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National Institute for Occupational Safety and Health

SC&A Review of NIOSH Response to SC&A's Supplemental Review of M&C Work Group Issues

Response Paper

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1 Introduction

At the request of the Metals and Controls Corporation (M&C) Work Group (tasked on March 3, 2022), SC&A issued a “Supplemental Review of M&C Work Group Issues” on August 22, 2022 (SC&A, 2022). The tasking was for SC&A to focus on any remaining lines of inquiry or outstanding issues relevant to the work group’s final review of the Special Exposure Cohort (SEC)-00236 petition evaluation report (ER) that would benefit from additional assessment. As SC&A noted in the introduction to that review (SC&A, 2022, p. 6):

This review is based on the available record of work group discussions, former worker input, and supporting documents, including NIOSH and SC&A reports, responses, white papers, and presentations. However, it does not represent a consensus among SC&A staff and is intended to be responsive to the work group’s request for a timely and supplemental means to inform final work group deliberations on M&C. It should be emphasized that in matters of interpreting plausibility and sufficient accuracy in the context of exposure modelling and bounding assumptions, there is obviously a high degree of professional judgment involved. The purpose of this review is to consider all such interpretations so that the Advisory Board on Radiation and Worker Health (Board) is in the best possible position to complete its review of the M&C evaluation report.

To accomplish its supplemental review, SC&A pursued three lines of inquiry:

1. **Line of Inquiry 1:** Are the conditions and work activities associated with the M&C residual period unusual or different such that (a) standard modeling procedures do not apply and (b) exposure potentials higher than those addressed by ORAUT-OTIB-0070, revision 01 (NIOSH, 2012; “OTIB-0070”), and Battelle-TBD-6000, revision 1 (NIOSH, 2011; “TBD-6000”), and supporting exposure pathway bounding analyses may have resulted?
2. **Line of Inquiry 2:** Are the exposure pathway bounding methods prescribed by the ER and subsequent National Institute for Occupational Safety and Health (NIOSH) reviews appropriate and consistent with how other Atomic Weapons Employer (AWE) sites have been addressed?
3. **Line of Inquiry 3:** Are the available source term, survey data, and other information applied by NIOSH to support its dose bounding methods sufficiently accurate and plausibly applied?

SC&A’s supplemental review had two findings and two observations (SC&A, 2022):

- **Finding 1.** The back application of a high 1995 sediment survey result to bound inside subsurface activities is not adequately supported by information for M&C worker activities from the earlier residual time period.

- **Finding 2.** The application of surrogate data from the Mound project to provide a dust-loading factor for M&C subsurface activities does not satisfy the Board’s surrogate data policy.
- **Observation 1.** The use of blended decontamination and decommissioning (D&D) characterization survey data from 1984 and 1992 to support a bounding dose for outside subsurface activities may not be necessarily bounding for work in nonuniform soil contamination, given the presence of hot spots that existed during the residual period at M&C.
- **Observation 2.** References to the M&C safety and health manual, U.S. Nuclear Regulatory Commission (NRC) inspection results, operator training, and other programmatic considerations do not necessarily substantiate the conservatism of the 95th percentile soil contamination value being applied.

On January 13, 2023, NIOSH issued its response to SC&A’s supplemental review. This paper provides SC&A’s assessment of NIOSH’s response, organized into general and specific comments.

2 General Comments

NIOSH repeats the comment throughout its response to SC&A’s supplemental review that it does not find any “new technical information or technical justifications,” and couples that with the observation that NIOSH and SC&A “have done extensive work” on each issue and have “previously agreed” on them.

SC&A disagrees with NIOSH’s first comment and finds the second not consistent with the purpose and intent of the work group’s tasking. For the M&C work group review, it is not apparent that anyone has previously surfaced the presence of confined spaces and their impact on the assumed dust loading factor and levels of airborne radioactive contaminants. No one has brought up the implications to drainage pipe sediment levels of coagulant wire lubricant being released during the residual period. And while highly contaminated scale has been mentioned, no one has previously raised the issue of aerosolization or volatilization of such scale during pipe cutting. These are among the new issues that are highlighted in SC&A’s supplemental review and, as noted in that report, add to the uncertainty surrounding the work activities, potential source terms, and exposure levels upon which NIOSH’s models for M&C are based.

While the implication is that the preceding is neither new information nor technical in nature, it represents key questions on how available information and data are being interpreted. As for agreement being already achieved with SC&A, it should be noted that the two findings from this supplemental review address additional considerations upon which the Board may base its judgment regarding dose reconstruction with sufficient accuracy; they are not a reassessment of the results of SC&A’s past reviews of proposed dose reconstruction models.

3 Specific Comments

Sections 3.1 and 3.2 focus on NIOSH’s response to the two supplemental review findings, drawing from the relevant analyses and conclusions in NIOSH’s response paper. Sections 3.3–3.5 respond to the rest of NIOSH’s analyses and conclusions (addressing, for example, the two observations), which do not impact the SEC evaluation directly but influence the modelling assumptions being made or comparisons with other AWE sites or operations.

3.1 Finding 1: Subsurface inside (pipe sediments)

3.1.1 Cleaning blocked drain lines – first comment

NIOSH cites an M&C worker interview that indicated they “cut the line with a snap cutter [and] replace[d] the line” (NIOSH, 2023, p. 2) and contends that maintenance workers during the residual period used “common practices similar to those used by D&D workers to remove the Priority 1 drain lines (e.g., pipe removal versus cleanout)” (NIOSH, 2023, p. 3). NIOSH interprets the M&C worker’s description as meaning those workers were not “cleaning out blocked drain lines,” as SC&A states, and that it “resembles the decontamination and decommissioning (D&D) work the health physicist describes” (NIOSH, 2023, p. 2) in a second worker interview quoted by SC&A and reproduced by NIOSH (2023, p. 3):

I think that one of the differences that I would suggest is that these remediation workers are not handling the material inside the piping because usually it is dealt with in some way that it is a sealed entity. In many cases when there was piping or ductwork, the idea was not to take material out of it and clean it. The idea was to get rid of it. **On the other hand, the maintenance worker’s job is to clean the pipe. So, I think the difference is the proximity to the source term, the handling of the source term, and their physical presence near the source term was probably a little different.** [NIOSH, 2017a, p. 6; emphasis added]

3.1.1.1 SC&A response

NIOSH’s citation of SC&A’s second interview quote (which was taken from a NIOSH interview summary, NIOSH, 2017a) reinforces our original comment that M&C maintenance workers cleaned the pipes. According to this interview, a knowledgeable worker saw a distinct difference between how D&D workers handled extraction of piping versus the cutting of piping as performed by M&C maintenance workers who were unclogging pipes. In the first quote cited, to “replace the line” for a M&C maintenance worker would likely still have involved “cleaning out blocked drain lines” before installing a new segment, entailing more handling and closer proximity, with the potential for higher exposure. This is consistent with commentary provided by another interviewee, who emphasized the contrast between the controlled manner in which D&D workers performed such work as compared with M&C maintenance workers (NIOSH, 2017b, p. 6).

3.1.2 Cleaning blocked drain lines – second comment

NIOSH (2023, p. 3) indicates that it and SC&A:

have done extensive work on the subsurface model and have previously agreed, as shown in the following:

SC&A believes the impacts of the conservatism of the assumptions applied to the model are greater than the impacts of the uncertainties associated with the material dilution and extraction. Taken in combination, SC&A believes that the methods and assumptions used by NIOSH to reconstruct internal doses to M&C workers involved in subsurface maintenance and repurposing activity in Building 10 during the residual period are scientifically sound and claimant favorable [SC&A [2021], PDF p. 15].

3.1.2.1 SC&A response

As pointed out in the supplemental review (SC&A, 2022), there are uncertainties associated with other potential exposure pathways during the M&C residual period that have not been addressed in past reviews of the inside subsurface model. These include those related to the presence of confined work spaces, the volatilization or aerosolization of contaminated scale during pipe cutting, and the potential concentration of drain pipe sediment due to the regular discharge of a known coagulant. The scientific soundness and claimant favorability of the model, as based on its current scoping of exposures, are not as much in question as are its full treatment of all potential exposure pathways, including those identified in SC&A's supplemental review.

Beyond the technical adequacy of the model itself is the question of its plausibility, given, as the former Board chairman put it for the SEC review for Linde, "we may have a bounding dose, but is it a plausible bounding dose, given how little information we have and the fact that most of these people probably weren't engaged in the activity that we have done the dose reconstruction for?" (ABRWH, 2011, p. 124). Is it plausible to back apply pre-D&D sediment values over a 27-year residual period given the lack of actual source term and monitoring data for M&C maintenance activities during that time period, compounded by "intrusive activities, high exposure conditions, uncertain facility activities, or unknown contamination sources" (NIOSH, 2023, p. 17)?

3.1.3 Materials released into drains

NIOSH contends that the "premise in the SC&A review is inaccurate," in that the release of coagulant oil during the residual period by High Flux Isotope Reactor (HFIR) operations did not introduce higher concentrations of "covered uranium and thorium from AWE operations (1952–1967) to the subsurface" (NIOSH, 2023, p. 12). NIOSH also repeats its summary from the SEC ER of the NRC investigatory surveys that led that agency to be "satisfied that the interiors of Buildings 3, 4, and 10 were sufficiently decontaminated and they released Buildings 3, 4, and 10 for unrestricted use" (NIOSH, 2023, p. 12). More specifically, NIOSH stated that "wire operations during the residual period did not process radioactive materials; therefore, most material rinsed into the drains was non-radioactive except for residual contamination that remained in cracks and crevices" (NIOSH, 2023, p. 12).

3.1.3.1 SC&A response

The release of nonradioactive coagulant oil to drain lines was done separately from any HFIR operational radioactive releases and may have had a collateral influence on how AWE-related uranium and thorium contamination already in the piping would have concentrated over the years following those original discharges. In fact, in its response, NIOSH supports this interpretation by making the case that "wire operations during the residual period did not process

radioactive materials; therefore, most material rinsed into the drains was non-radioactive except for residual contamination that remained in cracks and crevices” (NIOSH 2023, p. 12). SC&A agrees with NIOSH that the wiring operations did not contribute radioactive materials to the drain lines. It was the coagulant oil itself that may have consolidated the uranium and thorium already entrained in the pipes (“cracks and crevices”) that would have impacted the covered AWE material from prior years (the resulting sediment would not have been distinguishable between AWE and HFIR residual contamination). The AWE sediment was clearly present within the system following the cessation of AWE operations; any later introduction of oil-based coagulant solutions within that system may have collected and concentrated the uranium and thorium already present in that system and led to higher sedimentation to which M&C maintenance workers would have been exposed. This concern represents a new issue that has not been addressed.

3.1.4 Drain line contamination

NIOSH contends that cutting of drain lines with contaminated scale exceeding 1,000,000 disintegrations per minute per 100 square centimeters (dpm/100 cm²) would constitute “isolated hot spots,” not a systemic condition, and that in any case, it does not believe there is any evidence that even higher activity levels might have existed. (NIOSH, 2023, p. 16). NIOSH also notes it was a clay pipe, not a metal pipe, that showed the elevated radioactive scale.

3.1.4.1 SC&A response

NIOSH presents no evidence that this contaminated scale would not have been present elsewhere in the piping system, could have involved both metal and clay pipes, or that even higher activity levels may have been present elsewhere in the pipe network. NIOSH fails to address the source of this concern: the U.S. Department of Energy’s (DOE’s) Bridgeport Brass AWE hazard assessment, where it was warned that pipe cutting involving internal radioactive contamination could lead to airborne releases that may involve worker exposure (DOE, 1996, PDF p. 48). NIOSH’s reliance on “mass-based sample data” and “soil-sampling plans” does not address the simple question raised: Given that an AWE hazard assessment raised this general worker exposure concern, can this potential exposure pathway at M&C be characterized and bounded? This concern represents a new issue that has not been addressed.

3.1.5 D&D measurements

NIOSH contends that it is not “back-applying conservative D&D measurements” from 1995 in its bounding method for subsurface inside and that it “incorporated extreme conservatism in its modeling to account for intrusive activities, high exposure conditions, uncertain facility activities, or unknown contamination sources” (NIOSH, 2023, pp. 16–17). Further, NIOSH and SC&A “have done extensive work on this issue” and have already agreed on a bounding method (NIOSH, 2023, p. 17).

3.1.5.1 SC&A response

This appears to be inexact terminology on the part of SC&A. NIOSH is noting that compared with SC&A’s statement, it is actually “back-applying measurements taken by M&C and NRC Contractors **before** D&D” (NIOSH, 2023, p. 16; emphasis added). There is no disagreement, as that meaning was the intent of SC&A’s statement. SC&A’s use of the term “D&D” referred to D&D-related sampling in 1995 for characterization purposes, a meaning made clear in the first

sentence (and footnote) of SC&A’s review of the subsurface inside model in section 3.2.2.1 of its supplemental review (SC&A, 2022, p. 19). SC&A’s point, as elaborated in the supplemental review, is to question how confident one can be to take these 1995 survey measurements and apply them back over the previous 27 years of the residual period. NIOSH refers to the “extreme conservatism in its modeling to account for intrusive activities, high exposure conditions, uncertain facility activities, or unknown contamination sources” (NIOSH, 2023, p. 17), but this NIOSH approach employs a maximized value to compensate for the lack of any actual data for the period in question. When is the back application of a modeled bounding value based on a much later set of pre-D&D measurements plausible? For the M&C evaluation, this is ultimately a Board judgment and decision. Regarding previous agreement between SC&A and NIOSH, our earlier general comment applies: This supplemental review addresses additional considerations upon which the Board may base its judgment regarding dose reconstruction with sufficient accuracy; it is not a reassessment of the results of SC&A’s past reviews of proposed dose reconstruction models.

3.1.6 Applying the 1995 sediment survey result

NIOSH (2023, pp. 17–18) clarifies that it did not use one high 1995 sediment survey result to create its model (in response to SC&A’s finding that “the back application of a high 1995 sediment survey result to bound inside subsurface activities is not adequately supported by information for M&C worker activities from the earlier residual time period” (SC&A, 2022, p. 23)).

3.1.6.1 SC&A response

SC&A’s finding is directed at the bounding value adopted by NIOSH, based on the 95th percentile equivalent of 6,888 picocuries per gram (pCi/g), which is clearly based on the 1995 pre-D&D survey measurements.

3.2 Finding 2: Use of Mound surrogate data

3.2.1 Site characterization

NIOSH observes that SC&A’s characterization of potential confined spaces at M&C (various manholes, trenches, pits, and vault spaces) is not clear on what vault spaces are being referred to and believes manholes would not be a significant source term problem (NIOSH, 2023, p. 21).

3.2.1.1 SC&A response

To clarify, vault spaces are typically concrete enclosures used to surround large pieces of equipment or utility areas. Regarding NIOSH’s comment about manholes, SC&A simply identified all the obvious confined spaces at M&C and made the statement: “it is not apparent how the Mound project addressed considerations related to resuspension or dust loading in a confined space, such as the various manholes, trenches, pits, and vault spaces at M&C in which maintenance workers actively worked” (SC&A, 2022, p. 31). As emphasized in former worker interviews, it was not uncommon to be working in a trench doing routine utility repairs or pipe cleanouts for days and up to a week (NIOSH, 2017c, pp. 1–2). One installation project in Building 10 involved the cutting out of an existing drain line and installation of new equipment, piping, and large tanks, necessitating a trench 100 feet long, with a depth of 8–10 feet in places, that was worked in for 6 months in 1983–1984 (NIOSH, 2017d, p. 11). NIOSH does not respond

to the central question posed: In applying the Mound surrogate data to derive a dust loading factor, did they address confined space considerations? From a larger perspective, did they consider the impact of confined spaces on their modeled airborne resuspension of uranium and thorium? The answer appears to be “no” in both cases. Confined spaces represent a new issue that has not been addressed.

3.2.2 Surrogate data

NIOSH cites SC&A’s finding 2 (that surrogate data from the Mound project do not satisfy the Board’s surrogate data policy) but does not respond directly. NIOSH merely observes that it has committed to revisit OTIB-0070 in terms of how surrogate data are applied at other sites and cites the previous SC&A conclusion that while the Mound data can be applied, they may not be sufficiently conservative due to other factors (e.g., moisture of soil, dust loading variables). NIOSH, while indicating that it will consider SC&A’s previous points, concludes it “did not find where SC&A provided any new technical information or technical justification to indicate why the proposed approach is not considered bounding” (NIOSH, 2023, p. 22).

3.2.2.1 SC&A response

NIOSH did not respond to the finding. Instead of addressing whether confined space issues would make a difference in applying the Mound data to M&C exposure pathway modeling and if so, how that could be mitigated in resulting dust loading and other airborne concentration estimates, NIOSH does not provide a direct answer. Instead, what is provided is an account of a past NIOSH and SC&A exchange where it is acknowledged that the dust loading factors in OTIB-0070 will need to be “uniquely evaluated at each site” and that “one size will not fit all” (NIOSH, 2023, pp. 21-22). NIOSH’s proposed application of Mound project data for deriving the M&C dust loading factor does not satisfy the Board’s surrogate data policy for site and process similarity given disparities between the sites for confined space conditions. This is a new concern that bears on the technical accuracy and plausibility of NIOSH’s model.

3.3 Other NIOSH comments

Sections 3.3.1–3.3.8 address the balance of NIOSH’s responses for the two SC&A observations and other issues.

3.3.1 Controlled D&D and typical maintenance work

NIOSH objects to SC&A’s quoting of a former worker to characterize the intrusiveness of M&C maintenance work because the health physicist cited was “not present during maintenance work” (NIOSH, 2023, p. 4). NIOSH then provides interview quotes from other M&C maintenance workers to refute or qualify the statements of that health physicist and to illustrate that contamination monitoring was being performed and maintenance workers were performing work under a sound safety and health program. NIOSH concludes that “the statement in SC&A’s supplemental review might incorrectly lead the reader to believe that Texas Instruments found spreading dust clouds of contamination throughout the plant to be an acceptable practice” (NIOSH, 2023, p. 6). However, NIOSH also makes the qualifying statement that “NIOSH acknowledges that some aggressive activities briefly resulted in a dusty environment and elevated exposure” (NIOSH, 2023, p. 6).

3.3.1.1 SC&A response

SC&A's only purpose in presenting alternate points of view from worker interviews was to provide a more diverse commentary on plant conditions during the residual period.¹ The interviewee's comment was simply intended to contrast what that worker understood as the difference between the work environment during Texas Instruments-managed D&D-related activities ("controlled") and that of M&C maintenance activities ("uncontrolled, unconfined, aggressive") (NIOSH, 2017a, pp. 4–5). Clearly, recollections back over the decades by former maintenance workers and other personnel can and do often vary. However, NIOSH's final statement admitting "some aggressive activities briefly resulted in a dusty environment and elevated exposure" is the salient one before the work group. Such intrusive work at close proximity within ditches and pits would have exposed M&C maintenance workers to not only resuspended dust but also volatilized aerosols and fumes from welding and machine tool cutting of contaminated piping, all of which would have been concentrated by confined spaces. This is the context of SC&A's citation of the interview comment, not to characterize how Texas Instruments may have managed its contamination control program.

3.3.2 Routine equipment maintenance

NIOSH clarifies that its equipment discussion is related to "tasks when workers penetrated the concrete floor, accessed the subsurface, or went into the overhead to make connections" (NIOSH, 2023, p. 7). It is further clarified that "a few substantial pieces of equipment were left in place with residual contamination in inaccessible locations" (NIOSH, 2023, p. 7).

3.3.2.1 SC&A response

SC&A's question, here, regards the repurposing of M&C equipment, which does not appear to be addressed in terms of covered exposure to M&C workers performing later maintenance on that equipment during the residual period. While the SEC-00236 ER does cite the contamination surveys performed and that a few substantial pieces of equipment were left in place with residual contamination in inaccessible locations, NIOSH does not address whether later repurposing of M&C equipment may have led to exposures to the workers performing the repurposing and whether later maintenance on such equipment would have been a potential exposure pathway.

3.3.3 Intrusive nature of maintenance work

NIOSH contends that the "intrusiveness" of work at M&C ought to be judged in terms of "applying standard industrial hygiene or nuclear industry resuspension factors to a source term" (NIOSH, 2023, p. 8). NIOSH also observes that Norton Co. and Vitro Manufacturing were not added to the SEC because of the intrusiveness of their activities, and that the "source term at the Linde Ceramics Plant was considerably larger than M&C's" (NIOSH, 2023, p. 10). It was also observed that the only data NIOSH could use in the Linde SEC-00107 ER were "air samples taken during jackhammering," and that NIOSH's approach for Linde was unlike that for M&C because for M&C NIOSH had developed "separate models of the highest maintenance exposure

¹ SC&A does not judge the validity of interviewee comments at face value but accepts them as individual perspectives based on unique experience, some of which may not be apparent to an outside reviewer. For clarification, it may be useful to re-interview the health physicist in question to reconcile their commentary and experience with that of the other workers interviewed by NIOSH.

scenarios, using scenario-specific pre-D&D data, which resulted in much smaller doses (71 mrem/yr CED [millirem per year committed effective dose])” (NIOSH, 2023, p. 10).

3.3.3.1 SC&A response

The use of the standard exposure model for M&C, as founded on OTIB-0070 and TBD-6000 and complemented by exposure pathway bounding, can be predicated on no work activities during the residual period being so intrusive or disruptive that they would have “altered the materials present and placed employees close to the disturbed materials”² (NIOSH, 2020, slide 7). If such activities “briefly resulted in a dusty environment and elevated exposure” as acknowledged by NIOSH (2023, p. 6), the question becomes whether that level of exposure can be characterized and bound by an approach that presupposes more passive exposures (i.e., OTIB-0070 and TBD-6000) but requires six bounding models to address intrusive activities at M&C.

This is compounded by additional uncertainties identified by SC&A’s supplemental review: confined space concentration of particulates and gases, potential coagulant concentration of pipe sediments, and release of contaminated scale from pipe cutting. Even the brevity of exposure is open to question, given feedback from M&C maintenance workers that they performed work in trenches for up to a week at a time and in one case, for up to a 6-month period, all under confined space conditions. While the question of how intrusive work activities may have been at M&C is obviously a subjective one, SC&A believes there is clear evidence that maintenance activities during the M&C residual period were unique in terms of their level of intrusiveness (excavations, pipe cleaning, pipe cutting), work environments (confined spaces), and uncertain or unknown source terms (contaminated pipe sediments, presence of coagulants, contaminated scale, confined space concentration of airborne particulates). While other AWE sites, such as Carborundum and Dow Madison had residual work activities (e.g., welding, torch-cutting, soil excavation) similar to those of M&C maintenance workers, the difference is the aforementioned level of intrusiveness and uncertain or unknown source terms. Ultimately, NIOSH acknowledges the “high exposure conditions” and “unknown contamination sources” that may have been associated with such M&C intrusive activities (NIOSH, 2023, p. 17) in developing its bounding models.

3.3.4 NRC regulatory direction

NIOSH acknowledges that hot spots identified during the burial ground remediation were higher than 30 pCi/g, but that “NIOSH’s statement was explicitly about the airline installation process” (NIOSH, 2023, p. 18). Further, “NIOSH does not construe the lack of NRC regulatory direction to signify the elevated levels were merely above background, but less than release criteria (30 pCi/g), as SC&A states,” but that “when M&C reviewed documented surveys of the airline debris, M&C determined those contamination levels to be below applicable NRC release criteria” (NIOSH 2023, p. 18).

3.3.4.1 SC&A response

SC&A accepts NIOSH’s clarification of this issue.

² This criterion was cited for the SEC-00173 evaluation of the Norton Company AWE.

3.3.5 Blended D&D characterization survey data

In response to SC&A's observation 1, regarding the use of blended D&D characterization data, NIOSH notes that the 95th percentile is applied as opposed to a maximum value for hot spots, given that they are limited exposures and not a normally expected condition (NIOSH, 2023, p. 20).

3.3.5.1 SC&A response

SC&A accepts NIOSH's clarification of this issue given the availability of soil measurements.

3.3.6 95th percentile

NIOSH responds to SC&A's observation 2 by noting that it was not using the M&C safety and health manual, NRC inspection results, operator training, and other programmatic considerations to justify using the 95th percentile (NIOSH, 2023, p. 23).

3.3.6.1 SC&A response

NIOSH appears to misunderstand the essence of this observation. As noted in the basis for SC&A's observation 2 (SC&A, 2022, p. 37):

The claim "that M&C's area monitoring **assures** that the 95th percentile soil-contamination value is conservative based on routine surveys of Building 10 during the first 14 years of the residual period (1968-1981)" (NIOSH, [2021], pp. 7-8) is not necessarily substantiated by the assumed strength of the M&C radiological surveillance program. Without corroborating accounts or evidence regarding the actual implementation of non-HFIR workplace contamination surveillance procedures at M&C, assurance cannot be placed solely on typical HFIR-specific survey results or the assumed implementation of procedural requirements such as the M&C safety manual or NRC inspection requirements. [Emphasis added.]

Whether using these program documents to justify, or to demonstrate, corroborate, illustrate, or show that such monitoring procedures and oversight "assures" that the 95th percentile soil contamination value is conservative is a distinction with little difference. SC&A stands by its observation that the program references NIOSH cites "do not necessarily substantiate the conservatism of the 95th percentile soil contamination value being applied" (SC&A, 2022, p. 37).

3.3.7 NIOSH's response to SC&A's conclusion comment

NIOSH first cites SC&A's conclusion:

Precedent suggests that while less precision or technical accuracy can be tolerated if the exposure of a worker cohort is relatively low, the use of a high exposure or concentration values based on these data to bound or represent that of other workers in a facility or on a site for long time periods would not be appropriate if their exposure potential could be higher, conditions were different, or if there is lack of information upon which to make those judgments. As noted in the Board's deliberations on the Linde residual period, the question of where to draw the line

for applying such bounding constructs is a subjective one, weighing the precision (or accuracy) of the bounding assumption and data, as well as the plausibility of their application to the target worker population. [SC&A, 2022, p. 36]

NIOSH then appears to parse SC&A's conclusion, citing the low exposure precept and attributing it to M&C, followed by the application of a "high exposure" for bounding purposes, and attributing it to the Linde case. NIOSH finds that the Linde case does not apply to M&C because the potential exposure level is much higher (5,479 mrem/yr CED). NIOSH goes on to note that it has a "more complete data set" with which to work for M&C and a better understanding of M&C work processes than it did with Linde (NIOSH, 2023, p. 24).

3.3.7.1 SC&A response

In its conclusion, SC&A is not referring to a specific value (e.g., Linde's), but any site monitoring data not related to the actual operations in question being back extrapolated over a long period of time with a formulation that is made ultra conservative to compensate for the lack of data and to address the inherent uncertainties and unknowns of that approach. These policy approaches, and his concerns about them, were articulated more fully by Dr. James Melius, former chair of the Board, in the Linde proceedings. As the Chair stressed in that discussion, when information is lacking for affected worker populations, the application of generalized bounding doses, no matter how maximized, may not be appropriate (ABRWH, 2011, pp. 121–123). As the Chair explained:

To me, the lack of information — and we have no sampling data during this renovation time period. We have very little information on what was done at the site during this time period and who was involved, and how many people were involved, that it seems to me that [it] is just as appropriate to be designated a Special Exposure Cohort.

I think putting it into our terms, we may have a bounding dose, but is it a plausible bounding dose, given how little information we have and the fact that most of these people probably weren't engaged in the activity that we have done the dose reconstruction for? [ABRWH, 2011, pp. 123–124]

As noted in the supplemental review, this statement suggests that the use of a high exposure or concentration value based on a later set of specific workplace data to bound or represent that of earlier workers in a facility or on a site, particularly over a lengthy time period, would not be appropriate if their exposure potential could be higher, work conditions were different, or if there is lack of information upon which to make that judgment. Regarding conservatism, while any measurement can be made extremely conservative by the multiple layering of favorable assumptions and statistical 95th percentile values, the Board's original question remains: Where do we draw the line with the application of bounding values? (SC&A, 2022, p. 30).

3.3.8 NIOSH's response to lines of inquiry conclusions

3.3.8.1 Line of inquiry 1

Are the conditions and work activities associated with the M&C residual period unusual or different such that (a) standard modeling procedures do not apply and

(b) exposure potentials higher than those addressed by OTIB-0070 and TBD-6000 and supporting exposure pathway bounding analyses may have resulted? [SC&A, 2022, p. 7]

SC&A's supplemental review compared AWE sites (as illustrated in table 1 of the report) and found that:

The active and intrusive nature of the described maintenance work at M&C during the residual period clearly exceeded the residual period conditions and activities at other AWEs, as described in their corresponding evaluation reports and site profiles, and what would be assumed under OTIB-0070 for application of its resuspension and volumetric soil values. It falls within the continuum of post-operational intrusive activities ranging from Norton and Vitro (very active, D&D-like activities) to that of Linde (renovation activities), with M&C being closer to the latter, but without the radiological protection controls, protective equipment, and personnel monitoring that were typical of formal D&D programs. [SC&A, 2022, p. 14]

Based on where such intrusive activities would have "altered the materials present and placed employees close to the disturbed materials" (NIOSH, 2020, slide 7), the standard exposure model, as founded in OTIB-0070 and TBD-6000 and complemented by exposure pathway bounding, may not be sufficiently accurate or complete. At M&C during the residual period, maintenance workers conducted intrusive work activities, including cutting pipes containing contaminated scale, cleaning out contaminated pipe sediment, performing subsurface construction, and providing maintenance support for utilities in various subsurface, confined spaces for sometimes extended periods of time. Unlike D&D workers, M&C maintenance workers were unaware of the radiological contamination and conducted these activities with no radiological control program implemented, no apparent health physicist presence, and no radiological control oversight.

While NIOSH claims that it has "demonstrated that M&C exposure potentials are not higher than those addressed by ORAUT-OTIB-0070 and ORAUT-TBD-6000" (NIOSH, 2023, p. 11), it has not fully considered potential exposure pathways attributable to the intrusive nature of M&C maintenance work, with new issues identified by SC&A's supplemental review such as confined space atmospheres, coagulant oil discharges, and airborne releases of contaminant scale during pipe cutting. This is in addition to the six exposure models that have been deemed necessary to bound intrusive activities at M&C that could not be addressed under OTIB-0070 and TBD-6000. It appears the solution to these unknown or uncertain exposure potentials is that NIOSH has "incorporated extreme conservatism in its modeling to account for intrusive activities, high exposure conditions, uncertain facility activities, or unknown contamination sources" (NIOSH, 2023, p. 17). The work group will need to judge whether such "extreme conservatism" in the service of NIOSH's bounding analyses can be considered plausible given the level of uncertainty and lack of information about M&C maintenance worker exposure during the residual period.

3.3.8.2 Line of Inquiry 2

Are the exposure pathway bounding methods prescribed by the ER and subsequent NIOSH reviews appropriate and consistent with how other AWE sites have been addressed? [SC&A, 2022, p. 7]

SC&A examined (1) whether the NIOSH bounding approach for exposure pathways applied to M&C is consistent with past practice and precedent for AWE residual periods, and (2) whether dose reconstruction methods for these pathways can be considered plausible and sufficiently accurate. Like other AWEs, M&C had residual contamination resulting from earlier uranium and thorium operations, and work activities that were similar. However, the nature of some of the M&C maintenance activities differed by the degree of its intrusiveness, which placed some workers in close proximity to elevated contamination sources in normally inaccessible locations. As already noted, SC&A found several new issues that bear on the potential exposure of M&C maintenance workers that bring into question the bounding approach for subsurface inside exposures, leading to finding 1.

While NIOSH contends its exposure pathway bounding methods are appropriate and consistent with how other AWE sites are addressed, it does not address the increased exposure potential posed by confined space atmospheres, nor does it adequately consider the implications of coagulant oil discharges and airborne contaminant scale releases to its subsurface inside exposure pathway analyses. The necessity of complementing the normal application of OTIB-0070 and TBD-6000 with six exposure pathway models that incorporate “extreme conservatism” to address these and other uncertain or unknown exposures at M&C sets it apart from how other AWEs have been addressed in the past.

3.3.8.3 Line of Inquiry 3

Are the available source term, survey data, and other information applied by NIOSH to support its dose bounding methods sufficiently accurate and plausibly applied? [SC&A, 2022, p. 7]

A guiding principle that NIOSH follows for addressing the “uncertainty around the work performed” or the “complete understanding of the work performed” is that it is “NOT an issue when the bounding doses are very low, and specifically, during AWE residual periods such as at M&C” (NIOSH, 2020, slide 14). However, as pointed out by SC&A’s supplemental review, the question of determining a bounding dose in the absence of sampling data during the AWE residual period and applying sufficient conservatism to it is not without precedent and carries with it the question of plausibility. As pointed out during the Board’s Linde review, if “carried to an extreme, we could take any site . . . and we could come up with what we think is the highest possible exposure at that site that would occur, and that would be bounding, and apply that to everybody that ever worked at the site” (ABRWH, 2011, p. 129). However, the essential questions, as the former Board Chair put it, are “is that a plausible bound? And then, who are we trying to characterize?” (ABRWH, 2011, p. 129).

NIOSH’s response, that it has “incorporated extreme conservatism in its modeling to account for intrusive activities, high exposure conditions, uncertain facility activities, or unknown contamination sources” (NIOSH, 2023, p. 17) at M&C for the residual period, raises the very

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concern raised by Dr. Melius during the Linde AWE proceedings that contributed to the Board’s decision on that SEC evaluation. In the absence of source term and monitoring data for the facility time period in question, is it plausible to incorporate what NIOSH terms “extreme conservatism” in its bounding value for inside subsurface exposures based on information from a much later time frame (27 years), from a different operation (pre-D&D), and with different work conditions when attempting to address what NIOSH terms “intrusive activities, high exposure conditions, uncertain facility activities, or unknown contamination sources”? (NIOSH, 2023, p. 17)?

While NIOSH notes that M&C dose estimates are relatively low and it has “a more complete data set to characterize M&C and a better understanding of M&C maintenance work than we had with Linde” (NIOSH, 2023, p. 24), it has not addressed the increased exposure potential posed by confined space atmospheres, nor does it similarly consider the implications of coagulant oil discharges and airborne contaminant scale releases to its exposure pathway analyses. NIOSH may claim that the extreme conservatism of its modeling would bound even these exposure pathways, but in the absence of validating information, such a claim may be considered by the work group to be unfounded and implausible.

4 Summary and Conclusions

SC&A was tasked by the M&C Work Group to focus on any remaining lines of inquiry or outstanding issues relevant to the work group’s final review of the SEC-00236 ER that would benefit from additional assessment. The supplemental review pursued several new issues that heretofore had not received attention. This has led to two findings that derive from SC&A’s premise as stated in its review: “The use of a high exposure or concentration value based on a set of specific workplace [pre-D&D sediment] data to bound or represent that of other workers in a facility or on a site, particularly over a lengthy time period, would not be appropriate if their exposure potential could be higher, conditions were different, or if there is a lack of information upon which to make that judgment” (SC&A, 2022, p. 36).

Finding 1 is that “the back application of a high 1995 sediment survey result to bound inside subsurface activities is not adequately supported by information for M&C worker activities from the earlier residual time period” (SC&A, 2022, p. 36). NIOSH’s disputes that coagulant oil could have introduced higher concentrations of covered uranium and thorium from AWE operations into the drains, a response that SC&A finds does not comport with the possible physical and chemical reactions that this known coagulant may have had on already entrained uranium and thorium in the cracks and crevices of the M&C drainage system. NIOSH disputes, without evidence, that cutting of drain lines with contaminant scale found to exceed 1,000,000 dpm/100 cm² is a systemic issue for M&C exposure potential, notwithstanding DOE’s emphasis on this exposure concern in its hazard assessment for the Bridgeport Brass AWE. NIOSH questions the distinction SC&A draws between how the exposure potential of D&D workers is smaller compared with M&C maintenance workers when performing pipe cutting and removals but references a worker account that supports the interpretation that the latter’s job is also to clean the pipe prior to repair (versus removal for D&D), and that, therefore, there would have been a difference in physical proximity and source term. NIOSH did not address the impact of confined space atmospheres on its bounding exposure assumption for inside subsurface work, such as

drain line cleaning, despite there being scientific evidence that this would have likely led to higher airborne concentrations of radioactive contaminants and intakes.

Apropos to this confined space issue is SC&A's finding 2, that the "application of surrogate data from the Mound project to provide a dust loading factor for M&C subsurface activities does not satisfy the Board's surrogate data policy" (SC&A, 2022, p. 37). NIOSH does not address the central question of the likely impact posed by confined space atmospheres but instead dismisses the review as not providing "any new technical information or technical justifications to indicate why the proposed approach is not considered bounding" (NIOSH, 2023, p. 22).

NIOSH's generic response, as stated in the preceding quote and repeated throughout its report, appears to key on two threshold criteria for what information it deems is acceptable for the work group to consider. First, that any new information or justification apparently needs to be "technical" to be valid, without explaining how that is defined in this context. Second, that this same information needs to justify why NIOSH's modeling approach is not bounding. On matters of dose reconstruction with sufficient accuracy, including the basis and application of bounding exposure values, it is the Board that ultimately weighs the scientific validity of information it chooses to consider in its SEC deliberations on such matters and whether NIOSH's justification based on "reliable science, documented experience, and relevant data" (Methods for Radiation Dose Reconstruction, 2002, p. 22332) is similarly adequate. On such matters, the burden of justifying its bounding approach belongs to NIOSH. Obviously, the work group can request that NIOSH provide additional justification in light of new information that brings into question the accuracy, conservatism, or plausibility of its approach.

SC&A's role in response to its tasking was to inform work group deliberations by identifying "any remaining lines of inquiry or outstanding issues" that needed to be addressed by the M&C work group (SC&A, 2022, p. 6). It has done so in a deliberate manner by applying its three lines of inquiry and identifying remaining issues that were not addressed or not fully considered in previous NIOSH and SC&A reviews.

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