

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 <u>Tailings</u> 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) <u>modeled</u> annual intakes from inhalation and ingestion of uranium (U-238/U-235/U-234), radium-226 (Ra-236), 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*

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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.

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 (μ 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 2.66E-12 μ 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 $2.68\times10^{-13} \,\mu\text{Ci/ml}$ and $1.906\times10^{-12} \,\mu\text{Ci/ml}$.

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 2.66E-12 μCi/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 (m³/hr) and 2,000 hours per year (hr/y).

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\begin{split} U_{inhal.} &= (2.66\text{E-}12~\mu\text{Ci/ml}) \times (1.0\text{E+}06~\text{milliliter per cubic meter}~[\text{ml/m}^3]) \times (0.502) \times \\ &\quad (1.2~\text{meters per hour}~[\text{m/hr}]) \times (2,000~\text{hours per year}~[\text{hr/y}]) \\ &= 3.21\text{E-}03~\text{microcuries per year}~(\mu\text{Ci/y}) \\ \\ \text{Ra-}226~\text{or}~\text{Th-}230 &= (2.66\text{E-}12~\mu\text{Ci/ml}) \times (1.0\text{E+}06~\text{ml/m}^3) \times (0.249) \times (1.2~\text{m/hr}) \times \\ &\quad (2,000~\text{hr/y}) \end{split}
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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.

 $= 1.59E-03 \mu Ci/y$

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\begin{split} U_{inhal.} &= (2.66\text{E-}12~\mu\text{Ci/ml}) \times (1.0\text{E+}06~\text{ml/m}^3) \times (0.092) \times (1.2~\text{m/hr}) \times (2,000~\text{hr/y}) \\ &= 5.87\text{E-}04~\mu\text{Ci/y} \\ \\ \text{Ra-}226~\text{or}~\text{Th-}230 &= (2.66\text{E-}12~\mu\text{Ci/ml}) \times (1.0\text{E+}06~\text{ml/m}^3) \times (0.454) \times (1.2~\text{m/hr}) \times \\ &\qquad \qquad (2,000~\text{hr/y}) \\ &= 2.90\text{E-}03~\mu\text{Ci/y} \end{split}
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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 2.66E-12 µCi/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 GJOO 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

	Uranium		Radium-226		Thorium-230	
Job Category ^a	Inhalation	Ingestion	Inhalation	Ingestion	Inhalation	Ingestion
	(μCi/yr)	(μCi/yr)	(μCi/yr)	(μCi/yr)	(μCi/yr)	(µCi/yr)
Sample Preparation 1975–1984 (Ore)						
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
Sample Preparation 1985–2003 (Tailings)						
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
Decontamination and Decommissioning 1989–2006 Natural Uranium (Ore, Yellowcake)						
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
Decontamination and Decommissioning 1989–2006 (Tailings)						
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.

Combined (all samples) (data copied from "Combined" sheet) X Variable 1 Line Fit Plot Count Concentra tion LN(value) SUMMARY OUTPUT -21 (uCi/ml) Rank 0.00167 -2.93465 #NUM! 0.003427 -2.70385 #NUM! 1998 BKG -23 0.005185 -2.56327 #NUM! Multiple R 0.9533 1998 BKG 1998 BKG 0.006942 -2.46025 #NUM! R Square 0.908781 -25 0.008699 -2.37817 #NUM! Adjusted F 0.908604 1998 BKG 0.010457 -2.30954 #NUM! Standard E 0.432901 1998 BKG BKG 0.012214 -2.25032 #NUM! -27 0.013972 -2.19808 #NUM! 1990 NA 1990 NA 0 0.015729 -2.15122 #NUM! ANOVA Predicted Y 1999 .98E-12 0.017487 -2.10866 #NUM! 10 ignificance 0.019244 -2.06961 #NUM! 2000 -1.76E-13 11 1 965,2489 965,2489 5150,656 5.6E-271 12 0.021002 -2.03349 #NUM! Residual 517 96.8874 0.187403 -3.01E-14 0.022759 -1.99983 #NUM! -33 -7.47E-15 -1 9683 #NUM! 0.024517 2000 -3.61E-15 0.026274 -1.93861 #NUM! Coefficients and ard Err t Stat P-value Lower 95% Upper 95% ower 95.0% pper 95.0% 0.028032 -1.91054 #NUM! Intercept -29.2532 0.01941 -1507.11 1995 16 0 -29.2914 -29.2151 -29.2914 -29.2151 0 -1.8839 #NUM! X Variable 1.581004 0.022029 71.76807 5.6E-271 1.537725 1.624282 1.537725 1.624282 1995 0 17 0.029789 -2 -1 0.031547 -1.85853 #NUM! 0 X Variable 1 1995 19 0.033304 -1.83431 #NUM! 1995 20 0.035062 -1.81112 #NUM! 0.036819 -1.78886 #NUM! RESIDUAL OUTPUT DISTRIBUTION CALCULATIONS exp(y) 0.038576 -1.76745 #NUM! 1995 22 0 0.040334 -1.74682 #NUM! Observation Predicted Y Residuals 1995 23 -29.25324 1.97E-13 1995 0.042091 -1.72692 #NUM! 1 -31.3774 -2.40993 84.1 %-tile -27.67223 9.60E-13 1995 25 0.043849 -1.70767 #NUM! 2 -31.3604 -2.07314 95th %-tile 1.645 -26.6525 2.66E-12 0 0.045606 -1.68904 #NUM! 1995 0 26 3 -31.3436 -2.08335 GSD 4 86 1995 27 0.047364 -1.67097 #NUM! 4 -31.327 -2.08361 N 569 (observations) 1995 28 0.049121 -1.65343 #NUM! 5 -31.3106 -1.93067 (observations >0) 0.050879 -1.63639 #NUM! 29 6 -31 2945 -1 57092 1995 Ω 0.052636 -1.61981 #NUM! 1995 0 30 7 -31.2786 -1.50579 0.054394 -1.60367 #NUM! 8 -31.2629 -1.44975 0.056151 -1.58793 #NUM! 9 -31 2473 -1 40286 1996 Ω 32 0.057909 -1.57258 #NUM! 10 -31.232 -1.35375 1995 34 0.059666 -1.55758 #NUM! 11 -31.2168 -1.36043 0.061424 -1.54293 #NUM! 1995 35 12 -31.2019 -1.34493 0.063181 -1.52861 #NUM! 1995 36 13 -31.1871 -1.35022 0.064938 -1.51459 #NUM! 1995 37 14 -31.1724 -1.16026

Figure 1. Combined GJOO Air Sample Data

0.066696 -1.50086 #NUM!

0.068453 -1.48741 #NUM!

15 -31,158

16 -31.1437 -1.03427

-1.039

0

0

38

1995

Summary of Lognormal Fits to GJOO Air Sample Data Comments (Action limits/LLDs) Building Remediated Demolished D&D NA NA NA 1989 Action limit = 7.0E-12; LLD for this sample was 3.36E-13 1989 1990 1.94E-13 7.92E-13 Action limit = 7.0E-12; LLDs ranged from 6.2E-15 to 8.6E-13 1999 NA NA Action limit = 7.0E-12; LLDs ranged from 2.81E-13 to 3.36E-13 NA NA 2001 2001 NA No data NA NA NA 1993 12/12A 2000 2000 No data 1994 1994 Action limit = 7.0E-12 until 2/9/94 then 2.0E-11; LLDs not calculated 18 2001 2001 36 8.81E-13 2.69E-12 1.26E-13 8.10E-13 1995 Action limit (DAC) = 1E-11; LLD, where calculated, was 1.61E-13 2000 2000 1996 1.42E-13 1.83E-12 4.74 1996 Action limit (DAC) = 1E-11 until 2/2/96 then 7.0E-12; 2/21/96 5.0E-1 2006 12 11 2.84E-13 2.66E-12 3.89 1997 1999 1997 28 1999 1992 188 185 1.90E-13 2.10E-12 4.31 31A 1998 86 83 3.59E-13 2.34E-12 3.12 Action limit (DAC alpha) = 2E-11; MDAs calculated by Protean PC 32 2000 2000 2000 2000 33 2001 119 114 1.61E-13 1.88E-12 4.46 2001 All 569 519 1.97E-13 2.66E-12 4.86 34 1996 1996 35 Averages for years with data: 2.68E-13 1.90E-12 1998 1998 Mutty doesn't like 50th less than MDA (assumed to be 1.61E-13) 1996 1996 37 1992 N = the number of observations 1992 n = the number of observations >0 Air Samples & Buildings D&Ded by Year 39 1992 Zeros were ranked, but not fit 42 2000 2000 200 44 1994 1994 The data fit was the last count recorded. 46 180 1999 1999 Where values were recorded as less than some numerical value, 52 the numerical value was fit. (Re-calculated 1995 with LLDs where listed) 1994 160 62 2001 Most of the data was low enough that it was not recounted 140 938 2000 at 7 days or longer as an official "record count." 2000 120 Samples were generally recounted if they exceeded 10% of an Action Limit 3022 1999 1999 100 3022 2000 2000 At least for a period of time, samples were recounted until they were <5% of the action limit or DAC. 27 26 without 2006 Most samples were only counted once or twice (original, recount). 60 1989 value was 1.45E-12 uCi/ml Year Remediated Demolished Air Samples Year Buildings Air Samples 40 1991 values were 1.50E-13 and <2.81E-13. 1989 1989 1990 1990 Substituting MDA for years wo data: 37 1.61F-13 1991 1991 1.94E-13 1992 1992 1.61E-13 1993 1993 1.61E-13 1994 1994 1.61F-13 Buildings ——Air Samples 1995 32 1995 32 19 1996 8.81F-13 1996 12 1997 1.26F-13 1997 12 1998 37 1 42F-13 1998 2.84E-13 1999 1999 188 188 7.30E-14 2000 86 2000 86 1.90F-13 2001 119 2001 119 3.59F-13 Air Samples & Buildings D&Ded by Year 1 61F-13 2.35E-13 10 180 160 120 <u>S</u> 100 ह 80 40 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 Demolished Remediated

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.

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