



SEC-00236 Metals and Controls Corporation Thorium and Welding Exposure Model

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Background

- The National Institute for Occupational Safety and Health (NIOSH) presented the Evaluation Report (ER) for SEC-00236, Metals and Controls Corp. (M&C) to the Advisory Board on Radiation and Worker Health on August 24, 2017.
- A petitioner raised a concern about the adequacy of the Evaluation Report (ER) in addressing maintenance-type work.
- In response to this concern, on September 5, 2017, NIOSH initiated strategies to continue M&C research and further develop SEC-00236.
 - Review monitoring records in the Site Research Database (SRDB)
 - Conduct interviews with M&C workers

Interviews

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

Additional Actions

- November 8, 2017 – The Metals and Controls Working Group (Working Group), SC&A, NIOSH, and ORAU team members held a teleconference to discuss technical issues associated with developing exposure models regarding maintenance work.
- February 6, 2018 – NIOSH obtained additional monitoring data regarding remediation work performed by Creative Pollutions Solutions (CPS) in 1992 and 1994.
- February 13, 2018 - NIOSH received a report by SC&A titled *Review of SEC Petition ER SEC-00236* (Mauro, 2018).

Additional Actions *(continued-1)*

- April 23, 2018 – NIOSH issued the *Metals and Controls Corp. Subsurface Exposure Model* white paper (NIOSH, 2018a) and made it available to SC&A and the Working Group.
- May 3, 2018 - During a Working Group meeting, SC&A presented their findings and observations associated with the SEC-00236 ER. The petitioners also made a statement and provided a letter with their concerns. After the meeting, an issues matrix was created.
- August 22, 2018 - During a full Advisory Board meeting, the Working Group presented their findings and observations associated with the SEC-00236 ER and NIOSH provided an update. The petitioners also made a statement and provided a letter with their concerns.

Additional Actions *(continued-2)*

- November 20, 2018 – During a Working Group meeting, NIOSH presented the *Metals and Controls Corp. Maintenance Exposure Model* white paper (NIOSH, 2018b) that included HVAC maintenance and Building 10 overhead exposure models. SC&A presented their observations associated with the *Metals and Controls Corp. Subsurface Exposure Model* and *Metals and Controls Corp. Maintenance Exposure Model* white papers.
- December 13, 2018 - During a full Advisory Board meeting, the Working Group presented an update. The petitioners also made a statement and provided a letter with their concerns.

Additional Actions *(continued-3)*

- April 8, 2019 – NIOSH issued the *Metals and Controls Corp. Thorium and Welding Exposure Model* white paper (NIOSH, 2019a) and made it available to SC&A and the Working Group.
- July 26, 2019 – NIOSH received an 8-page memo by SC&A titled *Review of NIOSH’s “Metals and Controls Corp. Thorium and Welding Exposure Model”* (SC&A, 2019).

Recent Petitioner Concerns

- The *Metals and Control Corp. Thorium and Welding Exposure Model* white paper addresses two concerns raised by the petitioner (Elliott, 2018):
 - Exposures to thorium that occurred while working inside Building 10
 - Exposures that occurred during welding activities

Internal Exposures to Thorium

- **Petitioner Issue**: The 1995 Drainage System Characterization Report (Weston, 1996) included 15 grab samples of accumulated sediment or surrounding soils in discrete locations of the pipe where elevated direct measurements were observed. The grab sample analyses reported an isotopic analysis of uranium but no other radionuclides. In retrospect, we now know that thorium would have also been present, as it was historically processed on the same manufacturing equipment as uranium during the Atomic Weapons Employer program. But given the limitation of the 1995 survey measurements, we have no way of knowing how much thorium source term was present in the residual radioactivity to which the M&C maintenance workers were exposed (Elliott, 2018).

Internal Exposures to Thorium *(continued-1)*

- Thorium Operations
 - During AWE operations, thorium-bearing component fabrication occurred (including reactor fuel, metallic alloys, and metallic foils).
 - The only definitive information regarding the amount of thorium at M&C is from a 1962 nuclear safety analysis that listed the total quantity of thorium as 244 kg.
 - There was approximately 32 times as much uranium as there was thorium-232 in the 1962 inventory data.
 - The activity ratio showed there was 188 times more uranium (assuming natural uranium and thorium-232).

Internal Exposures to Thorium *(continued-2)*

- As M&C cleaned the areas used for AWE operations prior to 1968, they buried waste and materials in the area between Buildings 11 and 12.
- In 1984 the U.S. Nuclear Regulatory Commission (NRC) performed verification sampling of the burial area.
 - Contamination above release limits
 - Presence of thorium
- In 1992 CPS performed additional sampling of the burial area and corroborated the presence of thorium.

Internal Exposures to Thorium *(continued-3)*

- New NIOSH Thorium Exposure Bounding Method
 - Although M&C only analyzed Building 10 subsurface samples for uranium in 1995, NIOSH can bound thorium exposures during maintenance work.
 - Assuming that the subsurface sediments contained equivalent amounts of natural uranium and thorium-232.
 - NIOSH determined the sediment to be about 1% (by weight) natural uranium.
 - Using the previously determined 95th percentile measured uranium activity in the sediment documented in the *Metals and Controls Corp. Maintenance Exposure Model* white paper (NIOSH, 2018b).

Internal Exposures to Thorium *(continued-4)*

- Thorium air concentration of $2.2 \mu\text{g}/\text{m}^3$
 - Subsurface was contaminated with equal amounts of thorium and uranium.
 - 1% of the sediment and sludge, and the subsequent dust loading created from maintenance work.
- Air concentration of $2.42 \times 10^{-13} \mu\text{Ci}/\text{mL}$.
 - Using the thorium-232 specific activity ($0.11 \mu\text{Ci}/\text{g}$),
- Inhalation committed effective dose (CED) of $10.42 \text{ mrem}/\text{yr}$.
- Adding ingestion the estimated dose becomes $14.78 \text{ mrem}/\text{yr}$.

Internal Exposures to Thorium Conclusions

- Calculated air concentrations can be used to bound internal thorium exposures that occurred while performing subsurface maintenance within Building 10.
- For those areas where gross alpha contamination surveys are available, NIOSH will continue to estimate worker doses using the most claimant-favorable isotope of thorium or uranium.
- For the burial area and Building 10 outside perimeter, NIOSH can use isotopic thorium-232 results to model air concentrations breathed by maintenance workers as previously described in the *Metals and Controls Corp. Maintenance Exposure Model* white paper (NIOSH, 2018b).

Internal Exposures from Welding

- **Petitioner Issue**: Sometimes the roof penetration work also involved welding of structural framework. This created a further risk of inhaling welding fumes without the benefit of any respirator (Elliott, 2018).

Internal Exposures from Welding *(continued-1)*

- Welding Operations
 - During the residual period, while performing maintenance work in the Building 10 overhead area, M&C workers were potentially exposed to contamination remaining from AWE operations:
 - Installing pipe racks;
 - Welding supports to the trusses to fortify the roof;
 - Cutting and drilling up through the roof to make penetrations for running services to rooftop equipment;
 - Installing equipment on the roof.

Internal Exposures from Welding *(continued-2)*

- A June 1981 NRC Inspection Report stated that there was a “Cutting and Welding Permit” program at M&C.
- The permit system used a card on which the necessary precautions required to be taken were listed.
- The 1964 M&C Safety Manual specified welding and flame-cutting precautions for fire safety, including pre-work cleaning of combustible debris, removal of deposits inside of ductwork, use of curtains and shields to protect personnel from glare and sparks, and use of “permit required” areas for sewers, pits, drains, ventilators, and ducts.
- The Safety Manual also stated that barricades were required for overhead work (M&C Nuclear, 1964).

Internal Exposures from Welding *(continued-3)*

- NIOSH Welding Exposure Bounding Method
 - Interviews of M&C maintenance personnel indicated that welding in the dusty overhead area of Building 10 was only one of their many duties, and occupied approximately 4 hours per month, or 48 hours per year.
 - NIOSH previously characterized the overhead work environment using the total surface activity, and assumed 10% of that activity was removable and available to generate airborne activity. NIOSH will continue to assign doses using this method for other work in the overhead area (e.g., light bulb replacements); however, for welding, NIOSH will assume 100% of the activity is resuspended.

Internal Exposures from Welding *(continued-4)*

- NIOSH previously modeled exposures for the entire overhead area uniformly using the 95th percentile contamination level and a 1×10^{-4} resuspension factor.
 - Good work practice requires clean bare metal prior to welding, which can include wire brushing and grinding as described in worker interviews and can generate the highest airborne concentrations.
 - NUREG-1400 (NRC, 1993) Section 1.2.3 indicates that a dispersibility factor of 10 should be used when modeling intakes that involve grinding operations.

Internal Exposures from Welding *(continued-5)*

- NIOSH will increase the resuspension factor and apply a value of 1×10^{-3} to the 95th percentile contamination level.
- This air concentration would be assumed to be inhaled for the 48 hours of welding that occurred per year for M&C personnel that performed welding in the Building 10 overhead area.
- Using this information NIOSH determined an air concentration of 4.05×10^{-12} $\mu\text{Ci/mL}$.
 - Inhalation CED of 16.75 mrem/year.
 - Estimated dose with ingestion is 16.77 mrem/year.

Internal Exposures from Welding Conclusions

- NIOSH will assume 100% of the total surface activity is removable and available for resuspension.
- NIOSH will increase the resuspension factor and apply a value of 1×10^{-3} to the 95th percentile contamination level.
- This air concentration will be assumed to be inhaled for 48 hours of welding each year and will be assigned in addition to other assigned exposures.

References

- Elliott, 2018, Special Exposure Cohort Petition SEC00236, correspondence to National Institute for Occupational Safety and Health; Michael J. Elliott; May 28, 2018. [SRDB Ref ID: 172717]
- Mauro, 2018, Review of SEC Petition Evaluation Report SEC-00236 Metals and Controls Corporation, SCA-TR-2018-SEC001, Revision 0; John Mauro, Robert Anigstein, Rose Gogliotti, and Nicole Briggs; February 2018. [SRDB Ref ID: 172715]
- M&C Nuclear, 1964, Health and Safety Manual; 1964. [SRDB Ref ID: 13642]
- NIOSH, 2018a, Metals and Controls Corp. Subsurface Exposure Model; April 23, 2018. [SRDB Ref ID: 174132]

References *(continued)*

- NIOSH, 2018b, Metals and Controls Corp. Maintenance Exposure Model; October 24, 2018. [SRDB Ref ID: 174357]
- NIOSH, 2019a, Metals and Controls Corp. Thorium and Welding Exposure Model, April 8, 2019. [SRBD Ref ID: 175938]
- NIOSH, 2019b, NIOSH Response Paper, SC&A Review of Metals and Controls Corp. Thorium and Welding Exposure Model; November 27, 2019. [SRDB Ref ID: 178695]
- NRC, 1993, NUREG-1400 Air Sampling in the Workplace, September 1993. [SRDB Ref ID: 20129]

References *(continued)*

- SC&A, 2019, *Review of NIOSH's "Metals and Controls Corp. Thorium and Welding Exposure Model, July 26, 2019.* [SRBD Ref ID 177001]
- Weston, 1996, Texas Instruments Incorporated Attleboro Facility Building Interiors Remediation Drainage System Characterization; prepared by Roy F. Weston, Inc., January 1996. [SRDB Ref ID: 165965]