Metals and Controls Corp. SEC-00236 Petitioner Concerns

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

On December 13, 2018, during a full Board meeting, the M&C Working Group presented an update. The petitioners also made a statement and provided a letter with their concerns at the meeting.

This response paper addresses concerns recently raised by the petitioner as *Oral Testimony to Advisory Board on Radiation and Worker Health by Michael J. Elliott, Petitioner for SEC No. 00236 on December 13, 2018* (Elliott, 2018).

PETITIONER CONCERNS AND NIOSH RESPONSE

NOTE: The italicized text that follows contains excerpts from the petitioner letter followed by responses from NIOSH.

> *Petitioner Concern 1: Per the instructions of Mr. Ted Katz, Designated Federal Official at the Advisory Board on Radiation and Worker Health Meeting #126 (12/13/2018), I am providing a transcript of my oral testimony before the Board on behalf of the M&C Petitioners for SEC 00236.*
>
> *This petition pertains to a class of workers at the M&C Facility during the "residual period" comprised of Facilities Construction and Maintenance Services Organization workers; Equipment R&M workers; and Production Machine Operators/Helpers who worked in certain affected areas of the facility. For simplicity, I will follow the same*

convention as the prior speakers, and refer to the entire class of workers covered under the petition simply as "M&C Maintenance Workers."

First, I would ask us to circle back to the regulation that prescribes procedures for designating classes of employees as members of the SEC (42 CFR Part 83).

Specifically, in Subpart C, Section 83.13 stipulates how NIOSH will evaluate petitions. Paragraph (c)(1)(i) states:

> *"Radiation doses can be estimated with sufficient accuracy if NIOSH has established that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred by any member of the class…"* [Emphasis added]

Paragraph (c)(1)(ii) further states that:

> *"…to establish a positive finding under (c)(1)(i) of this section would require, at a minimum, that NIOSH have access to reliable information on the identity or set of possible identities and maximum quantity of each radionuclide (the radioactive source material) to which members of the class were potentially exposed without adequate protection."* [Emphasis added]

I contend that NIOSH has failed to satisfy these fundamental regulatory requirements. I say this for a number of reasons:

- *Source term characterization is incomplete;*
- *Incomplete knowledge of the nature, frequency, and duration of jobs performed in intimate contact with the source term;*
- *A complete absence of any measurements or monitoring of the workers who are covered by this petition;*
- *And no comparable population with measurements or monitoring data that can be relied on as a surrogate for the class in question.*

NIOSH Response: The definition of sufficient accuracy has been the subject of discussion among stakeholders, the Board, and NIOSH since the inception of this project under the Energy Employees Occupational Illness Compensation Program Act of 2000 (EEOICPA). As quoted above, Subpart C of Section 83.13 states that radiation doses are considered to be estimated with sufficient accuracy if NIOSH has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could have been incurred in plausible circumstances by any member of the class.

NIOSH believes that there is adequate information in the residual contamination period at M&C to meet the requirement described above. To bound doses to the majority of M&C workers, i.e. those that performed production and support tasks, NIOSH used pre-D&D contamination survey data from the end of the AWE operational period (1967), in conjunction with data from closer to the end of the residual period (1982) (NIOSH 2017). To bound doses to maintenance workers, NIOSH used data that was taken before D&D to characterize the subsurface environments, and the roof and overhead areas (NIOSH 2018; NIOSH 2019).

Using our knowledge of the source term of radioactivity that was present and the work activities involved with this source term, and the use of surrogate dust-loading data qualified in accordance with OCAS-IG-004 (NIOSH 2018), NIOSH believes it has estimated the maximum radiation dose that could have been incurred under plausible circumstances. Even under these maximizing conditions (e.g., the use of the 95th-percentile and most claimant-favorable solubility types), the estimated doses to workers during the residual contamination period are quite small. In general, during periods of residual contamination, it was known that NIOSH would typically have access to sparse workplace monitoring data and often no worker monitoring data.

To determine the internal and external exposures to covered workers at Atomic Weapons Employer (AWE) facilities during periods of residual contamination, NIOSH developed standard approaches that are described in ORAUT-OTIB-0070, *Dose Reconstruction during Residual Radioactivity Periods at Atomic Weapons Employer Facilities* (ORAUT 2012). This document, which was specifically written to deal with the reconstruction of doses during periods where monitoring data are sparse or nonexistent, incorporates methods that were developed in two other NIOSH documents, OCAS-TIB-009, *Estimation of Ingestion Intakes* (NIOSH 2004), and Battelle-TBD-6000, *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals* (Battelle Team 2011). In the absence of little or no monitoring data, these documents rely on surrogate data and models to estimate internal and external exposure. Through its contractor, the Board has reviewed each of these documents for scientific validity. Although a number of issues and findings were raised during the review process, the Board's Subcommittee on Procedures Review and the Battelle-TBD-6000 Working Group reviewed each finding. Through a series of discussions and exchanges of white papers and memoranda, each of the findings and issues was resolved. In cases where NIOSH agreed that its original approach needed technical clarification or revision, the documents were revised accordingly.

> *Petitioner Concern 2: As concerns the incomplete source term characterization, the most obvious example is the 1996 drain characterization survey in the interiors of Bldg. 10 and Bldg. 4 where we observed the highest subsurface volumetric activity concentrations anywhere onsite. For a number of reasons that I previously described in my 8/29/2018 written comments, we only analyzed the sediment and soil samples [in the drains] for isotopic uranium. Therefore, we can never know for sure what the thorium concentrations might have been. (Recall that this was the reason that SEC00149 (NIOSH 2009) for the operational period employees was granted.)*

NIOSH Response: NIOSH has addressed the petitioner's concern about the lack of thorium analysis of sediment and soil samples in the *Metals and Controls Corp. Thorium and Welding Exposure Model* white paper (NIOSH 2019).

> *Petitioner Concern 3: Furthermore, by the time the drain survey was conducted in 1995, there had been close to 30 years of disturbances of the drain lines during the residual period – they were snaked numerous times, and some of the most plugged sections had been removed entirely. Therefore, there is no guarantee that the levels we documented [in the drain survey] represent the maximum levels ever present [and to which the M&C maintenance workers would have been exposed].*

NIOSH Response: NIOSH has addressed the petitioner's concern regarding the effect of 30 years of disturbance and removal on the representativeness of sediment analysis in the *Metals and Controls Corp. Maintenance Exposure Model* white paper (NIOSH 2018). In that paper, NIOSH stated that the drainage system under Building 10 required frequent maintenance during the residual period including the years prior to the characterization. Furthermore, since this maintenance could have potentially removed sediments with the highest uranium concentration and made the geometric mean of the survey data under-conservative, NIOSH calculated the 95th-percentile concentration and will use it to bound exposures.

> *Petitioner Concern 4: As has been previously discussed, the gross alpha screening analysis methodology that we used for the 1994-1995 comprehensive characterization surveys [for the majority of subsurface soils other than the drain survey area] was biased low at concentrations above the 30 pCi/gm cleanup standard. Recall that the main purpose of the comprehensive characterization surveys was to define the limits of excavation, to find clean boundaries. Therefore, we weren't terribly concerned about the low bias of the gross alpha screening method in the areas above the cleanup standard. We were more concerned about the high bias in the areas below the cleanup standard. [Since we were trying to limit the volume of soil that needed to be excavated, to the extent that isotopic analysis of subsurface soil samples was performed to QC the gross alpha method results, it would have been preferentially performed in areas that exhibited the low concentrations – on the order of 20 to 30 pCi/gm.]*

NIOSH Response: The subsurface exposure model developed by NIOSH (NIOSH 2018) used data from the following outside areas including the area surrounding Building 10, in the former Burial Area, the Metals Recovery Area, the Building 11 Stockade Area, the Building 11 Railroad Spur Area, and in the Building 12 West and South Lawn Areas. These areas were characterized with 2,391 soil samples collected prior to remediation of each area from 1985 to 1995, and the data was presented in the following reports as follows:

- *Radiological Survey of the Texas Instruments Site Attleboro, MA*. The area was gridded and samples were taken at grid intersections. In addition, samples were taken at locations of interest (e.g. areas with elevated rad levels) (Sowell 1985, PDF pp. 14-15).
- *Radiological Characterization of Texas Instruments, Inc. Attleboro, MA Industrial Facility*. Grab samples taken every 15-20 feet (CPS 1992a, PDF p.12).

- *Radiological Surveys of Open Land Areas Texas Instruments Inc. Attleboro, MA.* The area was gridded and systematically sampled (CPS 1995, PDF p. 10).
- *Radiological Survey Results, Appendices 1-4; Creative Pollution Solutions, Inc.* The area was gridded and systematically sampled (CPS undated, PDF p. 7).

In three of these reports, M&C used an established grid sampling method to determine where to take samples, and in the fourth report, M&C used a systematic method to take samples at predetermined intervals. NIOSH reviewed the available sampling maps that show where the samples were taken and observed that the locations M&C sampled were randomly selected and show no apparent bias.

In addition, NIOSH reviewed the screening method M&C developed to ascertain whether any bias was inherent in their analytical process. The M&C gross alpha screening method was developed during the pilot study excavation of the former burial area where M&C split samples, analyzed half of the samples with their field method, and sent the other half to Lockheed Analytical Laboratories for independent verification. M&C determined that their screening method results correlated very well with the isotopic uranium analyses by Lockheed Analytical Laboratories (CPS 1992a, PDF pp. 12, 37).

NIOSH reviewed the gross alpha screening method used by M&C, including the following excerpts:

> *The technique employed was gross alpha counting of a soil sample in intimate contact with a ZnS(Ag) detector. Using this method the ZnS(Ag) disc is disposable. Assuming a detector response due to a thick source in contact with ZnS(Ag) is described by:*
>
> $$\gamma(CPM) = C(Alpha/min/mg)\, A(cm^2)\, R_s(mg/cm^2)/4.$$
>
> *The sample counting analytical procedure is as follows:*
>
> 1. *The sample is prepared in a sample planchet under original field condition.*
> 2. *The range of the alphas in the source material, R1, was calculated using Zeigler's theoretical elemental ranges. The elemental ranges were weighted by the elemental mass fractions as determined for a standard soil by atomic absorption analysis.*
> 3. *Since the relative alpha energies were varied, we assumed average energy of 5.5 MeV. The average energy of all alphas emitted by the U-238 chain is about 5.4 MeV; the average alpha energy for the Th-232 chain is about 5.8 MeV.*
> 4. *The water content was estimated by drying an aliquot of representative samples 1-2 days at 50-75° c. Due to past experience, dry soil was assumed to still have 10% water content. Both this 10% and the fraction lost during*

drying were included in the mass fractions for hydrogen and oxygen used in (2) above.

5. *Uncertainties tabulated with the results are due solely to a propagated counting error. Due to the assumptions made, especially in (3) above, an additional uncertainty could be assumed as a conservative measure (CPS 1992a, PDF pp. 14-16)*

In practice, M&C used their gross alpha screening method as follows:

> *The soil sample results were obtained by using the field alpha counting technique previously described within the Final Report for the Remediation of the Former Radioactive Waste Burial Site, September 1993 (CPS 1992a). Past-established correlations demonstrated that the gross counts obtained in a 10-minute count with the alpha counting technique are equivalent to the total uranium concentration in the sample (pCi/g). Alpha screening results of less than 15 counts/10 minutes have been shown to be equivalent to approximately 2 pCi/g total uranium and therefore these results have been treated accordingly for purposes of determining grid cell averages. In addition to the results obtained from this field technique, 5 % of the samples are being analyzed by gamma spectroscopy and 1 % of the samples are being analyzed by alpha spectroscopy using an independent laboratory. Past reference samples (from the Former Burial Area), are also being selected for independent analysis as a quality assurance measure (CPS 1995, PDF p. 10).*

NIOSH has reviewed M&C's sampling practices and gross alpha screening method and has not identified a bias that would affect the conservativeness of our exposure model. If the petitioner is aware of additional details, please provide specific information to NIOSH as to why the data are not only biased but also biased low.

> *Petitioner Concern 5: In her summary, Ms. Josie Beach referred to the volume of residual contamination left over from the AWE operational period that was removed during the 1992-1996 decommissioning activities from a site that had ostensibly been released for unrestricted use, but that remained present during the residual period exposing M&C maintenance workers all the while to unknown and unknowable levels of exposure. She correctly referred to hundreds of rail cars of material above the cleanup standards that were removed during the decommissioning activities in the 1990s. In fact, my recollection is that the actual number was on the order of 325 rail cars. The exact volume of material removed during the decommissioning project is documented in the internal NRC memo to the Commissioners (NRC 1997) dated March 13, 1997, which states: "The volume of uranium-contaminated waste generated in the interior remediation project was 34,600 ft.^{3} of soil and concrete rubble. The exterior remediation projects generated primarily contaminated soil totaling 532,000 ft.^{3}" That is close to 600,000 ft.^{3} that was removed and shipped off by rail to Utah for disposal at Envirocare of Utah.*

NIOSH Response: The railcars of contaminated material generated after the U.S. Nuclear Regulatory Commission (NRC) initially released Building 10 are related to the changing release criteria and the subsequent use of more comprehensive investigative methods. Refer to the decontamination and decommissioning (D&D) section of the SEC-00236 Evaluation Report (NIOSH 2017 pp. 17–20) for a chronology of release criteria. The additional contamination identified using updated methods, including sections of the concrete floor and subsurface material, was previously inaccessible, and, as such, did not present a significant exposure hazard. It is important to note that although M&C, using updated techniques, was able to find contamination throughout the site after the NRC initially released Building 10, NIOSH incorporated these additional contamination data (e.g., Burial Area and Building 10 subsurface data) into its exposure models.

> *Petitioner Concern 6: Concerning the incomplete knowledge of the nature, frequency, and duration of jobs performed; the degree of confidence that the NIOSH and SC&A technical experts place in the one-month duration estimate for all intrusive activities, both subsurface and in overhead areas, seems overly confident, to say the least. When I have spoken to these workers, I have never felt that the workers have any solid recollection about how frequently or how much time they spent on these jobs. [Only after much consternation, and the prodding of Pat McCloskey (of ORAU) after the worker interviews concerning the time spent on roof penetration work in the overhead areas, did they reluctantly offer some tenuous responses. My co-petitioner, John Elliott, who was a Construction and Maintenance working supervisor, responded to ORAU that the roof penetration work was a near-daily activity, and he likely spent years of his career doing those activities. Another individual, the working supervisor of the instrumentation trades, responded to Mr. McCloskey that his people might spend 2-3 months a year working on roof projects. He added that maintenance of roof equipment was at least weekly and sometimes daily. These estimates were for just the roof penetration work that would not have included the additional time doing subsurface work or work in the utility pipe-chase service trenches.]*

NIOSH Response: Initially NIOSH allowed 1 month of additional exposure for subsurface work. However, NIOSH has evaluated additional exposure scenarios for maintenance workers (e.g., roof work, overhead area work, HVAC maintenance, and welding) and now provides for 2 months per year of these enhanced exposures.

Furthermore, according to interviews regarding the evaluated period (1968 to 1997), NIOSH understands that workers visited buildings throughout the site and some spent time in the High Flux Isotope Reactor (HFIR) area. Interviews also indicated that workers were promoted or changed job titles during the evaluated period, which affected their exposure potential (ORAUT 2017).

When NIOSH considers the experience of M&C workers, it only evaluates exposures to residual AWE contamination (e.g., non-HFIR work within Building 10); in addition, NIOSH considers the exposure potential for laborers to be different from a supervisor's exposure potential. It is

also important to understand that for these exposure models, NIOSH assumes that the same person does all of the work associated with the highest concentrations of airborne contaminants.

The following interview excerpt illustrates how the maintenance work at M&C was actually delegated:

> *Mr. McCloskey: How about the amount of time that you did this kind of work? How regularly did you do this? I know that it probably just applied to one phase of your career when you had a pipefitter job title. Specifically, we are concerned with Building 10.*
>
> *Worker #1: Right. I would say that there were dozens of times that I worked over there. A lot of times when we worked over there, it would take days to finish a job. You had to find where the blockage was, saw cut the floor, break up all of the concrete with a sledgehammer, excavate it, get down in there and cut the line with a snap cutter, replace the line, fill it all in again with soil, and then pour the cement.*
>
> *Mr. McCloskey: That's a big job. Was there a team working with you?*
>
> *Worker #1: There were other guys. The actual saw-cutting was done by a contractor.* [REDACTED] *would come in and we would tell him where to saw cut the floor, and then leave. There were two of us, sometimes maybe three, who would do the rest of the work. There weren't ten guys working on it. This was not a union shop. It was an open shop. I couldn't say to my boss, "I'm not breaking up that concrete. It's not my job" (ORAUT 2017).*
>
> *Petitioner Concern 7: As previously stated, there is a complete absence of any measurements or monitoring of the workers who are the subject of this petition. NIOSH has relied on measurement and monitoring data for several surrogate populations that include the health & safety monitoring of radiation workers at the end of the operational period ca. 1968; the health physics monitoring data for the D&D (decommissioning project) workers ca. the 1990s; and the Mound Canal project dust loading measurements ca. 1997. I would suggest, however, that these populations are not comparable to the typical M&C maintenance worker in the class covered by this petition. The surrogate classes [proposed by NIOSH] do not adequately characterize the maximum radiation dose to any member of the class covered by this petition.*
>
> *I would ask you to visualize for a moment the typical M&C maintenance worker in this class in this time period that may have received the maximum radiation dose. This individual would likely fit the following description:*
>
> - *Plumber, electrician, pipefitter, oiler/lubricator or any of the other Facilities and R&M maintenance trades;*
> - *No knowledge of work area exposures to radioactive source materials;*

- *No safety/health protocols in place to limit exposures;*
- *No special PPE or protective clothing required;*
- *Often came in direct contact with the source material (left over from the AWE operational period) in soil, sediments and accumulated dust with no knowledge of exposures;*
- *Wasn't trained to wear gloves or wash hands after working in these areas – indeed John Elliott describes handling the tools used to snake out drains with his bare hands;*
- *What decon the individual might have done often involved using shop air [compressed air supplied through the facility] to remove gross contamination – and that simultaneously created clouds of dust that would become respirable;*
- *Often worked in street clothes, but even if issued a uniform, the individual would wear his/her work clothes home and launder them at home as well, exposing other family members, and effectively extend his/her exposure to contaminants to possibly 24 hours per day, 7 days per week.*

The typical M&C maintenance worker in no way resembles the population of workers for which NIOSH has relied on measurement and monitoring data as the basis of their dose reconstruction modeling.

NIOSH Response: NIOSH interviewed a number of former M&C workers that held titles including plumber, electrician, pipefitter, oiler/lubricator, and other Facilities and R&M maintenance trades, and those interviews corroborated the petitioner's concern that there was little knowledge of work area exposures to radioactive source materials.

NIOSH analyzed M&C maintenance work including use of personal protection equipment (PPE) and safety/health protocols, and we modeled associated exposures using plausible circumstances and without taking credit for any PPE or exposure limiting procedures.

During NIOSH's research and interviews, it learned that maintenance workers did often come in direct contact with the source material (left over from the AWE operational period) in soil, sediments and accumulated dust, and that some personal decontamination involved the use of compressed air, or that workers remained contaminated when they left the work site. It is because of these working conditions and others that NIOSH created additional exposure models (e.g. subsurface) to address worker contact with sediments and to allow for longer exposure occupancy durations. In addition, NIOSH used maximizing assumptions (e.g. 10^{-3} and 10^{-4} resuspension factors) to address work scenarios that involved work with accumulated dust (e.g. overhead area and welding).

NIOSH recognizes there is some uncertainty when trying to bound doses to a class of workers that performed multiple and diverse tasks during an extended period. For this reason, NIOSH applied the use of the 95th percentile radioactivity levels in its models to accommodate any uncertainty associated with work process assumptions. It is worth mentioning again here that NIOSH assumes the same person does all of the work associated with the highest concentrations of airborne contaminants, which provides additional conservatism to the exposure models.

> *Petitioner Concern 8: In a letter to Ms. Josie Beach, dated November 20, 2018, Congressman Joseph Kennedy, who represents the 4th Congressional District in Massachusetts [which includes the City of Attleboro], acknowledged the uncertainty "among members of the work group as to how to evaluate the extent of the radiation these workers were exposed to in order to ascertain their eligibility for compensation." But Congressman Kennedy goes further by stating: "It is my hope that the workgroup takes a broader view and considers the cases of these workers in their final determination."*
>
> *I feel the Congressman hit the nail on the head with his advice to take a broader view. Unfortunately, I fear that NIOSH has failed to take a broader [and more accurate] view of the typical M&C maintenance worker. The measurement and monitoring data from the 1960s, 1980s and the 1990s for radiation workers and D&D workers, [on which NIOSH has relied for their dose reconstruction modeling], are not suitable to estimate the bounding dose for the class of M&C maintenance workers.*

NIOSH Response: In the SEC-00236 ER, NIOSH created a model to bound doses to the majority of M&C workers, i.e. those that performed production and support tasks. After NIOSH presented the ER to the Board on August 24, 2017, the petitioner raised a concern about the adequacy of the ER in addressing maintenance 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" (Elliott 2017, PDF p. 3). In response to this concern, NIOSH obtained additional information and developed models in subsequent white papers that bound doses to workers that performed more invasive tasks as identified by the petitioner.

In addition, the methods for the reconstruction of doses during periods of residual contamination have been established, documented, and accepted for use at numerous AWE sites with operations similar to those at M&C. Refer to the Attachment of this response paper for a detailed discussion and chronology of NIOSH and Board interactions that address the reconstruction of doses during periods where monitoring data are sparse or nonexistent. For maintenance activities that were unique at M&C, NIOSH used monitoring data from measurements obtained before D&D along with maximizing assumptions to create bounding exposure models.

> *Petitioner Concern 9: Following my oral testimony, Mr. William "Rusty" Lorenzen, an Operational Health Physicist who worked on the 1990s M&C Decommissioning Project and has supported the petitioners since first submitting our SEC petition application in*

August 2016, briefly offered some additional comments of his own. Rusty expressed grave concerns that NIOSH and SC&A would suggest that the measurement and monitoring data collected for D&D workers during the 1990s decommissioning project could be used as a surrogate for the types of exposures received by M&C Maintenance Workers during the residual period for estimating a bounding dose. Rusty compared this to "trying to fit a round peg into a square hole!" He unequivocally dismissed this application of the surrogate data as untenable and contrary to any real understanding of the two populations. Rusty continued by highlighting the fact that the D&D workers operated under strict health physics safety protocols and under the constant surveillance of qualified health physics professionals. The M&C maintenance workers, by contrast, had none of these benefits (i.e. no health physics monitoring or controls), and as was stated numerous times, had absolutely no knowledge of the residual contamination that they were exposed to on a regular basis.

NIOSH Response: Although it is arguable whether the D&D work processes (e.g., use of Bobcats) produced a lower airborne exposure potential when compared with the work processes used to snake clogged drain lines, NIOSH only used the D&D exposure data for its comparative value and not for dose reconstruction modeling as alleged by the petitioner. NIOSH used monitoring data from measurements obtained before D&D along with maximizing assumptions to accommodate any extreme conditions encountered by M&C maintenance personnel to create bounding exposure models.

Petitioner Concern 9: Rusty also echoed the remarks of Ms. Josie Beach and a couple of the other Board members on the M&C work group who commented that it is virtually impossible to identify every conceivable exposure scenario that the M&C maintenance workers were exposed to. (One workgroup member likened maintenance workers to emergency response personnel who, on any given day, could be asked to do any of a number tasks of an unanticipated and unpredictable nature.) Given that reality, it is impossible to reconstruct the bounding dose received by any member of this vulnerable population in anything that can be considered a scientifically sound and claimant favorable manner.

NIOSH Response: NIOSH researched M&C maintenance work and interviewed workers to model exposures associated with their worst-case tasks. Whenever new exposure scenarios were identified, NIOSH evaluated them and created additional exposure models as necessary. NIOSH will continue to exercise due diligence in our research to further understand M&C maintenance work and ensure that all significant exposure scenarios are addressed.

CONCLUSION

NIOSH continues its research to further understand maintenance work at M&C in an effort to create bounding exposure models. In addition, NIOSH will continue to work with all stakeholders including the petitioners and the M&C Working Group to expedite these evaluations. NIOSH believes all of the exposure models developed to date adequately bound maintenance exposures experienced by M&C workers during the residual radiation period.

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ATTACHMENT: ADVISORY BOARD REVIEW OF NIOSH METHODS FOR THE RECONSTRUCTION OF DOSES DURING PERIODS OF RESIDUAL CONTAMINATION, JAMES W. NETON, PH.D., CHP

Background

A number of Atomic Weapons Employer (AWE) sites that produced and/or processed material for the Atomic Energy Commission (AEC) became contaminated from the generation and settling of airborne radioactive particulate on plant equipment and surfaces. If this material was not cleaned up during or after the AEC contract period, any remaining contamination could serve as a source of internal and external radiation exposure to workers. As documented in the National Institute for Occupational Safety and Health (NIOSH) *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*, 103 of the 201 AWE facilities evaluated have the potential for significant residual contamination outside of the periods in which weapons-related production occurred (NIOSH 2006).[1] In accordance with the requirements of the Energy Employees Occupational Illness Compensation Program Act (EEOICPA), NIOSH must reconstruct doses to workers during these periods of residual contamination.

Many of the AWEs that performed work for the AEC were not normally involved in the processing of radioactive material. Because of this, these facilities did not have expertise in the control and monitoring of radioactive material in the workplace. During the AEC contract period, the AEC often provided personnel to perform contamination surveys and air sample measurements. During the residual contamination period, however, very little support was provided to the AWEs. There were very few surface contamination or air sample measurements after the AEC contract ended. It was not until the Formerly Utilized Site Redial Action Program (FUSRAP) was initiated in 1974 that the levels of residual contamination were systematically assessed.

To determine the internal and external exposures to covered workers at AWE facilities during periods of residual contamination, NIOSH uses standard approaches that are described in ORAUT-OTIB-0070, *Dose Reconstruction during Residual Radioactivity Periods at Atomic Weapons Employer Facilities* (ORAUT 2012). This document, which was specifically written to deal with the reconstruction of doses during periods where monitoring data are sparse or nonexistent, incorporates methods that were developed in two other NIOSH documents, OCAS-TIB-009 (NIOSH 2004) and Battelle-TBD-6000 (Battelle 2011).

The documents referenced above include methods to calculate the levels of surface contamination during residual contamination periods using measured or surrogate levels of air concentration, estimate the amount of ingestion, and determine the depletion of surface contamination over time. Through their support contractor, Sanford Cohen and Associates (SC&A), the Advisory Board on Radiation and Worker Health (the Advisory Board or the

[1] This report can be found on the NIOSH Division of Compensation Analysis and Support website at: http://www.cdc.gov/niosh/ocas/pdfs/tbd/rescon/rcontam0811.pdf.

Board) has reviewed each of these documents for scientific validity and applicability to dose reconstructions under EEOICPA. Using the process established by the Board, all of the findings identified in the SC&A review have been evaluated by members of the Advisory Board who were appointed to a working group or subcommittee by the Board chair. The conclusions reached by each working group or subcommittee were eventually reported to the full Board, which accepted their recommendations. Through this review process, all of the findings identified in each of the reviews have been officially closed by the Board. That is, through discussions and exchange of white papers among the Board, SC&A, and NIOSH, the approaches used by NIOSH in ORAUT-OTIB-0070, OCAS-TIB-009, and Battelle-TBD-6000 were determined to be scientifically valid and appropriate for the reconstruction of doses under EEOICPA. It should be noted that in cases where NIOSH agreed that its original approach needed technical clarification or revision, the documents were revised accordingly. The discussion below provides the findings that were identified by SC&A in their review and a description of the resolution process for each document. Where appropriate, web links to documents that were used in the deliberations are provided.

ORAU-OTIB-0070

The stated purpose of ORAUT-OTIB-0070 is to provide guidance for estimating doses to workers at AWE facilities during periods when NIOSH determined there was "significant residual contamination" in its *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities* (NIOSH 2006) or any update to that report.

Revision 00 of ORAUT-OTIB-0070 (ORAUT 2008) identified the following seven methods that may be used to estimate inhalation dose resulting from residual contamination. Selection from among the seven methods is based on the availability of data involving air sample measurements and surface contamination levels (SC&A 2008):

1. Use of air sample measurement data taken during and after facility operations allows for the determination of the exponential decline in air concentration defined by the surface contamination depletion factor coefficient.

2. Use of operational air-sample measurement data that are adjusted by a source-term depletion factor to determine post-operational air concentrations from residual contamination.

3. Use of exponential data fitting that is based on empirical post-operational air-sample measurement data and estimated air activities during the facility's operational period.

4. Use of surface contamination data taken during and after facility operations. Air concentrations from residual contamination are derived for any given year by means of an empirically derived surface contamination source-term depletion constant and an assumed resuspension factor.

5. Use of surface contamination data taken during the operational period and the application of a resuspension factor to provide the basis for estimating air concentration during the operational period. To estimate air concentration during any post operational year, the previously derived operational air concentration is reduced by the source-term depletion factor.

6. Use of surface contamination data taken during the post-operational period and the application of a resuspension factor to provide an estimate of the post-operational air concentration. For the operational period, a default air concentration is assigned, which, in combination with the derived post-operational air concentration, permits an exponential fit.

7. Use of source terms, material quantities, release fractions, and confinement factors to calculate potential intake by inhalation.

SC&A was tasked by the Advisory Board to review Revision 00 of ORAUT-OTIB-0070, and its review was provided to the Board's Procedures Review Subcommittee on August 29, 2008 (SC&A 2008). In total, SC&A identified 15 findings, 4 of which were classified by SC&A as conditional. Conditional findings were defined as those that were linked to three NIOSH documents about guidance in ORAUT-OTIB-0070, Battelle-TBD-6000, Battelle-TBD-6001, and OCAS-TIB-009. In the opinion of SC&A, the status of these findings depended on future revisions to these three documents.[2]

NIOSH evaluated the findings contained in the review by SC&A and provided written responses to the Procedures Review Subcommittee and SC&A on June 7, 2010. Subsequent to the NIOSH transmittal of their initial responses, the Procedures Review Subcommittee initiated their deliberations on these issues at their July 26, 2010, meeting. Their discussion continued during parts of the next five meetings. Table 1 provides the dates of these meetings and the page numbers of the verbatim transcripts where the ORAU-OTIB-0070 discussions can be found. The transcripts for each of these meetings can be found on the NIOSH Division of Compensation Analysis and Support (DCAS) website at http://www.cdc.gov/niosh/ocas/pubmtgs.html. A matrix of SC&A findings and initial responses to those findings by NIOSH is attached to this document as Table 2.

[2] Since the time of the SC&A review, Battelle-TBD-6001 has been withdrawn.

Table 1. Procedure Review Subcommittee Discussions of ORAUT-OTIB-0070

Meeting Date	Transcript Page Numbers
July 26, 2010	282–310
January 5, 2011	191–289
July 14, 2011	134–140
September 19, 2011	74
April 11, 2012	60–62
July 31, 2012	45–85

Over the course of the discussions that were held with the Subcommittee, NIOSH agreed to modify key portions of ORAT-OTIB-0070. The most significant modification was the change from a default depletion rate of 1% per day to a value of 0.067% per day that was derived using empirical data from four separate facilities. On March 5, 2012, the ORAU Team issued Revision 01 of ORAUT-OTIB-0070, which NIOSH believes addressed all outstanding issues. At the request of the Procedures Review Subcommittee, SC&A reviewed Revision 01 and on May 29, 2012, issued an e-mail to the Subcommittee indicating that 13 of the findings should be closed. The Subcommittee reviewed and concurred with the SC&A recommendation to close those findings at its July 31, 2012, meeting. The remaining two findings (numbers 12 and 15) were related to issues with Battelle-TBD-6000 or OCAS-TIB-009 and were to be addressed separately during the review of these documents. The issue brought up in finding number 12, the assertion that the air concentration values in Battelle-TBD-6000 might not be claimant favorable in all situations, was eventually closed under issue number 4 of the Battelle-TBD-6000 review (see below). Finding number 15, related to the ingestion model employed by NIOSH, was transferred to the Procedures Review Subcommittee and addressed during their review of OCAS-TIB-009.

BATTELLE-TBD-6000 REV. 0

Battelle-TBD-6000 provides an exposure matrix for workers at AWE facilities that performed metalworking operations with uranium metal; the matrix is based on radiological measurements that were performed at many AWE facilities when they worked with uranium metal. Over 110 facilities performed these operations, and this document provides guidance for dose reconstruction at any of these facilities. The main body of the document includes general discussions of operations and exposure conditions at these facilities. Following the main body of the document is a collection of appendices, with each appendix containing information for one AWE site that performed metalworking operations. The site-specific information in an appendix can be used for dose reconstruction for the site it addresses.

During the meeting of the Advisory Board on Radiation and Worker Health held in Richland, Washington, on July 17–19, 2007, the Board directed SC&A to perform a review of Revision 0 of Battelle-TBD-6000 (Battelle 2006).[3] On September 14, 2007, SC&A delivered their review of Battelle-TBD-6000, which identified seven findings.[4] To evaluate the SC&A report, the Board established a Battelle-TBD-6000 Work Group whose original meeting was held on November 10, 2008. At this first meeting, SC&A went over the findings and the background behind each finding. Because NIOSH had not yet responded to the SC&A findings, further discussion was tabled until the next meeting. Prior to the next meeting on March 11, 2009, SC&A provided to the Battelle-TBD-6000 Work Group an issues-resolution response matrix, which included all seven findings and the written responses from NIOSH to the findings.

Using the matrix as the basis for discussion, the issues surrounding the findings were discussed at subsequent Battelle-TBD-6000 Work Group meetings, which were held on October 14, 2009; December 16, 2009; May 12, 2010; and October 12, 2010. At the October 12, 2010, meeting, an updated response matrix was issued that summarized the status of the discussions that had been held up to that point. Attached to this matrix were eight SC&A and NIOSH white papers that were generated during the Battelle-TBD-6000 Work Group deliberations. The response matrix and associated attachments can be viewed on the DCAS website at http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-gsi-tbdim-100710.pdf. As indicated in the matrix, the Battelle-TBD-6000 Work Group had resolved five of the seven issues, although some issues were placed in abeyance until NIOSH made the agreed-to changes in Revision 1 of Battelle-TBD-6000 and the Battelle-TBD-6000 Work Group could confirm that the appropriate changes were made. The two findings that were not closed (numbers 6 and 7) were related to ingestion and resuspension that are dealt with in OCAS-TIB-009 and ORAUT-OTIB-0070, respectively. As such, these findings were transferred to the Procedures Review Subcommittee.

BATTELLE-TBD-6000 REV. 1

During a review of NIOSH documents that relied on the use of Battelle-TBD-6000, Revision 1, SC&A discovered some potential issues associated with using that document that were not apparent when Battelle-TBD-6000 was originally reviewed. As discussed above, SC&A previously reviewed Revision 0 of Battelle-TBD-6000 and, based on the findings, the document was revised by NIOSH in 2011 (Battelle 2011). The supplementary comments, as described in the SC&A report of May 20, 2013, dealt with four areas:

1. The suitability of using a terminal settling velocity of 0.00075 m/s and the time required to reach an equilibrium surface concentration;

2. The attenuation rate for surface contamination;

[3] Although Revision 0 of Battelle-TBD-6000 included a section to evaluate thorium exposure that was marked as reserved, this section was not included in revision 1 and the title was modified to reflect this change.

[4] Although the SC&A report identified these as issues, these are considered synonymous with findings for purposes of this discussion.

3. A comparison of site-specific air concentrations with generic data used in Battelle-TBD-6000; and,

4. Operations not explicitly covered in Battelle-TBD-6000.

Of the areas discussed in the SC&A report, the only one that raised a technical concern was issue number 1, the suitability of the settling velocity used in Battelle-TBD-6000 and the time required to reach equilibrium. The other three areas of discussion confirmed that the values and/or technical approaches used in Battelle-TBD-6000 were appropriate. The full report can be found on the NIOSH website at http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-tbd6000-r0.pdf.

At the Battelle-TBD-6000 Work Group meeting on June 20, 2013, SC&A presented their comments on the particulate settling issue. Because NIOSH had not yet prepared a written response to the SC&A comments, further discussion was tabled. Subsequent to the meeting, NIOSH issued a response paper on the settling issue[5] and SC&A issued their responses to that white paper on October 7, 2013.[6] After considerable discussion of the issue, SC&A agreed in principle that the use of a settling velocity of 0.00075 m/s, along with a settling time of 30 days, was technically appropriate. However, SC&A indicated they needed a little time to review the calculations. On October 14, 2013, SC&A issued a memo that concurred with the NIOSH approach to the settling of particulate. In part, the memo stated:

> *If the dose reconstructor is required to assume that deposition is continuous for 30 days to calculate the amount settled on a surface and to use a default value for the terminal settling velocity of 0.00075 m/s, then based on the information presented here, the amount deposited will not be understated.*

Based on the latest comments by SC&A, this issue was closed by the Board.

OCAS-TIB-009

On April 13, 2004, NIOSH issued OCAS-TIB-009, *Estimation of Ingestion Intakes, Technical Information Bulletin* (NIOSH 2004). In the absence of bioassay monitoring information (e.g., urinalyses), there is no direct way to estimate the amount of radioactive material that is ingested in the workplace. To account for ingestion when bioassay information is lacking, OCAS-TIB-009 relies on a model that correlates the amount of material ingested with levels of airborne radioactive particulate that are generated during production and/or processing activities. As part of their review of NIOSH procedures that are used in dose reconstruction, the Advisory Board, through their contractor SC&A, conducted a review of OCAS-TIB-009. On June 8, 2006, SC&A issued a report that contained a review of 32 NIOSH documents that are used in dose reconstruction, which included a review of OCAS-OTIB-009 on pages 89 to 93. The concern of SC&A with OCAS-TIB-009 was that: "The fundamental scientific approach to reconstructing

[5] Available at: http://www.cdc.gov/niosh/ocas/pdfs/dps/dc-tbd6000-0813.pdf.

[6] Available at: http://www.cdc.gov/niosh/ocas/pdfs/abrwh/scarpts/sca-tbd6000dst-r0.pdf.

ingestion exposures has flaws that could lead to an underestimate of ingestion doses under certain circumstances."

Because OCAS-TIB-009 is used to reconstruct doses from ingestion intakes at many covered facilities, the SC&A review of this document was transferred as an overarching issue to the Procedures Review Subcommittee. Thus, on November 7, 2007, the single finding by SC&A was entered into the Board Review System Database as overarching issue number 2. On October 23, 2012, NIOSH issued a white paper to the Procedures Review Subcommittee that empirically evaluated the approach employed in OCAS-TIB-009 that used surface contamination and air concentration data from four AWE facilities.[7] The result of this evaluation supported the NIOSH position that there is a linear relationship between air concentration and surface contamination. At the Procedures Review Subcommittee meeting on November 1, 2012, there was a lengthy discussion between SC&A and NIOSH on the validity of the methodology employed in OCAS-TIB-009, which included a discussion of the October 23, 2012, white paper.[8]

At the end of this meeting, NIOSH agreed to review a U.S. Environmental Protection Agency (EPA) document on ingestion intakes that SC&A offered as evidence that ingestion intakes were likely to be higher than those estimated using OCAS-TIB-009 (EPA 2003). NIOSH reviewed this document and provided a response via e-mail on January 4, 2014, to SC&A and the Procedures Review Subcommittee. SC&A reviewed the NIOSH e-mail and entered the following response into the Board Review System Database on January 7, 2013 (provided below).

> *On January 4, 2013, the following email was received from NIOSH (Jim Neton):*
>
> *By the way, I did review the World Trade Center exposure paper that was discussed at the last subcommittee meeting. My reading of this EPA produced document was that it was developed to "identify contaminants of primary health concern .....in support of planned residential cleanup efforts in Lower Manhattan." Thus, the methodology described in this document is oriented towards the screening analysis of exposures to residents living in the vicinity of the World Trade Center and not oriented towards the quantification of exposure to World Trade Center cleanup workers. In light of this, DCAS believes that the occupational ingestion parameters contained in the RESRAD document (which was used in the recent ingestion white paper) remain the best set of data from which to estimate ingestion exposures under EEOICPA.*
>
> *SC&A responded:*

[7] See http://www.cdc.gov/niosh/ocas/pdfs/dps/dc-tib9-102312.pdf.

[8] This can be viewed on pages 49 to 98 in the verbatim transcripts of this meeting at: http://www.cdc.gov/niosh/ocas/pdfs/abrwh/2012/sctr110112.pdf.

The RESRAD hand-to-mouth ingestion model may very well be "the best set of data from which to estimate ingestion exposures." SC&A's problem with it is that it is the only set of data from which to estimate ingestion exposures. Sure, in addition to the RESRAD document (i.e., NUREG/CR-6755), there is NUREG-5512, Volume 3; ANL/EVS/TM/11-3; PNL-4722; ANSI/HPS 1999; and others. The problem is that all of these documents are authored by (or refer back to) the same group of individuals out of the Pacific Northwest National Laboratory (PNNL). So in effect, all hand-to-mouth ingestion models used by the radiological community are based on a single set of data.

Because it comes from outside of the radiological community and is completely independent of the PNNL data, SC&A offered the World Trade Center (WTC) study as a benchmark for (rather than as an alternative to) the RESRAD model. The key parameter to compare the RESRAD and WTC models is the effective transfer rate (cm^2/hr.). These rates are dependent on the age of the individual but are independent as to whether the individual is a worker or resident. In most non-radiological studies that were identified by SC&A, these effective transfer rates were determined for children or toddlers. However, the WTC study specifically adjusted the effective transfer rate to be applied to adults, another reason SC&A selected it. Using the WTC data, the adult effective transfer rates are 11.25 and 2.25 cm^2/hr. for hard and soft surfaces, respectively, while the RESRAD effective transfer rate is represented by a log-uniform distribution with values between 0.28 and 2.9 cm^2/hr., with a mean of 1.1 cm^2/hr. (DCAS, October 23, 2012). Comparing DCAS (October 23, 2012) Equation 1 to Equation 2, shows that the TIB-009 recommended effective transfer rate is about twice the RESRAD value or 2.2 cm^2/hr. Considering all of the differences between the WTC study and TIB-009, and all the uncertainties involved, this amount of agreement between the hand-to-mouth effective transfer rates is considered quite reasonable.

The difference in the hand-to-mouth ingestion model between workers and residents is the exposure durations assumed, not the effective transfer rates. For example, for a worker, the duration might be 8 hr./day, 250 days/year, and 20 years. While for a resident, the duration might be 12 hr./day, 365 days/year, and 30 years.

Based on the NIOSH White Paper and the above discussion, SC&A recommends that this issue be Closed.

At the Procedures Review Subcommittee meeting on February 5, 2013, there was a discussion of the NIOSH comment on the EPA document and the SC&A response to that comment.[9] After the Procedures Review Subcommittee completed their discussion, they decided to act on the recommendation by SC&A and closed the finding.

[9] This discussion can be viewed on pages 58 to 67 and 302 to 313 in the verbatim transcripts of this meeting at http://www.cdc.gov/niosh/ocas/pdfs/abrwh/2013/sctr020513.pdf.

Summary and Conclusion

To determine the internal and external exposures to covered workers at AWE facilities during periods of residual contamination, NIOSH has developed standard approaches that are described in ORAUT-OTIB-0070, *Dose Reconstruction during Residual Radioactivity Periods at Atomic Weapons Employer Facilities* (ORAU 2012). This document, which was specifically written to deal with the reconstruction of doses during periods where monitoring data are sparse or nonexistent, incorporates methodology that was developed in two other NIOSH documents, OCAS-TIB-009 and Battelle-TBD-6000 (NIOSH 2004, Battelle 2011). In the absence of little or no monitoring data, these documents rely on surrogate data and models to estimate internal and external exposure. Through its contractor, the Advisory Board has reviewed each of these documents for scientific validity. Although a number of issues/findings were raised during the review process, the Board's Procedures Review Subcommittee and the Battelle-TBD-6000 Work Group reviewed each finding. Through a series of discussions and exchanges of white papers and memoranda, each of the findings/issues was resolved. In cases where NIOSH agreed that their original approach needed technical clarification or revision, the documents were revised accordingly.

References

Battelle 2006, *Battelle-TBD-6000, Site Profiles for Atomic Weapons Employers that Worked Uranium and Thorium Metals*, Rev. 0; Division of Compensation Analysis and Support (DCAS);, effective December 13. [SRDB Ref ID: 30671]

Battelle 2011, *Battelle-TBD-6000, Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*, Rev. 1; Division of Compensation Analysis and Support (DCAS); effective June 17. [SRDB Ref ID: 101251]

EPA (U.S. Environmental Protection Agency) 2003, *World Trade Center Indoor Environment Assessment: Selecting Contaminants of Potential Concern and Setting Health-Based Benchmarks*, Prepared by the Contaminants of Potential Concern (COPC) Committee of the World Trade Center Indoor Air Task Force Working Group, available at https://archive.epa.gov/wtc/web/pdf/contaminants_of_concern_benchmark_study.pdf.

NIOSH (National Institute for Occupational Safety and Health) 2004, *Estimation of Ingestion Intakes, Technical Information Bulletin*, OCAS-TIB-009, Revision 0, Office of Compensation Analysis and Support, Cincinnati, Ohio, April 13.

NIOSH (National Institute for Occupational Safety and Health) 2006, *Report on Residual Radioactive and Beryllium Contamination at Atomic Weapons Employer Facilities and Beryllium Vendor Facilities*, December. [SRDB Ref ID: 29386]

ORAUT (Oak Ridge Associated Universities Team) 2008, *Dose Reconstruction during Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, Revision 0, ORAU Team Dose Reconstruction Project for NIOSH; March 10.

ORAUT (Oak Ridge Associated Universities Team) 2012, *Dose Reconstruction during Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, Revision 1, ORAU Team Dose Reconstruction Project for NIOSH; March 5. [SRDB Ref ID: 108851]

SC&A 2008, *Sanford Cohen and Associates Review of ORAUT-OTIB-0070: Dose Reconstruction during Residual Radioactivity Periods at Atomic Weapons Employer Facilities*, August 29.

Table 2. SC&A Review Comments on ORAUT-OTIB-0070 and NIOSH's Initial Responses, July 7, 2010

Date	Procedure No.	Finding No./ Page No.	Procedure Title	SC&A Findings/NIOSH Initial Response
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-01-17	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Inconsistent Use of a Resuspension Factor -- The most obvious flaw concerning the default value of the 1% per day source-term depletion as derived above is the use of a resuspension factor (K) of 8E-05 per meter. This value is nearly 2 orders of magnitude higher than NIOSH's recommended resuspension factor of 1E-06 per meter.
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-01-17	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** As stated in the OTIB, the removal by ventilation is only one factor, which contributes to the reduction in resuspension of contamination over time. This is indicated within the text of the OTIB and the example shown in the text (citing the 8E-05 value) is presented to demonstrate the theoretical resuspension needed if one only considered ventilation alone. However, the 1% a day factor is intended to account for both the physical reduction in the quantity of radioactive material present from all removal mechanisms (ventilation, tracking offsite, and dilution over a larger surface area) and reduced susceptibility of the material present to contribute to airborne radioactivity levels through migration into building surfaces and toward low traffic areas.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-02-17	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Misinterpretation/Misuse of References -- Section 2.5 of OTIB-0070 references Sehmel 1980, Till and Meyer 1983, Linsley 1978, and Healy 1971. A review of these references shows that all but Healy 1971 pertain to outdoor soil contamination, which involves conditions that bear little resemblance to building surfaces, building uses, room heights, and ventilation rates. (NOTE: References are defined in the SC&A report.)

Date	Procedure No.	Finding No./ Page No.	Procedure Title	SC&A Findings/NIOSH Initial Response
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-02-17	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** The cited text identifies clearly indicates that the referenced studies are from outdoor environments: *The decrease in particulate resuspension with time has been well documented in experimental studies in **outdoor environments** (Sehmel 1980, Till and Meyer 1983). Measured resuspension factor "half-lives" in the range of 35 days to years have been reported (Sehmel 1980). Models for this effect have been proposed in the form of a constant (steady state component) and a second component with an exponential term. For example, Linsley reported an expression (Linsley 1978):* *$K(t \text{ in days}) = [10^{-6} \cdot \exp^{(-0.01t)} + 10^{-9}]m^{-1}$ with the 10^{-6} factor being replaced by 10^{-5} for periods of "**regular disturbance by vehicular or pedestrian traffic**."* ***Fewer data are available on the variation of resuspension factors with time in indoor environments**. However, Healy recommends a decay constant value of 0.1 d^{-1}; that represents the effects of source depletion with time (Healy 1971). While no experimental studies were identified for indoor facilities, an exponential decrease in resuspension is expected to occur due to the conservation of mass and the depletion of easily suspended contaminants.* The use of the citation from Healy provides an example of the specification of a source-term depletion factor in the scientific literature and is stated as such; therefore, the cited text is not an example of "misinterpretation/misuse of references." It should be noted that the value used by Healy was an order of magnitude higher than that recommended by the OTIB (0.1 versus 0.01).

Date	Procedure No.	Finding No./ Page No.	Procedure Title	SC&A Findings/NIOSH Initial Response
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-03-18	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Inappropriate Assumption Regarding the Impact of Ventilation on Source Term Depletion -- Implicit in Equation 5 employed by NIOSH for deriving the value of λ (the source term depletion rate) is that airborne contaminants are (1) uniformly distributed throughout the interior volume of a facility and (2) removed with 100% efficiency. Neither of these assumptions is likely to exist.
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-03-18	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** The equation presented in the OTIB is provided as a manner of calculating a source term half-life under a given set of conditions (input factors). The equation is provided and subsequently used to demonstrate the impact of ventilation alone on source depletion. The OTIB does not indicate that the source half-life should be calculated from these input factors and subsequently applied.

Date	Procedure No.	Finding No./ Page No.	Procedure Title	SC&A Findings/NIOSH Initial Response
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-04-22	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Inconsistencies Exist Between Deriving Operational Air Concentration for Uranium AWEs (via Battelle TBDs 6000/6001) and Thorium AWEs (via Attachment B of OTIB-0070) -- For uranium facilities, the use of Battelle-TBDs-6000/6001 identified relatively large air concentrations during facility operations that were job specific. In contrast, Attachment B of OTIB-0070 identifies but a single geometric mean value for each of three thorium sites that more importantly excludes process air sampling data, which are likely the most relevant locations for assessing air concentrations during, as well as after, facility operations. The unexplained inconsistency of excluding process area general air samples will lead to inhalation intakes that may be orders of magnitude too low.
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-04-22	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** Air samples were selected to be indicative of general area conditions within the facilities to be used as input into an estimate of airborne exposure at the start of the residual period. They are not intended to be indicative of potential exposure during the operational period. Since the general area air samples include contributions from both resuspension of residual radioactive material and process releases into the workspace, this methodology would be bounding for the start of the residual period, at which time process activities have stopped and the only source of airborne radioactivity would be resuspension of surface contamination.

Date	Procedure No.	Finding No./ Page No.	Procedure Title	SC&A Findings/NIOSH Initial Response
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-05-23	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Attachment B Cites Survey Data for Three Separate Thorium Facilities but Provides No Further Guidance on How These Data Sets are to be Used -- The three data sets identify values that differ significantly, but there is no guidance for the dose reconstructor regarding their use.
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-05-23	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** As stated in Section 3.1.5, the thorium air-sample data is intended to be used as a bounding estimate of general area air activity for use with the exponential attenuation model. Guidance on the selection of the dataset is beyond the scope of this document since it would need to be based on site-specific data in conjunction with OCAS-IG-004.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-06-23	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Use of Horizons' Summary Survey Data as a Default Value for Operational Air Concentration at a Thorium Refining Facility is inappropriate and not Claimant Favorable

Date	Procedure No.	Finding No./ Page No.	Procedure Title	SC&A Findings/NIOSH Initial Response
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-06-23	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** The document does not specify Horizons summary survey data as the default value for operational air concentrations at a thorium refining facility. The basis of this finding is unclear. As stated in Appendix B, the air sample data sets were selected to be indicative of general area air conditions and as such breathing zone and process samples were excluded. Guidance on the selection of the dataset is beyond the scope of this document since it would need to be based on site-specific data in conjunction with OCAS-IG-004.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-07-25	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** On the Assumption that the Geometric Mean Value of 4.8 dpm/m^3 (cited for Horizons in Attachment B of OTIB- 0070) Reflects Data Contained in Exhibit #5, It Is Unclear How This Value Was Derived by NIOSH
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-07-25	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** As stated in Appendix B, the air sample data sets were selected to be indicative of general area air conditions and as such breathing zone and process samples were excluded. A spreadsheet documenting the analysis and defining the sample selection will be provided for Subcommittee review.

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08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-08-27	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** The Derivation of Air Concentration Values Cited in Attachment B for Nuclear Metals was Not Adequately Explained by NIOSH and Does Not Appear to Correspond to Values Reported in the Survey as Given in Tables II and IV (AEC 1958).
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-08-27	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** As stated in Appendix B, the air sample data sets were selected to be indicative of general area air conditions and as such breathing zone and process samples were excluded. A spreadsheet documenting the analysis and defining the sample selection will be provided for Subcommittee review.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-09-31	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** The Derivation of Air Concentrations Values Cited in Attachment B for Lindsay was Not Adequately Explained by NIOSH and Values Does Not Appear to Correspond to Those Reported in the Survey
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-09-31	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** As stated in Appendix B, the air sample data sets were selected to be indicative of general area air conditions and as such breathing zone and process samples were excluded. A spreadsheet documenting the analysis and defining the sample selection will be provided for Subcommittee review. It should be noted that a data transcription error was identified in the original dataset and as such, a revised analysis is provided. A slight change to the parameters listed in Appendix B is warranted (95^{th} percentile changes from 411 to 416 dpm/m^3) and will be published in the next revision of the procedure.

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08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-10-36	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** NIOSH's Recommended Resuspension Factor of 10^{-6} per meter is Inappropriate. -- Indoor resuspension factors cited in the scientific literature that involve substantial industrial activities (as would be expected in an AWE facility that may continue to operate after operations were performed for the MED or AEC) may experience air concentrations corresponding to RF values of 10^{-4} to 10^{-3} per meter.
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-10-36	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** The resuspension factors cited represent point measurements and as such are not directly comparable to sustained conditions for 2000 hours per year under which they are applied by NIOSH. Moreover, a probabilistic assessment, conducted using the RESRAD-BUILD model and using reasonable estimates of all sensitive parameters demonstrated the appropriateness of the 10^{-6} value. This assessment is documented in Attachment A of OTIB-070.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-11-39	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Use of NUREG-1400 as Stated in OTIB-00070 is Both Inappropriate and Technically Not Feasible Since the Total Absence of Data Precludes a Quantitative Assignment to the Source Term that Reflects Residual Contamination.

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07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-11-39	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** The framework outlined in OTIB 70 is to establish bounding estimates of airborne radioactivity and as such, NUREG 1400 provides a technically defensible approach. The fact that the NRC and DOE allow the use of NUREG 1400 methodology to determine the need for air monitoring of radioactivity for compliance with 10 CFR 20 and 10 CFR 835 are examples of other agencies that have concluded that this methodology is considered bounding.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-12-20/21	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Use of Battelle-TBD-6000 for Assigning Operational Air Concentration Values May Not be Claimant Favorable Under Task Order No. 3, SC&A previously conducted a separate review of BattelleTBD-6000 and submitted a working draft report to the Board in September 2007. Identified in the draft report was the following finding: Default airborne dust loadings used in the TBD to derive external exposures and inhalation exposures are based on data provided in Harris and Kingsley (1959). The TBD would benefit from including a review of the time-weighted daily average uranium dust loadings reported in the Adley et al. report, Study of Atmospheric Contamination in the Metal Melt Building (AEC 1952), and in the site profile for Simonds Saw and Steel, ORAUT-TKBS-0032. SC&A's review of these documents revealed that the bounding, default, time-weighted average airborne uranium dust concentrations recommended in the TBD might not be claimant favorable. At this time, the above-cited finding has not completed the resolution process and therefore, it is identified herein as a conditional finding.

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07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-12-20/21	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** Response to SC&A concerns on the application of Battelle-TBD-6000 methodology is pending resolution of comments specific to that document. This item is tracked as Issue 4 in the Battelle-TBD-6000 issues matrix.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-13-21	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Use of Battelle-TBD-6001 for Determining Inhalation Doses May Not be Claimant Favorable Under Task Order No. 3, SC&A previously conducted a separate review of BattelleTBD-6001 and submitted a working draft report to the Board in February 2008. Identified in the draft report were the following findings relevant to this section: It is not possible to judge whether the basic approach to developing inhalation doses in TBD-6001 is claimant favorable, based on the information presented in that document. However, based on analyses presented in this review, it appears that the average inhalation doses used in TBD-6001 are not claimant favorable, particularly for the period prior to 1948. At this time, the above-cited finding has not completed the Battelle-TBD-6001 resolution process and therefore it is considered a conditional finding herein.

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07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-13-21	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** Response to SC&A concerns on the application of Battelle-TBD-6001 methodology is pending resolution of comments specific to that document. This item is tracked as Finding 1 in the Battelle-TBD-6001 issues matrix.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-14-21	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Use of Battelle-TBD-6001 for Determining Inhalation Doses May Not be Claimant Favorable Under Task Order No. 3, SC&A previously conducted a separate review of BattelleTBD-6001 and submitted a working draft report to the Board in February 2008. Identified in the draft report were the following findings relevant to this section: The approach taken by NIOSH to develop year-specific correction factors to inhalation doses does not appear to be claimant favorable. Doses in the early years may be understated. At this time, the above-cited finding has not completed the Battelle-TBD-6001 resolution process and therefore it is considered a conditional finding herein.

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07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-14-21	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** Response to SC&A concerns on the application of Battelle-TBD-6001 methodology is pending resolution of comments specific to that document. This item is tracked as Finding 5 in the Battelle-TBD-6001 issues matrix.
08/29/2008	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-15-41	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**SC&A Finding** Many of the Fundamental Assumptions that Form the Technical Basis of the OCAS-TIB-009 Ingestion Model are Too Restrictive and May Yield Low Values Under Task 3, NIOSH's ingestion model, as described in OCAS-TIB-009, was previously reviewed by SC&A in a draft report issued on May 30, 2006. In that review, SC&A concluded that NIOSH's model is simplistic and is likely to yield intakes that are too low for multiple reasons. However, issue TIB-009-01 has not been formally finalized and is thus regarded here as a conditional issue.
07/05/2010	ORAUT-OTIB-0070, Rev. 00	OTIB-0070-15-41	Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities	**NIOSH Initial Response** Response to SC&A concerns on the application of OCAS-TIB-009 is pending resolution of comments specific to that document.