



REVISED MEMORANDUM

TO: Subcommittee for Procedures Reviews; NIOSH; Ted Katz, DFO
FROM: Hans Behling, SC&A, Inc.
DATE: August 14, 2017
SUBJECT: Revision 1 to Resolution of Finding 3 under SC&A's Review of DCAS-PER-047 (GJOO)

This revision to the June 22, 2017, memorandum corrects a typographical error in the Tailings calculation on page 3.

Relevant Background

In February 2015, SC&A submitted its draft report, *A Review of NIOSH's Program Evaluation Report DCAS-PER-047, "Grand Junction Operations Office"* (SC&A 2015). Among findings identified in SC&A's review of DCAS-PER-047 (NIOSH 2014) was Finding 3. Finding 3 pertains to the National Institute for Occupational Safety and Health's (NIOSH's) modeled annual intakes from inhalation and ingestion of uranium (U-238/U-235/U-234), radium-226 (Ra-226), and thorium-230 (Th-230) during the decontamination and decommissioning (D&D) period (1988–2006) as cited in Table 6 of the revised Grand Junction Operations Office (GJOO) template and reproduced herein as Table 1.¹

In support of these intakes, NIOSH only briefly mentioned the use of *"five-hundred and sixty-nine air sample measurements [that] were recovered for onsite D&D work, including both general area and breathing zone samples..."* Given this limited information and the inability to assess/confirm NIOSH's modeled intakes, SC&A identified Finding 3, which stated the following: *"NIOSH provides neither the raw data nor a documented source for the 569 air sample measurements associated with D&D work for years 1989–2006."*

Following discussions of SC&A's findings with the Subcommittee for Procedure Reviews (PRSC) on February 18, 2015, and on April 28, 2015, NIOSH identified a total of 15 references from the Site Research Database (SRDB) that contained the 569 air sampling data during the D&D period.

At the request of the PRSC, SC&A conducted a limited review of said references and realized the enormity of a complete and independent review of these data. For example, *Building 20*

¹ Templates (inclusive of the GJOO template) are **not** posted/available on the NIOSH website and can only be retrieved in **conjunction** with a completed Dose Reconstruction Report for a claimant who worked at the GJOO facility.

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Health & Safety, SRDB Ref. ID 89938, contains 1,488 pages in support of survey data performed in Building 20.

Given the time and effort that would be required to retrieve, sort, and analyze these data from among the 15 documents, SC&A issued a request (with approval of Ted Katz, DFO) to NIOSH on February 21, 2017, for summary air sampling data and their analysis.

On February 21, 2017, NIOSH provided SC&A with the needed summary data in the form of a complex spreadsheet. A summary portion of the spreadsheet provided by NIOSH is enclosed here as Figures 1 and 2.

Summary Data for D&D Air Samples. For the 569 air samples that represent the years 1989 through 2001 of the D&D period, 519 samples showed air concentrations with a positive value (i.e., > 0). A plot of the natural log y of the 519 positive air samples yielded a distribution shown in Figure 1:

- At $x = 0$, this distribution yielded a y value of -29.25324 and for $e^{-29.25324}$ corresponds to a 50th percentile air concentration of 1.97×10^{-13} microcuries per milliliter ($\mu\text{Ci/ml}$) of gross alpha activity.
- At $x = 1.645$, this distribution yielded a y value of -26.6525 and for $e^{-26.6525}$ corresponds to the 95th percentile air concentration of $2.66\text{E-}12$ $\mu\text{Ci/ml}$ of gross alpha activity.

Figure 2 identifies the lognormal fits of air sample data for each of the 13 years for 1989 through 2001. Due to data limitations, years 1988, 1991, 1992, and 1993 could not be assessed; for the remaining nine years, the average 50th and 95th percentile gross alpha air concentrations corresponded to 2.68×10^{-13} $\mu\text{Ci/ml}$ and 1.906×10^{-12} $\mu\text{Ci/ml}$.

In reviewing the collective versus annualized air concentration data, NIOSH came to the following conclusions, as stated in the revised GJOO template:

*Initially, the air samples captures were analyzed as lognormal distributions year-by-year for the period 1989-2001, but the 50th percentiles were under the estimated MDA for about one third of the years. There was only one sample recovered for 1989 and none for 1991-1993....Due to the gaps described, the decision was made to analyze the air sample results **collectively**. The 95th percentile of the lognormal analysis was used to determine the intake rates to be assigned. **The 95th percentile from the collective analysis resulted in intakes about 40% higher than the year-by-year analyses....This distribution is deemed to apply to any D&D period before or after the samples were collected. For example, the D&D was essentially complete by 2001, but Building 20 was demolished in 2006....The results are shown for both ore and tailings in Table 6. The ore values overestimate the doses from yellowcake by assuming that Ra-226 and Th-232 are in equilibrium with U-238.** [Emphasis added.]*

Assessment of Assigned Uptakes of U, Ra-226, and Th-230 during D&D

As shown in Table 1, annual inhalation and ingestion intakes were derived based on the 95th percentile of gross alpha air concentrations from the collective analysis of 519 air samples for (1) four job categories, (2) three radionuclide groupings, and (3) two source terms (i.e., ore and tailings).

As part of this review, SC&A evaluated all assigned intake values for the D&D period. For illustration, however, only the highest job category (i.e., operator) is assessed for the inhalation intakes of U, Ra-226, and Th-230 for each of the two source terms, since all other values are based on fixed ratios of these values.

Annual Inhalation Intakes for Operator

Ore

- For the 95th percentile gross alpha air concentration of $2.66\text{E-}12$ $\mu\text{Ci/ml}$, U contributes 50.2 percent and Ra-226 and Th-230 are each assumed to contribute 24.9 percent.
- For annual inhalation, intakes assume breathing rate of 1.2 cubic meter per hour (m^3/hr) and 2,000 hours per year (hr/y).

$$\begin{aligned} U_{\text{inhal.}} &= (2.66\text{E-}12 \mu\text{Ci/ml}) \times (1.0\text{E+}06 \text{ milliliter per cubic meter } [\text{ml}/\text{m}^3]) \times (0.502) \times \\ &\quad (1.2 \text{ meters per hour } [\text{m}/\text{hr}]) \times (2,000 \text{ hours per year } [\text{hr}/\text{y}]) \\ &= 3.21\text{E-}03 \text{ microcuries per year } (\mu\text{Ci}/\text{y}) \end{aligned}$$

$$\begin{aligned} \text{Ra-226 or Th-230} &= (2.66\text{E-}12 \mu\text{Ci/ml}) \times (1.0\text{E+}06 \text{ ml}/\text{m}^3) \times (0.249) \times (1.2 \text{ m}/\text{hr}) \times \\ &\quad (2,000 \text{ hr}/\text{y}) \\ &= 1.59\text{E-}03 \mu\text{Ci}/\text{y} \end{aligned}$$

Tailings

- For tailings, the assumed fractional contributions to the gross alpha activity are 0.092 for U, and 0.454 for Ra-226 and Th-230.

$$\begin{aligned} U_{\text{inhal.}} &= (2.66\text{E-}12 \mu\text{Ci/ml}) \times (1.0\text{E+}06 \text{ ml}/\text{m}^3) \times (0.092) \times (1.2 \text{ m}/\text{hr}) \times (2,000 \text{ hr}/\text{y}) \\ &= 5.87\text{E-}04 \mu\text{Ci}/\text{y} \end{aligned}$$

$$\begin{aligned} \text{Ra-226 or Th-230} &= (2.66\text{E-}12 \mu\text{Ci/ml}) \times (1.0\text{E+}06 \text{ ml}/\text{m}^3) \times (0.454) \times (1.2 \text{ m}/\text{hr}) \times \\ &\quad (2,000 \text{ hr}/\text{y}) \\ &= 2.90\text{E-}03 \mu\text{Ci}/\text{y} \end{aligned}$$

SC&A's Comments/Observation

A comparison of values derived by SC&A above with corresponding D&D values cited in Table 1, confirms the use of an air concentration of $2.66\text{E-}12$ $\mu\text{Ci/ml}$. This air concentration of

gross alpha activity represents the 95th percentile of 519 air samples collected for years 1989 through 2001 as shown in Figures 1 and 2.

SC&A concurs with NIOSH's methodology for the assignment of claimant-favorable internal exposures to unmonitored workers during the D&D period.

SC&A, therefore, recommends closure of Finding 3.

Table 1 shows that for two time periods (i.e., Sample Preparation 1975–1984 [ore] and Sample Preparation 1985–2003 [tailings]) intakes for the job category “General Labor” were one-half the intake of “Operators.” The reduced intake for “General Labor” is consistent with guidance in the GJO template, which states the following:

*The data are assigned to all operations personnel. Intakes for other workers were determined using the ratios between job classes found in Section 8.5.1 of the Technical Basis Document: Site Profiles for Atomic Weapons Employers that Worked Uranium Metals (SRDB Reference 101251). **Laborers received one-half the intake of operators**, supervisors receive one-quarter, and administrative personnel receive one-tenth of the supervisor intake. The intakes are provided in the Table 6 and are assigned as a constant distribution. [Emphasis added.]*

Observation 1. It is unclear and inconsistent why intakes for the job category “General Labor” are the same as for “Operator” for the D&D period of 1989–2006.

Table 1. Reproduction of Table 6, “Inhalation and Ingestion Intake Rates (1975–2006),” from the Revised GJOO Template

Job Category ^a	Uranium		Radium-226		Thorium-230	
	Inhalation (µCi/yr)	Ingestion (µCi/yr)	Inhalation (µCi/yr)	Ingestion (µCi/yr)	Inhalation (µCi/yr)	Ingestion (µCi/yr)
<i>Sample Preparation 1975–1984 (Ore)</i>						
Operators	7.57E-03	1.59E-04	7.57E-03	1.59E-04	7.57E-03	1.59E-04
General Labor	3.79E-03	7.95E-05	3.79E-03	7.95E-05	3.79E-03	7.95E-05
Supervisors	1.89E-03	3.98E-05	1.89E-03	3.98E-05	1.89E-03	3.98E-05
Administrative	1.89E-04	3.98E-06	1.89E-04	3.98E-06	1.89E-04	3.98E-06
<i>Sample Preparation 1985–2003 (Tailings)</i>						
Operators	5.74E-04	1.21E-05	2.83E-03	5.95E-05	2.83E-03	5.95E-05
General Labor	2.87E-04	6.03E-06	1.42E-03	2.98E-05	1.42E-03	2.98E-05
Supervisors	1.44E-04	3.01E-06	7.08E-04	1.49E-05	7.08E-04	1.49E-05
Administrative	1.44E-05	3.01E-07	7.08E-05	1.49E-06	7.08E-05	1.49E-06
<i>Decontamination and Decommissioning 1989–2006 Natural Uranium (Ore, Yellowcake)</i>						
Operators	3.21E-03	6.74E-05	1.59E-03	3.33E-05	1.59E-03	3.33E-05
General Labor	3.21E-03	6.74E-05	1.59E-03	3.33E-05	1.59E-03	3.33E-05
Supervisors	8.02E-04	1.68E-05	3.97E-04	8.34E-06	3.97E-04	8.34E-06
Administrative	8.02E-05	1.68E-06	3.97E-05	8.34E-07	3.97E-05	8.34E-07
<i>Decontamination and Decommissioning 1989–2006 (Tailings)</i>						
Operators	5.87E-04	1.23E-05	2.90E-03	6.09E-05	2.90E-03	6.09E-05
General Labor	5.87E-04	1.23E-05	2.90E-03	6.09E-05	2.90E-03	6.09E-05
Supervisors	1.47E-04	3.08E-06	7.25E-04	1.52E-05	7.25E-04	1.52E-05
Administrative	1.47E-05	3.08E-07	7.25E-05	1.52E-06	7.25E-05	1.52E-06

a. If worker duties cannot be determined, then the most claimant-favorable intake rate should be assumed.

Figure 1. Combined GJOO Air Sample Data

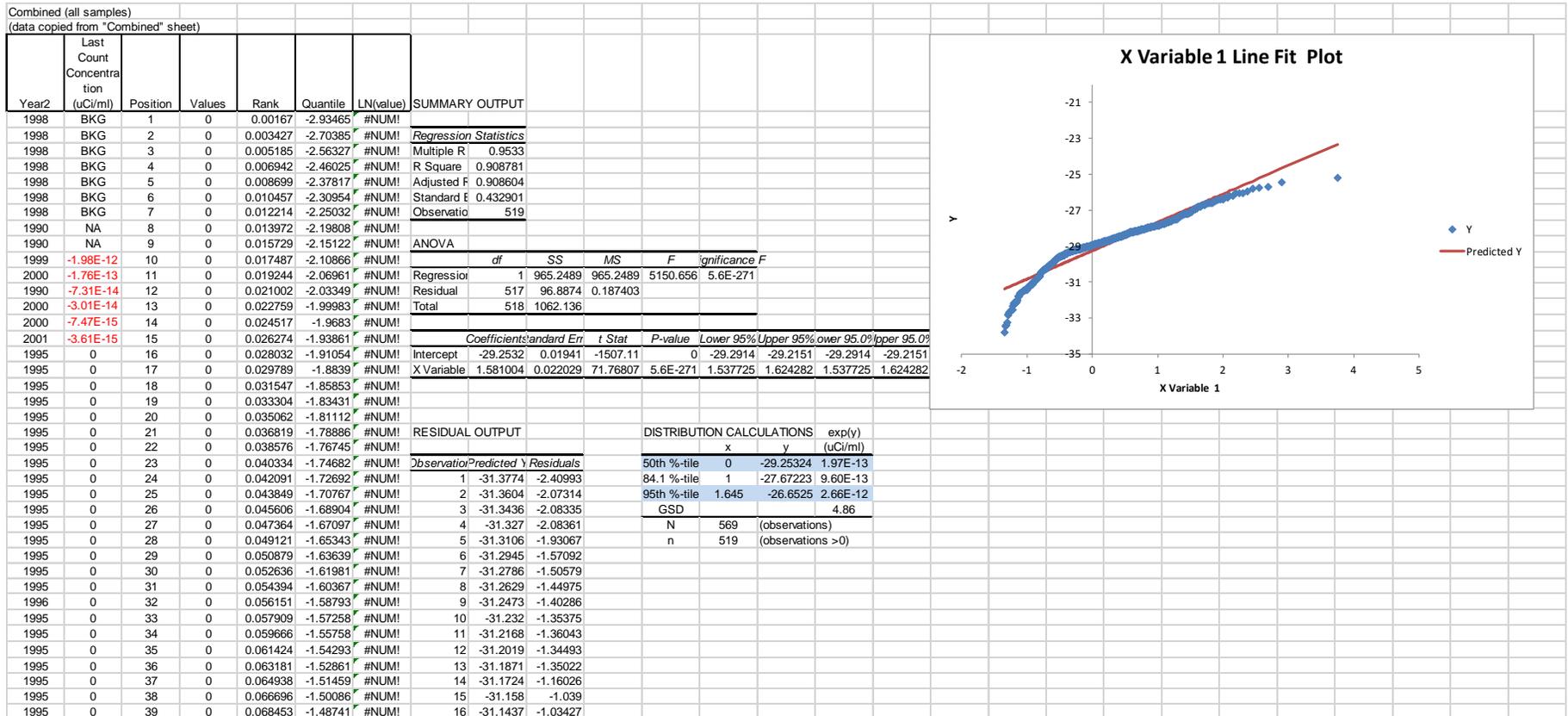


Figure 2. Summary of Lognormal Fits to GJOO Air Sample Data



References

NIOSH 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.

SC&A 2015. *A Review of NIOSH's Program Evaluation Report DCAS-PER-047, "Grand Junction Operations Office,"* Revision 1, SCA-TR-PR2015-0093, SC&A, Inc., Vienna, Virginia. February 10, 2015.

SRDB Ref.ID: 89938 Undated. *Building 20 Health & Safety*.