back-up generator for the facility (76616)
2	Y	N	1944	---*	(76628) The north portion of the building was used as a shower and change facility for uranium workers; the south portion was a warehouse. Released for unrestricted use as part of Remedial Action Program. "It is assumed yellowcake U_3O_8 is the primary radiological contaminant, although uranium mill tailings may also be involved" (76650). The north end of the building is suspected of containing non-uniform contamination related to the change room activities of the mill workers, and thus, probably contains U-238 and its decay products.
3	---	---	---	---	Research Laboratory (76720)
6	Y	Y	1953	April 1992	Housed a bench-scale pilot mill for testing the resin-in-pulp uranium milling process. Milling activities commenced in 1953 and continued until December 1954, processing a total of 2,500 tons of uranium ore (Small Pilot Plant). Subsequently used as laboratory and office space. (76619)

Table 5-3: Grand Junction Site Building Information
(This table spans five pages)

Bldg. No.	Contaminated? (Y/N)		Date Built	Date Demolished	Building Function (SRDB Ref ID)
	Building	Underlying or Adjacent Soil			
7	Y	Y	1952	---	Drum-handling activities; sample plant. (76720)
7A	Y	---	1956	---	Building 7A was constructed as an addition to Building 7 as a sample preparation laboratory for the Analytical Chemistry Laboratory (Building 20). The center section of Building 7 had formerly been used for sample preparation. (89880)
8	N	N	1950	---	Office (Walker Lybarger) (76720)
9	N	N	1954	---	Paint Shop (76720)
9A	N	N	1955	---	Office (90182)
10	N	N	---	---	Garage (76720)
11	N	N	1955	---	Built as a primary guardhouse (South Gate) and continues to serve this function. (76626) This was an office before 1954 (76720).
12	N	N	1953	---	Office (Administration) (76720)
12A	---	---	---	---	
13	---	---	---	---	Warehouse (Camp Supplies) (76720)
14	---	---	---	---	Warehouse (Furniture) (76720)
15	---	---	---	---	Warehouse (Materials) (76720)
16	---	---	---	---	Carpenter Shop (76720)
17	---	---	---	---	Warehouse (USGS) (76720)
18	---	---	---	---	Receiving Building (76720)
19	N	N	1948	NA	Used as the main gate. Currently, it serves as a guardhouse (North Gate) and office space for security personnel. Major modifications of the building occurred in 1953 and 1967. (76629)
20	N	N	1951	---	Analytical Laboratory (76720). Building was expanded in 1954 (89903)
20A	---	---	---	---	
21	---	---	---	---	Supply Building (AS&R) (76720)
22 22A	---	---	---	---	Warehouse (Paint) (76720) Buildings 22 and 22A were completed in 1953 as sedimentation and electronics laboratories and associated warehouse and office space. These buildings were combined as Building 22 and subsequently combined with Building 30, creating Building 3022, used for core storage and a core hole logging vehicle support facility (90201)
23	---	---	---	---	Warehouse (Materials) (76720)
24	---	---	---	---	Core Storage (USGS) (76620)
25	---	---	---	---	Core Storage (USGS) (76620)
26	N	N	1954	NA	Core Storage (76620). Formerly an engineering office and training center (89943)
28	N	N	1954	---	Built as a maintenance and repair facility for vehicles, heavy equipment, and electrical equipment, and as a site support building with offices and facility maintenance shops. In 1999, it was vacant.

Table 5-3: Grand Junction Site Building Information
(This table spans five pages)

Bldg. No.	Contaminated? (Y/N)		Date Built	Date Demolished	Building Function (SRDB Ref ID)
	Building	Underlying or Adjacent Soil			
29	N	N	1954	---	Built as a guard station and scale house for trucks entering the site with uranium ore; later used for paint storage. Now serves as office space for management personnel. (76611)
30/3022	N	N	1955	---	Building 30 was the south wing of Building 3022. Building 30 was constructed in 1955 as a purchasing and supply warehouse and an operations building. In 1982, Building 30 was joined to Building 22 by constructing a high bay area between them. The Building 30 portion has been used as an electronics laboratory, radiological instrument storage, and office space. (76614)
30B	N	N	1980	---	Machine shop and electronic shop. Currently used to store and calibrate small field instruments and house personal protective equipment. The building also houses contaminated trash in transit from controlled areas to radioactive material storage areas. (76614)
31	Y	Y	1954	1992	Housed the acid-leach circuit of the pilot-scale uranium ore mill. Subsequently used for storage, including uranium and vanadium concentrates. Demolished in 1992. (76615) (76614)
31A	Y	N	1954	---	Building 31A was constructed in 1954 as an analytical chemistry laboratory and office building. Later, the building was used as a physics and radon laboratory with associated offices. Demolished during remedial activities in August and September 1998 and not rebuilt. (90173)
32	N	N	1954	---	Chemical storage and change building (76720). Later used for seed storage, core preparation and viewing, and radon research. In 2000, the building housed an environmental laboratory and offices. (89999)
33	Y	---	1954	1998	Associated with the Large Pilot Plant Alkaline leach pilot mill (76720). After the mill ceased operations, the building was used for storage. The building was demolished during remedial action activities in August and September 1998 and was not rebuilt (90175).
34	Y	N	1954	1996	Built as a boiler house for the large pilot mill. (76620)
35	Y	---	1954	1998	Drum Handling and feed preparation plant (76720)
36	Y	Y	1945	1996	Used as early as 1945 as a paint shop for the small pilot mill near the present location of Building 12. In 1954, the building was moved to the south end of the facility for use as a uranium concentrate drying facility. Subsequently, it was used for storage of uranium concentrate and later for general storage.
37	Y	Y	---	1992	Scale House for a truck scale.

Table 5-3: Grand Junction Site Building Information
(This table spans five pages)

Bldg. No.	Contaminated? (Y/N)		Date Built	Date Demolished	Building Function (SRDB Ref ID)
	Building	Underlying or Adjacent Soil			
39	Y	Y	---	1992	Housed pumps and valves that controlled the supply of fuel from emergency reserve tanks to the facility back-up generator and boiler plant.
40	N	N	1995	---	Natural gas meter house (90016)
41	N	N	1956	---	Storage shed (90019)
42	N	N	---	2000	Assembled and expanded on three occasions using structures located elsewhere on the GJO facility. The building was used as a permitted hazardous and mixed waste storage area. The permit and stored materials were transferred to Building 61C in June 2000. (90179)
43	N	Y	1976	---	Storage shed to support operations in Buildings 20 and 30. Stored barrels of contaminated personal protective equipment. Released. (90023)
44	Y	N	1956	1994	Originally used for gas cylinder storage. (90031)
45	---	---	---	---	
46	Y	Y	1977	---	Constructed in 1977 as a cafeteria. Foundation elements and potentially-contaminated utilities from the former lab were beneath Building 46.
47	---	---	---	---	
48	---	---	---	---	
49	---	---	---	---	
51	N	N	1976	---	Gas bottle storage facility. Released for unrestricted use. (90036)
52	Y	Y	1956	1994	Constructed in 1956 to store oil and grease from the pilot plant uranium milling activities. After the cessation of milling activities, it was used for storage. Before 1990, it was used to store a small quantity of uranium mill tailings and a Ra-226 source. These sources were used to generate radon for radon flux measurements and experiments. The tailings were placed in an open soil-lined sump dug into the ground beneath the floor. (90166)
54	N	N	1992	---	Installed on site in 1992, it consists of 15 modular units joined together with the interior to accommodate office space and medical facilities. Presently serves as office space for facilities management, the analytical laboratory, and medical personnel. (76617)
56	N	N	1992	1997	Buildings 61A, B, and C are modular units installed on a concrete pad in 1993. The buildings were used to store hazardous and mixed waste materials generated by GJO operations and remedial action projects.
61A, B, & C	N	N	1993	---	Modular units installed on a concrete pad in 1993. The buildings were used to store hazardous and mixed waste materials generated by GJO operations and remedial action projects.

Table 5-3: Grand Junction Site Building Information
(This table spans five pages)

Bldg. No.	Contaminated? (Y/N)		Date Built	Date Demolished	Building Function (SRDB Ref ID)
	Building	Underlying or Adjacent Soil			
810	N	N	1981	---	Building 810 was formed when Building 8 and Building 10 were joined by an addition in 1981. Buildings 8 and 10 were never used for uranium milling or brokerage activities, but the area was crossed by a haul road that served the MED refinery. The building has been used for offices and conference rooms for DOE and GJO contractor personnel.
938	---	---	---	---	Building 938 was formed when two formerly separate buildings, 9 and 38, were joined by connecting additions. Building 9 was constructed in 1954; Building 38 was built in 1955. The original addition (Bldg. 9A) was also built in 1955. The buildings were joined in 1981. The building was used for offices and conference rooms for the DOE-GJO contractor personnel. The buildings were never used for uranium milling or brokerage activities.

* Three hyphens (---) in a table cell represent a lack of information.

5.2 Radiological Exposure Sources from GJOO Operations

The function of a uranium mill is to extract uranium in concentrated form from naturally-occurring ore. The product is a semi-refined uranium compound called yellow-cake. The process of uranium extraction varies among the mills, due in part to differences in the chemical composition of the ores. Steps basic to all mills are crushing, grinding, chemical leaching of the uranium from the ore, and recovery of the uranium from the leach solution (Sears, 1976).

The primary sources of external exposure to Grand Junction Operations workers (other than X-rays) were direct radiation from handling and processing uranium ore and tailings and submersion in the contaminated dust cloud. Inhalation and ingestion of contaminated air resulting from dust generated during the various milling operations was the primary source of internal exposure.

Sources of Exposure

GJOO site workers included geologists, engineers, chemists, accountants, secretaries, laborers, groundskeepers, and warehousemen. Some of these workers were exposed to the following internal and external radiation hazards during the performance of their job duties. It should be noted that these sources represent examples of potential exposure of workers and do not represent a list of exposures that are evaluated for the class under evaluation. This list was obtained from the *U.S. Department of Energy Grand Junction Office: Nonradiologic Site Profile for Facility Workers* (GJ Nonradiologic Site Profile, undated).

- Radiation from pilot plant tailings
- Radiation from uranium concentrate storage
- Radiation and concentrate dust when the sampling plant employees were moving and re-drumming leaking drums and disposing of contaminated drums
- Radiation when removing uranium ore samples and rejects from the analytical chemistry laboratory to the landfill
- Radiation and uranium ore and silica dust when reclaiming the landfill on the GJOO site
- Radiation and uranium and silica dust when demolishing and remodeling portions of the pilot plant
- Radiation when moving furniture, equipment, uranium concentrate drums, etc., into the warehouses that were formerly part of the pilot plant
- Radiation when moving ore samples from the receiving area to the analytical chemistry laboratory
- Radiation while constructing the test pits to calibrate borehole logging equipment on the GJOO site.
- Radiation from high-grade uranium mineral specimens that were accumulated and displayed in some laboratories and offices.

Workers such as painters, carpenters, plumbers, and electricians were also exposed to:

- Uranium and vanadium dust when working in the concentrate sampling plant
- Radiation from uranium ores and concentrate (yellowcake) when working in the pilot plant
- Radiation from residual debris when remodeling the sampling plant and certain pilot plant buildings

After the concentrate sampling plant (Building 7) was remodeled into offices, a radiometric survey determined that the walls, the mechanical room floor that was the ceiling over the first-floor center portion of the building, the roof trusses, and the concrete floor were still contaminated with uranium.

Building occupants, especially the Publications Services Department, were exposed to elevated gamma radiation.

The following subsections provide an overview of the internal and external exposure sources for the Grand Junction Operations Office class under evaluation.

5.2.1 Internal Radiological Exposure Sources from GJOO Operations

Inhalation and ingestion of uranium ore dust and uranium concentrate dust generated during the various milling operations was the primary source of internal exposure for Grand Junction workers. Inhalation of radon/radon progeny was also a source of internal exposure. These operations included the receipt, sampling, and analysis of uranium and vanadium concentrates and ores received from the various ore-processing operations in the western United States.

5.2.1.1 Uranium

The Grand Junction mill received tailings from other mills such as Durango and Uravan, which refined other tailings from mills that produced vanadium containing uranium. The Grand Junction mill received the partially-refined material and removed all but the last traces of vanadium. The process proceeded as follows:

- The material was received by truck. Metal barrels were unloaded and the contents dumped through a grader grating into a hopper beneath the floor of the loading platform. The grader grating ensured the removal of rock chunks and other extraneous material and also served as a coarse sieve.

- From the hopper, the material was conveyed to a roaster by means of a belt conveyer. As the material moved along the conveyer belt, a measured amount of soda ash was added. By roasting with soda ash, the vanadium in the material was made water-soluble.

- The roaster discharged into a wet ball mill where water was added to the roasted material and it was ground to a very fine consistency. The ball mill discharged through a classifier, which removed such foreign materials as small stones, nails, and bits of metal. The resultant slurry was then pumped through a series of Peterson filtration filters.

- The sludge from the Peterson filters was conveyed to a drier. The dried sludge was placed in metal barrels and stored before shipment to the Tonawanda Area. This dried material contained about 15 % uranium, the rest being silica, iron, and traces of vanadium.

- The filtrate from the Peterson filters was passed through a series of Sperry Filter Presses. The filtrate from the Sperry Filter, called alumina cake, was allowed to air-dry. It was stored because it contained small amounts of uranium that might be reclaimed if the need ever arose.

- The filtrate from the Sperry Presses was pumped into a precipitation tank where a small amount of H_2SO_4 was added along with sodium peroxide. This caused precipitation of the vanadium as a red-colored sludge. These precipitation tanks were built with false filter bottoms so that after precipitation was complete, the filtrate could be drawn off through the bottom of the tank and discarded.

- The precipitate was shoveled from the tank into a fusion furnace maintained at 800^o C. The red sludge was changed into an oxide (V_2O_5) which melted and dripped from a small pouring spout. The molten V_2O_5 dripped onto a slowly-revolving metal ring where it solidified and scraped onto the floor at a point opposite the pouring spout. The V_2O_5 was in the form of flat plates about 2 to 3 inches in diameter, which were broken up into smaller pieces for barreling by pounding the pile of plates with a maul (Inspection, 1945).

There are a number of steps in the milling process that could result in the generation of dust. The ore dumping, crushing, screening, sampling, and ore movement by conveyer all generate airborne dusts. Until the late 1950s, there was little or no ventilation of ore-handling operations which, in turn, meant that ore dusts were contained inside the buildings (Sears, 1976).

At the Grand Junction mills, there were potential dust inhalation hazards during the following processes:

- Dumping the material on the loading platform. This process was conducted in an open area and the metal barrel contents were dumped through the grader grating into the hopper below the unloading platform.

- The transfer of ore on the conveyer belt generated dust.

- In the roaster, dust was released if the roaster joints were not maintained as tightly as possible. In this step, very few people and very little supervision were required and only for short intervals.

- The discharge from the drier was fitted with an exhaust cone that reduced the dust considerably.

- In breaking up of the V_2O_5 plates, considerable dust was generated.

There were also a few potential inhalation hazards in the Army Sampling Laboratory, located in the warehouse adjoining the Grand Junction mill. Samples were taken from three points during the process. A sample was taken upon receipt, which was a composite of small pipe thief samples withdrawn from each barrel of each lot just before the barrels were dumped at the unloading platform. Another sample was taken of the material that was barreled for shipment to the Tonawanda Area. This sample was also a composite of small pipe thief samples withdrawn from each barrel of each lot just after the lot had been placed in the warehouse for storage before shipment. The third sample was taken from the barrels of black V_2O_5 just before storage in the warehouse (Dust Samples, 1945).

No particular hazard was encountered in obtaining the samples. The potential hazards arose during preparation of the sample after it had been thoroughly dried. After drying, the sample was pulverized with a special maul on the floor of the Preparation Room and screened through a 10 mesh screen

(Note: mesh refers to the openings between the threads of a screen and is measured by the number of openings per inch. 10 mesh equals 10 holes or openings per inch). While there was considerable dust from this process, most of the dust was removed by a portable hood that was attached to the suction system. From here, the sample was reduced in size by subsequent quartering procedures and riffling. It was also passed through a pulverizer and finally through a 100 mesh screen. Dust was present in all these operations but there seemed to be adequate suction hoods over each operation and the workmen wore respirators (Dust Samples, 1945).

In the storage warehouses, the dust was kept at a minimum because all material was kept in sealed drums and the floors were vacuum-cleaned at frequent intervals.

Uranium continued to be a potential source of exposure during the resource evaluation and remediation period. In particular, during the remediation period, hundreds of soil and air samples were taken and analyzed. The destruction of the buildings and/or their restoration offered the potential for subjecting the workers to inhalation of uranium dust. In addition, small quantities of uranium mill tailings used to generate radon for radon flux measurements and experiments were stored in Building 52 (Building 52 D&D, 1996).

NIOSH has located evidence that there was an air sampling and bioassay program at Grand Junction from the earliest days of operation (see Section 6.1 for details).

5.2.1.2 Thorium

Thorium-232 was not a contaminant of concern at the DOE-GJPO facility (Rust Geotech, 1996a, pdf p. 24). Thorium-230 was present in the ore in approximate equilibrium with U-234. Thorium-230 was depleted relative to U-234 in ore concentrates (yellowcake), but enhanced relative to uranium in the mill tailings.

5.2.1.3 Radium

The Grand Junction pilot plants processed 30,000 tons of ore from 1953-1958. With the exception of small residual amounts of uranium, the uranium was extracted and all other members of the uranium decay chains remained in the tailings at their original activities (Uranium, 2004). As such, Ra-226 was present in approximate equilibrium with U-234 in the ore. Most of the radionuclides (other than uranium) remain insoluble during leaching and leave the mill (pilot plant) with the solid tailings (Sears 1976). As this infers, Ra-226 was depleted in the concentrates and enhanced in the mill tailings relative to uranium. A similar condition occurred with Th-230.

5.2.1.4 Radon

Radon would be expected in areas and buildings that processed or handled uranium or in buildings built on tailings piles. As such, radon/radon progeny could have presented an inhalation hazard to workers. See the subsection *Air Monitoring Data* in Section 6.1 and Table 6-2.

5.2.2 External Radiological Exposure Sources from GJOO Operations

ATTRIBUTION: Section 5.2.2 was completed by Ed Scalsky and Roger Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The material processed at the Grand Junction mill from 1943-1945 had previously been partially refined at Uravan and Durango and was not ore, but processed tailings from the mills that produced vanadium. The Grand Junction mill removed all but the last traces of vanadium.

It was felt that the greatest radiation hazard would be in Warehouse 2013 where the more highly-concentrated materials were stored. Measurements made two inches from a barrel of that material showed a reading of 1 mR/8 hrs. With the cover off the barrel, the reading at 6 inches above the barrel was 2 mR/8 hrs. A reading taken on the 15% uranium sludge to be shipped to the Tonawanda Area was reported as zero. Readings on tailings piles were also reported as zero (Inspection, 1945).

Table 5-4 shows the principal emissions from natural uranium. Th-230 and Ra-226 may also have been present.

Table 5-4: Principal Radiation Emissions from Natural Uranium and Its Short-lived Decay Products

Radionuclide	Half-life	Beta Energy (MeV Max)	• • • •••• ••• •••• •
U-238	4.468 x 10^9 years	None	x: 0.013 (8.8%)
Th-234	24.1 days	0.096 (25%) 0.189 (73%)	x: 0.013 (9.6%)

5.2.2.1 Photon

Table 5-4 shows the primary isotopes and photon energies associated with natural uranium. Exposure to these photons was possible during all phases of handling and processing the natural uranium ore. Radium-226 was also a source of external exposure to the workers. Other gamma-emitting uranium progeny from the U-238 and U-235 decay chains were present and contributed to the photon exposure, although the U-235 concentration represents a small part (0.72 % by weight) of the isotopic composition of natural uranium while U-238 represents 99.27 % by weight.

5.2.2.2 Beta

Table 5-4 shows the principal beta emitters and their energies for natural uranium. As indicated, there are a significant number of high-energy beta radiations that represent a shallow dose exposure concern for those in close contact with the ore. Protactinium-234m is the primary source of external beta exposure. Other beta-emitting progeny from both the U-238 and U-235 decay chains were present and contributed to the beta exposure.

5.2.2.3 Neutron

Neutron sources such as Californium-252 and neutron generators using deuterium and tritium targets were used on site by one contractor (Personal Communication, 2010b). There is a reference to Grand Junction purchasing a “small quantity” of zetatrons (a neutron-producing device that uses a tritium target) in the 1991-1995 timeframe. The same reference indicates no zetatrons at Grand Junction in the 1980-1990 period (Lutz, 1995). Neutron doses were reported for a few monitored workers from 1986 through 2005 (see Table 6-6).

5.2.3 Incidents

A review of the available documentation identified only one minor incident at the Grand Junction Operations Office that involved a spill of yellowcake (Building 7 Bioassay, 1994).

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 Grand Junction class under evaluation.

6.1 Available Grand Junction Operations Office Internal Monitoring Data

ATTRIBUTION: Section 6.1 was completed by Eugene Potter, Mel Chew & Associates; and Ed Scalsky, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

Bioassay Data

When the Grand Junction site was established, it was recognized that bioassay may be required for personnel “directly exposed to special materials” (Ruhoff, 1943). However, there is no comprehensive database of bioassay results for the Grand Junction site. A limited number of bioassay results are contained in documents captured by NIOSH for the period 1945-1973 and 1995-1999, as shown in Table 6-1.

Within Table 6-1, it should be noted that there is some overlap in the references and that some of the early results are not very legible. The small number of results captured to date is due to two factors: (1) only a relatively small number of workers on site directly handled the radioactive materials; workers were sampled based on perceived likelihood of intakes (just as workers are sampled under current DOE standards); and (2) the captured data are from general site records rather than individual exposure records (which would likely represent a more complete dataset).

A review of the claimants in NIOSH’s database indicates that some workers do have bioassay measurements included in their records; however, there are not enough claimants with bioassay information available to indicate which workers were included in a bioassay program.

Initially, urine samples were analyzed for total uranium by fluorometric methods by the AEC New York Operations Office Health and Safety Laboratory. It appears that bioassay samples were subsequently analyzed on site, but the dates are unclear. In 1971, the sampling plant was shut down (GJ Contractors, undated), and by early 1975, the remaining drums of uranium concentrate stored on site were shipped out. While analytical laboratory operations continued, the source term for most workers was then reduced to residual building and environmental contamination. The on-site analytical laboratory did not accept high-activity samples, and the workers were not required to be in a bioassay program (Personal Communication, 2010h). Bioassay requirements were determined on a case-by-case basis by the Health and Safety Plan that governed the specific decontamination and decommissioning project (Henwood, 1986; Personal Communication, 2010c). A site procedure entitled *Internal Radiation Dosimetry Program* was revised in 1990 to comply with DOE Order 5480.11; the revision required weekly samples for subcontractors and monthly samples for site employees if they were working in an Airborne Radioactivity Area (Procedure, 1990).

Table 6-1: Grand Junction Office Bioassay Data in the Site Research Database (This table spans three pages)				
Year	**Approx. No. of Results**	**Company/Organization**	**SRDB Ref IDs**	**Notes**
1945	11	GJ Mill (Refinery)	16855	U in urine, 1 set[a] in Jun
1949	7	None shown	3306	U in urine, all from Dec.
1953	11	American Cyanamid	6645	U in urine, 2 sets - Jul and Dec
1953	4	American Cyanamid	11452	U in urine, 1 set in Dec
1953	32	American Smelting	3319	U in urine, 3 sets Feb, May, and Sep
1953	22	American Smelting	11452	U in urine, 2 sets - Feb and May
1954	10	American Cyanamid	6645	U in urine, 2 sets - Feb and Jul
1954	10	American Cyanamid	11452	U in urine, 2 sets - Feb and Jul
1954	24	American Smelting	3319	U in urine, 2 sets - Jan and Nov
1954	13	American Smelting	11452	U in urine, 2 sets - Jan and May
1956	66	Lucius Pitkin	3307, 3397	U in urine; 3 sets - May, Jun, and Oct
1956	1	None shown	76923	U in urine; result reported Aug 0.009 mg/l
1956	1	None shown	76924	U in urine; result reported Jul 0.078 mg/l
1957	49	Lucius Pitkin	3307, 3397	U in urine; 2 sets - May and Oct
1958	25	Lucius Pitkin	3307, 3397	U in urine, 1 set - Jun
1958	29	Lucius Pitkin	11451	U in urine, 1 set in Dec
1958	1	None shown	76938	One "composite" U in urine sample, 0.016 mg/l from Feb
1958	1	None shown	76940	U in urine; one sample, 0.032 mg/l from Jan
1959	31	Lucius Pitkin	3307, 3397	U in urine, 1 set - Jun; plus 1 Aug result
1959	28	Lucius Pitkin	11451	U in urine, 1 set in Dec
1960	49	Lucius Pitkin	3307, 3397	U in urine, 2 sets - Jun and Dec
1961	57	Lucius Pitkin	3307, 3397	U in urine; 2 sets - Jun and Dec; plus 2 Jan results and 1 Mar result.
1962	26	Lucius Pitkin	3307, 3397	U in urine, 1 set - Jun; plus 1 Jan result.
1964	See Notes	Lucius Pitkin	14442	Annual report for 1964. 8 employees sampled in Jul and Dec. One additional in Dec. Results were in the range from 0.008 to 0.021 mg/l, below the reference point[b] (RP) of 0.05 mg/l.
1969	See Notes	Lucius Pitkin	13800	Annual report for 1969. In Mar, 23 samples were collected. All were below the reference point of 0.025 mg/l with 4 exceptions who were re-sampled. In Oct, 17 samples were collected and all were below the RP with again 4 exceptions. Re-sampling showed 3 of 4 were below. Two employees are listed by name with results of 0.054 and 0.077 mg/l.
1972	See Notes	Lucius Pitkin	13802	Annual report for 1972. No. of samples not given, but all were in the range of 0.001 to 0.008 mg/l.
1973	See Notes	Lucius Pitkin	13803	Annual report for 1973. No. of samples not given, but all were in the range of 0.001 to 0.056 mg/l.
1995	7	RUST Geotech	90511	7 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U).

Table 6-1: Grand Junction Office Bioassay Data in the Site Research Database
(This table spans three pages)

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
1995	10	RUST Geotech	90512	10 urine samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U, Th-230, and Ra-226).
1995	18	RUST Geotech	90513	18 urine samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U, Th-228/230, and Ra-226).
1995	7	RUST Geotech	90514	7 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis. 4 Pu/Am and 3 U for 6 personnel (one had both).
1995	10	RUST Geotech	90515	10 urine samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U).
1995	12	RUST Geotech	90516	12 urine samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U, Th-230, and Ra-226).
1995	10	RUST Geotech	90517	10 urine samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U). Collected 10/3/95.
1996	11	MACTEC	90528	11 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U).
1997	12	MACTEC	90528	12 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U).
1997	9	MACTEC	90508	9 post-job fecal samples collected 5 days after potential exposure; sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U). Additional urine and fecal baseline results on pdf p. 65.
1997	45	MACTEC	90510	45 urine samples sent to Lockheed-Martin Idaho Lab in 1997. Total U results in µg/l.
1997	10	MACTEC	90523	10 urine samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U). Collected 1/6/97.
1997	11	MACTEC	90524	11 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U). Collected 11/12/97.
1997	11	MACTEC	90525	11 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U). Collected 11/12/97.
1997	9	MACTEC	90526	9 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U). Collected 11/12/97.
1997	10	MACTEC	90527	10 urine samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U). Collected 4/1/97.

Table 6-1: Grand Junction Office Bioassay Data in the Site Research Database
(This table spans three pages)

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
1998	6	MACTEC	90507	4 urine samples collected in June 1998 sent to Lockheed Martin Idaho Technologies Company Bioassay Laboratory for total U as the result of an off-site incident (facial contamination from windblown tailings at Monticello). 2 fecal samples collected in September 1998 and analyzed for isotopic U following demolition work at the GJO site.
1999	670	MACTEC	90509	Radon personal dosimeter data for individuals using Landauer "DRNT" detector (track detector). Two quarterly periods and one semi-annual period. Exposures reported in pCi/l-days. Of the total, 24 were area monitors.

[a] A "set" is a group of samples taken at approximately the same time.
[b] A definition of "reference point" was not located. Workers above the reference point were re-sampled.

Air Monitoring Data

A limited number of air sample results were located for the period of 1975 and earlier. Initially, these samples were taken during visits or inspections by the NYOO. Later, the GJOO organizations acquired their own sampling and analytical capabilities. Commonly, gross alpha (GA) counts were done by scintillation detectors and interpreted as uranium activity. In a few cases, an additional analysis was done for radium. In 1967 and 1968, 16 measurements of Rn-222 were made within the Grand Junction compound as a part of a large study of radon from tailings (Radon, 1967-68; Public Health Service, 1969). In December 1985, three high-volume air samplers were installed on the site; air concentrations of uranium, Th-230, and Ra-226 are reported in annual environmental reports for 1986 through 1993 (Environmental Monitoring, 1986; Environmental Monitoring, 1987; Environmental Monitoring, 1988; Environmental Monitoring, 1989; Environmental Monitoring, 1990; Environmental Monitoring, 1991; Environmental Monitoring, 1992; Environmental Monitoring, 1993). Radon measurements are available in the annual environmental reports for 1987 through 1993.

The annual atmospheric releases of radioactive materials are available for most years from 1992 through 2001. These reports indicated that very low levels were released; therefore, the on- and off-site concentrations would have been relatively low. The air monitoring data are summarized in Table 6-2. For the decontamination and decommissioning (D&D) period (1986-2001), numerous other examples of air monitoring, including breathing zone samples, have been located. For example, the remediation of Building 7, which was contaminated during use for sample preparation, was divided into three phases (areas). There were 60 area measurements and 15 personnel measurements made in Building 7 just in Phase III (Airborne Radioparticulates, 1994). Most of these measurements were made following a 1994 contamination incident caused by a water leak, and during removal of contaminated concrete in 1999. Other building health and safety data files contain similar air monitoring data (Building 11 H&S Data, 1993-1997; Building 12 H&S Data, 1991-2000; Building 18 H&S Data, 1991-2001; Building 20 H&S Data, 1990-2000; Building 26 H&S Data, 1980-1998;

Building 28 H&S Data, 1986-2000; Building 29 H&S Data, 1997; Building 31/31A H&S Data, 1990-1992; Building 36 H&S Data, 1992-1996; Health and Safety Checklists, 1990-1991).

Table 6-2: Grand Junction Office Air Monitoring Data in the Site Research Database
(This table spans three pages)

Year	Approx. No. of Results	Area/Company/ Organization	SRDB Ref IDs	Notes
1945	3	GJ Mill (Refinery)	16855	All results below 25 µg/m^3; collected in Jun
1945	3	GJ Warehouse Area	16855	2 results above 25 µg/m^3
1945	2	Sampling Lab	16855	All results below 25 µg/m^3
1953	10	American Cyanamid	6650	Samples taken in May, Jul and Aug. 3 samples in May are in terms of alpha counts/m^3.
1954	1	American Cyanamid	6650	Sample from Jun
1956	64	Lucius Pitkin	3307, 3397	Results appear to be GA; Jun and Sep; some are BZ samples
1956	6	Lucius Pitkin	3307, 3397	Results appear to be Ra; Ra analysis on some GA samples
1956	3	Lucius Pitkin	3337	Report in July of "high" air samples in auger sampling room; no concentrations given in this report but probably are those used for comparison with 1959 samples in 3343.
1956	See Notes	Lucius Pitkin	3393	Report not attached. Summarized as "In the initial sampling room the air samples were between 200 and 400 d/p/m^3. In the blender room they were of the order of 2,000." Probably included in 3307/3397.
1956	See Notes	National Lead	3382	Report not attached. Summarized as "of the 79 employees who were studied, all but three had exposures which were less than 50 d/m/m^3. Only one of the remaining three had a really significant exposure. This man was exposed to uranium dust in a concentration of approximately 250 mg/m^3 (350 d/m/m^3)."
1956	79	National Lead	10241	Samples from Jul and Sep
1957	25	National Lead	10241	Samples from Apr and Sep
1959	14	Lucius Pitkin	3307, 3397	Results appear to be GA; Nov
1959	3	Lucius Pitkin	3343	22 samples taken in Aug by GJO. Only three results were reported by NYOO in terms of concentrations
1959	22	Sampling Plant, Lucius Pitkin	11452	Samples from Aug
1960	28	Falling Stream Pilot Plant, Lucius Pitkin	3307, 3397	Results appear to be GA; Jun and Jul
1960	41	GJO (general)	11452	Samples from Jun and Jul - Outside areas (environmental-type)

Table 6-2: Grand Junction Office Air Monitoring Data in the Site Research Database (This table spans three pages)				
Year	**Approx. No. of Results**	**Area/Company/ Organization**	**SRDB Ref IDs**	**Notes**
1961	12	GJO (general)	11452	Samples from Nov - Outside areas (environmental-type)
1961	80	Sampling Plant, Lucius-Pitkin	3307, 3397	Results appear to be GA; Jun (most) and Sep
1967	5	GJ AEC Compound	17031	Rn-222 levels in pCi/l; Jul, Sep, Oct, and Nov; included in 17034
1967	7	GJ AEC Compound	17034	Rn-222 levels in pCi/l; Jul, Sep, Oct, Nov, and Dec
1967	16	GJO (general)	82790	Radon levels in GJ area 1967-1968; 16 measurements are for one station in or near the AEC compound.
1968	9	GJ AEC Compound	17034	Rn-222 levels in pCi/l; Jan, Feb, Mar, Apr, Jun, and Aug
1986	See Notes	GJO (general)	90851	Annual Environmental Report with particulate monitoring results for three stations.
1986	See Notes	GJO (general)	29855	Statement that there are "no significant radionucide emissions from GJPO facilities including the laboratories, sample preparation facility, and the radon chamber."
1986	300	GJO (in doors)	6640	100 radon-daughter-concentration (RDC) measurements in each of Bldgs. 33, 34, and 35. RDCs averaged 0.0051, 0.177and, 0.0069 WL, respectively with 0 percent thoron.
1987	See Notes	GJO (general)	90847	Annual Environmental Report with particulate monitoring results for three stations (total U, Th-230, Ra-226); radon monitoring results for three stations.
1988	See Notes	GJO (general)	90846	Annual Environmental Report with particulate monitoring results for three stations (total U, Th-230, Ra-226); radon monitoring results for three stations.
1989	See Notes	GJO (general)	90856	Annual Environmental Report with particulate monitoring results for four stations (total U, Th-230, Ra-226); radon monitoring results for three stations.
1990	See Notes	GJO (general)	90845	Annual Environmental Report with particulate monitoring results for four stations (total U, Th-230, Ra-226); radon monitoring results for three stations.
1990	1	GJO (general)	37700	Annual atmospheric release of radioactive material

Table 6-2: Grand Junction Office Air Monitoring Data in the Site Research Database (This table spans three pages)				
Year	**Approx. No. of Results**	**Area/Company/ Organization**	**SRDB Ref IDs**	**Notes**
1991	See Notes	GJO (general)	90853	Annual Environmental Report with particulate monitoring results for four stations (total U, Th-230, Ra-226); radon monitoring results for eight stations.
1991	1	GJO (general)	37700	Annual atmospheric release of radioactive material
1991	30	GJO (in doors)	13191	Results of the DOE indoor radon study; 19 occupied buildings measured.
1992	See Notes	GJO (general)	90860	Annual Environmental Report with particulate monitoring results for three stations (total U, Th-230, Ra-226); radon monitoring results for seven stations.
1992	1	GJO (general)	37700	Annual atmospheric release of radioactive material
1993	See Notes	GJO (general)	90857	Annual Environmental Report with particulate monitoring results for three stations (total U, Th-230, Ra-226); radon monitoring results for seven stations.
1993	1	GJO (general)	37700	Annual atmospheric release of radioactive material
1994	1	GJO (general)	37700	Annual atmospheric release of radioactive material
1996	1	GJO (general)	76642	Annual atmospheric release of radioactive material
1998	1	GJO (general)	44873	Annual atmospheric release of radioactive material
1999	1	GJO (general)	44873	Annual atmospheric release of radioactive material
2000	1	GJO (general)	44873	Annual atmospheric release of radioactive material
2001	1	GJO (general)	44873	Annual atmospheric release of radioactive material

Other Monitoring Data

The cited references contain other types of monitoring from which intakes of radioactive material could be inferred, namely soil samples, direct beta-gamma or alpha surface measurements, and smear surveys. Most of these references are from the period of site remediation (1986-2001).

A survey of the facility was conducted in 1985 (Forbes, 1997). At that time, only two small areas of the facility had been remediated, an area around Building 7 and a triangular fenced area north of Building 18. The survey included soil sample analysis for Ra-226, Th-232, and K-40. At that time, there were 49 buildings on site. Four buildings (31, 33, 34, and 35) were included in contamination surveys; they were suspected of being contaminated because they had been part of the Large Pilot Plant. The other buildings on site were used primarily for office space. The sample data from this survey are useful because they represent the accumulation of contamination from the pilot plants' operations and ore sampling and purchasing activities prior to any major site remediation.

A report, *Confirmatory Radiological Survey of the Grand Junction Projects Office Remedial Action Project Exterior Portions, 1989-1995* (Forbes, 1997), provides the results of surveys performed by the Independent Verification Contractor. Air emissions were not measured. No significant emissions would have been expected because the outdoor areas had been remediated at that point.

Whole-body counting is a technique developed in the early to mid-1960s to monitor photon-emitting radionuclides in the body. There is no indication that whole-body counting or other *in vivo* counting techniques were employed for Grand Junction workers.

6.2 Available Grand Junction Operations External Monitoring Data

ATTRIBUTION: Section 6.2 was completed by Roger Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

NIOSH's research located no dosimetry data prior to 1952. NIOSH found 43 film badge results for four individuals monitored from November 1952 through January 1953 (Film Badge Results, 1952-1953). Most of those results indicated no detectable exposure, although some low-level dose was recorded. The jobs and work locations of those four workers are unknown.

Periodic film badge data are available for 10-15 Grand Junction workers in 1957 (Film Badge Results, 1957a; Film Badge Results, 1957b). Several of those monitored workers had recorded dose. AEC memoranda indicate that workers were being monitored for off-site exposure due to entry into mines (Harris, D. G., 1957; Harris, W. B., 1957).

Lucius Pitkin, Inc., monitored 15 of its Sampling Plant workers for exposure in 1958. Film badge results are available from January through April, when monitoring was apparently discontinued. However, records are also available for a ten-day period in late December 1958 (Film Badge Results, 1958). No positive results were reported.

Lucius Pitkin again requested film badges for its Sampling Plant workers in August 1959 to check their exposures. Twenty-five results were reported for a two-week period with all values recorded as zero dose. Other results from 1959 are a two-day monitoring period for 32 personnel in a training exercise; all results were reported as zero.

Exposure data summaries were reported to the AEC and DOE for the Grand Junction Office listing the number of personnel monitored broken down by exposure ranges for the years 1960 through 1980 with the exception of 1974 (Rad Exposure Report, 1975; Rad Exposure Report, 1976; Rad Exposure Report, 1977; Rad Exposure Report, 1979; Rad Exposure Report, 1980; Rad Exposure Summary, 1960-1961; Rad Exposure Summary, 1961-1962; Rad Exposure Summary, 1962-1963; Rad Exposure

Summary, 1963-1964; Rad Exposure Summary, 1964; Rad Exposure Summary, 1963-1965; Rad Exposure Summary, 1966; Rad Exposure Summary, 1967; Rad Exposure Summary, 1968; Rad Exposure Summary, 1969; Rad Exposure Summary, 1970; Rad Exposure Summary, 1971; Rad Exposure Summary, 1972; Rad Exposure Summary, 1973-1974).

It is unclear if the exposure data discussed above included off-site exposure. These data show the number of monitored individuals who fall into various exposure ranges. Shallow beta exposures are not listed. For 1974 and for years after 1981, data for the Grand Junction Office are not listed in the available summary reports.

For the years 1960 through 1973, the reported ranges were 0 to 1 rem/yr, 1 to 2 rem/yr, 2 to 3 rem/yr, etc. The finest division that may be made of these data is in whole rem. All Grand Junction personnel fell within the 0 to 1 rem category with the exception of one person in 1970 who fell in the 1 to 2 rem category. For the years 1975 through 1980, the reports divided the categories more finely. Table 6-3 lists all report years and the maximum upper limit on any reported exposure.

Table 6-3: Maximum Annual Exposure Reported to AEC and DOE for GJOO

Year	Maximum Exposure to Individual (rem)
1960	1
1961	1
1962	1
1963	1
1964	1
1965	1
1966	1
1967	1
1969	1
1970	2
1971	1
1972	1
1973	1
1974	None reported
1975	0.75
1976	All reported as Less Than Measurable
1977	0.50
1978	0.50
1979	0.75
1980	1.00

Interviews indicate that TLDs were used during the NURE and GJRAP activities but no individual results were available for review. A limited number of employees who worked with neutron-generating equipment used neutron dosimetry (Personal Communication, 2010b) but the neutron results were not available for review nor is the specific type of dosimetry known.

Dosimetry data for DOE facilities are compiled in the Radiation Exposure Monitoring System (REMS) database. A request to the REMS Project Manager returned annual results for Grand Junction employees for 1985 through 2009, the latest year with available data. An analysis was performed on the records to obtain the simple average, the number of records with values, the maximum annual value reported, the geometric mean of the non-zero values, and the geometric standard deviation of the non-zero values.

Table 6-4 shows the data distribution for the penetrating photon exposure; Table 6-5 shows the data distribution for shallow beta exposure results; and Table 6-6 shows the data distribution for neutron results. Note that the REMS report tool returns results in millirem instead of in rem as reported in the preceding discussion of AEC and DOE reports.

Table 6-4: Statistical Data on Annual Photon Exposure Reported by REMS for GJOO Personnel

Year	No. of Individuals	Average (millirem)	Maximum (millirem)	Geometric Mean (millirem)	Geometric Standard Deviation
1985	118	126.91	8500	55.07	1.70
1986	54	48.44	145	41.67	1.75
1987	115	23.39	120	20.28	1.66
1988	62	23.45	146	18.03	1.90
1989	81	23.83	134	18.25	1.91
1990	147	21.45	442	16.45	1.73
1991	36	31.86	411	20.81	1.91
1992	46	38.41	193	30.39	1.85
1993	3	53.00	125	31.07	2.85
1994	12	61.08	317	25.92	3.09
1995	10	21.50	40	19.66	1.54
1996	24	15.58	30	14.92	1.34
1997	4	17.50	30	15.65	1.60
1998	120	40.41	189	31.94	1.99
1999	14	23.14	48	19.35	1.82
2000	34	5.50	35	3.29	2.70
2001	33	3.30	13	2.47	2.11
2002	31	6.00	17	4.38	2.33
2003	37	6.68	25	5.21	1.98
2004	41	5.51	29	3.87	2.24
2005	6	11.83	17	9.84	2.08
2006	4	12.50	24	11.13	1.57
2007	10	2.80	15	1.68	2.28
2008	39	3.23	25	2.28	2.12
2009	10	52.50	499	4.25	5.30

Table 6-5: Statistical Data on Annual Beta Exposure Reported by REMS for GJOO Personnel					
Year	**No. of Individuals**	**Average (millirem)**	**Maximum (millirem)**	**Geometric Mean (millirem)**	**Geometric Standard Deviation**
1986	48	57.85	323	39.23	2.29
1987	126	29.99	426	22.82	1.86
1988	76	31.84	146	22.62	2.22
1989	91	80.12	2441	27.02	3.10
1990	156	26.15	462	18.00	1.94
1991	50	38.60	411	26.59	2.05
1992	60	45.58	193	35.80	1.93
1993	7	62.43	170	36.96	2.73
1994	13	80.92	349	34.65	3.51
1995	12	21.33	40	19.30	1.58
1996	26	24.77	240	17.25	1.81
1997	7	32.86	60	26.43	2.02
1998	125	45.38	255	35.19	2.04
1999	18	31.44	70	25.67	1.94
2000	50	7.56	58	3.84	2.94
2001	40	4.80	14	3.72	2.10
2002	36	6.72	19	5.25	2.07
2003	41	7.61	28	6.08	1.98
2004	54	7.67	61	4.29	2.79
2005	52	5.65	28	4.06	2.25
2006	48	7.29	29	5.04	2.41
2007	39	6.03	27	4.19	2.27
2008	49	7.82	131	3.93	2.66
2009	17	48.76	471	6.68	4.98

Table 6-6: Statistical Data on Annual Neutron Exposure, Reported by REMS for GJOO Personnel					
Year	**No. of Individuals**	**Average (millirem)**	**Maximum (millirem)**	**Geometric Mean (millirem)**	**Geometric Standard Deviation**
1986	6	94.17	181	79.21	1.79
1987	18	26.61	68	19.17	2.47
1988	13	51.38	180	40.59	1.92
1989	2	50.50	76	43.59	1.74
1990	9	36.44	128	28.91	1.80
1991	5	67.40	223	40.98	2.47
1992	3	22.00	31	21.12	1.32
1996	1	20.00	20	20.00	1.00
1997	1	20.00	20	20.00	1.00
1998	3	62.00	70	61.75	1.09
1999	3	37.33	49	36.50	1.23
2003	1	15.00	15	15.00	1.00
2005	1	15.00	15	15.00	1.00

For the film badges and the TLDs, the dosimeters were required primarily for off-site activities (e.g., mine visits in the 1950s and vicinity property work in the 1970s and 1980s). For both these cases, off-site exposure results cannot be distinguished from on-site exposure results. A 1957 memo requesting film badges for Grand Junction discussed the need to monitor employees who routinely enter mines where exposure levels were typically between 5 and 10 mR/hr and, in some cases, exceeded 20 mR/hr (Harris, D. G., 1957). These levels are higher than any values that have been located by NIOSH for the Grand Junction site.

Interviews with current workers indicate that there is no external monitoring currently (i.e., in 2010) performed for Grand Junction employees (Personal Communication, 2010b; Personal Communication, 2010d).

7.0 Feasibility of Dose Reconstruction for the Class Evaluated by NIOSH

The feasibility determinations for the class of employees under evaluation in this report are 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 DCAS'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-00175 as submitted by the petitioner. (Section 7.4)

7.1 Pedigree of Grand Junction Operations Office 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

<u>ATTRIBUTION</u>*: Section 7.1.1 was completed by Eugene Potter, Mel Chew & Associates; and Ed Scalsky, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.*

The urine bioassay and air sampling data from the MED/AEC/DOE are contained in original reports and are, therefore, primary data sources. Thus, no additional pedigree review was performed for these data.

Early bioassay and air results captured by NIOSH were produced by the Health and Safety Lab of the AEC's New York Operations Office. This source is common to most of the atomic-related sites operating in the 1940s and 1950s. At some point, on-site bioassay capability was added; however, NIOSH has not located a starting date. No site-analyzed bioassay data were located for use in this evaluation. By 1995, bioassay samples were analyzed by off-site laboratories. By that time, it had become common for DOE sites to specify quality assurance requirements in statements-of-work for contract laboratories. Examples of complete data packages showing that quality assurance parameters had been met have been captured by NIOSH for the D&D era (see Table 6-1).

7.1.2 External Monitoring Data Pedigree Review

NIOSH reviewed film badge reports from the 1950s that are associated with specific employees by name. From associated memos, NIOSH concludes that workers selected for badging were those considered most likely to be exposed in the Lucius Pitkin Sampling Plant as well as a group of workers who entered off-site mines. These results include gamma and beta exposures and are typically for two-week periods. There are no available data for workers who processed ore in the pilot plants.

DOE and AEC reports were used to obtain the maximum annual gamma exposure for the years 1960 through 1980. The reports listed the number of employees who received annual gamma exposure by numerical ranges (e.g., 0-1 rem, 1-2 rem, 2-3 rem). Reports from the years 1975 through 1980 listed ranges that were more finely divided (e.g., 0-0.10 rem, 0.10-0.25 rem). The reports neither list individuals nor provide any beta exposure information. For each year, Grand Junction employees were tabulated by range of exposure. NIOSH assumes that these employees were also wearing their dosimetry at off-site locations and acquiring exposure not associated with the site.

The REMS database was used to create a report for exposures associated with the Grand Junction Office. Data were found for the years 1985 through 2009. The report provided individual annual data for penetrating photon, shallow beta, and penetrating neutron exposures. These data are summarized in Table 6-6, *Statistical Data on Annual Photon Exposure, Reported by REMS for GJOO Personnel*. It is assumed that these data include persons who used their dosimetry at off-site locations. Employee interviews indicated that this was a common practice for this time period.

No external monitoring data were found for 1974 or the years 1981 through 1985 in either the DOE annual reports or in the REMS database.

Although the external dosimetry data are not available for all dates, reported dose ranges provide bounding values for photon exposure starting in 1960 when the site performed sampling and assay functions. There are reported ranges in published reports for the latter half of the 1970s during the NURE and GJRAP clean-up initiatives. There are also reported ranges from the REMS database for 1998 to 2001 that apparently include the period when neutron sources were used.

7.2 Evaluation of Bounding Internal Radiation Doses at GJOO

ATTRIBUTION: Section 7.2 and its related subsections were completed by Eugene Potter, Mel Chew & Associates. These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The principal source of internal radiation doses for members of the class under evaluation was the potential inhalation and ingestion of airborne natural uranium and its decay products by employees directly involved in refining, milling, and sampling of uranium ore or concentrates. Other employees were potentially exposed to the emissions from these facilities or the re-suspension of contamination on surfaces or in soil during the course of their work on site. The following subsections address the ability to bound internal doses, methods for bounding doses, and the feasibility of internal dose reconstruction.

7.2.1 Evaluation of Bounding Process-Related Internal Doses

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

7.2.1.1 Urinalysis Information and Available Data

As shown in Table 6-1, approximately 700 uranium urine and fecal samples for 1943-1999 have been captured from site and DOE records. The urinalysis program targeted workers who were directly exposed to the uranium ores and concentrates. Unmonitored workers were exposed to a small fraction of these sources. Data have been captured for the operation of the refinery, the Small Pilot Plant, and the Sampling Plants. No urine bioassay data have been captured for the Large Pilot Plant.

Some urinalysis and fecal analysis data for on-site remediation activities from 1986 through 2001 have been recovered. These data are from contractor bioassay laboratories; the data packages include quality assurance data and information.

7.2.1.2 Fecal Samples

Some fecal data for on-site remediation activities from 1986 through 2001 have been recovered. These data are from contractor bioassay laboratories; the data packages include quality assurance data and information.

7.2.1.3 Airborne Levels

Approximately 700 air sample results have been recovered from site and DOE records for 1945-1993. The details are shown in Table 6-2. Between 1945 and 1961, the results were generally particulate samples counted for gross alpha which was then interpreted as uranium. There are indications of daily-weighted-exposure studies done in the Large Pilot Plant in 1956 (Survey, 1956) and in the Sampling Plant in 1956 and 1959 (Lucius Pitkin, 1959), but only summary results have been captured (giving the highest or most significant exposures). For the 1960s, only radon or radon daughter results have been recovered. In 1985, 100 radon-daughter-concentration (RDC) measurements were located for each of three buildings that had once been used to process uranium. Thirty radon measurements were made of 19 buildings in 1989-1990 as a part of the DOE Indoor Radon Study (Radon, 1989-1990, pdf pp. 153-154). During remediation, GJO documents frequently cite the data from the DOE Indoor Radon Study in terms of Working Level (WL), assuming a typical indoor equilibrium factor of 0.5. Other WL measurements in 1989 for Buildings 6 and 31, and in 1997-1998 for Buildings 7, 28, 30, 31A, 32, 54, and 810 were located in the characterization data (Attachment 1). In addition to the data in Table 6-2, evidence has been captured of an extensive air sampling program during the D&D of the site buildings, including breathing zone samples (Airborne Radioparticulates, 1994).

7.2.1.4 Alternative Data Sources for Bounding Internal Dose

Alternative data include two sets of soil samples. The first set of soil samples was taken as part of an early-1985 survey and published in a 1986 report (Henwood, 1986). At the time of these measurements, only two small areas had been remediated. Therefore, the conditions represented the accumulated environmental contamination from the milling, sampling, and storage operations done on site. Most of the contaminated material was located at two sites, a tailings burial area and along a dike that bordered the Gunnison River in the southwest part of the site. Four buildings which had been part of the Large Pilot Plant were also surveyed. The buildings, which had been part of the Large Pilot Plant, were surrounded by shallow soil contamination. The interiors were surveyed for alpha contamination and radon daughter concentrations in air. The soil samples were characterized for Ra-226, Th-232, and K-40 using gamma-ray spectroscopy.

The second set of soil samples was taken in 1995 and the results are in a 1997 report issued by the Independent Verification Contractor after the remediation of the outdoor areas of the site (Forbes, 1997). The tailings had been removed from the site by the end of 1994. All of the buildings had been removed or decontaminated to acceptable levels. Although contamination may still have existed under buildings and asphalt, it was not likely to become airborne. The soil samples were characterized for Ra-226, Th-230, and total uranium.

Characterization data have been captured in a series of close-out reports for buildings decommissioned in 1989-2001 (see Attachment 1). These reports identify fixed and removable contamination found before remediation.

7.2.2 Evaluation of Bounding Ambient Environmental Internal Doses

In early 1975, the last of the stockpiled ore concentrates were shipped off site. After 1975, locations of possible discharge to the atmosphere were the Chemical Laboratory (Building 20) and the Sample Preparation Laboratory (Building 7). Both of these buildings were found to be minor sources (Environmental Monitoring, 1979). In 1983, a chamber for the study of radon measurements was constructed on site. Radon released from this facility was reported to be “insignificant” (Environmental Monitoring, 1984).

Particulates from ground-surface contamination and radon from buried tailings were also potential sources. There were no buildings or operational activities in the tailings area. In January 1980, a fence and warning signs were installed at the tailings burial site (Environmental Monitoring, 1979, pdf p. 10). In the early 1980s, radon from the tailings was considered to be the only significant source of airborne radiation. The environmental monitoring programs for radon and particulates were initiated in 1984 and 1985, respectively. In 1986, DOE made the statement that there are "no significant radionuclide emissions from GJPO facilities including the laboratories, sample preparation facility, and the radon chamber" (Air Emissions, 1985). It is likely that this had been the case at least since the ore concentrates had been removed from the site.

Data from the 1986 Environmental Monitoring Report (Environmental Monitoring, 1986) can be used to bound the environmental dose from particulates for the period February 1, 1975 through December 31, 1986 because conditions on site changed very little during this period. Radon environmental monitoring data were not reported until the 1987 Environmental Monitoring Report (Environmental

Monitoring, 1987). These radon data can be used to bound the environmental dose from radon for the period February 1, 1975 through December 31, 1987. Particulate and radon data for 1987-1993 (during the remediation period when site conditions changed) are available in the corresponding Environmental Monitoring Reports. For the remediation period (1986-2001), values for the total annual atmospheric release of radioactive material were also located (DOE, 2001; DOE, 2004; Environmental Monitoring, 1997). After removal of uranium mill tailings from open-land areas of the facility was completed in July 1994, three air monitoring programs designed to monitor the effect of GJORAP contamination on the facility's ambient air quality were discontinued (Environmental Monitoring, 1997). In November 1999, GJPO was included on the list of sites that do not conduct ambient air radioactive particulate or tritium monitoring (Baumann, 2000). For the period 1994-2001 (after the open land areas were remediated), data from the 1993 Environmental Monitoring Report can be used to bound the environmental dose from particulates and radon. Following a review of the available data, NIOSH has determined that, after 2001, environmental doses were equal to background radiation; the site was released for unrestricted use in 2001.

7.2.3 Methods for Bounding Internal Dose at Grand Junction

7.2.3.1 Methods for Bounding Operational Period Internal Dose

NIOSH finds it is not feasible to estimate internal dose with sufficient accuracy for all workers on site from March 23, 1943, through January 31, 1975 because there is insufficient information to estimate radon exposures from plant operations during this period. Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Grand Junction Operations Office during the period from March 23, 1943 through January 31, 1975, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

Bounding Uranium Inhalation Intakes from February 1, 1975 through July 31, 2010

By February 1, 1975, concentrate sampling operations had ended and the site mission had changed to mainly off-site work (e.g., NURE, UMTRA). Some workers occupied areas that had been used for sampling operations (e.g., converted to office space). The area contained mainly fixed contamination, but there was loose contamination in some overhead spaces, in walls, and in areas that were normally unoccupied. The workers were mainly exposed to residual yellowcake contamination. Some workers continued to be exposed to radioactive materials during sample preparation, laboratory operations, waste processing, etc. This work involved relatively small sample quantities. Air samples were taken at the Sampling Plant in July 1980 while ore samples were being prepared. The highest measured concentration was 0.0046 mg/m^3 (3.1 pCi/m^3) (Environmental Monitoring, 1980). While some of the process buildings from the Large Pilot Plant were still on site (Buildings 31, 33, 34, and 35), they were generally unoccupied and used for storage (D&D Report, 1995, pdf p. 15).

For an office worker scenario, a wealth of data was located in close-out survey reports. These reports summarized the characterization data that had been collected prior to the remediation or decommissioning of the site buildings. A summary of the characterization data is provided in Attachment 1. A review of the data indicates that most of the removable contamination was in inaccessible areas and was normally less than 1000 dpm/100 cm^2. This was also the GJO limit for removable alpha or beta-gamma contamination. Therefore, 1000 dpm/100 cm^2 could be used with an appropriate re-suspension factor and respiration rate to calculate a bounding intake for either an office worker exposed to residual contamination or an analytical laboratory worker whose work area would have been controlled to well below this level on a long-term basis.

Investigations for site remediation began in 1984. The remedial investigation/feasibility study (RI/FS) was done in 1989. The Record of Decision (ROD) was approved in 1990 (GJ MAP, 1996). The tailings were removed in 1989-1994. A close-out survey by the independent verification contractor (IVC) for the outdoor areas of the site was completed in 1995 (Forbes, 1997). Additional close-out surveys and verifications were done for each building on site that was released for unrestricted use (see Attachment 1). Each close-out report includes a statement about the successful use of health and safety practices during the clean-up. In 2001, the site was turned over to a non-profit corporation and DOE leased back office and laboratory space.

Thousands of pages of health and safety data (e.g., RWPs, survey maps, field measurements, air samples) have been recently captured for the period 1991-2007, when most of the D&D activities took place (Building 7 H&S Data, 1991-2001; Building 11 H&S Data, 1993-1997; Building 12 H&S Data, 1991-2000; Building 18 H&S Data, 1991-2001; Building 20 H&S Data, 1990-2000; Building 26 H&S Data, 1980-1998; Building 28 H&S Data, 1986-2000; Building 29 H&S Data, 1997; Building 31/31A H&S Data, 1990-1992; Building 36 H&S Data, 1992-1996; Health and Safety Checklists, 1990-1991). Some bioassay data have also been captured for the period 1995-1999. There is no database of results that can readily be used for a co-worker study. However, from these data it is evident that the most highly-exposed workers were monitored. If no data are available for a D&D worker, the bounding dose scenario can be constructed from the health and safety data. For example, Buildings 7 and 7A were used for sample preparation and were extensively contaminated. Building 7 was remediated to unrestricted area levels and was transferred to the U.S. Army Reserve. Contaminated concrete was removed with a concrete saw and jack-hammer or "scabbled" (mechanical removal of a thin layer by a power tool). Walls with internal contamination were removed and rebuilt. Health and Safety monitoring data are available for these operations (Building 7 H&S Data, 1991-2001; Building 7A H&S Data, 1991-2001; Building 7A H&S Data, 2001; Building 7 H&S Data - Phase I, 1972-1999; Building 7 H&S Data - Phase II, 1980-2000). The bounding dose could then be assigned to other years with less data or less-intrusive work. NIOSH concludes that sufficient data are available to bound doses for D&D workers. By extension, these doses would bound workers with jobs requiring less exposure to contaminated materials.

<u>Bounding Inhalation Intakes from Ra-226, Th-230, and Th-232</u>

During a site characterization in 1985, the Th-232 in soils was insignificant compared to Ra-226 and would contribute a negligible additional dose (Henwood, 1986, pdf pp. 47-54).

For 1975-2001, the primary source term for an office worker in a former sampling building was yellowcake. Sample preparation and analytical laboratory workers were mainly exposed to non-ore materials and occasionally ore samples during NURE work. The UMTRA program and other environmental restoration activities carried out by the GJO only required the analysis of relatively small, low-activity samples. However, the chemical work was carried out in fume hoods. Protection from the highly-toxic acids used to digest rock samples would also have protected the workers from radioactive materials (Environmental Monitoring, 1980). Similarly, the sample preparation area required adequate ventilation to protect workers from silica dust, which would also have provided protection from radioactive materials. D&D workers were exposed to yellowcake during D&D of the sampling buildings (e.g., Buildings 7 and 7A). They were also potentially exposed to tailings during D&D of the former Large Pilot Plant buildings (31, 33, 34, and 35). Workers (mainly subcontractors) were exposed to tailings during the remediation of tailings and open land areas in 1989-1994. There is ample evidence of protective measures (i.e., dust suppression), H&S monitoring, and bioassays being collected during these operations (Health and Safety Checklists, 1990-1991). Some bioassay samples were analyzed for Th-230 and Ra-226 (see Table 6-1), indicating the site's awareness of the hazards of uranium tailings. Other workers on site who were not directly involved in the D&D of the former Large Pilot Plant buildings or the remediation of open land areas may have been exposed to Ra-226 and Th-230 from tailings as a result of this work. The dose to these workers can be accounted for by assigning ambient environmental internal dose.

Bounding Intakes of Radon and Radon Decay Products

Radon in the outdoor environment is discussed in Section 7.2.3.2. No data on radon in the buildings have been recovered for the operational period (March 23, 1943 through January 31, 1975). By February 1975, the last of the 103,776 drums of uranium concentrates had been shipped from the site. Because these drums contained between a few hundred pounds to a few tons of Ra-226, they probably represented a relatively minor source of radon exposures. Although concentrate sampling operations were reported to have ended in 1971, it is unclear whether this also applied to ore sampling, which was a potential source of radon exposures. In any case, by February 1975, the amount of material stored on site was greatly reduced and the site's primary mission was the NURE program.

The NURE program was not a uranium exploration program. Rather, extensive geologic studies were done to identify and evaluate geologic environments favorable for locating uranium (Albrethsen, 1986). On-site sample preparation and analytical activities were primarily on non-ore materials. After the operational period ended on January 31, 1975, the Ra-226 in surface contamination, and in soils under/around the buildings remained relatively constant until the remediation of the outdoor areas.

Radon in buildings was studied extensively in the D&D era (1989-2001). There are indoor radon-decay-product measurements for most of the buildings, including 300 daughter measurements taken in 1985 in some of the former pilot plant buildings. Only Building 34, the former boiler building for the Large Pilot Plant, exceeded 0.02 WL (averaged over 100 hours) (Henwood, 1986, pdf p. 36). This building had been used to store ore and yellowcake and was not routinely occupied (Facility Tour, 1984, pdf p. 2). In 1990, the site implemented and participated in the DOE radon study that included all occupied buildings on site at that time. The study's measurements were representative of the highest radon levels in those portions of the buildings that were fit for occupancy (Radon, 1989-1990, pdf p. 19). An analysis of these data indicates that the median concentrations were less than 2 pCi/l or 0.010 WL. Only three buildings were greater than 4 pCi/l or 0.020 WL: Building 26 (4.5 pCi/l), Building 30B (5.7 pCi/l), and Building 32 (4.9 pCi/l). These buildings were reassessed in 1997-1998 after remediation and all measured less than 0.008 WL (1.6 pCi/l) (Attachment 1). The available radon measurements can be used to establish a bounding dose from radon and radon decay products for February 1, 1975 to December 31, 2001. After 2001, the site radon values were reduced to background levels and there were no occupational exposures to radon at the GJO site.

7.2.3.2 Methods for Bounding Ambient Environmental Internal Dose

Because environmental conditions on site changed very little during the period February 1, 1975 through December 31, 1986, airborne concentrations of total uranium, Th-230, and Ra-226 measured at three locations and reported in the 1986 Environmental Monitoring Report were used to calculate bounding intakes of particulates for this period (Environmental Monitoring, 1986). Both a mean concentration and the maximum concentration per year were reported. The 1986 values included all particulates, even those above the 10 micron respirable range. The reported concentrations did not include any background subtraction; therefore, the maximum concentration values are bounding for the 1975-1986 period. For each year during the important outdoor remediation period (1987-1993), annual measured concentrations are also available. Since remediation of the outdoor areas had been completed, the period 1994-2001 is represented by the 1993 values. To calculate the maximum intakes, a breathing rate of 1.2 m^3/hour and an exposure time of 2,000 hours per year were assumed. No solubility information was located. Ingestion intakes were assumed to be 2.1% of the inhalation intakes. The results are presented in Table 7-1.

Table 7-1: Bounding Particulate Environmental Intakes, 1975-2001

Time Period	Uranium		Th-230		Ra-226	
	Inhalation (pCi/yr)	Ingestion (pCi/yr)	Inhalation (pCi/yr)	Ingestion (pCi/yr)	Inhalation (pCi/yr)	Ingestion (pCi/yr)
2/1/75-1986	1.20E+01	2.51E-01	2.40E+00	5.04E-02	2.06E+00	4.32E-02
1987	4.80E-01	1.01E-02	5.52E+00	1.16E-01	3.12E+00	6.55E-02
1988	1.27E+00	2.67E-02	4.08E+00	8.57E-02	5.28E+00	1.11E-01
1989	1.73E+01	3.63E-01	3.36E+00	7.06E-02	3.84E+00	8.06E-02
1990	9.12E+00	1.92E-01	4.32E+00	9.07E-02	3.84E+00	8.06E-02
1991	5.49E+01	1.15E+00	1.70E+01	3.58E-01	7.74E+00	1.63E-01
1992	1.92E+00	4.03E-02	4.56E+00	9.58E-02	5.04E+00	1.06E-01
1993-2001	2.09E+00	4.38E-02	1.25E+00	2.62E-02	1.08E+00	2.27E-02

Radon environmental monitoring data were not reported until the 1987 Environmental Monitoring Report. However, the report states that the “radon values measured during this more recent period are also consistent with the previous years’ annual averages, which indicates a constant rate of radon emission from the contaminated areas” (Environmental Monitoring, 1987). For 1987 through 1993, annual average concentrations in µCi/ml for three to eight stations per year are available. Importantly, radon data are available during the remediation period when site conditions changed. More monitoring stations were used during the invasive tailings removal work in 1991-1993. For 1987-1991, the annual values reported were for November of the previous year to November of the reported year. Any slight differences in the values for the calendar year were ignored for this analysis. For 1992-1993, the annual values reported closely matched the calendar year. The 1987 maximum annual average data can be used to bound the environmental dose from radon for the period February 1, 1975 through December 3, 1987. For 1988-1993, annual maximum averages are available. The data from the 1993 Environmental Report is representative of the period 1994-2001. After 2001, radon was reduced to background levels and no radon dose is assigned. The maximum annual average radon value for each year was used to calculate the radon-daughter maximum working level months per year by assuming a typical outdoor equilibrium factor of 0.3, 2000 hours per year of exposure, and 170 hours per working level month. The data are presented in Table 7-2. It should be noted that none of the reported annual radon averages included a background subtraction (Environmental Monitoring, 1987). In 1988, the background in the Grand Junction area was reported to be 8.4 x 10^{-10} µCi/ml (Environmental Monitoring, 1988).

Table 7-2: Bounding Radon Daughter Intakes, 1975-2001

Time Period	Radon Concentration (µCi/ml)	Radon Concentration (pCi/l)	WL	WLM/yr
2/1/75-1987	1.80E-09	1.80E+00	5.40E-03	6.35E-02
1988	3.30E-09	3.30E+00	9.90E-03	1.16E-01
1989	3.50E-09	3.50E+00	1.05E-02	1.24E-01
1990	1.80E-09	1.80E+00	5.40E-03	6.35E-02
1991	1.54E-09	1.54E+00	4.61E-03	5.43E-02
1992	9.13E-10	9.13E-01	2.74E-03	3.22E-02
1993-2001	5.80E-10	5.80E-01	1.74E-03	2.05E-02

7.2.4 Internal Dose Reconstruction Feasibility Conclusion

NIOSH finds it is not feasible to estimate internal dose with sufficient accuracy for all workers on site from March 23, 1943 through January 31, 1975. There is insufficient information to estimate radon exposures from plant operations during this period. By February 1, 1975, sampling operations had ended, the amount of material stored on site was greatly reduced, and the site's primary mission was the NURE program. Although geological samples were still analyzed on site, the quantities were much smaller than during the uranium procurement program and they were mainly non-ore materials. The UMTRA program and other environmental restoration activities carried out by the GJO only required the analysis of relatively small, low-activity samples. On site, the workers were mainly exposed to residual contamination until D&D operations began. NIOSH has identified sufficient information and data related to residual contamination in the buildings and air samples during the D&D operations to support bounding internal dose for the February 1, 1975 through July 31, 2010 period using available methodologies.

Although NIOSH found that it is not possible to completely reconstruct internal radiation doses for the period from March 23, 1943 through January 31, 1975, NIOSH intends to use any internal monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at the Grand Junction Operations Office during the period from March 23, 1943 through January 31, 1975, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.3 Evaluation of Bounding External Radiation Doses at GJOO

ATTRIBUTION: Section 7.3 was completed by Roger Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

The principal source of external radiation doses for members of the evaluated class was uranium progeny, primarily radium-226 for penetrating photon exposures and protactinium-234m for shallow beta exposures.

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

NIOSH found no dosimetry records prior to November 1952. Limited film badge data are available from November 1952 through 1959. Available data include Sampling Plant workers and a group of workers who received off-site exposure. No dosimetry results are available for pilot plant workers, nor are there summary reports of site exposures for all operations. There are site exposure summary data starting in 1960, which include the sampling and assay and laboratory era, the remediation era, and the post-remediation era. Some of the reviewed data can be associated with personnel on particular projects or operations; the values likely included off-site exposures for certain workers. It is assumed that personnel with the greatest exposures, regardless of the operation, were issued film badges.

Photon

Film badge data from the 1950s include photon exposure. These results are identifiable by name and date. The greatest majority of the film badge results were listed as zero exposures. The reports include the statement: "NOTE: Where no exposure figure is given, the measured exposure is less than 150 mR or equivalent." However, dose reports for those workers who received measured dose in that era (mainly workers receiving dose for entry into off-site mines) routinely included measured dose much lower than 150 mR.

From 1960 through 1980, with the exception of 1974, AEC and DOE reports summarized data for Grand Junction employees. These reports state the number of employees who received photon exposure within specified numeric ranges.

No data were found for the years 1981 through 1985 in either the DOE annual reports or in the REMS database.

For the data obtained from the REMS system for the years 1985 through 2009, the system reported annual exposure results for individuals. These data are summarized in Table 6-4.

Although external dosimetry data are not available for all years, there are annual dose reports that provide bounding values for photon exposures for the 1960s during the period when the site continued with assay and laboratory functions. There are reported ranges in published reports for the latter half of the 1970s during the NURE and GJRAP clean-up initiatives; and there are detailed data from the REMS database for the years from 1985 through 2009.

Beta

Film badge data from the 1950s include beta exposure. These results are identifiable by name and date. The greatest majority of the film badge results for the monitored Sampling Plant workers were listed as zero exposures. The reports included a statement that said: "NOTE: Where no exposure figure is given, the measured exposure is less than 150 mR or equivalent."

From 1960 through 1980, DOE and AEC reports summarized data for Grand Junction employees. These reports do not include beta exposure results.

For the data obtained from the REMS database for the years 1985 through 2009, the annual beta exposure is reported. These data are summarized in Table 6-5.

Although external dosimetry data are not available for all years, there are representative film badge data with photon and beta results. During the life of the site, the same materials were encountered by the workers, albeit in varying amounts. It would be expected that available data that include a ratio of beta to gamma exposures would provide a representative ratio for other years of operation.

Neutron

The only neutron exposure data reviewed were from the REMS system, which reported annual neutron exposures between 1986 and 2005. Only a few individuals (in some years, only one) were reported to have received exposures greater than zero. These data are summarized in Table 6-6.

7.3.1.2 Area Monitoring Data

There are very few area monitoring data prior to 1968, and only qualitative results have been found in the documents that were reviewed. A July 1945 report indicated that "no radiation hazard exists in the Colorado Area" (Inspection, 1945, pdf p. 9). In the same document, a result of "1 mR/8hrs" was reported from a measurement taken two inches above a closed barrel of relatively high-grade ore. A measurement result of 2 mR/8 hours was also reported for six inches above the barrel with the lid removed. The document specified that the ore contained 30% uranium.

In a memo detailing a visit to the sampling plant in 1953, it is stated that “No radiation hazard exists in the plant” (Site Visit, 1953). A 1956 memo about a Grand Junction Pilot Plant survey states, “Direct radiation and radium concentrations were found to be insignificant” (Survey, 1956).

In 1968, as part of a radon study, several CaF_2 TLDs were placed three feet above the ground at various locations, including directly over tailings piles. The readings over the piles were 0.2 and 0.4 mR/hr; all other readings were reported as 0.020 mR/hr (Public Health Service, 1969).

In 1980, a site-wide survey was performed measuring ambient levels at 424 points, both inside and outside the buildings (Survey, 1980). This survey may best represent site conditions prior to the remediation activities that began in 1988. Readings were taken with a portable ionization chamber coupled to a Victoreen femtometer on a 100-foot grid at waist height. This survey determined that elevated readings were associated with buried tailings piles and were “located well away from daily work areas for compound employees” (Survey, 1980, pdf p. 9). This same report indicated that the highest reading for an inhabited building was 62 μR/hr, and the average compound employee would receive approximately 102 millirem per year. Note that this figure includes exposure from both on-site sources and local background.

During the remediation of the site under the GJORAP program, extensive verification surveys of the exterior areas were performed between 1989 and 1995 by the Oak Ridge National Laboratory (ORNL) (Forbes, 1997). The primary purpose of these surveys was to seek out and screen contaminated materials rather than assess ambient exposure levels; however, the report contains specific locations of elevated readings and many maps delineating the gamma exposure ranges and their lateral extent (Forbes, 1997, pdf pp. 37-41, 66-79).

In September 1995, DOE published the *Final Report of the Decontamination and Decommissioning of the Exterior Land Areas at the Grand Junction Projects Office Facility* (D&D Report, 1995). Table D-1 in Appendix D of that report contains several thousand verification measurements showing the ambient gamma exposure rates. The listed values were typically in the 14 to 20 μR/hr range with some measurements exceeding a few hundred microroentgens per hour, with the highest reading being 767 μR/hr (D&D Report, 1995, pdf pp. 68-92).

7.3.2 Evaluation of Bounding Ambient Environmental External Doses

For the time period prior to the remediation work, the ambient levels were low and difficult to distinguish from background levels. This is supported by several statements in memos and reports, and numerically by the 1968 TLD data collected as part of a radon study (Public Health Service, 1969). The 1968 data indicate a value of 20 μR/hr for all locations except those directly on the tailings piles; those locations were measured as high as 0.4 mR/hr. In a *Radiometric Survey of the Grand Junction Facility, March 1980,* the average value for exterior readings (including those collected over the tailings piles) was 22.82 μR/hr. This same report indicated that the highest reading for an inhabited building was 62 μR/hr, and the average compound employee would receive approximately 102 millirem per year (Survey, 1980, pdf p. 12). These results included the local background radiation. These values may be considered representative of all years prior to the remediation activities.

The *Final Report of the Decontamination and Decommissioning of the Exterior Land Areas at the Grand Junction Projects Office Facility* states that the exterior land areas had been remediated for release for unrestricted use (D&D Report, 1995, pdf p. 9). In the table, *Post Excavation Sampling and Measurement Results for Exterior Land Use* (D&D Report, 1995, pdf pp. 68-92), the greatest majority of readings fell below 20 μR/hr. These results may be considered representative of the post-remediation condition of the site.

7.3.3 Grand Junction Occupational X-Ray Examinations

ATTRIBUTION: Section 6.2 was completed by Roger Halsey, Oak Ridge Associated Universities (ORAU). These conclusions were peer-reviewed by the individuals listed on the cover page. The rationales for all conclusions in this document are explained in the associated text.

Semi-annual medical examinations with annual chest X-rays were initially recommended for Grand Junction in 1943 (Ruhoff, 1943).

Information on the X-ray frequency, type, and (for certain years) the model of X-ray machine with the actual settings used has been documented for Grand Junction. Generally, chest X-rays were administered for new hires and annually thereafter. For the years 1989 through 1992, an additional lateral chest X-ray was performed for new hires (Site X-Ray History, undated).

For years prior to 1947, it is unclear whether the X-rays were taken on or off site. For the years 1947 through 1961, X-rays were taken off site at an uncovered facility. The dose from X-rays at an off-site, uncovered facility is not included during dose reconstruction. For 1962 through 1969, X-rays were taken with a portable unit brought to the Grand Junction Office; after 1969, they were taken off site at an uncovered facility (Site X-Ray History, undated).

The medical X-ray dose can be bound using these data along with the assumptions contained in the technical information bulletin, *Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures* (ORAUT-OTIB-0006).

7.3.4 Methods for Bounding External Dose at Grand Junction

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
- Neutron Dose
- Medical X-ray Dose

7.3.4.1 Methods for Bounding Operational Period External Dose

Photon Dose

There are no dosimetry or area radiation surveys available for exposures in the refinery or during the operational years of the pilot plants. Limited data are available for 1952 through 1959. Therefore, photon dose cannot be reconstructed for all exposures from 1943 through 1959. Photon dose can be reconstructed from 1960 through July 31, 2010.

For 1960 through 1973, only summary data from AEC and DOE reports are available. The summary data indicate the maximum value that any single employee may have received. For all years from 1960 through 1973, with the exception of 1970, the maximum value is 1 rem per year. For 1970, the maximum possible value is 2 rem. This is also a very conservative estimate as the ranges reported were from 0 to 1 rem and any positive result would have caused the result to fall within that range. In addition, it is expected that the reported results would have included off-site exposure. These values may be used as a bounding estimate for these years for an exposed worker without personal dosimetry results (e.g., operator, laborer, construction worker, scientist, or engineer). Ambient environmental exposure should be applied as the bounding estimate for those workers not exposed to radioactive material (e.g., office workers).

Grand Junction was not listed in the DOE report for 1974 but it appeared again in reports for subsequent years. This may indicate that no one on the site was using dosimetry. Nevertheless, because site activities are not known to have changed significantly between 1973 and 1974, a value of 1 rem may also be used for 1974.

From 1975 through 1980, Grand Junction appears again in DOE reports. The maximum value for anyone in 1975 was 0.75 rem. For 1976, all results were reported as less than measurable. For 1977, the maximum value was 0.50 rem; for 1978, it was 0.50 rem; for 1979, it was 0.75 rem, and for 1980 it was 1.00 rem. For these years, these maximum values may be used as a bounding estimate for an exposed worker (e.g., operator, laborer, construction worker, scientist, or engineer) without personal dosimetry results. Ambient environmental exposure should be applied as the bounding estimate for those workers not exposed to radioactive material (e.g., office workers).

For years after 1980, Grand Junction is not listed in the DOE reports. However, documentation indicates that all workers wore TLDs during site remediation through 1992. In 1992, the number of workers wearing TLDs was reduced "because monitoring had been conducted in the construction area by Health, Safety and Security personnel and TLD results, to this time, had not indicated any exposures above background for the workers in the vicinity of GJPORAP radiological waste" (D&D Report, 1995, pdf p. 32).

The data supplied by the REMS database for 1985 through 2009 underwent a statistical analysis of all annual exposures greater than zero. As most reported results were zero, this causes a positive bias by shifting all results higher. Had the zeros been included, the statistical means would have been lower. These results may be used to estimate exposure for anyone who does not have personal exposure data. The 1985 data may be extended retroactively to cover the time between 1981 and 1984, when similar work was occurring at the site. Ambient environmental exposure should be applied as the bounding estimate for those workers not exposed to radioactive material (e.g., office workers).

Beta Dose

Film badge records from the 1950s include beta and gamma results. However, no other beta exposure data were available in the reviewed documents. For all positive film badge results, the average ratio is 1.2 millirem beta to 1.0 millirem gamma.

The radioactive materials at Grand Junction and at the off-site locations where employees wore their film badges were comprised of uranium and uranium decay progeny. There was no location with beta exposure without gamma exposure or gamma exposure without beta exposure. The beta-to-gamma ratio from these film badge data may reasonably be used to estimate beta exposure from all gamma exposure in later years. There was concern that dust accumulation on the badges would influence the results (Harris, D. G., 1957). Any such dust would have caused a greater beta exposure relative to the gamma exposure and influenced the ratio upward. However, this ratio may be used to estimate beta exposure in the absence of dosimetry records. The ratio would apply to all years and for all job titles.

The data supplied by the REMS database for 1985 through 2009 underwent a statistical analysis of all annual beta exposures greater than zero. Because most reported results were zero, this causes a conservative bias by shifting all results higher. Had the zeros been included, the statistical means would have been lower. These results may be used to estimate exposure for anyone who does not have personal exposure data. The 1985 data may be extended retroactively to cover the time between 1981 and 1984, when similar work was occurring at the site.

Neutron Dose

Neutron sources were used at the Grand Junction site. All personnel involved wore dosimetry that measured neutron exposure (Personal Communication, 2010b).

The data supplied by the REMS database for 1985 through 2009 underwent a statistical analysis of all the annual neutron exposures greater than zero. Because most reported results were zero, this causes a conservative bias by shifting all results higher. Had the zeros been included, the statistical means would have been lower. These values may be used to provide an upper bound on neutron exposure from 1985 through 2009 for scientists and engineers who do not have personal dosimetry.

Medical X-ray Dose

On-site medical X-ray dose may be estimated by using the relatively-detailed information that has been documented for the site (Site X-Ray History, undated). The only known period when the X-rays were performed on site was between 1962 and 1969 using a portable X-ray unit.

The medical X-ray dose from on-site administration may be calculated using the assumptions contained in the technical information bulletin, *Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures* (ORAUT-OTIB-0006).

7.3.4.2 Methods for Bounding Ambient Environmental External Doses

There are direct survey data available that are representative of the time period prior to remediation and the time period after remediation. Higher values that were encountered during remediation (i.e., during the times when the tailings piles were exposed) applied only to the workers involved and would be included with their occupational exposure.

For the time after remediation, a value of 20 μR/hr is representative of the ambient exposure. This value is conservative because it includes any background that would have existed absent the existence of the site. Note that in the 1980 survey, a background of 11 μR/hr was estimated (Survey, 1982, pdf p. 16).

7.3.5 External Dose Reconstruction Feasibility Conclusion

NIOSH has not found sufficient data to support bounding external doses prior to 1960. Therefore, NIOSH concludes that it is infeasible to reconstruct all external doses from March 23, 1943 through December 31, 1959.

For the period from January 1, 1960 through July 31, 2010, NIOSH concludes that there are sufficient data to estimate bounding levels for external exposure. Exposures were reported to the AEC and DOE and summarized in annual reports. Those reports were used to provide a conservative upper bound for external exposure. For the years 1985 through 2009, many individual annual exposures are available and may be used to bound doses for individuals without individual dosimetry. General information, supported by site-wide surveys performed before and after remediation activities, documents near-background exposure levels. For those years where data are absent, conservative estimates were developed based on consistent site activity.

Although NIOSH found that it is not possible to completely reconstruct external radiation doses prior to 1960, NIOSH intends to use any external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Dose reconstructions for individuals employed at Grand Junction Operations Office during the period from March 23, 1943 through December 31, 1959, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.4 Evaluation of Petition Basis for SEC-00175

The following assertion was made on behalf of petition SEC-00175 for the Grand Junction Operations Office.

Lack of Radiological Monitoring

SEC-00175: …*In talking to numerous people who were employed at the Grand Junction operations office* [sic], *working at the facility myself in* [date redacted], *and looking for records, I found that employees at this facility were never monitored, including laborers (includes my* [relationship redacted] *who was a* [job titles redacted]*) painters and grounds persons…*

It was GJOO policy to only monitor those employees likely to be exposed to radioactive materials. NIOSH has located internal and external monitoring data for the GJOO site. As detailed in this evaluation, it is not feasible to reconstruct internal dose from radon from March 23, 1943 through January 31, 1975. There are sufficient data to reconstruct internal dose for the period from February 1, 1975 through July 31, 2010. There are insufficient data to reconstruct external dose for the period from March 23, 1943 through December 31, 1959. There are sufficient data to reconstruct external dose for the period from January 1, 1960 through July 31, 2010.

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at Grand Junction Operations Office during the period from March 23, 1943 through January 31, 1975, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

7.5 Summary of Feasibility Findings for Petition SEC-00175

This report evaluates the feasibility for completing dose reconstructions for employees at the Grand Junction Operations Office from 1943 through July 31, 2010. NIOSH found that the available monitoring records, process descriptions and source term data available are insufficient to estimate the complete radiation dose for the period from March 23, 1943 through January 31, 1975. Doses for later years (February 1, 1975 through July 31, 2010) can be reconstructed.

Table 7-3 summarizes the results of the feasibility findings at the Grand Junction Operations Office for each exposure source during the time period from March 23, 1943 through July 31, 2010.

Table 7-3: Summary of Feasibility Findings for SEC-00175

Source of Exposure	March 23, 1943 through January 31, 1975		February 1, 1975 through July 31, 2010	
	Reconstruction Feasible	Reconstruction Not Feasible	Reconstruction Feasible	Reconstruction Not Feasible
Internal[1]		**X**	**X**	
- Radon		X	X	
External	**X** (Jan 1, 1960 through Jan 31, 1975)	**X** (Mar 23, 1943 through Dec 31, 1959)	**X**	
- Gamma	X	X	X	
- Beta	X	X	X	
- Neutron	X	N/A	X	
- Occupational Medical X-ray	X (Mar 23, 1943 through Jan 31, 1975)		X	

[1] Internal includes an evaluation of urinalysis (*in vitro*), air sample, and soil data

As of December 22, 2010, a total of 58 claims have been submitted to NIOSH for individuals who worked at the Grand Junction Operations Office and are covered by the class definition evaluated in this report. Dose reconstructions have been completed for 48 individuals (~83%).

Although NIOSH found that it is not possible to completely reconstruct radiation doses for the proposed class, NIOSH intends to use any internal and external monitoring data that may become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures). Therefore, dose reconstructions for individuals employed at the Grand Junction Operations Office during the period from March 23, 1943 through January 31, 1975, but who do not qualify for inclusion in the SEC, may be performed using these data as appropriate.

8.0 Evaluation of Health Endangerment for Petition SEC-00175

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's evaluation determined that it is not feasible to estimate the complete radiation dose for all workers from March 23, 1943 through January 31, 1975. Modification of the class definition regarding health endangerment and minimum required employment periods, therefore, is required. For the later years in the evaluated class (February 1, 1975 through July 31, 2010), a health endangerment determination is not required because NIOSH has determined that it has an established methodology for estimating dose.

9.0 Class Conclusion for Petition SEC-00175

Based on its full research of the class under evaluation, NIOSH has defined a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. The NIOSH-proposed class to be added to the SEC includes all employees of the Department of Energy, its predecessor agencies, and its contractors and subcontractors who worked at the Grand Junction Operations Office from March 23, 1943 through January 31, 1975, for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

The class under evaluation was divided because there is a lack of radon data for reconstructing internal dose. By February 1, 1975, sampling operations had ended, and the site mission had changed to mainly off-site work. The large quantities of uranium concentrate were removed from the site. There are sufficient data to reconstruct internal dose for the period from February 1, 1975 through July 31, 2010. External exposures cannot plausibly be estimated for March 23, 1943 through December 31, 1959 because NIOSH has not found sufficient data to bound external doses prior to 1960. There are sufficient data to reconstruct external dose for the period from January 1, 1960 through July 31, 2010.

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-00175. 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.

10.0 References

29 C.F.R. pt. 1910, *Occupational Safety and Health Standards;* Part 1910.1000 to End; U.S. Department of Labor; 1999; SRDB Ref ID: 44836

42 C.F.R. pt. 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000;* Final Rule, Federal Register/Vol. 67, No. 85/Thursday, p. 22,296; May 2, 2002; SRDB Ref ID: 19391

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

42 U.S.C. §§ 7384-7385 [EEOICPA], *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended

Affidavit, 2010, *Affidavit from Survivor in Support of SEC Petition SEC-00175*; June 25, 2010; OSA Ref ID: 112121

Air Emissions, 1985, *Various Air Emissions Annual Reports for Multiple Sites*; various dates throughout 1985; SRDB Ref ID: 29855

Air Dust Results, 1956-57, *Air Dust Results for National Lead, Grand Junction, Colorado*, U. S. Atomic Energy Commission, NYOO Medical Division; various dates in 1956-57; SRDB Ref ID: 10241, pdf pp. 25-27

Air Dust Results, 1959-61, *Air Dust Results for Grand Junction Operations Office*, U. S. Atomic Energy Commission, NYOO Medical Division; various dates in 1959-61; SRDB Ref ID: 11452, pdf pp. 428-435

Airborne Radioparticulates, 1994, Airborne Radioparticulate Sampling Data Sheets, Grand Junction Projects Office (GJPO); various dates in 1994; SRDB Ref ID: 89872, pdf pp. 275-341

Albrethsen, 1986, *A Summary History of the Activities of the Grand Junction Office of the AEC, ERDA, and DOE*; Al Albrethsen, Bill Chenoweth, and Frank McGinley; September 1986; SRDB Ref ID: 76371

Battelle-TBD-6001, *Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium*, Rev. F0; December 13, 2006; SRDB Ref ID: 30673

Baumann, 2000, *A Compilation of Ambient Air Monitoring Parameters at DOE Facilities*; Alice R. Baumann; submitted to the 2000 American Radiation Safety Conference and Exposition for June 2000; SRDB Ref ID: 22441

Building 7 Bioassay, 1994, *Bioassay Results Related to Building 7 Radiological Hold*, memo to Distribution from V. A. King; Rust Geotech, Inc.; June 28, 1994; SRDB Ref ID: 89872, pdf p. 121

Building 7 H&S Data, 1991-2001, *Compilation of Building 7 Health and Safety Information and Data*, various contractors at the Grand Junction Projects Office; various dates in 1991-2001; SRDB Ref ID: 89872

Building 7 H&S Data - Phase I, 1972-1999, *Compilation of Building 7 Phase I Health and Safety Information and Data*, various contractors at the Grand Junction Projects Office; various dates in 1972-1999; SRDB Ref ID: 90164

Building 7 H&S Data - Phase II, 1980-2000, *Compilation of Building 7 Phase II Health and Safety Information and Data*, various contractors at the Grand Junction Projects Office; various dates in 1980-2000; SRDB Ref ID: 90155

Building 7A H&S Data, 1991-2001, *Compilation of Building 7A Health and Safety Information and Data*, various contractors at the Grand Junction Projects Office; various dates in 1991-2001; SRDB Ref ID: 90118

Building 7A H&S Data, 2001, *Compilation of Building 7A Health and Safety Information and Data*, various contractors at the Grand Junction Projects Office; various dates in 2001; SRDB Ref ID: 90154

Building 11 H&S Data, 1993-1997, *Compilation of Building 11 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1993-1997; SRDB Ref ID: 89928

Building 12 H&S Data, 1991-2000, *Compilation of Building 12 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1991-2000; SRDB Ref ID: 89926

Building 18 H&S Data, 1991-2001, *Compilation of Building 18 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1991-2001; SRDB Ref ID: 89931

Building 20 H&S Data, 1990-2000, *Compilation of Building 20 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1990-2000; SRDB Ref ID: 89938

Building 26 H&S Data, 1980-1998, *Compilation of Building 26 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1980-1998; SRDB Ref ID: 89942

Building 28 H&S Data, 1986-2000, *Compilation of Building 28 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1986-2000; SRDB Ref ID: 89979

Building 29 H&S Data, 1997, *Compilation of Building 29 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1997; SRDB Ref ID: 89966

Building 31/31A H&S Data, 1990-1992, *Compilation of Building 31/31A Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1990-1992; SRDB Ref ID: 89991

Building 36 H&S Data, 1992-1996, *Compilation of Building 36 Health and Safety Information and Data*, various contractors at the Grand Junction Office (GJO); various dates in 1992-1996; SRDB Ref ID: 90015

Building 52 D&D, 1996, *Final Report of the Decontamination and Decommissioning of Building 52 at the Grand Junction Projects Office Facility*, U.S. Department of Energy, Grand Junction Projects Office Remedial Action Project; August 1996; SRDB Ref ID: 90166

Chenoweth, 1997, *Raw Materials Activities of the Manhattan Project on the Colorado Plateau*, William L. Chenoweth, Nonrenewable Resources, Vol. 6, No. 1; 1997; SRDB Ref ID: 3325, pdf pp. 27-35

Contract Modification, 1963-1970, *U.S. Atomic Energy Commission Division of Raw Materials Grand Junction Office Modification No. 5 to Contract No. AT(05-1)-266 and Related Agreements with Atlas Minerals Division of Atlas Corporation*, reported in two volumes; contract modification effective from July 1, 1963 through December 31, 1970; SRDB Ref ID: 75875

Contractor History, 1943-2002, *Prime Contractors at the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado*, description of contractors from August 1943-July 2002; unspecified author; unspecified date, but written sometime after July 2002; SRDB Ref ID: 76366

D&D Report, 1995, *Final Report of the Decontamination and Decommissioning of the Exterior Land Areas at the Grand Junction Projects Office Facility*, U.S. Department of Energy, Grand Junction Projects Office Remedial Action Project; September 1995; SRDB Ref ID: 88610

DOE, unspecified, *Environmental Management Grand Junction Projects Office Site Summary Projections*; Department of Energy (DOE); unspecified date; SRDB Ref ID: 88323

DOE, 1993, *Fiftieth Anniversary of the Grand Junction Projects Office*; Department of Energy (DOE); assumed date of 1993 (history of GJPO began in 1943); SRDB Ref ID: 76370

DOE, 2001, *Summary Site Environmental Report Radiological Doses and Releases for 1990-1994*; Department of Energy (DOE); September 2001; SRDB Ref ID: 37700

DOE, 2004, *Summary Annual Site Environmental Report Radiological Doses and Releases for 1998-2004*; Department of Energy (DOE); December 2004; SRDB Ref ID: 44873

Dust Samples, 1945, *Report of Dust Samples Taken at the Colorado Area from 13-20 June 1945*, Captain J. L. Ferry, Medical Corps, U.S. Engineer Office, Manhattan District; July 11, 1945; SRDB Ref ID: 16855, pdf pp. 15-17

Environmental Monitoring, 1979, *1979 Environmental Monitoring Report for the U.S. Department of Energy Facilities in Grand Junction, Colorado, and Monticello, Utah*; prepared by Bendix Field Engineering Corporation; April 1980; SRDB Ref ID: 90858

Environmental Monitoring, 1980, *1980 Environmental Monitoring Report for the U.S. Department of Energy Facilities Grand Junction, Colorado, and Monticello, Utah*; prepared by Nic Korte and Ralph Thul, Bendix Field Engineering Corporation; April 1981; SRDB Ref ID: 90862

Environmental Monitoring, 1984, *Environmental Monitoring Report on Department of Energy Facilities at Grand Junction, Colorado, and Monticello, Utah, for Calendar Year 1984*; prepared by Nic Korte and Sandra Wagner, Bendix Field Engineering Corporation; March 1985; SRDB Ref ID: 90859

Environmental Monitoring, 1986, *Environmental Monitoring Report on Department of Energy Facilities at Grand Junction, Colorado, and Monticello, Utah, for Calendar Year 1986*; prepared by Michael Sewell and Larick Spencer, UNC; March 1987; SRDB Ref ID: 90851

Environmental Monitoring, 1987, *Environmental Monitoring Report on the U.S. Department of Energy's Grand Junction Projects Office Facility, Grand Junction, Colorado, for Calendar Year 1987*; U.S. Department of Energy Grand Junction Projects Office; May 1988; SRDB Ref ID: 90847

Environmental Monitoring, 1988, *Environmental Monitoring Report on the U.S. Department of Energy's Grand Junction Projects Office Facility, Grand Junction, Colorado, for Calendar Year 1988*; prepared by UNC Geotech; May 1989; SRDB Ref ID: 90846

Environmental Monitoring, 1989, *Environmental Monitoring Report on the U.S. Department of Energy's Grand Junction Projects Office Facility, Grand Junction, Colorado, for Calendar Year 1989*; prepared by UNC Geotech; May 1990; SRDB Ref ID: 90856

Environmental Monitoring, 1990, *Grand Junction Projects Office Site Environmental Report for Calendar Year 1990*; prepared by Chem-Nuclear Geotech, Inc.; May 1991; SRDB Ref ID: 90845

Environmental Monitoring, 1991, *Grand Junction Projects Office Site Environmental Report for Calendar Year 1991*; prepared by Chem-Nuclear Geotech, Inc.; May 1992; SRDB Ref ID: 90853

Environmental Monitoring, 1992, *Grand Junction Projects Office Site Environmental Report for Calendar Year 1992*; prepared by RUST Geotech Inc,; May 1993; SRDB Ref ID: 90860

Environmental Monitoring, 1993, *Grand Junction Projects Office Site Environmental Report for Calendar Year 1993*; prepared by RUST Geotech Inc.; May 1994; SRDB Ref ID: 90857

Environmental Monitoring, 1997, *Site Environmental Report for Calendar Year 1996*; prepared by WASTREN-Grand Junction; June 1997; SRDB Ref ID: 76642

Facility Tour, 1984, *GJAO – SFMP Facility Tour – June 29, 1984*, Grand Junction Area Office; June 29, 1984; SRDB Ref ID: 71090

Film Badge Results, 1952-1953, *Grand Junction Exploration Branch Film Badge Reports*; reports with dates ranging from November 10, 1952 through January 26, 1953; SRDB Ref ID: 3401

Film Badge Results, 1957a, *Various Film Badge Results*; film badge cards with dates ranging from February to November 1957; SRDB Ref ID: 54137

Film Badge Results, 1957b, *Various Film Badge Results and Related Documents*; various dates throughout 1957; SRDB Ref ID: 54139

Film Badge Results, 1958, *Grand Junction Exploration Branch Film Badge Reports*; reports with dates ranging from January to April 1958; SRDB Ref ID: 54138

Film Badge Results, 1959, *Various Film Badge Results and Related Documents*; various dates throughout 1959 and 1960 cover letters; SRDB Ref ID: 54140

Forbes, 1997, *Confirmatory Radiological Survey of the Grand Junction Projects Office Remedial Action Project Exterior Portions, 1989-1995*; G. H. Forbes and P. V. Egidi of Oak Ridge National Laboratory; April 1997; SRDB Ref ID: 76720

GJ Contractors, undated, *Other Contractors at the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado: Uranium Concentrate Sampling*; Grand Junction Operations Office; undated; SRDB Ref ID: 3325, pdf p. 4

GJ Prime Contractors, undated, *Prime Contractors at the U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado*; Grand Junction Operations Office; undated; SRDB Ref ID: 3325, pdf pp. 1-3

GJ MAP, 1996, Grand Junction Projects Office Management Action Process (MAP), prepared for the U.S. Department of Energy by Rust Geotech; April 1996; SRDB 88611, pdf p. 21

GJ Nonradiologic Site Profile, undated, *U.S. Department of Energy Grand Junction Office: Nonradiologic Site Profile for Facility Workers*, author unknown, Grand Junction Operations Office; undated; SRDB Ref ID: 3325, pdf pp. 6-8

Harris, D. G., 1957, *Personnel Monitoring Equipment*, correspondence to W. B. Harris; D. G. Harris; January 3, 1957; SRDB Ref ID: 3377, pdf p. 2

Harris, W. B., 1957, *Personnel Monitoring Equipment and Surveys,* correspondence to D. G. Harris; W. B. Harris, February 5, 1957; SRBD Ref ID: 3372

Health and Safety Checklists, 1990-1991, *Collection of Health and Safety Checklists*, UNC Geotech and Grand Junction Projects Office; various dates in 1990-1991; SRDB Ref ID: 89900

Henwood, 1986, *Radiologic Characterization of the Department of Energy Grand Junction Projects Office Facility*; Paul Henwood and Callie Ridolfi; January 1986; SRDB Ref ID: 6640

Inspection, 1945, *Medical Inspection of Colorado Area*, Memorandum to the Files from Captain F. A. Bryan, Medical Corps, U.S. Engineer Office, Manhattan District; 1945; SRDB Ref ID: 16855, pdf pp. 3-12

Lucius Pitkin, 1959, *Lucius Pitkin Sampling Plant Air Sample Data*, memo from W. B. Harris (HASL, NYOO) to F. J. Williams (Safety Engineer, GJOO); September 25, 1959; SRDB Ref ID: 3343

Lutz, 1995, *LMSC Controlatron/Zetatron Shipments for Years 1980-1995*, correspondence to A. R. Parker, includes attached data table; P. R. Lutz; December 6, 1995; SRDB Ref ID: 13203, pdf pp. 4-5

McGinley, 2000, *Summary History of Uranium Mills for the Period January 1, 1942 to December 31, 1971*; Frank E. McGinley; March 14, 2000; SRDB Ref ID: 55738

OCAS-PR-004, *Internal Procedures for the Evaluation of Special Exposure Cohort Petitions*, Rev. 0; National Institute for Occupational Safety and Health (NIOSH); Cincinnati, Ohio; September 23, 2004; SRDB Ref ID: 32022

ORAUT-OTIB-0006, *Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures*, Rev. 03 PC-1; ORAU Team Dose Reconstruction Project for NIOSH; December 21, 2005; SRDB Ref ID: 20220

ORAUT-OTIB-0018, *Internal Dose Overestimates for Facilities with Air Sampling Programs*, Rev. 01; ORAU Team Dose Reconstruction Project for NIOSH; August 9, 2005; SRDB Ref ID: 19436

O'Rear, 1966, *United States Atomic Energy Commission, Grand Junction Office: Summary and Chronology of the Domestic Uranium Program*, N. B. O'Rear, Grand Junction Office; May 1966; SRDB Ref ID: 3325, pdf pp. 36-87

O'Rear, 1969, *Background Information-Grand Junction Office*; N. B. O'Rear, Atomic Energy Commission; July 1969; SRDB Ref ID: 76372

Personal Communication, 2010a, *Personal Communication with a Former Section Head for ORNL Office*; Telephone Interview by ORAU Team; October 12, 2010; SRDB Ref ID: 90652

Personal Communication, 2010b, *Personal Communication with a Former Physicist*; Telephone Interview by ORAU Team; October 19, 2010; SRDB Ref ID: 90653

Personal Communication, 2010c, *Personal Communication with a Former Senior HP Technologist*; Telephone Interview by ORAU Team; October 14, 2010; SRDB Ref ID: 90654

Personal Communication, 2010d, *Personal Communication with a Former Systems Analyst and Programmer*; Telephone Interview by ORAU Team; October 19, 2010; SRDB Ref ID: 90655

Personal Communication, 2010e, *Personal Communication with a Former Senior Health Physicist in Charge of Internal and External Dosimetry*; Telephone Interview by ORAU Team; August 25, 2010; SRDB Ref ID: 90656

Personal Communication, 2010f, *Personal Communication with a Former Health Physicist*; Telephone Interview by ORAU Team; August 24, 2010; SRDB Ref ID: 90651

Personal Communication, 2010g, *Personal Communication with a Former Field Assistant-Geologist*; Telephone Interview by ORAU Team; December 8, 2009: SRDB Ref ID: 82163; follow-up interview on December 2, 2010: SRDB Ref ID: 90997

Personal Communication, 2010h, *Personal Communication with a Former Analytical Chemistry Manager*; Telephone Interview by ORAU Team; December 2, 2010; SRDB Ref ID: 90999

Personal Communication, 2010i, *Personal Communication with a Sampling Plant Manager*; Telephone Interview by ORAU Team; December 6, 2010; SRDB Ref ID: 90998

Personnel Monitoring, 1957, *Personnel Monitoring Equipments and Surveys*, three memos regarding personnel monitoring between W. B. Harris (HASL, NYOO) and D. G. Harris (GJOO); various dates in 1957; SRDB Ref ID: 3372

Procedure, 1990, Internal Radiation Dosimetry Program, ES&H Procedure 3.8, UNC Geotech, October 3, 1990; SRDB Ref ID: 90529

Public Health Service, 1969, *Evaluation of Radon-222 Near Uranium Tailings Piles*; U.S. Department of Health, Education, and Welfare Public Health Service (Public Health Service); March 1969; SRDB Ref ID: 82790, pdf p. 12

Rad Exposure Report, 1975, *Eighth Annual Report of Radiation Exposures for ERDA and ERDA Contractor Employees-1975*; Energy Research and Development Administration; SRDB Ref ID: 26904

Rad Exposure Report, 1976, *Ninth Annual Report of Radiation Exposures for DOE and DOE Contractor Employees-1976*; Pacific Northwest Laboratory; April 1978; SRDB Ref ID: 26903

Rad Exposure Report, 1977, *Tenth Annual Report of Radiation Exposure for DOE and DOE Contractor Employees-1977*; Pacific Northwest Laboratory; February 1982; SRDB Ref ID: 26902

Rad Exposure Report, 1979, *Twelfth Annual Report of Radiation Exposure for DOE and DOE Contractor Employees-1979*; Pacific Northwest Laboratory; February 1982; SRDB Ref ID: 26887

Rad Exposure Report, 1980, *Thirteenth Annual Report of Radiation Exposure for DOE and DOE Contractor Employees-1980*; Pacific Northwest Laboratory; February 1982; SRDB Ref ID: 26888

Rad Exposure Summary, 1960-1961, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with dates ranging from 1960-1961; SRDB Ref ID: 13786

Rad Exposure Summary, 1961-1962, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with dates ranging from 1961-1962; SRDB Ref ID: 13789

Rad Exposure Summary, 1962-1963, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with dates ranging from 1962-1963; SRDB Ref ID: 13790

Rad Exposure Summary, 1963-1964, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with dates ranging from 1963-1964; SRDB Ref ID: 13792

Rad Exposure Summary, 1963-1965, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with dates ranging from 1963-1965; SRDB Ref ID: 13797

Rad Exposure Summary, 1964, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1964; SRDB Ref ID: 14442

Rad Exposure Summary, 1966, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1966; SRDB Ref ID: 13798

Rad Exposure Summary, 1967, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1967; SRDB Ref ID: 16915

Rad Exposure Summary, 1968, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1968; SRDB Ref ID: 13799

Rad Exposure Summary, 1969, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1969; SRDB Ref ID: 13800

Rad Exposure Summary, 1970, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1970; SRDB Ref ID: 13801

Rad Exposure Summary, 1971, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1971; SRDB Ref ID: 16918, pp. 12-95

Rad Exposure Summary, 1972, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with various dates in 1972; SRDB Ref ID: 13802

Rad Exposure Summary, 1973-1974, *Various Radiation Exposure Summary Documents for Multiple Sites*; documents with dates ranging from 1973-1974; SRDB Ref ID: 13803

Radon, 1967, *Concentrations of Radon 222 Found in 48-Hour Integrated Air Samples from Grand Junction, Colorado,* from Evaluation of Radon-222 Near Uranium Tailings Piles: First Quarterly Report; U.S. Atomic Energy Commission and U.S. Public Health Service; September 30, 1967; SRDB Ref ID: 17031, pdf p. 15

Radon, 1967-1968, *Concentrations of Radon 222 Found in 48-Hour Integrated Air Samples from Grand Junction, Colorado,* U.S. Atomic Energy Commission and U.S. Public Health Service; 1967-68; SRDB Ref ID: 17034, pdf p. 14

Radon, 1989-1990, *Results of the U.S. Department of Energy Indoor Radon Study, Volume 1*; prepared by UNC Geotech; results compiled August 1990; SRDB Ref ID: 13191

REMS data, 2010, REMS Data for Grand Junction Office Personnel, accessed October 22, 2010 at http://www.hss.energy.gov/csa/analysis/rems/rems/ri.htm; SRDB Ref ID: 89785

Ruhoff, 1943, *Frequency of Physical and Laboratory Examinations*, correspondence to Area Engineer, Colorado Area; J. Ruhoff; November 9, 1943; SRDB Ref ID: 4504

Rust Geotech, 1996a, *Final Report of the Decontamination and Decommissioning of Building 1 at the Grand Junction Projects Office Facility*; Rust Geotech; August 1996; SRDB Ref ID: 76616

Rust Geotech, 1996b, *Final Report of the Decontamination and Decommissioning of Building 34 at the Grand Junction Projects Office Facility*; Rust Geotech; August 1996; SRDB Ref ID: 76620

Sears, 1976, *Airborne Effluent Control at Uranium Mills*; M. B. Sears, Oak Ridge National Laboratory; presented at ANS-AICHE Topical Meeting August 5-6, 1976; SRDB Ref ID: 76578

Site Visit, 1953, *Visit to Commission-owned Sampling Plant at Grand Junction*, memo from W. B. Harris (HASL, NYOO) to S. P. Wimpfen (GJOO); April 30, 1953; SRDB Ref ID: 76636

Site X-Ray History, undated, *U.S. Department of Energy Grand Junction Office: Site X-Ray History*, author unknown, Grand Junction Operations Office; undated; SRDB Ref ID: 3325, pdf pp. 9-11

Survey, 1956, Transmittal of HL-1, memo from W. B. Harris (HASL, NYOO) to D. G. Harris (GJOO) transmitting report HL-1 covering a survey performed at the GJOO Pilot Plant; December 4, 1956; SRDB 3382, pdf p. 2

Survey, 1980, *Radiometric Survey of the Grand Junction Facility, March 1980, Final Report*, Bendix Field Engineering Corporation, Grand Junction Operations; June 1980; SRDB Ref ID: 76719

Survey, 1982, *May 1982 Follow-up Report to Radiometric Survey of the Grand Junction Facility, March 1980, Final Report*, Bendix Field Engineering Corporation, Grand Junction Operations; May 1982; SRDB Ref ID: 6641

Uranium, 2004, *Uranium Mining and Milling Wastes: An Introduction*, WISE Uranium Project; last updated August 15, 2004; accessed December 1, 2010; www.wise-uranium.org/uwai.html

Urine Data, 1949, *Fluorimetric Urine Analysis Results for Grand Junction, Colorado*, U. S. Atomic Energy Commission, NYOO Medical Division; reported December 9, 1949; SRDB Ref ID: 3306

Urine Data, 1953-54a, *Fluorimetric Urine Analysis Results for Grand Junction, Colorado*, U. S. Atomic Energy Commission, NYOO Medical Division; various dates in 1953-54; SRDB Ref ID: 3319

Urine Data, 1953-54b, *Fluorimetric Urine Analysis Results for American Cyanamid Co., Grand Junction, Colorado*, U. S. Atomic Energy Commission, NYOO Medical Division; various dates in 1953-54; SRDB Ref ID: 6645

Urine Data, 1953-55, *Fluorimetric Urine Analysis Results for American Smelting & Refining Co., Grand Junction, Colorado*, U. S. Atomic Energy Commission, NYOO Medical Division; various dates in 1953-55; SRDB Ref ID: 11452, pdf pp. 42-50

Urine Data, 1956-62, *Fluorimetric Urine Analysis Results for Grand Junction, Colorado*, U. S. Atomic Energy Commission, NYOO Medical Division; various dates in 1956-62; SRDB Ref ID: 3307

Urine Data, 1958-59, *Fluorimetric Urine Analysis Results for the Western Uranium Project, Grand Junction, Colorado*, U. S. Atomic Energy Commission, NYOO Medical Division; various dates in 1958-59; SRDB Ref ID: 11451, pdf pp. 144-145

Urine Sample, July 1956, Grand Junction Urine Sample, memo to J. A. Quigley, M.D. from R. L. Hoover; July 27, 1956; SRDB Ref ID: 76924

Urine Sample, August 1956, Grand Junction Urine Sample, memo to J. A. Quigley, M.D. from R. L. Hoover; August 21, 1956; SRDB Ref ID: 76923

WASTREN, 1997, *Final Report of the Radiological Release Survey of Building 29 at the Grand Junction Office Facility*; WASTREN-Grand Junction; September 1997; SRDB Ref ID: 76611

Attachment 1: Characterization Data Related to Internal Dose

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
1	Building 1 was constructed in 1943 as part of the larger refinery structure to house boilers. All other portions of the refinery were removed during the 1950s, leaving only the boiler house and the annex. Subsequently, the building contained the steam boilers and back-up generator for the facility. Steam pipe trenches extended from Building 1 to other structures on the facility. Building 1 was found to be radiologically contaminated and was demolished in 1996.	1992	Fixed contamination on generator (generator room) up to 110,550 dpm/100 cm^2. Fixed contamination is identified on the roof.	89913, pdf p. 103
		1996	In 1992, fixed beta-gamma contamination ranging as high as 2,197 dpm/100 $cm^2$was identified on the roof. In 1993, fixed beta-gamma contamination ranging up to 110,550 dpm/100 $cm^2$was detected on the auxiliary generator, and elevated beta-gamma activity was detected beneath asbestos cement board siding. In 1995, no contamination was detected in the soil, but fixed beta-gamma surface activities of 48,240 dpm/100 cm^2were detected on exposed and buried concrete surfaces. After removal of the structures and contaminated piping, the soil beneath and adjacent to the building was remediated and was released for unrestricted use.	76616, pdf p. 19
2	Building 2 was built in 1944. The north portion was used as a shower and change facility for uranium workers, the south portion was a warehouse. Later it housed telecommunications equipment and offices.	1992	Fixed contamination was found on a window sill in the telephone equipment room at 10,057 dpm/l00 cm^2. Smearable contamination was found under the heater in the telephone room at 674 dpm/100 cm^2. The area was posted on August 2, 1991. The closet in Room 26 was surveyed at 296 dpm/100 cm^2. The attic in Building 2 has fixed contamination up to 11,000 dpm/100 cm^2 and loose surface contamination up to 1000 dpm/100 cm^2.	89913, pdf p. 103
		1996	Radon concentration was less than the detection limit (1 pCi/l) for all measurements. In an exposure from 11/13/89 to 2/13/89, the concentration in Building 2 was 1.4 pCi/l. Since then, significant remedial actions have occurred on the GJPO site that removed nearby radon sources. No removable contamination greater than guideline values was found in any sampling unit. Using field screening techniques, the highest 34 smears were re-evaluated with a desktop scaler counter. The mean of these measurements was -4.7 dpm/100 cm^2 with a standard deviation of 43. For dose modeling purposes, the one sigma upper limit, 39 dpm/100 cm^2, from this conservatively-biased sample of smears was to be used as the removable contamination level in a dose evaluation.	89913, pdf pp. 129, 131

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
6	Building 6 was constructed in 1953 to house a bench-scale pilot mill for testing the resin-in-pulp milling process. Milling activities commenced in 1953 and continued until December 1954, processing a total of approximately 2500 tons of uranium ore. The building was used subsequently as laboratory and office space. The building was demolished in 1992.	1996	Building 6 was surveyed for radiological hazards in 1989. The survey identified contamination on the interior walls and floors, on horizontal surfaces of the steel and wood structural members, on exterior wall surfaces, and on an associated concrete sump and steam pipe chase. Preliminary radon daughter-product concentration (RDC) measurements averaged 0.027 WL. Soil collected from the sump had a Ra-226 concentration of 313.3 pCi/g. Beta-gamma surface activities ranged as high as 397,122 dpm/100 cm^2. Alpha surface activities ranged as high as 8,520 dpm/100 cm^2. The remediation consisted of demolishing the building and remediating the soil underneath.	76619, pdf p. 18
7	Building 7 was constructed in 1952 as a sampling plant and materials staging area. Eventually, Building 7 consisted of offices, laboratories, and storage areas.	1992	Construction/Subcontracts Contamination was found in overhead vents and on a filter in a door in Rooms 108, 110, and 107 with levels up to 40,445 dpm/l00 cm^2 fixed and up to 4,009 dpm/l00 cm^2 loose; surface contamination on floor areas was widespread. Fixed contamination identified on the east side of the building with levels up to 18,186 dpm/l00 cm^2. The vents were removed, decontaminated, and replaced. Loose surface contamination was found in Rooms 107, 108, 109, 110, 111, the hallway, and the Document Services room. The entire floor of Building 7 had fixed contamination between 10,000 - 25,000 dpm/100 cm^2. Publication Services Fixed contamination was found in the floor as well as in the Photo Lab. The attic area of Building 7 has been identified as contaminated.	89913, pdf p. 103 (not a close- out report)
		1993	Contamination in excess of limits was found in all rooms except Rooms 200 and 207. Levels ranged from 6,700 to 134,000 dpm/100 cm^2 beta-gamma and 0 to 13,040 dpm/100 cm^2 alpha. No removable contamination was detected.	89872, pdf p. 36 (not a close out report)

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
7 (cont.)	The Phase I area (south bay area) was enlarged and enclosed during reconstruction and remodeling in 1956, 1978, and 1984. Upon completion of remediation and reconstruction activities, the Phase I area was remediated and was turned over to the U.S. Army Reserve on May 15, 1999.	1999	Phase I (south bay area) A building survey conducted in 1993 indicated a maximum fixed gross beta-gamma activity of 9,380 dpm/100 cm^2 in the Phase I area. The exterior areas adjacent to the south bay area were assessed for contamination, and deposits along the east and south sides were remediated during the remediation of exterior land areas in 1989-1994. A characterization survey of the south bay area in February and March 1999 identified surface contamination on and within the north clay tile wall, on surfaces of the stem wall that supports the north clay wall, in a floor expansion joint, and on a portion of the surface of the concrete floor. Intrusive measurements within the ceiling and exterior walls did not indicate any contamination. Contaminated concrete was removed and underlying soils were remediated. The north wall was removed and reconstructed. Decontamination of the stem wall was accomplished by scabbling the surface to a maximum depth of 1 cm.	89869, pdf pp. 12-13 (Phase I report)
	The north section of the Phase II area was enlarged and enclosed during reconstruction and remodeling in 1956, 1978, and 1984. The Phase II portion of the building was turned over to the U.S. Army Reserve in 1999 or 2000.	1999	Phase II (center and north sections) An RDC measurement taken the winter of 1990 was 0.009 WL. Three RDC measurements taken between August 1997 and January 1998 (before remediation) in a former office were 0.0024, 0.0029, and 0.0035 WL; the average of these was 0.0029 WL. Soil containing Ra-226 was identified under the floor slab in 1992. A survey in 1993 indicated a maximum fixed gross beta-gamma activity of 134,000 dpm/100 cm^2. Exterior areas adjacent to Phase II were remediated during remediation of the exterior land areas during GJOPORAP. In March 1999, surface contamination was identified on and within walls, on concrete floors, on stem wall and foundation surfaces, on concrete column support pads, within the center section mechanical room floor wood framing, and on the center section attic framing and truss surfaces. The maximum beta-gamma surface contamination was approximately 480,000 dpm/100 dpm/cm^2 in the attic. Some contamination was fixed by a layer of paint. Cores through the center section concrete floor indicated Ra-226 and total uranium contamination exceeding the authorized limits for soil (5 pCi/g and 103 pCi/g, respectively (Ref ID 88610).	90168, pdf pp. 12, 13 (Phase II report)

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings

Building	Description	Report Date	Characterization Data Related to Internal Dose	Reference
7A	Building 7A was constructed as an addition to Building 7 in 1956 as a sample preparation laboratory for the Analytical Chemistry Laboratory (Building 20). The center section of Building 7 had formerly been used for sample preparation.	1992	Surface contamination was throughout most of Building 7A with average beta-gamma activity exceeding 27,000 dpm/l00 cm^2 in one large sample-crushing room.	89880, pdf p. 13 (Phase III report)
7 and 7A	Phase III	1997	A radon daughter-product (RDC) concentration measurement was 0.0068 WL.	89880, pdf p. 13 (Phase III)
		1999	Remediation and radiological verification of Building 7 during 1999 indicated the presence of uranium contamination (yellowcake) on the clay tile and steel truss of the common wall between Buildings 7 and 7A. Also, contamination found under floors and on foundation surfaces in Building 7 indicated that similar contamination probably was present in Building 7A.	89880, pdf p. 14 (Phase III)
		2000	Processing equipment, the ventilation system, and vent hoods were sampled and found to contain uranium and radium isotopes in excess of release limits with a maximum Ra-226 concentration of 1,407 pCi/g. Due to past sample processing activities, the ventilation system characterization included analyses for suspected transuranic isotopes. None over the limits for unrestricted release were found.	89880, pdf p. 14 (Phase III)
11	Building 11 was constructed in 1955 as the primary guardhouse (South Gate). It continued in the same function up to recent times.	1997	The result of a three-month-long RDC measurement, completed in February 1990, was 0.008 WL. During the comprehensive survey of structures in 1993, no radiological contamination was identified. Three deposits of contaminated soil, parts of which were within 3 m of the building, were assessed and remediated during the remediation of exterior land areas in 1989-1994. Other remedial actions were not required.	76626, pdf pp. 15-16
12	Building 12 was constructed in 1953 as an office building. The building incorporated an existing log structure on its east wing referred to as the Log Cabin (constructed prior to 1943). A south addition (Bldg. 12A) was constructed in 1956. Vaults for records storage were added in the late 1970s.	2000	Two RDC measurements taken during the winter of 1990 were 0.015 WL and 0.016 WL. A building survey in 1993 indicated no surface contamination on the interior or exterior of the building. Exterior areas adjacent to the building were assessed for tailing contamination and soil was excavated and replaced with clean fill as a part of the remediation of exterior land areas in 1989-1994.	90170, pdf pp. 12-13

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings

Building	Description	Report Date	Characterization Data Related to Internal Dose	Reference
19	Building 19 was constructed in 1948 as the Main Gate. Later, the building served as a guardhouse (North Gate) and office space for security personnel. Major modifications to the structure occurred in 1953 and 1967.	1997	The result of a three-month-long RDC measurement, completed in February 1990, was 0.011 WL. During the comprehensive survey of structures in 1993, no radiological contamination was identified. One deposit of contaminated soil within 3 m of the building was assessed and remediated during the remediation of exterior land areas, 1989-1994. Other remedial actions were not required.	76629, pdf p. 17
20	In 1951, the first section of the existing Building 20 Analytical Chemistry Laboratory structure was constructed to support the site mission to evaluate ore quality and to evaluate uranium concentrate samples. The original structure is the east wing of the current building. The building was expanded in 1954 with the addition of the west wing. The building incorporated filtered fume hoods for working with unencapsulated samples.	1990	Radon daughter product (RDC) concentrations: 1/12/90: 0.0059 WL average; 0.0178 WL maximum 2/16/90: 0.0014 WL average; 0.0054 WL maximum	89903, pdf p. 2
		2000	The final status survey concluded that the median concentrations for all survey units were indistinguishable from the instrument response background with the exception of the interior of the liquid drain pipe system. The residual contamination in this system did not exceed the criteria selected for release of the facility from radiological controls.	90199, pdf p. 170
26	Building 26 was constructed in 1954. It was built as an engineering office building and has been used as office space and as a training facility. In 1999, Building 26 was leased to the Western Colorado Business Development Corporation (along with Buildings 28, 30, 46, and 56).	1999	A radon study conducted in 1990 measured RDC of 0.023 WL in the building office. A radiological survey of the building in 1993 indicated no contamination. Exterior areas adjacent to the building were identified as contaminated in 1990 and soil was excavated and replaced with clean fill circa 1995.	89943, pdf p. 79

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
28	Building 28 was constructed in 1954. It was built as a maintenance and repair facility for vehicles, heavy equipment, and electrical equipment, and as a site support building with offices and facility maintenance shops. In 1999, it was vacant.	1999	An investigation into the historical activities indicated that the maintenance shop contained wash facilities for heavy equipment and smaller vehicles used around uranium ore, mill tailings, and yellowcake at the mill site and in the concentrate storage areas. A radon study in 1990 measured an RDC of 0.009 WL in Room 45. Measurements in 1998 indicated RDCs of 0.0041 WL and 0.0048 WL. Exterior areas adjacent to the building were assessed for contamination; two small deposits located along the west wall were remediated in 1992. In 1993, contamination was found in a floor drain, sump, expansion joints, an exhaust fan, and in concrete. The latter had beta-gamma activities as high as 20,090 dpm/100 cm^2 in Room 7 and 6,700 dpm/100 cm^2 in Room 10. Remedial activities for these areas were conducted in 1994 and 1995. The contamination on concrete floors was removed by scabbling the paint and contaminated concrete surface (pdf p. 105).	90185, pdf pp. 12-13
29	Building 29 was constructed in 1954. It was built as a guard station and scale house for trucks entering the site with uranium ore, and later was used for paint storage. In 1997, Building 29 served as office space for facilities management personnel.	1997	Building 29 was included in the 1993 comprehensive survey of the structures at the DOE-GJO facility. No radiological contamination was identified. Two deposits of contaminated soil, parts of which were located within 3 m of the building, were assessed and remediated during the decontamination and decommissioning of the exterior land areas in 1995.	89967, pdf p. 74
30	Building 30 was constructed in 1955 as a purchasing and supply warehouse and an operations building. In 1982, Building 30 was joined to Building 22 by constructing a high bay area between them. The Building 30 portion has been used as an electronics laboratory, radiological instrument storage, and office space.	1999	A radon study in 1990 measured an RDC of 0.012 WL in Room 105. The average of three measurements in January 1998 was 0.0033 WL. A radiological survey in 1993 indicated no contamination. Remedial actions were not required. The exterior areas adjacent to Building 30 were assessed for contamination; a small deposit located within 3 m of the south side of the building was remediated during remediation of the exterior land areas in 1989-1994.	90189, pdf p. 11
30B	Building 30B was erected in 1985 as a machine shop and electronics laboratory. After 1985, it was used to store and calibrate small field instruments and house personal protective equipment. It was also used for temporary storage of radioactive trash and for storage of controlled radioactive sources.	1997	The result of a three-month-long RDC measurement, completed in February 1990, was 0.0285 WL. During the comprehensive survey of structures in 1993, no radiological contamination was identified. Deposits of contaminated soil within 3 m of the building were assessed and found to not exceed limits. Other remedial actions were not required.	76614, pdf p. 14

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
31	Building 31 was constructed in 1954 to house the acid-leach circuit of a pilot-scale uranium ore mill. Milling activities commenced in 1955 and continued until 1958. The building was subsequently used for storage, including uranium and vanadium concentrates. The building was demolished in 1992.	1996	A survey in 1986 detected fixed alpha surface activities as high as 1,440 dpm/100 cm^2. A more comprehensive survey in 1989 identified contamination on multiple surfaces and in cracks and crevices. Preliminary RDC measurements were approximately 0.02 WL. Ra-226 concentrations in contaminated sediment from the concrete trenches ranged as high as 343.2 pCi/g. Beta-gamma surface activities ranged as high as 850,563 dpm/100 cm^2. Alpha surface activities ranged as high as 46,860 dpm/100 cm^2. The building was demolished and the foundation and associated utilities were removed. The soil underneath the building was then remediated.	76615, pdf pp. 18-19
31A	Building 31A was constructed in 1954 as an analytical chemistry laboratory and office building. Later, the building was used as a physics and radon laboratory with associated offices. It was demolished during remedial activities in August and September 1998 and not rebuilt.	1999	Measurements in 1996 indicated Ra-226, Th-230, and total uranium contamination in a sump under the concrete floor, and fixed surface contamination on the floor in a couple of hot spots with beta-gamma activities up to 5,720 dpm/100 cm^2. Removable contamination was found in the attic ductwork with beta-gamma activities up to 10,400 dpm/100 cm^2. Contamination was suspected inside the south wall that had been shared with a previously demolished pilot mill building (Bldg. 31). Boreholes through the floor did not identify any radiological contaminants in the underlying soil. An average RDC of 0.007 WL was measured in 1997. Exterior areas adjacent to the building were assessed for tailing contamination and soil was excavated and replaced with clean fill as a part of the remediation of exterior land areas in 1989 and 1990.	90173, pdf p. 12

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
32	Building 32 was constructed in 1954 as a chemical storage area and warehouse. It was later used for seed storage, core preparation and viewing, and radon research. In 2000, the building housed an environmental laboratory and offices.	2000	A radon daughter product concentration (RDC) measurement taken during the winter of 1990 was 0.0245 WL. This measurement was taken in an office prior to remediation that occurred during remodeling of the southern portion of the building. Three RDC measurements, taken in the former radon chamber room between August 27, 1997, and January 9, 1998, were 0.0053, 0.0056, and 0.0060 WL. The average of these three measurements is 0.0056 WL. A building survey conducted in 1993 indicated no surface contamination on exterior and interior surfaces of the building. Subsequent measurements identified fixed contamination of unreported beta-gamma activity on the concrete floor in the north portion of the building. Intrusive characterization measurements collected in 1997 did not identify contamination on roof material surfaces, inside the exterior walls, or under the concrete floor. Two floor locations near the east wall of the north portion of the building were confirmed to have fixed contamination during a building survey conducted in 1999, with a maximum beta-gamma activity of 10,400 dpm/l00 cm^2. During the final release survey, the maximum removable activity was 422.2 dpm/100 cm^2; the maximum projected upper limit for total contamination was 3,232 dpm/l00 cm^2.	89999, pdf pp. 38, 41, 42
33	Building 33 was constructed in 1954 as a mill operations building. After the mill ceased operations, the building was used for storage. The building was demolished during remedial action activities in August and September 1998 and was not rebuilt.	1999	Direct alpha measurements made in 1985 were 78 to 16,167 dpm/100 cm^2, and an RDC measurement was 0.005 WL. The soil beneath the floor slab was not sampled. A building survey conducted in 1993 indicated surface contamination throughout the building with a maximum fixed gross beta-gamma activity of 6,881 dpm/100 cm^2. Building 33 was extensively decontaminated during 1988 and 1989, which resulted in a conditional release but not a release for unrestricted use. Exterior areas adjacent to the building were assessed and remediated during the remediation of exterior land areas in 1989-1994.	90175, pdf pp. 12-13
34	Building 34 was constructed in 1954 as a boiler house for the large pilot mill. Subsequently, it was used for storage. The building was demolished in 1996.	1996	In 1986, the building was surveyed and no alpha contamination or Ra-226 concentrations of the underlying soil exceeded limits. However, RDC concentrations as high as 1.48 WL were recorded. In 1993, fixed beta-gamma surface activities ranging as high as 32,571 dpm/100 cm^2 were identified on concrete foundation and steel surfaces. Analysis of expansion joint material collected from the perimeter of the building indicated Ra-226, Th-230, and total uranium concentrations of 9.5, 62.4, and 78.3 pCi/g, respectively.	76620, pdf p. 19

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
35	Building 35 was constructed in 1954 as a uranium ore and yellowcake feed preparation and sample plant. Ancillary structures, including a conveyor belt, were removed after completion of mill operations. The building was demolished during remedial action activities in August and September 1998 and was not rebuilt.	1999	Direct alpha measurements made in 1985 were 312 to 15,444 dpm/100 cm^2, and a RDC measurement was 0.007 WL. Boreholes through the floor slab did not indicate any Ra-226 concentrations above background. A building survey conducted in 1993 indicated a couple of hot spots with a maximum fixed gross beta-gamma activity of 25,460 dpm/100 cm^2. Building 35 was extensively decontaminated during 1988 and 1989, which resulted in a conditional release but not a release for unrestricted use. Exterior areas adjacent to the building were assessed and remediated during the remediation of exterior land areas in 1989-1994.	90178, pdf p.12
36	Building 36 was used as early as 1945 as a paint shop for the small pilot mill. In 1954, the building was moved to the south end of the facility for use as a uranium concentrate drying facility. Subsequently, it was used for storage of uranium concentrate and later for general storage. The building was demolished in 1996.	1996	Beta-gamma surface activities measured in 1989 ranged as high as 100,462 dpm/100 cm^2 on the concrete and wall surfaces of the building; analysis of the underlying soil indicated that the soil was not contaminated. The area was subsequently vacuumed in 1989 or 1990. Fixed beta-gamma activity of 5000 dpm/100 cm^2 was detected on the concrete floor and 80,400 dpm/100 cm^2 was detected on wall materials in 1993.	76621, pdf pp. 18-19
37	Building 37 was a scale house for a truck scale located near the perimeter fence in the southern portion of the facility. The building and scale were demolished and the underlying soils were remediated in 1991-1992.	1999	Elevated beta-gamma activities were identified on the exterior surfaces of the scale house, on the foundation surfaces of the scale house, and on the scale platform. A soil sample collected in the area was 140.6 pCi/g prior to the area being remediated.	90201, pdf p. 2
39	Building 39 was a metal shed that housed pumps and valves that controlled the supply of fuel from emergency reserve tanks to the facility back-up generator and boiler plant. The building was demolished in April 1992.	1996	The building was surveyed in 1992. No radiological contamination was identified on surfaces or installed equipment. However, the soil under the building was assessed as contaminated. The soil was remediated after removal of the building, equipment, and concrete pad.	76623, pdf p. 19
40	Building 40 was constructed in 1958 as a natural gas meter house.	1999	The exterior areas were assessed for contamination but no deposits were identified and no remediation was required. Surveys in the building did not identify any contamination. Radon concentrations were not measured since the building was considered uninhabitable.	90016, pdf pp. 13-15

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
41	Building 41 was constructed in 1956 as a storage shed.	1999	Building 41 currently is located on a concrete slab constructed after underlying soils were remediated during GJPORAP remediation of exterior land areas in 1989. The underlying soil was remediated. Radiologically-contaminated materials were removed and the excavations were backfilled with clean material. Health and safety radiological surveys conducted in the building did not identify contamination. The final close-out survey confirmed that there was no fixed or removable contamination above established limits. Radon concentrations were not measured because the building was considered uninhabitable.	90019, pdf pp. 13-15
42	The original year of construction is unknown. Building 42 was assembled and expanded on three occasions using structures located elsewhere on the GJO facility. The building was used as a permitted hazardous and mixed waste storage area. The permit and stored materials were transferred to Building 61C in June 2000. The building was demolished in July 2000.	2000	A building survey conducted in 1993 did not identify any surface contamination. Exterior areas adjacent to the building were assessed and remediated during the remediation of exterior land areas in 1990 and 1991. In 2000, soil samples from four boreholes did not indicate elevated concentrations of Ra-226 or total uranium. Net results for all direct beta-gamma surface measurements were less than 1,000 dpm/100 cm^2.	90179, pdf p. 12
43	Building 43 was constructed in 1976 as a storage shed to support operations in Buildings 22 and 30. Barrels of contaminated personal protective equipment (PPE) have been stored in the building.	1999	The exterior areas adjacent to Building 43 were assessed for contamination, and deposits located along the west side of the building were remediated in 1990 during GJPORAP remediation of exterior land areas; radiologically-contaminated materials were removed and the excavations were backfilled with clean material. Health and safety radiological surveys conducted in the building did not identify contamination. The final close-out survey confirmed that there was no fixed or removable contamination above established limits. Radon concentrations were not measured because the building was considered uninhabitable.	90023, pdf pp. 13-15
44	Building 44 was constructed in 1956 and was originally used for gas cylinder storage.	1996	Building 44 was surveyed for radiological hazards in 1993. Beta-gamma surface activity ranging as high as 20,600 dpm/100 cm^2 was identified on the concrete floor and interior wood surfaces. Building 44 was demolished in 1994. Measurements and soil samples indicated that the underlying soil was not contaminated.	90031, pdf pp. 22, 23

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
46	Building 46 was constructed in 1977 as a cafeteria. It was erected on the site of a former mineralogy laboratory built in the early 1950s and demolished in the early 1970s. Foundation elements and potentially-contaminated utilities from the former lab were beneath Building 46.	1999	Surface, RDC, and soil measurements were taken during various investigations in 1993-1995. No contamination was found on or inside the building. Contaminated soil was detected beneath the uncontaminated north stem wall. The exterior areas adjacent to the building were remediated in 1989. In 1996, the floor slab was removed, the soil excavated and replaced, and the building was refurbished as a cafeteria.	90034, pdf pp. 28-29
51	Building 51 was constructed in 1976 as a gas bottle storage building to support analytical laboratory operations in Building 20.	1999	The exterior areas adjacent to Building 51 were assessed for contamination, and deposits located near the east and west sides of the building were remediated in 1991. Building surfaces were characterized in September 1999 and no measurements exceeded authorized limits.	90036, pdf p. 13
54	Building 54 was installed on the DOE-GJO site in 1992. It consists of 15 modular units joined together with the interior reconstructed to accommodate office space and medical facilities. Prior to installation on the GJO site, the units served as the student center and cafeteria during a remedial action project at Mesa State College in Grand Junction, Colorado. In 1997, Building 54 served as office space for facilities management, analytical laboratory, and medical personnel.	1997	The building was surveyed prior to moving to GJO and found to be free of contamination. This was verified during the release survey. Most of the soil located beneath and within 3 m of the building was assessed and remediated during the decontamination and decommissioning of the exterior land areas prior to the installation of the building. The average of three RDC measurements taken during a 3-month-long period in 1997 was 0.0017 WL.	90067, pdf p. 20
56	Building 56 was installed in 1992 as office space, equipment storage, and laboratories for ORNL. It was removed in May 1997 following completion of the radiological release survey. Following completion of the release survey, the laboratory equipment was removed to Building 7.	1997	Building 56 was surveyed prior to being installed and found to be free of contamination. Subsequently two rooms were posted as radioactive material areas because they were used to analyze mill tailings samples. The soil beneath the building had been remediated prior to its installation as a part of the remediation of the exterior land areas. No remediation of the building was required because there was no contamination identified.	90187, pdf p. 16

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
61A, B, and C	Buildings 61A, B, and C are modular units that were installed on a concrete pad in 1993. The buildings were used to store hazardous and mixed waste materials generated by GJO operations and remedial action projects.	2000	A building survey conducted in 1993 indicated no surface contamination on interior and exterior surfaces of the buildings. Building 61A has no record of being used to store radiological materials. Buildings 61B and 61C have been used to store containerized radioactive materials but no known spills have occurred in these buildings. Building surfaces were characterized in May 2000 and no measurements exceed authorized limits. Remedial action was not required.	90195, pdf p. 12
810	Building 810 was formed when Building 8 and Building 10 were joined by an addition in 1981. Building 8 was constructed in 1950. Building 10 was constructed in 1949. Buildings 8 and 10 were never used for uranium milling or brokerage activities but the area was crossed by a haul road that served the MED refinery. The building has been used for offices and conference rooms for DOE and GJO contractor personnel.	2000	RDC measurements taken in the winter of 1990 were 0.010 WL in Room 112 and 0.0023 WL in Room 177. Measurements made between August 1997 and January 1998 averaged 0.0106 and 0.0052 for the north and south wings, respectively. A building survey conducted in 1993 indicated no surface contamination on exterior and interior surfaces of the building, but elevated beta-gamma activity was identified on the soil surface in a small area. The exterior areas adjacent to Building 810 were assessed for contamination during the remediation of exterior land areas, but no contamination was identified within 3 m of the building. An extensive characterization was performed in 1996. Elevated concentrations located in the crawlspace were determined to be within limits and no remedial actions were required.	90196, pdf pp. 12-13
938	Building 938 was formed when two formerly separate buildings, 9 and 38, were joined by connecting additions. Building 9 was constructed in 1954; Building 38 was built 1955. The original addition (Bldg. 9A) was built in 1955. The buildings were joined in 1981. The building was used for offices and conference rooms for the DOE-GJO contractor personnel. The buildings were never used for uranium milling or brokerage activities.	2000	Radon decay product concentration measurements taken during the winter of 1990 were 0.009 WL in Room 114 (east wing) and 0.008 WL in Room 222 (courtyard addition). A building survey conducted in 1993 indicated no surface contamination on exterior surfaces of the building, but beta-gamma activity exceeding authorized limits was identified in the attic associated with a layer of vermiculite insulation. The exterior areas adjacent to Building 938 were assessed for contamination and several small deposits located near the building were remediated during the remediation of exterior land areas in 1989-1994.	90182, pdf pp. 12-13

Table A1-1: Characterization Data Related to Internal Dose for Various Grand Junction Buildings				
Building	**Description**	**Report Date**	**Characterization Data Related to Internal Dose**	**Reference**
3022	Building 3022 consists of the one-story north wing (formerly Buildings 22 and 22A) and the high bay. The two-story south wing (formerly Building 30) is addressed in a separate report. Buildings 22 and 22A were completed in 1953 as sedimentation and electronics laboratories with associated warehouse and office space. Subsequent modifications resulted in a joined roof (creating a new Building 22), removal of laboratories, and conversion to office space. Building 22 was joined to Building 30 and a high bay area was constructed in 1982. The high bay was used for core storage and a core-hole logging vehicle support facility. Later, it was converted for use as a facility maintenance area and the supply and procurement warehouse.	2000	Two RDC measurements taken in the winter of 1990 were 0.012 WL and 0.15 WL. A building survey in 1993 indicated no surface contamination on exposed or accessible interior and exterior surfaces. The exterior areas adjacent to Building 3022 were assessed for mill tailings contamination and deposits were remediated during the remediation of exterior land areas in 1989-1994. A characterization survey was conducted in September 1999. Two of three abandoned floor drains had Ra-226 and total uranium contamination exceeding authorized limits. The associated abandoned interior and exterior drain lines were assumed to be contaminated. A soil sample collected from an exterior borehole near the building had a Th-230 concentration of 84.0 pCi/g, which exceeded the authorized limit. Elevated beta-gamma activity was detected along the joint between the stem wall and exterior concrete apron on the west side of the north wing. Measurements of the attic louvers, roof vents, and roof materials did not indicate any surface contamination.	90184, pdf pp. 12-13

This page intentionally left blank

Attachment 2: Data Capture Synopsis

Table A2-1: Data Capture Synopsis for Grand Junction Operations Office			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
Primary Site/Company Name: Grand Junction Operations Office; (GJO), (GJOO) 1943 - Present DOE Other Site Names: U.S. Vanadium (Stratcor), 1943-1946, [Name redacted] American Smelting and Refining Co. (ASARCO) 1948-1955, [Name redacted] Ledoux and Company 1948, [Name redacted] American Cyanamid (Wyeth) 1953-1954, [Name redacted] National Lead Co. (NL Industries) 1954-1958, [Name redacted] Lucius Pitkin, Inc. 1956-1971, [Name redacted] Bendix Field Engineering Corporation 1975-1986 UNC Technical Services 1986-1987 UNC Geotech, Inc. 1987-1990 Chem-Nuclear Geotech, Inc. 1990-1993 RUST Geotech, Inc. 1993-1996 MACTEC Environmental Restoration Services 1996-2002 WASTREN, Inc. 1996-2002 S.M. Stoller Corporation 2002-Present	Material received from GJO or downloaded from the GJO website is summarized in the DOE Legacy Management - Grand Junction Office section below. NL Industries has informed the Project that a formal court order or records subpoena will be required before any GJO records that may exist can be released or disclosed. The other companies' records were either destroyed or submitted to GJO.	11/30/2009	0
State Contacted: [Name redacted], [Name redacted]	Colorado does not hold relevant records.	11/11/2009	0
Department of Labor/Paragon	A summary history of uranium mills, the Surgeon General's recommendations regarding building homes on uranium mill tailings, and an Atomic Energy Commission report on contamination removal.	12/30/2008	3
DOE Brookhaven National Laboratory	A Department of Energy report from 2000 that states that GJO does not conduct ambient particulate or tritium air monitoring.	03/01/2006	1
DOE Environmental Measurements Laboratory Library	Mill Tailings Project reports, dust sample reports, and a report on controlling employee exposures in underground uranium mines.	03/09/2005	5

Table A2-1: Data Capture Synopsis for Grand Junction Operations Office			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
DOE Legacy Management - Grand Junction Office	A listing of all contractors at GJO, summary histories of GJO, the Summary History of Domestic Uranium Procurement, Contract No. AT(05-1)-266 documents, material inventories, reports on the treatment of carnotite ores, annual UMTRA site inspections, UMTRA reports, remediation work plans, the S.M. Stoller Office of Legacy Management contract, reports on the treatment of ore concentrates, 1953 trip reports, a mixed waste report, final decontamination and decommissioning reports, the Manhattan Engineer District diagram of materials shipments, environmental reports, airborne effluent control at uranium mills, a 1980 radiometric site survey, a 1997 confirmation of exterior remediation activities, radon reports, a summary of process knowledge interviews, mill tailings studies and reports, the 1959 mill products sampling process and flow sheet, building decontamination and decommissioning reports with supporting and historical radiological survey data, and bioassay data from 1967 and the 1990s.	11/11/2010	322
DOE Legacy Management - Morgantown	A 1972 unclassified Fernald letter log with GJO correspondence, a Fernald report which mentions Colorado ores, and verification of GJO as the location of an ore concentrate stockpile.	6/30/2010	4
DOE Legacy Management - MoundView (Fernald Holdings, includes Fernald Legal Database)	A 1953 Health and Safety Division report which references instruments in use at GJO, raw materials development report for 1954-1959, a report which documents the analysis of GJO U_3O_8 at the New Brunswick Lab, data on ore concentrate shipments from GJO to Fernald in the 1970s, limited uranium urinalysis from the 1950s and 1960, ore concentrate treatment methods at Fernald, Mallinckrodt Chemical Co., and Weldon Spring, interlaboratory comparisons of ore concentrate assays, an ore concentrate management plan, ore sampling flow diagrams under Lucius Pitkin, ore concentrate specifications committee meeting minutes, an epidemiologic study of mill worker mortality, ore concentrate inventories and projections, a 1953 New York Operations Office report with the summary of distribution of film badge readings, and documentation of a security breach during a concentrate shipment.	05/13/2010	45
DOE Pacific Northwest National Laboratory	A Nuclear Regulatory Commission guidance document for performing occupational radiation monitoring at uranium mills.	04/02/2006	1
Federal Records Center, Kansas City	Film badge records, 1957-1960.	10/15/2008	4
Internet	1998-2001 REMS exposure data for GJO.	10/28/2010	1

Table A2-1: Data Capture Synopsis for Grand Junction Operations Office			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
Internet - DOE Comprehensive Epidemiologic Data Resource (CEDR)	No relevant data identified.	11/02/2009	0
Internet - DOE Hanford Declassified Document Retrieval System (DDRS)	No relevant data identified.	11/02/2009	0
Internet - DOE Legacy Management Considered Sites	A raw materials research report covering 1954-1959.	10/04/2007	1
Internet - DOE OpenNet	The fifteenth and eighteenth semi-annual reports to Congress, a report mentioning research on remote detection of uranium and thorium ore deposits, and a 1971 site visit report.	11/02/2009	6
Internet - DOE OSTI Energy Citations	No relevant data identified.	10/31/2009	0
Internet - DOE OSTI Information Bridge	Stannard's Radioactivity and Health, final decontamination and decommissioning reports, the long term surveillance plan for the Cheney Disposal Site, complex-wide radiological waste data, final report on the decontamination and decommissioning of exterior land areas, and uranium industry annuals.	09/20/2010	17
Internet - Google	Environmental reports, groundwater reports, final decontamination and decommissioning reports, Grand Junction Steel property cleanup, S.M. Stoller's contract for management of GJO, Projects Office Management Action Process, site environmental summary, the quantity of legacy material present at the site, overviews of mill tailings remediation, and complex-wide waste management, stewardship, and environmental restoration plans.	09/24/2010	30
Internet - Health Physics Journal	No relevant data identified.	11/04/2010	0
Internet - Journal of Occupational and Environmental Health	No relevant data identified.	11/04/2010	0
Internet - National Academies Press (NAP)	No relevant data identified.	11/02/2009	0
Internet - National Nuclear Security Administration (NNSA) - Nevada Site Office	No relevant data identified.	11/02/2009	0
Internet - NRC Agencywide Document Access and Management (ADAMS)	UMTRA, surveillance and maintenance, and site remediation reports.	09/01/2010	24
Internet - Washington State University (U.S. Transuranium and Uranium Registries)	No relevant data identified.	11/02/2009	0
Mesa State College, Tomlinson Library, Grand Junction, CO	No relevant documents not already in the SRDB were identified.	11/25/2009	0
National Archives and Records Administration (NARA) Atlanta	Manhattan Engineer District production, accountability, and medical reports and analysis of the first four lots produced at GJO.	06/19/2008	19

Table A2-1: Data Capture Synopsis for Grand Junction Operations Office			
Data Capture Information	**General Description of Documents Captured**	**Date Completed**	**Uploaded to SRDB**
National Archives and Records Administration (NARA) College Park	A 1974 study of inactive mill tailings piles.	04/13/2010	1
NOCTS	A 1978 Department of Energy press release and a 1971 New York Times article, both on mill tailings used as fill in residential construction.	01/17/2008	1
ORAU Team	The tenth and eleventh annual radiation exposure reports and two documented process knowledge interviews.	12/09/2009	4
SAIC	Summary radiation exposure reports for 1960, 1961, 1964, 1969, 1972, and 1973.	09/02/2004	6
SC&A	Film badge records.	NA	2
SC&A/DOE Idaho National Engineering Laboratory	A 1986 memo which states that the GJOO has nine CERCLA Units.	06/24/2010	1
Southern Illinois University	AEC construction cost differentials.	10/15/2008	1
Unknown	Urine sample data, air sampling data, results of 1991 indoor radon study, film badge reports, site characterization surveys, New York Operations Office correspondence and reports, and a request for special J slugs.	09/12/2004	45
TOTAL			**545**

Table A2-2: Database Searched for Grand Junction Operations Office			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
NOTE: Database search terms employed for each of the databases listed below are available in the Excel file called “Data Capture Synopsis for Grand Junction Operations Office, Grand Junction, CO”			
DOE CEDR http://cedr.lbl.gov/ COMPLETED 11/02/2009	See Note above	0	0
DOE Hanford DDRS http://www2.hanford.gov/declass/ COMPLETED 11/02/2009	See Note above	0	0

Table A2-2: Database Searched for Grand Junction Operations Office			
Database/Source	**Keywords / Phrases**	**Hits**	**Uploaded**
DOE OpenNet http://www.osti.gov/opennet/advancedsearch.jsp COMPLETED 11/02/2009	See Note above	36	6
DOE OSTI Energy Citations http://www.osti.gov/energycitations/ COMPLETED 10/31/2009	See Note above	909	0
DOE OSTI Information Bridge http://www.osti.gov/bridge/advancedsearch.jsp COMPLETED 09/20/2010	See Note above	442	17
Google http://www.google.com COMPLETED 09/24/2010	See Note above	924,702	30
HP Journal http://journals.lww.com/health-physics/pages/default.aspx COMPLETED 11/04/2010	See Note above	53	0
Journal of Occupational and Environmental Health http://www.ijoeh.com/index.php/ijoeh COMPLETED 11/04/2010	See Note above	1	0
National Academies Press http://www.nap.edu/ COMPLETED 11/02/2009	See Note above	211	0
NNSA - Nevada Site Office www.nv.doe.gov/main/search.htm COMPLETED 11/02/2009	See Note above	0	0
NRC ADAMS Reading Room http://www.nrc.gov/reading-rm/adams/web-based.html COMPLETED 09/01/2010	See Note above	1,211	24
U.S. Transuranium & Uranium Registries http://www.ustur.wsu.edu/ COMPLETED 11/02/2009	See Note above	0	0