SC&A Review of Metals and Controls Corp. Thorium and Welding Exposure Model

Response Paper

National Institute for Occupational Safety and Health

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) presented the Evaluation Report (ER) for SEC-00236, Metals and Controls Corp. (M&C) to the Advisory Board on Radiation and Worker Health (Board) on August 24, 2017. At the conclusion of that presentation, a petitioner raised a concern about the adequacy of the ER in addressing maintenance-type work. The petitioner stated that he "took great care to define the class of workers under evaluation in this petition as precisely and as *narrowly* as possible to coincide with workers for whom there is a high degree of confidence that they received elevated exposures to residual radioactive contamination."

In response to this concern, on September 5, 2017, NIOSH initiated strategies to continue M&C research and further develop SEC-00236. These strategies included plans to review monitoring records in the Site Research Database (SRDB) and plans to search for former M&C workers so that NIOSH could conduct interviews with them.

From October 24, 2017, through October 26, 2017, NIOSH, Oak Ridge Associated Universities (ORAU), and Sanford Cohen & Associates (SC&A) personnel interviewed 12 former M&C workers and individuals knowledgeable about maintenance work. Interviewers asked questions regarding the frequency and duration of work, including heating, ventilation, and air conditioning (HVAC), utility and drain line maintenance, and new equipment installations.

In addition to the interviews, other notable actions included the following:

- November 8, 2017 – The Metals and Controls Working Group (Working Group), SC&A, Division of Compensation Analysis and Support (DCAS), and ORAU team members held a teleconference to discuss technical issues associated with developing exposure models regarding maintenance work.
- February 6, 2018 – NIOSH obtained additional monitoring data regarding remediation work performed by Creative Pollutions Solutions (CPS) in 1992 and 1994 [CPS 1992, 1994].
- February 13, 2018 – NIOSH received a report by SC&A titled *Review of SEC Petition ER SEC-00236* [SC&A/Saliant 2018].
- April 23, 2018 – NIOSH issued the *Metals and Controls Corp. Subsurface Exposure Model* white paper [NIOSH 2018a] and made it available to SC&A and the Working Group.
- May 3, 2018 – During a Working Group meeting, SC&A presented their findings and observations associated with the SEC-00236 ER. The petitioners also made a statement and provided a letter [Elliott, 2018] with their concerns. After the meeting, NIOSH created an issues matrix.
- August 22, 2018 – During a full Board meeting, the Working Group presented their findings and observations associated with the SEC-00236 ER and NIOSH provided an update. The petitioners also made a statement and provided a letter with their concerns at the meeting.

- November 20, 2018 – During a Working Group meeting, NIOSH presented the *Metals and Controls Corp. Maintenance Exposure Model* white paper [NIOSH 2018b] that included HVAC maintenance and Building 10 overhead exposure models. SC&A presented their observations associated with the *Metals and Controls Corp. Subsurface Exposure Model* and *Metals and Controls Corp. Maintenance Exposure Model* white papers, and the petitioners also made a statement with their concerns.
- December 13, 2018 – During a full Board meeting, the Working Group presented an update. The petitioners also made a statement and provided a letter with their concerns at the meeting.
- April 8, 2019 – NIOSH issued the *Metals and Controls Corp. Thorium and Welding Exposure Model* white paper [NIOSH 2019a] and made it available to SC&A and the Working Group.
- June 18, 2019 – NIOSH issued the *Metals and Controls Corp. SEC-00236 Petitioner Concerns* response paper [NIOSH 2019b] and made it available to SC&A and the Working Group.
- July 26, 2019 – NIOSH received an 8-page memo by SC&A titled *Review of NIOSH's "Metals and Controls Corp. Thorium and Welding Exposure Model"* [SC&A 2019].

This response paper addresses the observations and findings presented in the SC&A memo titled *Review of NIOSH's "Metals and Controls Corp. Thorium and Welding Exposure Model"*.

INTERNAL EXPOSURES TO THORIUM

NOTE: The text that follows contains excerpts and some summaries from the SC&A memo followed by responses from NIOSH.

SC&A Observation 1: *The uranium inventory cited by NIOSH is inconsistent with that in the source document* [SC&A 2019, PDF p. 3].

NIOSH Response: Although as SC&A points out, the inventory is not used in the proposed dose methodology, NIOSH acknowledges that this was a data entry error.

SC&A Comment in Section 2.1.3: *…to determine an activity ratio of uranium to ^{232}Th, NIOSH cited 754 samples that were analyzed for both uranium and 232Th. "NIOSH determined a paired activity ratio of uranium to thorium-232 for each of these samples and calculated a geometric mean ratio of uranium to thorium-232 as 9.88:1." As explained later in the white paper, NIOSH intended to apply this ratio to measured concentrations of uranium in pipe sediments to estimate the concurrent concentrations of ^{232}Th* [SC&A 2019, PDF p. 3].

NIOSH Response: This is a possible misinterpretation by SC&A of information from the background section of the white paper. The ratio NIOSH provided was intended to be supplemental information to support the conservatism in the model described on page 4 of the

Metals and Controls Corp. Thorium and Welding Exposure Model white paper, where NIOSH assumes subsurface sediments contained equivalent mass concentrations of natural uranium and thorium-232.

SC&A Comment in Section 2.1.5: *They assumed equal concentrations of natural uranium and ^{232}Th by mass, based on the uranium-to-^{232}Th activity ratio of 9.88:1 cited in section 2.1.3 of the present memo, and on the relative specific activities of the two radionuclides* [SC&A 2019, PDF p. 5].

NIOSH Response: It is clear from multiple reports and inventory information [Coneybear et al., 1962] that uranium operations far exceeded thorium operations. Therefore, as stated in the New NIOSH Bounding Method (April 17, 2019), NIOSH assumed equal amounts of uranium and thorium to be conservative and did not incorporate the ratio observed in the sample results into any bounding-method calculations.

SC&A Comment in Section 2.1.6: *Assuming that the specific activity of the uranium contamination in the pipe sediments was that of natural uranium is not valid. According to Weston (1996, Table 1), the uranium isotopic ratios in the pipes indicated that in the 20 samples listed, 15 show enrichments of 1.5% to 35%, while two samples list only ^{235}U activity concentrations and no enrichment data. The remaining three samples had enrichments <0.72%, the relative abundance of ^{235}U in natural uranium. We thus conclude that most of the pipe sediments were contaminated with uranium of varying enrichments. It is therefore difficult to assign a single specific activity of uranium to these samples* [SC&A 2019, PDF p. 5].

NIOSH Response: NIOSH used Roy F. Weston, Inc.'s Table 1 [1996] isotopic values to determine "total" uranium values, and could have calculated an effective specific activity for these samples. However, any adjustment that would result in a higher specific activity (i.e., a higher enrichment for uranium) would be less favorable to the claimant. This is because an increase in uranium enrichment means, for a given uranium activity, a corresponding smaller uranium mass is present. Since NIOSH assumes the masses of thorium and uranium in the subsurface are equivalent, any assumptions that increase the uranium activity will result in a reduction of the assumed equivalent mass of thorium. Therefore, NIOSH believes that the assumption of natural uranium is the most favorable and bounding enrichment.

SC&A Comment in Section 2.1.7: SC&A provided the following alternate method for estimating Th-232 intakes by workers performing subsurface maintenance inside Building 10 [SC&A 2019, PDF pp. 5–7].

To determine a thorium to uranium ratio, SC&A identified one dataset, Table 6A, pp. 75–79 [Sowell 1985] that they believed demonstrated an acceptable correlation between U-235 and Th-232, and then SC&A calculated a 50th percentile of the distribution of Th-232/U-235 ratios of these concentrations.

To determine the 95th percentile activity, SC&A used the volume-weighted average of the U-235 activity concentrations in the samples from Roy F. Weston, Inc.'s Table 1 [1996] because it "…is almost twice that of ^{238}U, and since there are 20 activity measurements of this isotope vs. 18 of ^{238}U, the ^{235}U activity concentrations potentially constitute a more robust data set…"

SC&A stated that they ranked the U-235 activity concentrations with the corresponding volumes represented by the sample and calculated the 95th percentile volume. Then they used linear interpolation to derive the 95th percentile U-235 activity concentration (i.e., the concentration corresponding to 95% of the cumulative volume).

NIOSH Response: SC&A uses a paired-sample method to determine a U-Th ratio, which is one of the methods NIOSH considered. Although the doses SC&A calculated are slightly higher than the NIOSH model, SC&A's calculation of a paired-sample method appears to be inconsistent with standard practice. In addition, NIOSH did a statistical analysis of SC&A's method and determined that, based on the correlation coefficient between U-235 and Th-232, there is no statistical relationship that can be drawn between the two datasets [ORAUT 2019]. Therefore, NIOSH does not believe that this approach is statistically defensible and the assumption of equivalent mass is the most claimant-favorable and defensible approach.

SC&A Comment in Section 2.1.7: SC&A is recommending using OCAS-TIB-009 to determine the daily ingestion rate [SC&A 2019, PDF p. 7].

NIOSH Response: NIOSH does not agree with the use of this method and will use NUREG/CR-5512 to determine ingestion intakes when exposures are characterized by mass-based samples. OCAS-TIB-009 is based on the concept that ingestion is proportional to contamination and contamination is proportional to airborne. NIOSH is aware that the NUREG hourly ingestion rate is approximately one-half of that used in OCAS-TIB-009. In fact, this issue was addressed in a review by the Procedure's Subcommittee. The discussion of this is documented in the Board Review System under Overarching Issue #2.

SC&A Finding 1: *NIOSH underestimated the ^{232}Th concentration in the sediments and residues in the pipes under Building 10, leading to an underestimate of ^{232}Th intakes by workers performing subsurface activities* [SC&A 2019, PDF p. 7].

NIOSH Response: SC&A's finding that the Th-232 intake rates are underestimated is based on their comparison to their paired-sample method to determine a U-235/Th-232 ratio. However, as stated above, NIOSH's evaluation of this method determined that this approach is not statistically defendable [ORAUT 2019]. Therefore, because M&C's work with uranium greatly exceeded their thorium work, the assumption that there is an equivalent mass of thorium and uranium in the Building 10 subsurface is conservative and technically defensible.

INTERNAL EXPOSURES DURING WELDING

SC&A Observation 2: *NIOSH should clarify the source of the 4-h-per month time estimate* [SC&A 2019, PDF p. 7].

NIOSH Response: The correct reference is a 2017 documented communication with [redacted] [ORAUT 2017, PDF p. 15].

SC&A Finding 2: *NIOSH understated the resuspension factor related to activities accompanying welding* [SC&A 2019, PDF p. 8]. Note: OTIB-0070 Table 3-1, "vigorous sweeping by two workmen" resulted in RFs of 1.02×10^{-2} to 4.2×10^{-2}.

NIOSH Response: The decision to use a resuspension factor of 10^{-2} as opposed to 10^{-3} is considered a TBD issue. However, NIOSH believes the assumption of a resuspension factor of 10^{-3} is representative and bounding of the work activities and conditions at M&C. Work activities are a distribution of activities, of which the majority of resuspension factors in Table 3-1 of OTIB-0070 are sizably smaller (in most cases orders of magnitude smaller) than the proposed resuspension factor of 10^{-3}. Therefore, NIOSH believes that the use of a 10^{-3} resuspension factor is claimant favorable and bounding.

SC&A Observation 3: *In estimating doses from the welding scenario, NIOSH should assign doses using the most claimant-favorable isotope of thorium or uranium, selected from isotopes known to have been used at M&C* [SC&A 2019, PDF p. 8].

NIOSH Response: NIOSH agrees with this observation and intends to apply it to our exposure model. The surface contamination surveys used to create the welding exposure model were initially analyzed for gross-alpha content; therefore, NIOSH will choose the most claimant-favorable isotope of thorium or uranium when estimating worker doses. For thorium, both natural and triple-separated mixtures will be considered. For uranium, the recycled uranium ratios in Battelle-TBD-6000 will be considered.

CONCLUSION

NIOSH has considered all of the information presented in this, and preceding white papers, and will use it when applying exposure models for Metals and Controls Corp. that account for the descriptions of work by former employees, pre-remediation sample data, and a realistic dust resuspension model. NIOSH believes that its model adequately bounds maintenance exposures experienced by M&C workers during the residual radiation period.

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