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

Response Paper

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INTRODUCTION

On August 22, 2022, NIOSH received SC&A's *Supplemental Review of M&C Work Group Issues* [SC&A 2022]. This response paper addresses comments, observations, and findings from that review.

SC&A based their review [SC&A 2022] 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.* [PDF p. 7]

NIOSH RESPONSES TO SC&A COMMENTS, FINDINGS, AND OBSERVATIONS

SC&A's supplemental review posited three lines of inquiry based on current work group concerns, and NIOSH organized this response paper accordingly. In each SC&A Line of Inquiry section, NIOSH responds to SC&A findings, observations, and other SC&A comments where clarification is necessary.

SC&A Line of Inquiry 1: Conditions and Work Activities Associated with the Metals and Controls Corp. (M&C) Residual Period

SC&A Comment – Cleaning Blocked Drain Lines

SC&A provided a statement they obtained from interviewing former maintenance workers "who spoke of cleaning out blocked drain lines from Building 10 on a regular basis:"

> *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 sledge hammer, 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.* [SC&A 2022, PDF p. 14]

NIOSH Response – Cleaning Blocked Drain Lines

When this worker says they "cut the line with a snap cutter, replace the line," that is not the same as "cleaning out blocked drain lines," as SC&A mentions in the lead-in sentence prior to the worker statement. In fact, it resembles the decontamination and decommissioning (D&D) work the health physicist describes in SC&A's next paragraph (i.e., removal as "a sealed entity").

> *In terms of exposure potential, a health physicist who worked onsite during D&D made this distinction between how maintenance workers at M&C handled drain lines versus later commercial remediation workers:*
>
> > *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*** [emphasis added]. *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.* [SC&A 2022, PDF p. 14]

As illustrated by SC&A's example, when maintenance workers encountered a clogged drain, they used common practices similar to those used by D&D workers to remove the Priority 1 drain lines (e.g., pipe removal versus cleanout). In addition, M&C placed cones around work areas, hired a contractor to saw-cut the concrete floor, and applied water during cutting as a dust suppressant. After the concrete was broken, two or three M&C workers would use shovels to access the clogged pipe and remove it. Afterwards, "it was incumbent on us [M&C Maintenance workers] to clean up after we finished the job." [SC&A 2022, PDF p. 14]

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they believe the proposed approach is not considered bounding. NIOSH 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 conservativeness of the assumptions applied to the model are greater than the impacts of the uncertainties associated with 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 2021a, PDF p. 15].

SC&A Comment – Controlled D&D and Typical Maintenance Work

SC&A's supplemental review states:

> *In terms of contrasting controlled D&D activities with the typical maintenance work performed at M&C, a former health physicist observed that D&D is a "controlled environment where the workers were very aware of what [they] were doing," whereas the latter was "uncontrolled, unconfined, aggressive as hell, using mechanical processes that cause aggravation and clouds of dust."* [SC&A 2022, PDF p. 14]

NIOSH Response – Controlled D&D and Typical Maintenance Work

The health physicist that SC&A quotes was *not* present during maintenance work. Furthermore, his conjecture regarding unsafe work practices is contradicted in interviews with several employees who *did* work during the time in question. The following is a sample of statements from former workers demonstrating that they felt the work practices were safe.

An October 25, 2017, interview conducted with a production machinery maintenance worker, working from 1964–2000 (identified as Worker #6) [ORAUT 2017a] states:

> *Mr. McCloskey: Do you have an opinion on the Safety and Health organization at Metals and Controls? Did you see safety and health personnel around the site? Did they have rules about that? What is your opinion of the safety and health program?*
>
> *Worker #6: As far as I'm concerned, they were top-notch in their security and all of that kind of stuff. They really cared about their people.*
>
> *Worker #6: To me, safety was number one no matter what. If they said something was safe, I would think it was safe. If they told me that it was safe to go into a room, I would trust that they knew what they were talking about.*
>
> *Worker #6: I think I've covered everything. I hope I have been helpful. I was lucky to be there. I loved the job. They were so safety conscious. If they said something was safe, I believed them.* [PDF pp. 5–10]

An October 25, 2017, interview conducted with a facilities engineer, working from 1981–1997 (identified as Worker #8) [ORAUT 2017b] states:

> *Dr. Mauro: During the 1980s, we understand that some contractors came into Building 10, and maybe other buildings, and did what's called a radiation alpha survey, where they would take an instrument and scan the surface of the floor and take readings. Do you recall that? Did you see them doing that?*
>
> *Worker #8: I know that was done when there were some major mills that went into Building 10. Because of the foundations that were associated with the mills, they had to saw-cut the concrete floor to get into the soils below. They did some readings then to see if there was still any residual contamination.*
>
> *Dr. Mauro: So, you're saying in the 1980s… My understanding was that some surveys were done, mainly to confirm that it was clean. You're saying, though, that the surveys were done also in support of some refurbishment or some modifications before they went ahead and did anything. That's different then just simply going in to see if there's anything there. It's a precursor to doing some work.*

Worker #8: That was my observation, but I know they were always surveying the site for something. I don't remember them having a major survey just to see if there was anything left behind.

Mr. McCloskey: So, in the 1980s, we want to take a machine out of this area and want to put a new one in. So, we take the old one out and, you're saying, we survey the area underneath the old one. We do a radiation survey.

Worker #8: Yes, before we put the new one in… They mapped out a section of the floor for a foundation. They had to dig…they were going to have to cut the concrete out, excavate the earth below, and actually build another foundation below grade so that the mill that we were putting in—or that was going to be put in—could set inside of it. So, what they wanted to make sure of was that there wasn't anything residual at the floor line before they started to cut the floor. [PDF pp. 8–9]

An October 26, 2017, interview conducted with a maintenance, electrical, and construction supervisor, working from 1969–2007 (identified as Worker #10) [ORAUT 2017c] states:

Mr. McCloskey: The Health and Safety Manual says that, as a supervisor, you would have been responsible for their training for health and safety issues. How many people reported to you when you were a supervisor?

Worker #10: Fifteen people at the most. I had the HVAC, Instrumentation, and Electrical groups, and then I had the High Voltage group of electricians.

Mr. McCloskey: Did you feel that you could get them the tools they needed to do the job they had to do? Could you get them the safety equipment that they needed?

Worker #10: Texas Instruments had a great safety program. If you did not follow the safety procedures, you would be terminated quickly.

Ms. Gogliotti: Was that during the entirety of your employment or just the later years?

Worker #10: It grew. OSHA didn't exist when I started. We had a death somewhere near the Lewis Mill. A millwright fell off when we were rigging it to take it out. OSHA was already around at that point, but that accident triggered everything.

Mr. McCloskey: So, there was a good health and safety program as time went along, and if your guys had to go off to do a job, you could get them any kind of personal protective equipment that you thought they needed.

Worker #10: Yes. That was always from Day 1. [PDF pp. 8–9]

An October 26, 2017, interview conducted with a maintenance engineer and manager, working from 1959–2000 (identified as Worker #11) [ORAUT 2017d] states:

Worker #11: My response was going to be that in the early days, when Admiral Rickover came through, it was well-known that he did white glove inspections. He would wipe everything with his fingers looking for dust. I also recall a couple of locations that were undesirable: the high bay in Building 3 and the Research Lab—I can't recall if it was in Building 10 or Building 4. Those were the areas where we had to climb ladders and go up into the overhead. But generally speaking, when I was down on the floor, I found things very clean. I didn't work in dirt.

Mr. McCloskey: Did Admiral Rickover enforce a culture of cleanliness?

Worker #11: His reputation stayed with us. I never actually saw him do a white glove inspection; but long after he did it, which probably was in the early 1950s, well before my time…having known that he expected that of us, then we would expect to be keeping things clean.

Mr. McCloskey: So, by the time the 1970s came around, it sounds like you could say that Metals and Controls took safety pretty seriously and provided their employees with protections.

Worker #11: Yes. By that time, it was Texas Instruments; and yes, it was a big factor. In fact, I was the Manufacturing manager from 1974 to 1977, when I was actually running the Manufacturing Operations. [PDF 4–5]

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. Interviews with contemporary workers clearly contradict such a practice.

NIOSH acknowledges that some aggressive activities briefly resulted in a dusty environment and elevated exposure. However, NIOSH's proposed models that include the following conservative assumptions bound these exposures:

- The same person did all of the work.
- The highest air concentration generated during a task was present during the entire task.
- All airborne sediment is respirable.
- NIOSH uses the most claimant-favorable solubility type.

Furthermore, regarding the AWE source term at M&C, it must be noted that at least 80% of the work performed with radioactive materials was for the Naval Reactors Program (not EEOICPA-covered). The remainder was for the Air Force's Aircraft Nuclear Propulsion Program (also not covered), the AEC's national laboratories, and government-funded research reactors [Texas Instruments 1996c, PDF p. 9]. So again, NIOSH's bounding method is conservative because the doses assigned during the residual period do not subtract more than 80% of the non-covered source term.

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. NIOSH and SC&A have done extensive work on this issue and have previously agreed, as shown in *SC&A Commentary on NIOSH's Approach to Quantifying Outdoor and Indoor Airborne Dust Loadings* [SC&A 2021b], discussed in detail later in this report.

SC&A Comment – Routine Equipment Maintenance

> *Routine maintenance on equipment is cited by former workers* (citations omitted)*, and was performed by the M&C Repair and Maintenance group. It was also identified by NIOSH as not being addressed by the ER resuspension models (OTIB-0070) and involved "repurposing M&C equipment (e.g., removing and replacing mill units*)." (citation omitted) *A former worker noted that relocating equipment in Building 10 was a regular activity that typically took place on weekends* (citation omitted)*. The status of equipment carried over from the pre-1968 AWE operational period is not addressed explicitly in the ER. It should be assumed that any equipment used in the operational period, prior to D&D, may have had internal contamination, as well as contamination under it, to which maintenance workers would have been later exposed when servicing that equipment or moving it.* [SC&A 2022, PDF p. 15]

NIOSH Response – Routine Equipment Maintenance

Some clarification is warranted here. NIOSH's equipment discussion was related to tasks when workers penetrated the concrete floor, accessed the subsurface, or went into the overhead to make connections. The following is what NIOSH stated in *Metals and Controls Corp. Maintenance Worker Exposure Model White Paper* [NIOSH 2018] regarding the subsurface model:

> *During the interviews, it became apparent that Building 10 experienced recurring issues with water drainage* (citations omitted) *and underwent multiple equipment change-outs that necessitated subsurface and overhead work.* [PDF p. 3]

The SEC-00236 Evaluation Report [NIOSH 2017] *does* address contaminated equipment or equipment in place during the operational period as follows:

> *In addition, contamination surveys were performed on all material, equipment, or tools transferred from the UFMA to the CFMA* [Texas Instruments 1973–1979, PDF p. 5] (citation renamed using current reference formatting protocol). [PDF p. 19]
>
> *All of the equipment, tools, etc., used for fuel processing were disposed at an NRC-licensed facility or removed and sent to Babcock & Wilcox in Lynchburg, Virginia* (citation omitted). [PDF p. 20].

A few substantial pieces of equipment were left in place with residual contamination in inaccessible locations; these are discussed later in this paper.

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. NIOSH and SC&A have reviewed M&C maintenance work records and have previously agreed on the scenarios with the highest exposure potential. Additionally, NIOSH and SC&A have extensively worked together to develop claimant-favorable models.

SC&A Comment – Intrusive Nature of Maintenance Work

> *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, PDF p. 15]

NIOSH Response – Intrusive Nature of Maintenance Work

Work intrusiveness is primarily addressed by applying standard industrial hygiene or nuclear industry resuspension factors to a source term. In several evaluation reports for AWE facilities (e.g., Baker Brothers and Bliss & Laughlin Steel), NIOSH elected to use the default assumptions in ORAUT-TBD-6000 to derive internal doses during the residual period when site-specific data were limited.

Norton Co. and Vitro Manufacturing were not added to the Special Exposure Cohort (SEC) because of the intrusiveness of their activities. They were added because a lack of useful source-term information prevented NIOSH from calculating a plausible dose estimate. This is NOT the case at M&C because NIOSH does have relevant source-term information for M&C. For Norton Co. and Vitro Manufacturing, NIOSH had minimal information to characterize large source terms resulting in high bounding doses calculated with uncertainty. The following text illustrates an exposure scenario at Norton Co. where a large source term and resulting exposures led NIOSH to recommend adding this class to the SEC.

> *Refractory kilns and furnaces were dismantled brick-by-brick and transferred to barrels. Other equipment and materials were solvent-washed, dried with paper towels, dismantled, and transferred to barrels. Surface areas of the building were cleaned and the residue placed in barrels. The dismantling and cleaning processes sometimes led to dusty conditions* (citation omitted). *Materials removed included ceramic, aluminum oxide, silicon, carbide and zirconium oxide, bricks, batts, sagger plates, ventilation and dust collecting apparatus, pipes, and sheet steel pipe; all of these items came in contact with natural insoluble thorium (Th-232) and natural insoluble uranium (U-238)* (citations omitted). *In all, 287 barrels of materials and waste were collected. Norton Co. estimated*

> *that the gross weight of the barrels was between 18 to 20 tons and that the amount of radioactive materials present in that gross amount was 15 pounds of thorium and 25 pounds of uranium* (citation omitted). [NIOSH 2011a, PDF p. 16]

At Vitro Manufacturing, NIOSH was again confronted with a substantial source term in bulk material form and a lack of monitoring data to calculate sufficiently accurate doses.

> *Contract No. AT(49-6)-1158 was awarded to Vitro Manufacturing for the recovery of the U_3O_8 from these Port Hope Wastes, but was terminated before all residues were processed by Vitro Manufacturing, leaving two stockpiles of residues remaining on the Canonsburg site after 1959. One pile consisted of 4,268 dry tons of 0.42% to 0.47% U_3O_8, and the second pile consisted of 85 tons of 1.17% U_3O_8 and 105 tons of 0.95% U_3O_8.* [NIOSH 2011b, PDF p. 17]

> *The Port Hope Waste remained stored in open piles until August, 1965, when it was finally buried in a lagoon on the site* (citation omitted). *The only mitigation of exposure to radiation or radioactive materials in the piles appears to have consisted of installation of a chain link fence around the piles, a guard service patrolling the area 24 hours a day, and indications of some wetting of the surfaces to prevent resuspension of particles by wind. Reference documents cite several AEC inspections during this period* (citations omitted) *indicating the presence of radiation levels and radioactive effluents in excess of the applicable standards. NIOSH has been unable to locate the referenced inspection reports.* [NIOSH 2011b, PDF p. 17]

> *Operations involved shuttering the process equipment used to separate and concentrate the uranium from feed material into U3O8 oxide, and storing and removing ore residues. This includes decontamination and decommissioning activities to shut down the building operations, and possible exposure to particulates that might have been re-suspended from the residue piles by wind action during the months of 1960 when the facility was actively shutting down. The documentation located by NIOSH does not include a description of the shutdown activities or decontamination work performed to shutter the facility, nor were interviewees able to provide any detailed information about this cleanup period at Vitro Manufacturing.* [NIOSH 2011b, PDF pp. 17–18]

> *The project to bury the residue piles likely included survey work for both regulatory reasons and in preparation for the remediation work, as well as movement of the piles with heavy equipment including bulldozers, and the final burial in the lagoon area. This work would have caused significant disturbance of the residue materials, allowing resuspension of particulates and freeing any trapped gasses. These activities would have allowed potential exposure to residual uranium and decay chain radionuclides that had been chemically separated from each other and re-concentrated so that they were frequently not in equilibrium (the degree of disequilibrium is not identifiable from site records).* [NIOSH 2011b, PDF p. 18]

The source term at the Linde Ceramics Plant was considerably larger than M&C's. At Linde, seven different sources of uranium were processed: four African ores (three low-grade pitchblendes and a torbernite) and three domestic ores (carnotites from Colorado). Some of the domestic ores were tailings from vanadium processing and were pre-processed to concentrate the uranium before shipment from the western states. The majority of the radium in these ores was removed during pre-processing. The African ores were unprocessed and contained all the uranium decay series members, including radium, in secular equilibrium with the uranium. As a result of the radium content, the African ores produced substantially higher levels of radon gas than the domestic ores. The maximum quantity of African ore processed in any week was 1.5 million pounds [NIOSH 2011c, PDF pp. 16–17].

In addition, the only data NIOSH could use in the Linde SEC-00107 Evaluation Report were air samples taken during jackhammering at the end of the operational period in Building 30. NIOSH determined doses delivered to workers breathing this air (5,479 mrem/yr CED), bounded exposures during the residual period to all workers in Buildings 14, 30, 31, 37, 38, and exposures from outdoor soil contamination. After much deliberation, the Advisory Board decided that doses calculated with this bounding method would be appropriate for the renovation workers in Building 30; however, they would be implausibly high to assign to the rest of the class for a 16-year period [NIOSH 2011d, PDF p. 124].

Contrast Linde with M&C, where NIOSH developed separate models for the highest maintenance exposure scenarios, using scenario-specific pre-D&D data, which resulted in much smaller doses (71 mrem/yr CED). The Linde to M&C comparison illustrates the precedent that although NIOSH has much better scenario-specific data applicable to the space and time of M&C work, any lack of preciseness in our models is afforded due to their conservativeness and resulting low doses.

NIOSH previously stated that residual-period tasks performed by workers at other sites included contaminated soil excavation, welding, and torch-cutting in contaminated areas. Additional examples of intrusive work during the residual period include lathe work and grinding of carbon armor plating at Carborundum [NIOSH 2015, PDF pp. 24, 37], scrap handling, scrap cutting, and exposures to waste material blown airborne or spread via equipment and workers after dumping/bulldozing operations at Dow Madison [NIOSH 2008, PDF pp. 26, 29].

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. NIOSH and SC&A have done extensive work on this issue and have previously agreed, as shown in the following:

> *SC&A acknowledges that there are uncertainties that impact the materials found in the subsurface environment at M&C. These uncertainties include but are not limited to how often the subsurface pipes were used, the flow rate of the pipes, the typical pH of the materials moving through the pipes, and how often and where the materials in the pipes were disturbed. With currently available information, it is not possible to succinctly quantify possible dilutions caused by these actions. However, SC&A believes it is*

> *reasonable to assume it is a non-zero number. Similarly, it is not possible to quantify what exact concentrations of material were in the pipes accessed by maintenance workers during each individual extraction. SC&A believes it is possible to bound the exposures workers may have received in any given year, such that no worker received a higher dose in the aggregate over the course of a year*. [SC&A 2021a, PDF p. 14]

NIOSH Response to SC&A Line of Inquiry 1

SC&A's Line of Inquiry 1 states:

> *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, PDF p. 11]

NIOSH concludes the conditions and work activities associated with the M&C residual period are not unusual. Still, all sites have differences, so NIOSH starts with approved standard modeling procedures and applies scientifically sound and conservative modifications (e.g., 10^{-3} resuspension) to tailor these procedures to each site. Furthermore, NIOSH has demonstrated that M&C exposure potentials are not higher than those addressed by ORAUT-OTIB-0070 and ORAUT-TBD-6000.

SC&A Line of Inquiry 2: Exposure Pathway Bounding Methods for M&C Compared to Other AWE Sites

SC&A Comment – Materials Released into Drains

SC&A's supplemental review [SC&A 2022] asks:

> *Would it not be as likely that the regular release of a coagulant to the drain line system during active Building 10 operations (through 1981) would have led to more frequent and substantial blockages, perhaps involving higher concentrations of uranium and thorium as a function of the binding properties of the coagulant oil and other residues?* [PDF p. 22]

In a footnote, this same review [SC&A 2022] states:

> *The accumulation of various artifacts in the M&C drain lines can be attributed to missing grates on the drains, which allowed production residues and items to go down them, contributing to blockages that were apparently aggravated by the presence of vegetable-based oils used in production that coagulated in the drain lines* [ORAUT 2017e, PDF pp. 6–8] (citation renamed using current reference formatting protocol). [PDF p. 21]

NIOSH Response – Materials Released into Drains

The premise in the SC&A review is inaccurate, as demonstrated during the residual period before the final D&D in the mid-1990s. To understand the material available to be rinsed into drains, NIOSH provides the following excerpt from the SEC-00236 Evaluation Report [NIOSH 2017]:

> *Texas Instruments reported to the NRC that the three areas used for AWE operations (Buildings 3, 4, and 10) were decontaminated and decommissioned and that all radioactive materials were removed during the period from 1955 to 1968. The largest Building 10 cleanup effort occurred at the end of 1958* (citation omitted). *Texas Instruments also reported that all three areas were surveyed after each area's respective D&D efforts were completed* (citation omitted). *…Texas Instruments could not locate the survey documentation from 1968 for Buildings 3, 4, and 10, so in 1982, Texas Instruments resurveyed the areas used for AWE operations and documented that the three areas had remained decontaminated during the time since the end of AWE Facility operations* (citations omitted). *In 1983, the NRC was satisfied that the interiors of Buildings 3, 4, and 10 were sufficiently decontaminated and they released Buildings 3, 4, and 10 for unrestricted use, but the NRC withheld license termination pending further investigations into the former radioactive waste burial site between Buildings 11 and 12* (citations omitted). [PDF pp. 20–21]

After hearing reports from M&C workers of additional areas of concern, the Nuclear Regulatory Commission (NRC) hired a contractor to investigate. After identifying contamination in outside areas, the NRC directed another review of the Building 10 interior using revised release criteria and methods that are more comprehensive. The additional contamination identified using updated methods included sections of the concrete floor and subsurface previously inaccessible to outdated survey techniques, and it did not present a significant exposure hazard.

In addition, contributions to drain lines from production work specifying the use of radioactive materials during the residual period (i.e., High Flux Isotope Reactor) cannot be considered in determining Energy Employee Occupational Illness Compensation Program Act (EEOICPA)-covered exposures. Therefore, the release of coagulant oil and production materials carried with it did not introduce higher concentrations of *covered* uranium and thorium from AWE operations (1952–1967) to the subsurface.

More specifically, 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, as shown in the following figures.

Feature Description:	Beckhart Wire Drawing Machine. Feature is a large piece of machinery, which, due to its size and near constant use, was not movable. Material was left in place in concrete trench, under wire spool roller system. Trench runs from a depth of 1.3m at the east end, to 2m at the west end and is roughly 25m long. Radioactive residue was removed from the trench except for spaces under a pipe (see figures) situated in the bottom of the trench. Internal pipe surfaces were not contaminated.

Average Surface Contamination Levels (dpm/100cm^2)		
Feature	none	dpm/100 cm^2
Feature		dpm/100 cm^2
Feature		dpm/100 cm^2

Samples Collected:		Activity (pCi/g)		
Sample ID #	Sample Description	U-234	U-235	U-238
1121-09-7G-BSS	Trench East (of w. leg)	32.1	1.13	7.89
1121-09-8G-BSS	Trench West (of w. leg)	16.4	0.535	5.05
1130-12-5G-BSS	Trench East (of e. leg)	46	2.05	3.92
1130-12-5G-BSS	Trench West (of e. leg)	10.7	0.505	2.29
Mean		26.3	1.055	4.7875

Estimated Residual Soil Volume	0.612 (m^3)
Estimated Residual Soil Mass	7.41E+05 (g)

Residual Activity:		
	Uranium-234	0.01948641 (mCi)
	Uranium-235	0.00078168 (mCi)
	Uranium-238	0.00354719 (mCi)

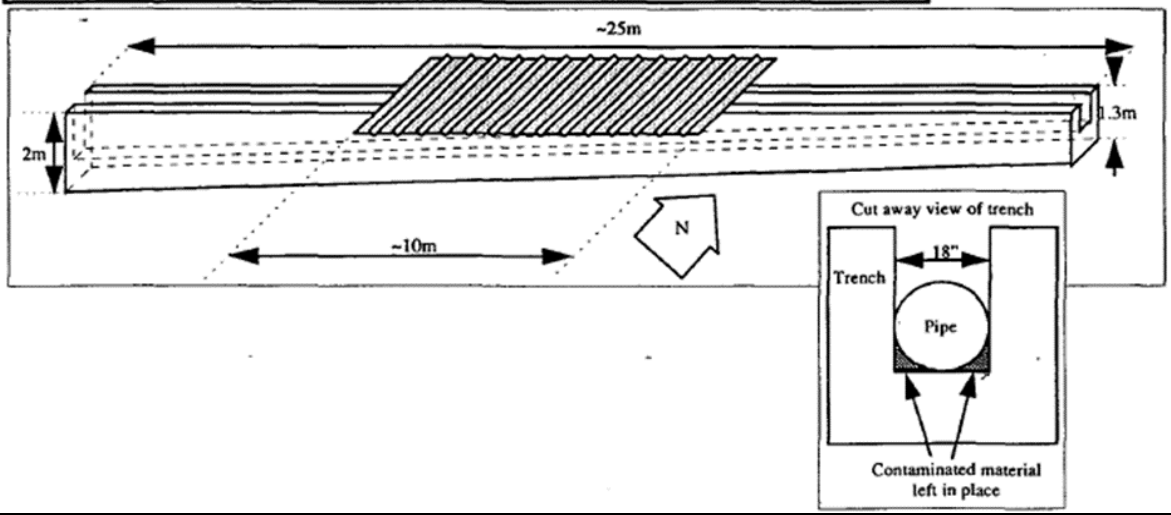

Figure 1: Beckhart wire drawing machine [Texas Instruments 1996a, PDF p. 185].

NOTE: The highest residue value from Figure 1 is 32.1 pCi/g. Therefore, any maintenance work associated with these machines is bounded by the 6,888 pCi/g used in the subsurface model.

Feature Description:	M-125 Wire Drawing Machine. Feature is a large piece of machinery, which, due to its size and near constant use, was not movable. Isolated contamination, in a crack in the concrete floor ran up to and under the west side of the machine. No laboratory samples were collected however surface readings and swipes suggested that the contamination was very isolated. All swipes and surface readings other than those listed below, were less than MDA.

Average Surface Contamination Levels (dpm/100cm^2)

Location #	Feature	Level	Fixed, Removable, Total	Alpha, Beta, or Gamma
1	Concrete edge	51	R	A
1	Concrete edge	6450	T	B,G
1	Concrete edge (after decon)	24	R	A
2	Concrete edge, SE of M-125	29	R	A

Samples Collected:		Activity (pCi/g)		
Sample ID #	Sample Description	U-234	U-235	U-238
None				

Estimated Residual Soil Volume	~0	(m^3)
Estimated Residual Soil Mass	~0	(g)

Residual Activity:	Uranium-234	~0	(mCi)
	Uranium-235	~0	(mCi)
	Uranium-238	~0	(mCi)

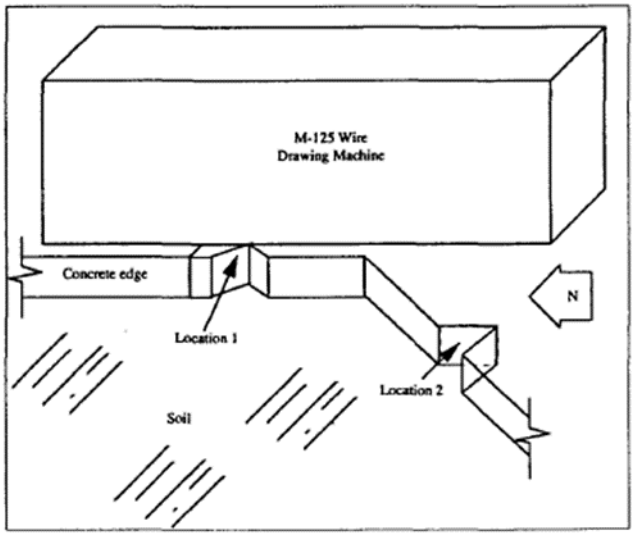

Figure 2: M-125 wire drawing machine [Texas Instruments 1996a, PDF p. 186].

An October 24, 2017, interview conducted with a former worker (identified as Worker #1) [ORAUT 2017f] provides descriptions of the work using these two large machines that did not contribute additional contamination to the drain lines:

> *I worked in the unclad area mostly, and we were bonding metals—mostly aluminum or steel, clad it in copper, and extrude it. I mentioned the Beckett Wire Drawing Machine and the FX right near there. That is where nearly all of the trenches that I worked in were located and all of the drainage. The copper was clad onto the aluminum or steel, extruded through diamond dies, and drawn down from about ¾ inch to 1 inch in diameter to very thin wire.* [PDF p. 4]

> *They clad the wire, and it's actually a pretty amazing process. They use a series of industrial diamond dies and, depending what gauge they want the wire, you would change out all the dies, and it had this cooling lubricant that would pour onto the wire. You would run the wire slowly through each die, and that would stretch the wire. You could crank this thing up to pull 4,000 to 5,000 feet per minute and wind it onto the reel. You could actually stack the reels on a skid, and when the reel reached the amount of wire, it would actually cut itself off and attach to another reel at 5,000 feet per minute. Fortunately, TI had set up a guard to keep that from being a safety issue. I worked at Collyer Wire when I was laid off from TI. They had the same machine, but no guard. Texas Instruments did it right when they set that machine up.* [PDF pp. 12–13]

Finally, NIOSH modeled the drain sediments as a dusty, dry material in the air for claimant favorability. Any wet or oily material would trap potential contaminants, reducing or preventing resuspension of the contaminant and limiting the potential for inhalation.

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. As previously stated in this report, NIOSH and SC&A have done extensive work on the subsurface model and have previously agreed on a bounding method.

SC&A Comment – Drain Line Contamination

SC&A's supplemental review [SC&A 2022] states:

> *Another historical aspect of M&C drain lines is the accumulation of contaminant scale that has plated out inside the piping. This scaling was found in at least one instance at M&C to exceed 1,000,000 dpm/100 cm^2 in a 4-inch mainline drain that was being cut and removed* (citation omitted). *While such pipe scale has been identified at other AWE sites, M&C maintenance workers frequently cut, repaired, replaced, and cleaned out such piping during the residual years using power tools such as saws, drills, grinders, and powered snakes, as well as cutting torches. As noted by DOE in its hazard assessment of the Bridgeport Brass AWE, "the residual uranium could eventually be released . . . through intrusive work activities such as pipe cutting and removal"* (citation

> omitted), *and that "it is possible that under certain conditions (such as cutting through a steel pipe with a cutting torch) surface activity attached to the steel could be released with the steel particles"* (citation omitted). *Such work procedures would have generated fine airborne aerosols, including airborne contamination from the plated material, which would have been concentrated by the confined space (i.e., trenches, pits) atmosphere within which they were working. While the million-count reading represents a high activity level, contaminated scale elsewhere in M&C's extensive drain line network could have had similar, if not higher, levels over the residual years. There is no available information to address this question at M&C. This exposure pathway is not addressed by the current models.* [PDF p. 22]

NIOSH Response – Drain Line Contamination

This is the highest surface contamination level identified by M&C or NRC contractors by orders of magnitude and there is no evidence or reason to believe higher unreported levels existed. When NIOSH models exposures to workers during excavation-type operations, it believes it is appropriate to use mass-based sample data (e.g., pCi/g) to characterize the exposure environment. Typical soil-sampling plans are designed to provide characterizations that enable NIOSH to develop models more representative of the subsurface work than do swipes of surface contamination. Although there is potential for isolated hot spots, there is no indication (nor would one expect there to be an indication) of systemic conditions at these hot spot levels. Therefore, NIOSH considers the use of the 95th percentile to be bounding.

Furthermore, SC&A's supplemental review describes metal working activities in conjunction with this data point which could mislead readers because this survey was on a vitreous clay drain line [Texas Instruments 1996b, PDF pp. 10–11].

SC&A Comment – D&D Measurements

SC&A's supplemental review [SC&A 2022] states:

> *While there are precedents for back-applying conservative D&D measurements for AWE residual periods (e.g., particulates in Linde utility tunnels and intakes at Chapman Valve), that modeling did not assume intrusive activities occurred or that those activities could involve higher exposures due to elevated exposure conditions, uncertain facility activities, or unknown contamination sources. The sediment readings taken in 1995 from a Priority-1 pipe obviously had a high uranium concentration, but is it the bounding case for all inside subsurface activities for the previous 27 years of the residual period?* [PDF p. 24]

NIOSH Response – D&D Measurements

NIOSH is not "back-applying conservative D&D measurements." NIOSH is back-applying measurements taken by M&C and NRC Contractors before D&D that they used to characterize the area to determine the maintenance and subsequent D&D work controls. In addition, NIOSH

incorporated extreme conservatism in its modeling to account for intrusive activities, high exposure conditions, uncertain facility activities, or unknown contamination sources.

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. NIOSH and SC&A have done extensive work on this issue and have previously agreed on a bounding method as shown in the following:

> *For perspective, it is also important to consider comparable dose reconstruction situations for residual periods at other Atomic Weapons Employer (AWE) sites. SC&A examined several AWE SEC discussions to identify situations in which little or no usable data are available from the end of operations and residual data taken many years into residual operations were deemed acceptable. In SC&A's opinion, the most comparable scenario occurred for Linde Ceramics regarding the reconstruction of internal dose for periodic entry into subsurface utility tunnels. In this case, the residual period1 not already covered by an SEC was 1970 through mid-2006. Surface survey contamination data taken in 2001 (specifically, surface external beta measurements) were used to develop a 95th percentile surface contamination in the tunnels. This, along with typical breathing rates (1.2 cubic meters per hour (m3/h)), a resuspension factor (10-6 per meter (m-1)), and an occupancy factor (50 percent exposure time to maintenance workers), was used to develop acceptable bounding intakes. It is notable that these derived intakes were used for the entire evaluated period without correction for degradation over time (~31 years between 1970 and 2001).*
>
> *Another comparable dose reconstruction methodology for AWE sites during the residual period was used for Chapman Valve. At this site, two residual periods exist: May 1, 1949, through December 31, 1949, and January 1, 1991, through December 31, 1993. No usable air sampling data were available for the residual periods, so intakes were derived using survey results taken in 1992. Specifically, the highest of 30 direct reading alpha measurements were used with a resuspension factor of 10-6 m-1, breathing rate of 1.2 m3/h, and an exposure time of 2,000 hours. The resulting intake was applied for the entire period from 1949 through 1993. No adjustments were made to the intake rate due to degradation over time (over 40 years)* [SC&A 2021a, PDF p. 15].

SC&A Finding 1 – Applying the 1995 Sediment Survey Result

SC&A's supplemental review [SC&A 2022] Finding 1 states:

> *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.* [PDF p. 24]

NIOSH Response – Applying the 1995 Sediment Survey Result

For clarification, NIOSH did not use *one* high 1995 sediment survey result to create its model. NIOSH calculated the 95th percentile contamination level from a sampling plan executed by M&C to characterize the subsurface environment before D&D. It is worth noting that the 95th percentile contamination level NIOSH calculated (6,888 pCi/g) results in a model with 1% natural uranium by weight in 100% of the subsurface since the specific activity of natural uranium is 6.83E5 pCi/g. Compare this to background levels of approximately 2.74 pCi/g in the Attleboro, Massachusetts area [Sowell 1985, PDF p. 14].

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. NIOSH and SC&A have done extensive work on this issue and have previously agreed, as shown in the following:

> *Note that although there are differences in many of the assumptions used by NIOSH and SC&A for reconstructing the subsurface doses to M&C workers in Building 10, we believe that both sets of assumptions are scientifically sound and claimant favorable, and SC&A is prepared to accept NIOSH's assumptions*. [SC&A 2020, PDF p. 14]

SC&A Comment – NRC Regulatory Direction

SC&A's supplemental review [SC&A 2022] states:

> *NIOSH construes the lack of NRC regulatory direction to signify that the reported "elevated levels" were merely "above background, but less than release criteria (30 pCi/g)," and that "information related to this task supports NIOSH's outside subsurface model, in that the 95th percentile contamination level NIOSH applied (118 pCi/g) is approximately four times higher than the contamination level these workers experienced" (i.e., 30 pCi/g)* (citation omitted)*, but without giving any apparent substantiation beyond inferring how NRC staff would have perceived the risk and what action they would or would not have taken*. [PDF p. 25]

NIOSH Response – NRC Regulatory Direction

NIOSH acknowledges that hot spots identified during the burial ground remediation were higher than 30 pCi/g; however, NIOSH's statement was explicitly about the airline installation process. Therefore, citing M&C's determination regarding contamination levels associated with that specific work is appropriate. 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 above. NIOSH intended to convey that when M&C reviewed documented surveys of the airline debris, M&C determined those contamination levels to be below applicable NRC release criteria (i.e., 30 pCi/g), as indicated in the following reference:

> [M&C] *also surveyed the area southeast of Building 12 and found slightly elevated levels of radioactivity. The contamination likely came from dirt moved from the burial site when*

> [M&C] *was installing the airline in 1980.* (Associated footnote) *The airline debris area was investigated but did not require remediation because the levels of radioactivity detected were below applicable NRC release criteria.* [Texas Instruments 1996c, PDF p. 33]

In addition, the M&C safety engineer, a trained health physicist, described the material as only slightly contaminated:

> *In early August 1980, Texas Instruments informed Region I that while digging a trench for a pipeline, slightly contaminated material from an old burial ground was dug up. The material which was dug up did not come from the HFIR area. It came from the burial of waste from nonlicensed activities which were performed by Metals and Controls as contractors to the federal government.*
>
> *The safety engineer for Texas Instruments, a trained health physicist, surveyed the material, dug up, and placed any contaminated material into 55-gallon drums. Eleven 55-gallon drums were sent to the Barnwell, South Carolina, burial site on October 31, 1980.*
>
> *To the best of the safety engineer's recollection, the burial trench filled over twenty years ago was about eight feet wide, 20 to 30 feet long, and 15 to 20 feet deep.*
>
> *The licensee revised the drawing for the compressed airline and marked the location where the radioactive low-specific activity waste material dump was excavated.* [NRC 1981–1982, PDF p. 14]

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. NIOSH and SC&A have done extensive work on this issue and have previously agreed on a bounding method as shown in the following:

> *The burial ground is large in comparison to the small amount of material displaced by the trench. SC&A does not believe that this removal altered the distribution of the materials in the burial grounds significantly enough to make later surveys not representative of the earlier exposure potential* [SC&A 2021a, PDF p. 19].

SC&A Observation 1 – Blended D&D Characterization Survey Data

SC&A's supplemental review [SC&A 2022] Observation 1 states:

> *The use of blended 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.* [PDF p. 28]

NIOSH Response – Blended D&D Characterization Survey Data

By definition, hot spots are limited exposures and not a normally expected condition. Hence, NIOSH uses the 95th percentile and not the maximum value. NIOSH does not model systemic exposures to hot spots but rather to expected conditions. In NIOSH's review of the information supporting this finding, we did not find where SC&A provided any new technical information or technical justifications to indicate why the proposed approach is not considered bounding. Furthermore, NIOSH and SC&A have done extensive work on this model, and SC&A recommended closing this issue along with the following:

> *In theory, we can assume that a worker might be involved in subsurface work in Building 10, two months per year, and spend ten months per year exposed outdoors to resuspended contaminated* [sediment]. *Given this scenario, the additional dose from this pathway of less than a mrem per year can be ignored. Alternatively, we can assign the subsurface internal exposures to uranium in Building 10 to the subsurface exposures to outdoor workers. The data indicate that such an approach would be extremely claimant favorable but would still result in relatively small doses.* [SC&A 2020, PDF p. 23].

NIOSH Response to SC&A Line of Inquiry 2

SC&A's Line of Inquiry 2 states:

> *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, PDF p. 17]

Yes, the exposure pathway bounding methods are appropriate and consistent with how other AWE sites have been addressed. Additionally, NIOSH continues to adapt approved procedures to each site's unique radiologic conditions, informed by affected workers and modified through work group discussions, to develop appropriate bounding methods.

SC&A Line of Inquiry 3: Source Term, Survey Data, and Other Information Applied by NIOSH

SC&A Comment – Site Characterization

SC&A's supplemental review [SC&A 2022] states:

> *…in terms of specific site characteristics for M&C, 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.* [PDF p. 32]

NIOSH Response – Site Characterization

It is not clear to NIOSH which vault areas the SC&A supplemental review is referring to above. The trenches and pits at Mound and M&C were very similar. As for the manholes, NIOSH and other SC&A reviewers do not believe they contained a significant source term as described in the following Advisory Board Work Group exchange [NIOSH 2021]:

> *Member Anderson: But the manholes that Pat commented here, they were never surveyed. So we don't know if there were materials that accumulated there.*
>
> *Ms. Gogliotti: Well, there are certainly materials that accumulated. But since they weren't directly handling radiological materials in the manholes, as far as we know, we wouldn't expect there to be a high contamination level there.*
>
> *Dr. Taulbee: Exactly. That's my reaction, too. I mean, in the electrical manholes, you're not going to be handling uranium at that point.* [PDF p. 44]

SC&A Finding 2 – Surrogate Data

SC&A's supplemental review [SC&A 2022] Finding 2 states:

> *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.* [PDF p. 34]

NIOSH Response – Surrogate Data

More precisely, this SC&A supplemental review [SC&A 2022] stated the following:

> *For four of the five Advisory Board surrogate data criteria* (footnote omitted)*—hierarchy of data, exclusivity requirements, temporal considerations, and scientific plausibility—as applied to use of the Mound project data, it is clear that the criteria are satisfied, as noted by SC&A in its 2021 review* (citation omitted)*. However,* ***for site and process similarities*** [emphasis added]*, this reviewer shares the reservations expressed by SC&A's 2021 review* (footnote omitted)*.* [PDF p. 32]

SC&A expressed reservations in their 2021 review [SC&A 2021b] about using site and process similarities for the universal application of the surrogate Mound data (i.e., 212 µg/m^3) to sites other than M&C as follows:

> *However, this cannot be said for the use of the 212 µg/m^3 for use as a generic value for outdoor and indoor excavations at some unknown facility or site. Hence, its use as a generic dust loading in OTIB-0070 should be uniquely evaluated at each site of proposed use.* [PDF p. 13]

To which NIOSH responded in their 2022 response [NIOSH 2022]:

> *Although NIOSH will use M&C to inform our modeling of similar Energy Employees Occupational Illness Compensation Program Act work, we agree with SC&A that "one size will not fit all." We will address this further during the next ORAUT-OTIB-0070 revision.* [PDF p. 9]

With regards to applying the surrogate Mound data (i.e., 212 µg/m^3) at M&C, SC&A provided the following:

> *Considering the totality of information compiled in this report, SC&A believes that the use of a dust loading of 212 µg/m^3 for subsurface work both indoors and outdoors at M&C is reasonably compatible with data and information summarized in this report, including the data reported from Mound by the interviewed SME. SC&A concludes that NIOSH's adoption of 212 µg/m^3 for estimating respirable outdoor dust loading during excavation activities is reasonable but not necessarily bounding. Additionally, SC&A believes that NIOSH should refer to the numerous dust loading studies cited in section 5 as the basis for the dust loading of 212 µg/m^3 in addition to the Mound data.*
>
> *While SC&A's survey and interpretation of the data indicate that the suggested value of 212 µg/m^3 may not necessarily be sufficiently conservative for many excavation scenarios, a number of mitigating factors are also present at M&C that should be considered. First, the soil at M&C was likely moist. Second, the dust loading used for dose reconstruction at M&C covered the entire assumed time period of 2 months; i.e., the suggested exposure models are not trying to reconstruct short-term exposures, where dust loading might peak during active and aggressive excavation, but are making use of the dust loading for deriving inhalation exposures over a more protracted period of time.* [SC&A 2021b, PDF pp. 21–22]

To which NIOSH responded:

> *NIOSH intends to review the references provided by SC&A and incorporate them as appropriate. In addition, NIOSH will update our M&C models that utilize dust loads (i.e., Subsurface Inside, Subsurface Outside) to consider the impact of enhancement factors.* [NIOSH 2022, PDF p. 10]

Beyond that, NIOSH's review of the information provided in support of this finding did not find where SC&A provided any new technical information or technical justifications to indicate why the proposed approach is not considered bounding.

SC&A Observation 2 – 95th Percentile

SC&A's supplemental review [SC&A 2022] Observation 2 states:

> *References to the M&C safety and health manual, NRC inspection results, operator training, and other programmatic considerations do not necessarily substantiate the conservatism of the 95th percentile soil contamination value being applied.* [PDF p. 36]

NIOSH Response – 95th Percentile

NIOSH 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. The 95th percentile is consistent with the statistical approach used at every site under the EEOICPA. The M&C Safety and Health manual, NRC inspection results, operator training, and other programmatic considerations provide credence that the site was mindful of the impact associated with the current and historical radiological work.

In NIOSH's review of the information supporting this observation, we did not find where SC&A provided any new technical information or technical justifications to indicate why the proposed approach is not considered bounding.

NIOSH Response to Line of Inquiry 3

SC&A's Line of Inquiry 3 states:

> *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, PDF p. 29]

Yes, the available source term, survey data, and other information applied by NIOSH are sufficiently accurate and plausible to support its dose bounding methods. NIOSH engaged site experts and former workers to develop multiple models that bound exposures to the class evaluated in SEC-00256. NIOSH was fortunate that M&C and the NRC provided adequate survey data for the worst-case contaminated areas and that workers beyond the petitioners came forward to describe work activities, including space and time considerations. This enabled NIOSH to tailor bounding methods to diverse maintenance activities rather than applying one model to the entire class.

SC&A Conclusion Comment

SC&A Comment – Precedent

SC&A's supplemental review [SC&A 2022] states:

> *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.* [PDF p. 37]

NIOSH Response – Precedent

Since the dose estimated for M&C is 71 mrem/yr CED, the first part of SC&A's conclusion applies, specifically:

> *Precedent suggests that while less precision or technical accuracy can be tolerated if the* ***exposure of a worker cohort is relatively low****...*

And the second part of SC&A's conclusion was applicable at Linde (where NIOSH estimated doses to be 5,479 mrem/yr CED), but does not apply to M&C, specifically:

> *...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.*

NIOSH 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 has performed due diligence since 2017 to identify the maintenance tasks with the highest exposure potential and has created models that bound exposures associated with these tasks.

CONCLUSION

SC&A previously reviewed the six exposure pathways described by NIOSH and only made recommendations to alter one model to which NIOSH agreed. Upon making those suggested modifications, SC&A concluded internal and external dose reconstruction from each maintenance exposure pathway is feasible [SC&A 2021a, PDF p. 29].

During NIOSH's review of the information supporting this comment, NIOSH did not find where SC&A provided any new technical information or technical justifications to indicate why they do not consider the proposed approach to be bounding. NIOSH continues searching for and welcomes any new technical information available to improve our bounding models.

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