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ADVISORY BOARD ON
RADIATION AND WORKER HEALTH

National Institute for Occupational Safety and Health

A FOCUSED REVIEW OF THE NIOSH SEC EVALUATION REPORT FOR GRAND JUNCTION OPERATIONS OFFICE, ADDENDUM TO PETITION SEC-00175

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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
AEDE	annual effective dose equivalent
Advisory Board	Advisory Board on Radiation and Worker Health
AL	annual limit
ALI	annual limit on intake
Bi	bismuth
BZ	breathing zone
DAC	derived air concentration
D&D	decontamination and decommissioning
DCAS	Division of Compensation Analysis and Support
$d/m/m^3$	disintegration per minute per cubic meter
DOE	U.S. Department of Energy
DR	dose reconstruction
ER	evaluation report
GA	general area
GJ	Grand Junction
GJOO	Grand Junction Operations Office
INEL	Idaho National Engineering Laboratory
INL	Idaho National Laboratory
IVC	independent verification contractor
µCi/ml	microcurie per milliliter
$µg/m^3$	microgram per cubic meter
m^3	cubic meter
mg/l	milligram per liter
mg/m^3	milligrams per cubic meter
MPC	maximum permissible concentration
mrem	millirem
NIOSH	National Institute for Occupational Safety and Health
NYOO	New York Operations Office
OCAS	Office of Compensation Analysis and Support
ORAU	Oak Ridge Associated Universities

ORAUT	Oak Ridge Associated Universities Team
Pb	lead
pCi/l	picocurie per liter
pCi/mg	picocurie per milligram
PER	program evaluation report
Po	polonium
PRSC	Procedures Review Subcommittee
Pu/Am	plutonium/americium
Ra	radium
RDC	radon-daughter-concentration
rem	roentgen equivalent man
RI/FS	remedial investigation/feasibility study
Rn	radon
ROD	Record of Decision
RP	reference point
RWP	Radiation Work Permit
SEC	Special Exposure Cohort
SRDB	Site Research Database
Th	thorium
U	uranium
U_3O_8	triuranium octaoxide
WL	working level

1.0 BACKGROUND AND STATEMENT OF PURPOSE

On April 29, 2011, the Secretary of Health and Human Services designated a Special Exposure Cohort (SEC) for workers at the Grand Junction Operations Office (GJOO) (NIOSH 2011). The SEC designation was based on the following deficiencies/limitations:

- The National Institute for Occupational Safety and Health (NIOSH) determined that there are insufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored external exposures for the period March 23, 1943, through December 31, 1959.

- NIOSH determined that there are insufficient data to reconstruct internal doses from all potential sources (inclusive of radon) during the period from March 23, 1943, through January 31, 1975.

No technical basis document has been developed for dose reconstructions (DRs) of workers at the GJOO. However, a "template" had been developed that contains the GJOO site- specific information and guidance in order to assess claimant exposures (hereafter referred to as the "DR template"). During NIOSH's evaluation of the GJOO SEC petition, a substantial body of new information was discovered with the potential for significant impacts on previously completed DRs. The availability of new data for DR required the original DR template to be revised on September 5, 2012, and the subsequent issuance of DCAS-PER-047 (DCAS 2014) on March 26, 2014, in order to evaluate the effect of these revisions on previous DRs.

During a teleconference meeting by the Procedures Review Subcommittee (PRSC) of the Advisory Board on Radiation and Worker Health (hereafter referred to as the "Advisory Board") on August 28, 2014, SC&A was tasked to conduct a review of DCAS-PER-047 (DCAS 2014).

The SC&A report, *A Review of NIOSH's Program Evaluation Report DCAS-PER-047, Grand Junction Operations Office*, SCA-TR-PR2015-0093, Revision 01, was issued on February 10, 2015, and contained four findings. Two findings were resolved at the April 28, 2015, meeting of the PRSC. Findings 3 and 4 have yet to be resolved.

On March 15, 2015, NIOSH issued an addendum to the SEC-00175 evaluation report (ER) (NIOSH 2015) addressing the time period from February 1, 1975, through July 31, 2010. On March 25, 2015, the Advisory Board approved the SEC-00175 ER addendum and tasked SC&A to review the addendum and available documentation, focusing on two issues:

1. Appropriateness of the revised SEC time period
2. Appropriateness of the air monitoring and bioassay data

This report summarizes the issues addressed in the original SEC-00175 ER (NIOSH 2011) and SCA-TR-PR2015-0093 (SC&A 2015) and evaluates the changes identified in the addendum (NIOSH 2015).

1.1 RELEVANT BACKGROUND INFORMATION

1.1.1 Overview of Facility History

Between 1943 and 1946, the Manhattan Engineering District acquired the Grand Junction site in order to concentrate triuranium octaoxide (U_3O_8) from "green sludge," which was considered a byproduct of vanadium production. Subsequently, in 1947, the U.S. Atomic Energy Commission (AEC) established a domestic uranium procurement program that was responsible for the receipt, sampling, and analysis of uranium (and vanadium) concentrates purchased from domestic ore processing operations until 1974.

From 1974 to 1984, the GJOO supported the National Uranium Resource Evaluation Program in the preparation of samples prior to analysis. Sample preparation activities, which included crushing, sizing, and blending, posed the greatest potential for internal exposure.

Other activities included cleanup under the Uranium Mill Tailing Remedial Action program starting in 1978, and the Grand Junction Remedial Action Program, involving 600 vicinity offsite properties from 1972 to 1988. However, offsite soil samples were prepared and analyzed in onsite facilities. By 2001, remediation that included onsite buildings had been completed and the facility had been approved for unrestricted use, but it remains under the U.S. Department of Energy's (DOE's) purview to this day.

1.1.2 Review of SEC-00175

On January 11, 2011, NIOSH submitted the SEC ER for SEC-00175 to the Advisory Board. In that report, NIOSH determined that (1) there are insufficient personnel monitoring, workplace monitoring, or source term data to estimate unmonitored external exposures for the period March 23, 1943, through December 31, 1959; and (2) that there is insufficient information to reconstruct internal doses from all potential sources (inclusive of radon) during the period from March 23, 1943, through January 31, 1975.

The SEC period end date of January 31, 1975, was established because of a lack of radon data for reconstructing internal dose during the period of sampling operations. By February 1, 1975, sampling operations had ended and the large quantities of uranium concentrate were removed from the site. NIOSH determined there are sufficient data to reconstruct internal dose for the period from February 1, 1975, through July 31, 2010. However, NIOSH also concluded that external exposures cannot be estimated for March 23, 1943, through December 31, 1959, because sufficient data were not found to bound external doses prior to 1960. However, there are sufficient data to reconstruct external dose for the period from January 1, 1960, through July 31, 2010.

Table 1-1 summarizes the results of the SEC-00175 ER feasibility findings.

Table 1-1. SEC-00175 ER Feasibility Findings

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	—	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	—

1.1.3 Review of SCA-TR-PR2015-0093

During a teleconference meeting by the Advisory Board's PRSC on August 28, 2014, SC&A was tasked by the Advisory Board to conduct a review of DCAS-PER-047, Grand Junction Operations Office (DCAS 2014).

DCAS-PER-047 states:

> *No Technical Basis Document exists for Grand Junction Operations Office (GJOO) claims. However, a template has been used as guidance to complete claims. During the evaluation of a Special Exposure Cohort petition, additional information was discovered that required a change to the template. The template was edited on 9/5/2012 to incorporate the additional information. This PER is intended to evaluate the effect of these changes on previous dose reconstructions.*

Subtask 2 of the SC&A report pertains to a review of the external doses, internal doses, and other information from the SEC-00175 ER that was used in the revised DR template.

External Dose

During the preparation of the SEC-00175 ER, NIOSH discovered a data report provided by the Idaho National Laboratory (INL), which contained more than 15,000 records of external monitoring data of GJOO workers for the period 1982 to 1998. These records identify gamma (penetrating) doses and the contribution of the beta dose to the skin. Records also include a

limited number of workers who were assessed for neutron exposures in the early years, but whose numbers increased in later years.

SC&A reviewed the dosimetry data and assumptions used to determine the external deep, shallow, and neutron doses to unmonitored workers at GJOO for the time period beginning in 1960 through the end of the SEC period. The SC&A (2015) report identified two findings regarding the external dose data. Both findings were resolved during the PRSC meeting on April 28, 2015.

Occupational Medical Dose

NIOSH determined it was feasible to bound the occupational medical dose to workers at GJOO for the entire SEC time period from March 1943 through July 2010. SC&A reviewed the revised DR template and raised an observation about the wording in the template of the guidance for the assignment of medical x-rays (SC&A 2015). This issue was discussed at the April 28, 2015, PRSC meeting and resolved.

Air Monitoring

SC&A reviewed the available air monitoring data and how they were used in the DR template. Air sampling was performed in the Sample Plant during July 1980 while ore samples were being prepared. The most concentrated sample contained 0.0046 milligrams per cubic meter (mg/m^3) of uranium. This result is used by NIOSH to assess unmonitored intakes during sample preparation from 1975 to 1984.

In 1986, time-weighted exposures for the first quarter were calculated in terms of maximum permissible concentration (MPC)-hours for individuals performing grinding operations of uranium mill tailings in the sample preparation laboratory. The exposure in MPC-hours was documented for the highest-exposed individual. For the period 1985–2003, intake values were based on time-weighted MPC-hours exposure to the highest exposed individual. The assigned MPC-hours exposure was conservatively assumed to represent thorium-230 (Th-230).

In addition, NIOSH states that 569 air sample measurements were recovered for onsite decontamination and decommissioning (D&D) work, including both general area and breathing zone samples. These samples are to be used to assign doses to D&D workers and others if individual bioassay results are not available.

SC&A reviewed and verified the 1980 air sample result and the 1986 documented time-weighted MPC-hours exposure result. However, no reference was initially provided that identifies the source document for the 569 air samples. Although NIOSH later provided multiple references to SC&A, SC&A still has a concern about implementation; that is, how the dose reconstructor will use the air sample information in lieu of bioassay results. This issue, identified as Finding 3 in SC&A 2015, was discussed at the April 28, 2015, PRSC meeting and remains open.

Radon

SC&A reviewed the radon concentrations/exposures cited in the DR template and found that the template does not identify these studies in its Reference List. Upon request, NIOSH then

provided additional information in support of the radon data. SC&A reviewed the additional information and concurs with radon exposure estimates cited in the revised GJOO DR template.

Internal Doses for Unmonitored Workers

The internal dose assessments are divided into two areas: sample preparation and D&D. Sample preparation is further divided into two time periods; 1975–1984 and 1985–2003.

Sample preparation internal exposures from 1975 to 1984 are based on the 1980 air sample result of 0.0046 mg/m^3 of uranium. The internal exposures from 1985 to 2003 are based on the 1986 documented time-weighted MPC-hours exposure result. SC&A was able to verify the internal exposure calculations from 1985 to 2003. However, during their derivation of intake rates for radium-226 (Ra-226) and Th-230, SC&A determined that NIOSH failed to employ activity fractions cited in the DR template. Identified as Finding 4 in SC&A 2015, this issue was discussed at the April 28, 2015, PRSC meeting and is in abeyance.

Unmonitored exposures from D&D activities that occurred from 1989 to 2006 are based on the previously described 569 air sample measurements that NIOSH recovered for onsite D&D. This issue is related to Finding 3 and, as such, SC&A was unable to verify the internal exposure calculations for this time period.

2.0 SUMMARY OF ISSUES RAISED IN SEC PETITON-00175 ADDENDUM

NIOSH concluded in its initial SEC-00175 ER (NIOSH 2011) that internal dose reconstruction was likely feasible for the period from February 1, 1975, through July 31, 2010, and that external dose reconstruction was likely feasible for the period from January 1, 1960, through July 31, 2010. NIOSH also found it likely feasible to reconstruct occupational medical dose for the GJOO workers with sufficient accuracy from March 23, 1943, through July 31, 2010.

During its presentation of the initial SEC-00175 ER (NIOSH 2011) to the Advisory Board, NIOSH indicated that it had recently received additional data that were pertinent to the post-1975 period at Grand Junction, which had not yet been fully evaluated. At that time, NIOSH indicated that it would continue its evaluation of the post-1975 period and include its findings in a revision to the SEC-00175 ER, or in the issuance of an addendum.

NIOSH prepared an addendum to SEC-00175, dated March 12, 2015 (NIOSH 2015). The NIOSH dose reconstruction feasibility findings contained in that addendum are based on the following:

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

- In this current evaluation, NIOSH has determined that there are insufficient data available to bound intakes of uranium, thorium, and their associated long-lived progeny, for the period from February 1, 1975, through December 31, 1985. Although sampling operations had ended by February 1, 1975, and the large quantities of uranium concentrate (the major source of radon emissions) had been removed from the site, NIOSH has determined that smaller-scale operations involving crushing and grinding of uranium and thorium ores continued at least through 1988. Operations in the Sample Plant involving high-grade uranium and thorium ores, particularly the crushing and grinding operations, were a potential source of internal exposures. NIOSH has now concluded that there are insufficient internal dosimetry data or air monitoring data available to estimate uranium or thorium intakes prior to 1986. Beginning in the first quarter of 1986, air monitoring data are available that are sufficient to bound intakes of uranium and thorium until the site internal dosimetry program was fully implemented by 1991.

- Based on the lack of internal dose monitoring data or air monitoring data for GJOO workers during the period from February 1, 1975, through December 31, 1985, NIOSH has determined that sufficiently accurate internal dose reconstruction is not feasible. However, NIOSH has identified sufficient information and data to support bounding internal dose estimates for the period from January 1, 1986, through July 31, 2010, using available air monitoring and bioassay data.

- NIOSH finds that it is likely feasible to reconstruct dose from radon for the GJOO workers with sufficient accuracy from February 1, 1975, through July 31, 2010.

- NIOSH finds that it is likely feasible to reconstruct occupational medical dose for the GJOO workers with sufficient accuracy from February 1, 1975, through July 31, 2010.

- NIOSH finds that it is likely feasible to reconstruct external dose for the GJOO workers with sufficient accuracy from February 1, 1975, through July 31, 2010.

Table 2-1 summarizes the results of the SEC-00175 ER addendum (NIOSH 2015) feasibility findings.

Table 2-1. Addendum to SEC-00175 ER Feasibility Findings

Source of Exposure	February 1, 1975, through December 31, 1985		January 1, 1986, through July 31, 2010	
	Reconstruction Feasible	Reconstruction Not Feasible	Reconstruction Feasible	Reconstruction Not Feasible
Internal	—	X	X	—
– Radon	X	—	X	—
– Thorium and Uranium (and their associated long-lived progeny)	—	X	X	
External	X	—	X	—
– Gamma	X	—	X	—
– Beta	X	—	X	—
– Neutron	X	—	X	—
– Occupational Medical X-ray	X	—	X	—

2.1 REVIEW OF EXTERNAL DOSIMETRY DATA

2.1.1 External Dosimetry

Exposure records are maintained at the Grand Junction office and in a database maintained by INL. Since the issuance of the initial SEC-00175 ER (NIOSH 2011), a data report was provided by INL that includes personnel believed to be associated with Grand Junction through the use of INL location codes. The dosimetry report has data between the years 1982 and 1998 and contains over 15,000 records, each with a gamma and beta result and occasional neutron results.

NIOSH has determined it is feasible to reconstruct external dose for the GJOO workers with sufficient accuracy from February 1, 1975, through July 31, 2010. This is the same as NIOSH's feasibility determination described in the original SEC-00175 ER (NIOSH 2011) as shown in Table 1-1.

SC&A reviewed the unmonitored external dose assessment in SCA-TR-PR2015-0093 (SC&A 2015) and concurs with NIOSH's feasibility determination.

2.1.2 Occupational Medical Dose

NIOSH finds that it is likely feasible to reconstruct occupational medical dose for the GJOO workers with sufficient accuracy from February 1, 1975, through July 31, 2010. This also is the same as NIOSH's feasibility determination described in the original SEC-00175 ER (NIOSH 2011) as shown in Table 1-1.

SC&A reviewed the occupational medical dose assessment in SCA-TR-PR2015-0093 (SC&A 2015) and concurs with NIOSH's feasibility determination.

2.2 REVIEW OF INTERNAL DOSIMETRY DATA

2.2.1 Radon

NIOSH finds that it is likely feasible to reconstruct dose from radon with sufficient accuracy from February 1, 1975, through July 31, 2010. This is the same as NIOSH's feasibility determination described in the original SEC-00175 ER (NIOSH 2011) as shown in Table 1-1. SC&A reviewed the unmonitored radon dose assessment in SCA-TR-PR2015-0093 (SC&A 2015) and concurs with NIOSH's feasibility determination.

2.2.2 Air Monitoring Data

Table 2-2 shows the air monitoring data captured by NIOSH (2011). As noted in SCA-TR-PR2015-0093 (SC&A 2015), prior to 1989, air samples generally lacked information about location. Between 1945 and 1961, the results were generally particulate samples counted for gross alpha, which was then interpreted as uranium. For the 1960s, only radon or radon daughter results are available. In 1986, time-weighted exposures for the first quarter were calculated in terms of MPC-hours for individuals performing grinding operations of uranium mill tailings in the sample preparation laboratory. Beginning in 1989, there are numerous air sample measurements for onsite D&D work, including both general area (GA) and breathing zone (BZ) samples.

Table 2-2. GJOO Air Monitoring Data

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

Year	Approx. No. of Results	Area/Company/Organization	SRDB Ref IDs	Notes
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 [Redacted per Privacy Act] had exposures which were less than 50 d/m/m^3. Only [Redacted per Privacy Act] of the remaining [Redacted per Privacy Act] had a really significant exposure. [Redacted per Privacy Act] 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 Grand Junction. 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	Grand Junction (general)	11452	Samples from Jun and Jul - Outside areas (environmental-type)
1961	12	Grand Junction (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	Grand Junction AEC Compound	17031	Rn-222 levels in pCi/l; Jul, Sep, Oct, and Nov; included in 17034
1967	7	Grand Junction AEC Compound	17034	Rn-222 levels in pCi/l; Jul, Sep, Oct, Nov, and Dec
1967	16	Grand Junction (general)	82790	Radon levels in GJ area 1967-1968; 16 measurements are for one station in or near the AEC compound.
1968	9	Grand Junction (general)	17034	Rn-222 levels in pCi/l; Jan, Feb, Mar, Apr, Jun, and Aug
1986	See Notes	Grand Junction (general)	90851	Annual Environmental Report with particulate monitoring results for three stations.

Year	Approx. No. of Results	Area/Company/Organization	SRDB Ref IDs	Notes
1986	See Notes	Grand Junction (general)	29855	Statement that there are "no significant radionuclide emissions from GJPO facilities including the laboratories, sample preparation facility, and the radon chamber."
1986	300	Grand Junction (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.
1986	3	Grand Junction (in doors)	98100	MPC-time weighted exposure for first quarter 1986. Measurements taken in sample prep lab during time of grinding of uranium mill tailings.
1987	See Notes	Grand Junction (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	Grand Junction (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	Grand Junction (general)	90856	Annual Environmental Report with particulate monitoring results for four stations (total U, Th-230, Ra-226); radon monitoring results for three stations.
1989	569	Grand Junction (general)	89872, 89909, 89926, 89931, 89938, 89979, 89991, 90015, 90087, 90105, 90118, 90154, 90155, 90164, 93709	Air sample measurements for on-site D&D work, post-1988, including both general area and breathing zone samples.
1990	See Notes	Grand Junction (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	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1990	16	Grand Junction (in doors)	100231	Technical basis document for internal dosimetry. Includes isotopic air concentration measurements for Bldg. 7A Sample Prep Laboratory.
1991	See Notes	Grand Junction (general)	90853	Annual Environmental Report with particulate monitoring results for four stations (total U, Th-230, Ra-226); radon monitoring results for eight stations.

Year	Approx. No. of Results	Area/Company/Organization	SRDB Ref IDs	Notes
1991	1	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1991	30	Grand Junction (in doors)	13191	Results of the DOE indoor radon study; 19 occupied buildings measured.
1992	See Notes	Grand Junction (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	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1993	See Notes	Grand Junction (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	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1994	1	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1996	1	Grand Junction (general)	76642	Annual atmospheric release of radioactive material
1998	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material
1999	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material
2000	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material
2001	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material

Source: NIOSH 2011.

After a review of the available air monitoring data, SC&A concludes that the lack of adequate air monitoring data prior to 1961 and the absence of air monitoring data from 1962 to 1985 support NIOSH's position that it is not feasible to reconstruct internal doses from February 1, 1975, through December 31, 1985.

2.2.3 Internal Dose to Unmonitored Workers

According to the SEC ER addendum (NIOSH 2015), there is no comprehensive database of bioassay results for the Grand Junction site. Only a limited number of bioassay results are contained in documents captured by NIOSH for the period 1945 through 1999, as shown in Table 2-3. NIOSH also found that, while some workers do have bioassay measurements included in their records, there are not enough claimants with bioassay information available to indicate which workers were routinely included in a bioassay program.

Table 2-3. Available Bioassay Data

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
1945	11	GJ Mill (Refinery)	16855	U in urine, 1 set 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
1956	47	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1957	49	Lucius Pitkin	3307, 3397	U in urine; 2 sets - May and Oct
1957	49	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
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
1958	63	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
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
1959	59	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1960	49	Lucius Pitkin	3307, 3397	U in urine, 2 sets - Jun and Dec
1960	49	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1961	57	Lucius Pitkin	3307, 3397	U in urine; 2 sets - Jun and Dec; plus 2 Jan results and 1 Mar result.
1961	58	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1962	26	Lucius Pitkin	3307, 3397	U in urine, 1 set - Jun; plus 1 Jan result
1962	49	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1963	44	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
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 (RP) of 0.05 mg/l.
1964	10	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1965	47	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1966	64	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1967	71	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1968	70	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
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.
1969	55	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1970	27	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1971	30	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
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.
1972	11	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
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.
1973	52	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1974	14	Lucius Pitkin	98104	Urinalysis Report, collected 5/24/11
1984	1	Bendix	97742	Exposure history for specific individual, collected 5/23/11
1984	1	Bendix	97813	Exposure history for specific individual, collected 5/25/11
1984-1986	1589	Bendix	98107	Urinalysis Sampling Log, collected 5/24/11
1986	16	INEL	97808	Bioassay Report for Grand Junction, collected 5/21/11
1986	8	UNC Technical Services	98096	Bioassay Report for Grand Junction, collected 5/24/11
1986	8	INEL	125901	Bioassay Report for Grand Junction, collected 5/24/11
1990	2	Lawrence Livermore National Laboratory	97808	Internal Dose Assessments for 1990, collected 5/21/11

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
1990	133	Thermo Analytical	97828	Radiological Analysis Results for Ra in urine, collected 5/24/11
1990	109	GeoTech	97828	1990 Bioassay Results, collected 5/24/11
1991	8	Thermo Analytical	97828	Radiological Analysis Results in urine, collected 5/24/11
1991	20	Thermo Analytical	97847	Radiological Analysis Results in urine, collected 5/24/11
1991	20	Thermo Analytical	97849	Radiological Analysis Results in urine, collected 5/24/11
1991	6	Thermo Analytical	97851	Radiological Analysis Results in urine, collected 5/24/11
1991	43	Thermo Analytical	97852	Radiological Analysis Results in urine, collected 5/24/11
1991	30	Thermo Analytical	97854	Radiological Analysis Results in urine, collected 5/24/11
1991	30	Thermo Analytical	97856	Radiological Analysis Results in urine, collected 5/24/11
1991	5	Thermo Analytical	97857	Radiological Analysis Results in urine, collected 5/24/11
1991	8	Thermo Analytical	97858	Radiological Analysis Results in urine, collected 5/24/11
1991	1	GeoTech	97637	Exposure history for specific individual, collected 5/23/11
1991	1	GeoTech	97679	Exposure history for specific individual, collected 5/23/11
1991	22	Thermo Analytical	97838	Radiological Analysis Results in urine, collected 5/24/11
1991	18	Thermo Analytical	97839	Radiological Analysis Results in urine, collected 5/24/11
1991	11	Thermo Analytical	97842	Radiological Analysis Results in urine, collected 5/24/11
1991	5	Thermo Analytical	97843	Radiological Analysis Results in urine, collected 5/24/11
1991	13	Thermo Analytical	97871	Radiological Analysis Results in urine, collected 5/24/11
1991	20	Thermo Analytical	97878	Radiological Analysis Results in urine, collected 5/24/11
1991	24	Thermo Analytical	97880	Radiological Analysis Results in urine, collected 5/24/11
1991	20	Thermo Analytical	97882	Radiological Analysis Results in urine, collected 5/24/11
1991	65	Thermo Analytical	97883	Radiological Analysis Results in urine, collected 5/24/11
1991	20	Thermo Analytical	97884	Radiological Analysis Results in urine, collected 5/24/11

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
1991	27	Thermo Analytical	97885	Radiological Analysis Results in urine, collected 5/24/11
1991	20	Thermo Analytical	97886	Radiological Analysis Results in urine, collected 5/24/11
1991	7	Thermo Analytical	97887	Radiological Analysis Results in urine, collected 5/24/11
1991	32	Thermo Analytical	97888	Radiological Analysis Results in urine, collected 5/24/11
1991	1	Thermo Analytical	97889	Radiological Analysis Results in urine, collected 5/24/11
1991	63	Thermo Analytical	97890	Radiological Analysis Results in urine, collected 5/24/11
1991	31	Thermo Analytical	97891	Radiological Analysis Results in urine, collected 5/24/11
1991	24	Thermo Analytical	97892	Radiological Analysis Results in urine, collected 5/24/11
1991	49	Thermo Analytical	97893	Radiological Analysis Results in urine, collected 5/24/11
1991	49	Thermo Analytical	97894	Radiological Analysis Results in urine, collected 5/24/11
1991	49	Thermo Analytical	97895	Radiological Analysis Results in urine, collected 5/24/11
1991	49	Thermo Analytical	98090	Radiological Analysis Results in urine, collected 5/24/11
1991-1992	139	GeoTech	97763	Radon log in sheets, collected 5/24/11
1992	15	Chem-Nuclear Geotech	97762, 97809	Internal Dose Assessments for 1992, collected 5/21/11
1992	7	GeoTech	97792	Memo about bioassay results and recommended follow-up testing, collected 5/23/11
1992	28	GeoTech	97784	Evaluation of Uranium Oxide Spill, collected 5/23/11
1992	18	Thermo Analytical	97841	Radiological Analysis Results in urine, collected 5/24/11
1995	12	RUST Geotech	97828	Internal Radiation Dose Assessment for Individuals Visiting, collected 5/24/11
1995	7	RUST Geotech	90511	7 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U)
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).

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
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

Year	Approx. No. of Results	Company/Organization	SRDB Ref IDs	Notes
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
1997	23	MACTEC	90528	23 fecal samples sent to Teledyne Brown Engineering Environmental Services for alpha-spec analysis (U), collected 11/11/2010
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.

Based on the available bioassay and air monitoring data, NIOSH has determined that the data are not sufficient to accurately reconstruct the internal doses during the period from February 1, 1975, through December 31, 1985. SC&A has reviewed the limited bioassay data available and the air monitoring data and agrees the available data are not sufficient to accurately reconstruct the internal doses during the period from February 1, 1975, through December 31, 1985.

2.2.4 Bounding Internal Doses

NIOSH believes there are sufficient data to support bounding internal dose estimates for the period from January 1, 1986, through July 31, 2010, using available air monitoring and bioassay data.

The time period for the bounding internal dose estimates is divided into pre-1991 and 1991 forward. Sample preparation activities occurred from 1986 to 1990 and D&D activities from 1988 to 1990. After 1991, DOE Order 5480.11, *Radiation Protection for Occupational Workers*, was implemented (DOE 1988). The order specifies that bioassay shall be collected if exposure indicates that a worker could be exposed to inhalation intake during the year that exceeded 200 derived air concentration (DAC)-hours and that a monitoring program must be in place for all workers who have the potential for 40 DAC-hours.

Sample Preparation

NIOSH determined sample preparation to be the highest onsite exposure potential scenario in the post-1985 time period. According to the SEC addendum (NIOSH 2015):

> *For the period of time from January 1, 1986 through December 31, 1990, bounding daily uranium intake rates for operators and laborers may be assigned by assuming that a worker received the MPC-hour limit every quarter. Thorium-230 may be assumed to be the limiting radionuclide. The applicable limiting MPC for Thorium-230 is 2.00E-12 µCi/mL.*

SC&A believes the method proposed by NIOSH to bound the uranium intakes is reasonable and adequate.

NIOSH states that the method for bounding uranium intakes during this time period is also appropriate to bound thorium intakes for the same period. The rationale for this conclusion is that the controls used for crushing and grinding uranium ore were the same as those used for crushing and grinding thorium, and both operations took place in the same facility.

NIOSH goes on to state:

> *Based on interviews (Personal Communication, 2014e; Personal Communication, 2014g; Personal Communication, 2014h) with former workers, the time required to complete the construction of a calibration pad, either uranium or thorium, would not exceed a calendar month. The physical crushing and grinding of the thorium ore, which is the main source of exposure, would actually have been completed in much less time than a full month.* ***For the purpose of bounding potential intakes of thorium from these operations a full calendar month of exposure to thorium ore is assumed for each operation involving crushing and grinding of thorium ore.*** *Laborers and operators may therefore be assumed to be exposed to the MPC for a full month for each thorium operation if employed at that time. Since the exact dates of the construction of the pads are not known, the most claimant-favorable period (first potential month) should be assumed for the assignment of the thorium exposure. Thorium progeny should also be assumed to also be present, and at the same concentration as Th-232.* **[emphasis added]**

SC&A carefully reviewed the three personal communications cited above.

One document is an interview with a manager. The other two documents are interviews with the supervisor/manager. The supervisor/manager described the sample operations time frame when asked: "What were the typical times for the entire process?" (Personal Communication, 2014e)

> *The crushing and grinding operation together would take about one week.*
>
> *I estimate the times involved for handling the batch materials to be:*
>
> - *5–10 minutes to load*

- *5–10 minutes to unload*
- *2–3 minutes to add the active material*

It took about 30 minutes to blend a batch inside the V blender. When a model was being made, the blending of batches went on for about two weeks.

So, with crushing/grinding taking about one week, and blending taking about two weeks, the preparation of material for a model would average about three weeks. The longest campaign (if it was a large model) would have been about one month.

While SC&A has no reason to doubt the interviewee, we do have one concern.

Concern 1:

Both interviewees are management-level employees, not operators or laborers who performed the actual work. It would be beneficial to obtain information from the actual workers about work conditions and controls to supplement the current information.

Decontamination/Decommissioning

According to the SEC addendum (NIOSH 2015):

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. 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. Additional close-out surveys and verifications were done for each building on site that was released for unrestricted use). 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.* **[emphasis added]**

Concern 2:

SC&A was not tasked to perform a comprehensive data review. As such, it is not clear how the "thousands of pages" of health and survey data will be used by the dose reconstructors or what guidance will be provided to assess the unmonitored internal dose to a D&D worker with no bioassay data.

DOE Order 5480.11 Implementation

The 1990 document, *Technical Basis for Bioassay Sampling for Sample Preparation Plant and Grand Junction Vicinity Property Workers* (Geotech 1990), describes the implementation of DOE Order 5480.11 for monitoring workers. It states that bioassay will be collected if exposure indicates that a worker could be exposed to inhalation intakes during the year that exceeded 200 DAC-hours. It further states that a monitoring program must be in place for all workers who have the potential for 40 DAC-hours. This document was issued in early 1990; NIOSH is assuming that full implementation was not in place until the end of 1990.

SC&A reviewed the bioassay sampling technical basis document prepared by Geotech (1990). It describes how the requirements of DOE Order 5480.11 will be implemented. The Executive Summary states:

> *The interim bioassay program consists of collecting routine urine samples which are analyzed for Ra-226. The detection of Ra-226 in urine allows the performance standard of the workplace monitoring program (i.e., detection of an intake resulting in a dose of 100 mrem committed effective dose equivalent) and the individual routine monitoring program (i.e., detection of an intake resulting in a dose of 100 mrem annual effective dose equivalent) to be accomplished. The program has two components: 1) prospective (workplace) monitoring; and 2) retrospective (individual worker) monitoring.*
>
> *Prospective (workplace) monitoring will consist of air monitoring and urine sample collection.* ***Air monitoring will be the primary method of monitoring the workplace.*** *Urine samples will be collected from representative workers (i.e., workers chosen to represent a particular work environment) every 6 days. This will be accomplished by rotating the workers on the routine bioassay program such that each individual employee submits a urine sample every 26 days. If the air monitoring data or urine samples indicate an intake, all workers in the work*

environment will be required to submit two follow-up urine or fecal samples. **[emphasis added]**

Retrospective (individual worker) monitoring will consist of routine urine sample collections from individual workers every 26 days. If the routine urine sample indicates an intake, two follow-up fecal samples will be required. In addition, urine samples will be required for new hires and radiation workers transferring to another facility if they report previous work with the same radionuclides. Urine samples will also be required from employees terminating employment.

Section 4.0 of Geotech 1990 describes the performance capabilities for workplace monitoring programs. It states, in part:

Air monitoring shall be the primary method for monitoring the workplace. Bioassay measurements may also be used to support the prospective monitoring program but shall not provide the primary bases for monitoring for loss of control in the workplace.

The only workplace air samples SC&A found were the 16 air sample results listed in Table 1 of the bioassay sampling technical basis document from the sample preparation laboratory located in Building 7 (Geotech 1990). These results are shown in Table 2-4 below. The limiting DAC for Th-230 is 3.00E-12 microcurie per milliliter (µCi/ml) or 3.00E-06 microcurie per cubic meter (µCi/m^3). Two of the 16 air samples exceed the limiting DAC for Th-230.

Table 2-4. Air Monitoring Data for the Sample Preparation Laboratory – Air Concentrations (µCi/m^3)

Sample ID#	Po-210	Ra-226	Th-230	Pb-210	U-238	Bi-210
MDN651	8.10E-07	0.00E+00	9.30E-07	9.30E-07	0.00E+00	9.30E-07
MDN652	2.60E-06	0.00E+00	3.10E-06	3.10E-06	0.00E+00	3.10E-06
MDN653	2.10E-06	2.20E-06	2.40E-06	2.40E-06	0.00E+00	2.40E-06
MDN654	6.40E-07	4.90E-06	6.40E-07	6.40E-07	0.00E+00	6.40E-07
MDN655	5.60E-07	0.00E+00	9.30E-07	9.30E-07	0.00E+00	9.30E-07
MDN656	4.80E-07	0.00E+00	4.80E-07	4.80E-07	0.00E+00	4.80E-07
MDN657	6.80E-07	0.00E+00	9.00E-07	9.00E-07	0.00E+00	9.00E-07
MDN658	5.60E-07	2.10E-06	1.10E-06	1.10E-06	0.00E+00	1.10E-06
MDN659	3.10E-06	7.80E-07	3.10E-06	3.10E-06	0.00E+00	3.10E-06
MDN660	3.20E-07	0.00E+00	4.20E-07	4.20E-07	0.00E+00	4.20E-07
MDN661	0.00E+00	0.00E+00	5.00E-07	5.00E-07	0.00E+00	5.00E-07
MDN662	1.30E-07	0.00E+00	2.60E-07	2.60E-07	2.70E-06	2.60E-07
MDN663	1.70E-07	0.00E+00	5.00E-07	5.00E-07	0.00E+00	5.00E-07
MDN664	5.90E-07	0.00E+00	5.00E-07	5.00E-07	0.00E+00	5.00E-07
MDN665	5.00E-07	0.00E+00	3.40E-07	3.40E-07	0.00E+00	3.40E-07
MDN666	3.50E-07	0.00E+00	2.60E-07	2.60E-07	0.00E+00	2.60E-07

Source: Geotech 1990, Table 1.

Section 7.0 of the bioassay sampling technical basis document (Geotech 1990) describes how the air monitoring and bioassay programs are to demonstrate compliance with DOE Order 5840.11:

7.1 Workplace (Prospective) Monitoring Program

Air monitoring data will be tracked by use of a database program *presently being developed. This program will track the derived air concentration (DAC) values of the air samples, sample location, worker's present, reductions due to respirator use, and the occupancy time. This will allow the determination of the need for follow-up bioassay sampling when a worker is suspected of having an intake equivalent to 0.02 ALI (40 DAC-h). When the air data indicates a potential intake of 0.02 ALs the worker will be required to submit a urine sample which will be sent to the TMA/NORCAL for analysis on a rush order. If the follow-up urine sample confirms an intake, two (special) bioassay samples will be taken to determine the internal dose resulting from the intake. The two follow-up bioassay samples shall consist of two urine samples if the time between the suspected intake and the follow-up sample collection time is less than 26 days. The two follow-up bioassay samples will consist of fecal samples if the time between the suspected intake and the follow-up sample collection time is greater than 26 days and preferably less than 53 days. This sampling schedule would meet the performance standard of follow-up samples detecting intakes at the 100 mrem AEDE objective.* **[emphasis added]**

Urine samples will be collected from a representative worker (i.e., a worker chosen to represent a particular work environment) every 6 days. If five or more workers are involved in the same work environment, individual employee will give a sample every 26 days (see section 7.2 routine bioassay) and will be on a rotational schedule such that at least one urine sample is received from a representative employee every 6 days. If the work environment consists of four workers, each employee would be required to supply a urine sample every 24 days, and the workers will be on a rotational schedule such that one urine sample is collected from a worker every 6 days. Air monitoring data will provide the basis for the prospective monitoring program for work environments which have less than four employees on the bioassay program.

Table 2-5 contains the available air monitoring information during and after the time period when the technical basis for bioassay sampling was implemented. With the exception of the workplace air monitoring results contained in the technical basis, no other workplace air monitoring results are found.

Table 2-5. Air Monitoring Results After 1990

Year	Approx. No. of Results	Area/Company/Organization	SRDB Ref IDs	Notes
1990	See Notes	Grand Junction (general)	90845	Annual Environmental Report with particulate monitoring results for four stations (total U, Th-230, Ra-226); radon monitoring results for three stations.

Year	Approx. No. of Results	Area/Company/Organization	SRDB Ref IDs	Notes
1990	1	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1990	16	Grand Junction (in doors)	100231	Technical basis document for internal dosimetry. Includes isotopic air concentration measurements for Bldg. 7A Sample Prep Laboratory.
1991	See Notes	Grand Junction (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	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1991	30	Grand Junction (in doors)	13191	Results of the DOE indoor radon study; 19 occupied buildings measured.
1992	See Notes	Grand Junction (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	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1993	See Notes	Grand Junction (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	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1994	1	Grand Junction (general)	37700	Annual atmospheric release of radioactive material
1996	1	Grand Junction (general)	76642	Annual atmospheric release of radioactive material
1998	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material
1999	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material
2000	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material
2001	1	Grand Junction (general)	44873	Annual atmospheric release of radioactive material

NIOSH states on page 29 of the ER addendum (NIOSH 2015):

> *Therefore, starting in 1991, it is assumed that unmonitored radiation workers would not have exceeded 200 DAC-hours in a given year (if they had they would*

have then been placed on a bioassay program). In addition, it is assumed that non-radiation workers would not have exceeded 40 DAC-hours in a given year.

Finding 1: Workplace air monitoring data do not support the assumption that unmonitored radiation workers would not have exceeded 200 DAC-hours or that non-radiation workers would not have exceeded 40 DAC-hours in a given year.

Although the technical basis document for bioassay programs (Geotech 1990) describes how the program should operate to detect intakes resulting in a dose of 100 mrem, no document or database was presented containing air monitoring results, sample locations, workers present, etc. to demonstrate that the workplace controls described in the technical basis document had actually been implemented. SC&A does not believe NIOSH has shown sufficient workplace air monitoring data to support its assertion that unmonitored radiation workers would not have exceeded 200 DAC-hours or that non-radiation workers would not have exceeded 40 DAC-hours in a given year.

3.0 SUMMARY OF FINDINGS AND CONCERNS

SC&A was tasked to review the addendum to the SEC Petition-00175 ER (NIOSH 2015) and available documentation focusing on two issues:

1. Appropriateness of the revised SEC time period

2. Appropriateness of the air monitoring and bioassay data

During SC&A's focused review of the addendum to the SEC Petition-00175 ER, we concluded that the revised SEC time period beginning February 1, 1975, through December 31, 1985, is appropriate based on the lack of sufficient air monitoring data prior to 1986.

However, SC&A did identify one finding and two issues of concern regarding the air monitoring and bioassay data.

Finding 1: There are insufficient workplace air monitoring data to support the assumption that unmonitored radiation workers would not have exceeded 200 DAC-hours or that non-radiation workers would not have exceeded 40 DAC-hours in a given year.

Concern 1: Both interviewees from the Sample Preparation Laboratory are management-level employees and not operators or laborers. It would be beneficial to obtain process and duration information from the workers who performed the work to supplement the information provided in the interviews.

Concern 2: SC&A was not tasked to perform a comprehensive data review. As such, it is not clear how the "thousands of pages" of health and survey data will be used by the dose reconstructors or what guidance will be provided to assess the unmonitored internal dose to a D&D worker with no bioassay data.

Also, SC&A believes it would be beneficial for the Advisory Board to review the DR template when it is revised to incorporate the changes proposed in the addendum.

4.0 REFERENCES

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]

DCAS 2014. *Grand Junction Operations Office*, DCAS-PER-047, Revision 0, National Institute for Occupational Safety and Health, Division of Compensation Analysis and Support, Cincinnati, Ohio. March 26, 2014.

DOE 1988. *Radiation Protection for Occupational Workers*, DOE Order 5480.11, U.S. Department of Energy. December 21, 1998.

Geotech 1990. *Technical Basis for Bioassay Sampling for Sample Preparation Plant and Grand Junction Vicinity Property Workers*, UNC Geotech. March 1990. [SRDB Ref. ID 100231]

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]

NIOSH 2011. *SEC Petition Evaluation Report for Petition SEC-00175, Grand Junction Operation Office*, Revision 0, January 11, 2011.

NIOSH 2015. *Addendum to SEC Petition Evaluation Report, Petition SEC-00175, Grand Junction Operation Office*, Revision 0, National Institute for Occupational Safety and Health. March 12, 2015. [SRDB Ref. ID 141458]

Personal Communication 2014e. Personal Communication with a Former Grand Junction Employee, Telephone Interview by ORAU Team, December 18, 2014, 11:00 AM EST. [SRDB Ref.ID 139114]

Personal Communication 2014g. Personal Communication with a Former Grand Junction Employee, Telephone Interview by ORAU Team, December 10, 2014, 11:00 AM EST. [SRDB Ref. ID 139116]

Personal Communication 2014h. Personal Communication with a Former Grand Junction Employee, Telephone Interview by ORAU Team, October 24, 2014, 9:00 AM MST. [SRDB Ref. ID 139128]

SC&A 2015. *A Review of NIOSH's Program Evaluation Report DCAS-PER-047, Grand Junction Operations Office*, SCA-TR-PR2015-0093, Revision 01, SC&A, Inc., Vienna, Virginia. February 10, 2015.