DCAS Response to Work Group and Petitioner Questions

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Advisory Board on Radiation and Worker Health
Metals and Controls Work Group Meeting

Teleconference: March 18, 2021

September 2020 Work Group Meeting

- At the September 2020 Metals and Controls work group meeting, NIOSH was asked to address several questions
- NIOSH documented the response to these questions in a paper titled,
  - *Response to Comments from the Metals and Controls Corp. Work Group Meeting held on September 2, 2020*
- An additional question for NIOSH and SC&A was received on 1/12/2021
- NIOSH addressed this question separately in a memo to the work group titled,
  - *Response to comments related to soil disturbances at the burial ground*

WG Comment 1 – Does the exposure model bound dose for all fires?

A Working Group member expressed a concern that there were additional fires or explosions beyond the aluminum dust explosion addressed by NIOSH in a previous response paper, *Response to Metals and Controls Corp. Working Group Comments*

NIOSH RESPONSE:

- NIOSH re-examined the interview summaries
  - One worker indicated uranium would sometimes catch fire and they described a fire on the roof of building 10 (bldg. 10)
  - Another interviewee described a Positive Temperature Coefficient powder explosion in the late 1980s or early 1990s that shook bldg. 10

WG Comment 1 – Does the exposure model bound dose for all fires? cont.

- NIOSH re-examined the interview summaries (cont.)
  - A third interviewee described dust explosions in bldg. 10's Flame Spray Area. This individual also mentioned explosions in the electrical-buss ducts in bldg. 4, as well as a couple of explosions in electrical manholes between bldgs. 10 and 4
- NIOSH reviewed SRDB reports for additional information regarding fires and explosions
- NIOSH Conclusion: NIOSH has not found any interviews or reports that indicate a potential for radiation exposures beyond those that are already bounded by existing contamination-resuspension exposure models

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations?

The WG asked if the drain lines in bldg. 10 were used during the residual period, and if using the drain lines would reduce the concentration over time due to the addition of non-radioactive material. Also, a WG member asked about sample data from one pipe in the west end of bldg. 10 that was one million dpm/100 cm^2

NIOSH RESPONSE:

- NIOSH reviewed interviews and SRDB documents for information on whether drain lines were used during the residual period
- Although there are reports of drain-line work from interviewed workers, NIOSH has not found any records indicating that major sections of drain lines were isolated or bypassed

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations? Cont.

- The suggestion that only non-radioactive material was added to the drain lines after the cessation of AWE operations in 1967 is not accurate for bldg. 10
  - Non-covered HFIR operations continued until 1981
  - From 1967 to 1981 the only radiological work was from HFIR
- During operations at least 80% of the work performed with radioactive materials was for the naval reactors program (Non-covered)
- To understand the non-uniform subsurface activity and determine if something abnormal was involved with the scaling of M&C drain lines, NIOSH examined similar conditions at other AWE sites

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations? Cont.

- Six sites were identified that documented drain-line sediment sample results
- In each of the cases, the maximum specific activity was at least an order of magnitude larger than most of the other samples, which indicates the presence of sporadic hot spots like M&C

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations? Cont.

- NIOSH believes there was not a significant difference in the mechanism of deposition and accumulation of sediment and pipe scale at M&C when compared to other sites
  - This does not directly answer the question but does point to a consistent pattern
  - The highest contamination area at M&C contained a uranium rod
    - This indicates there was not a significant reduction in sediment in that spot

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations? Cont.

- As for the sample data from one pipe that was one million dpm/100 cm^2, NIOSH found the following information:
  - *During contaminated concrete removal at the north side of the Screen Print Room (Area 7), the initiation point of a 4-inch vitreous clay (VC) mainline was encountered. This line exhibited surface contamination levels (on the pipe interior) as high as 1,000,000 dpm/100 cm^2, although did not contain a visible accumulation of residue*
  - *Minor soil contamination was noted near the initiation point of the line and excavated. Soil concentrations were 71.6 and 9.8 pCi/g in soils near the initiation point and line-removal termination point*

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations? Cont.

- 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 use mass-based samples to allow models to characterize subsurface work better than swipes of surface contamination
- Although there is potential for isolated hot spots, there is no indication of systemic conditions at these hot spot levels
- Therefore, NIOSH considers the use of the 95th percentile to be bounding

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations? Cont.

- NIOSH Conclusion: NIOSH's bounding method is conservative because:
  - The doses assigned during the residual period include doses received from the more than 80% of the non-covered source term
  - The same person is doing all the work to arrive at the bounding dose
    - For example, the same person does the 48 hours per year of welding when you know there was more than one person doing the welding
  - NIOSH uses the 95^{th}-percentile contamination level
  - NIOSH applies a 212 $\mu g/m^3$ dust load for wet sediment

WG Comment 2 – Could you have a reduction in sediment in the drain lines from continued use after operations? Cont.

- NIOSH Conclusion (cont.): NIOSH's bounding method is conservative because:
  - NIOSH assumes all airborne sediment is respirable
  - Using the most claimant-favorable solubility type
  - The sediment area with the highest activity concentration contained a uranium rod
    - The activity concentration had not been reduced over time

WG Comment 3 – Concerns regarding the routine alpha contamination surveys performed in Building 10

The Petitioner and the Work Group Chair were concerned that they had not seen the bldg. 10 surveys that NIOSH had mentioned. They wanted NIOSH to follow-up on these surveys and provide more detail about them

- NIOSH attempted to make the case that M&C's area monitoring assures that the 95th percentile soil-contamination value is conservative based on routine surveys of bldg. 10 during the first 14 years of the residual period (1968-1981)
- To make its case, NIOSH referenced the Metals and Controls Health and Safety Manual that was in place at the start of the residual radiation period

WG Comment 3 – Concerns regarding the routine alpha contamination surveys performed in Building 10 cont.

- NIOSH believes this manual adequately describes M&C's established concern for contamination control
- The M&C manual instituted survey requirements for:
  - Routine work-area contamination
  - Personal shoes and clothing
  - Any item leaving the work area
  - All production materials before entering the work area
- The manual also required the constant review of these surveys by supervisors, and investigations if control levels were exceeded

WG Comment 3 – Concerns regarding the routine alpha contamination surveys performed in Building 10 cont.

- NIOSH is also aware that the NRC enforced these contamination surveys so that whenever M&C wanted to change administrative requirements (e.g., frequency of surveys), they sent a request to the NRC
- NRC inspections during the residual period provide NIOSH with independent assurance that radiological controls were monitored or maintained. NRC inspectors stated:
  - *Each of the four operators interviewed demonstrated good knowledge of the nuclear safety requirements for the operation*
  - *They also demonstrated knowledge of the precautions they should take for their personal radiation protection*

WG Comment 3 – Concerns regarding the routine alpha contamination surveys performed in Building 10 cont.

- NRC inspectors stated (cont.):
  - *The alpha survey instrument used at the exit from the Fuel Manufacturing Area (FMA) was operating properly*
  - *The inspector observed that the operating personnel surveyed themselves upon leaving the FMA*
  - *The licensee also had a record of the training of an individual in health physics*
- The areas where AWE facility weapons-related operations occurred were cleaned as those operations ended
  - Survey data for 1968-1969 first two years of residual period

WG Comment 3 – Concerns regarding the routine alpha contamination surveys performed in Building 10 cont.

- Table 3 in NIOSH report identifies typical contamination survey results for HFIR project
  - General Manufacturing Area also known as Clad Fuel Manufacturing Area surveyed monthly
    - Larger part of bldg. 10 outside of main HFIR project area (See bldg. 10 floor plan layout (Figure 1, pg.10 of report)
- Although NIOSH does not have the individual surveys from the HFIR project, NIOSH has typical contamination survey results and frequencies that clearly indicate contamination was controlled within bldg. 10 during the HFIR project
  - Table 3 of the report

WG Comment 4 – Provide a consolidated list of exposure models

Since the SEC-00236 ER was presented to the Board in August 2017, NIOSH, the Work Group, and SC&A have had numerous exchanges while developing the exposure models

Subsurface Inside

- NIOSH calculated the 95th percentile concentration (6,888 pCi/g) and will use it to bound uranium exposures
  - Approximately 1% natural uranium by weight in the sediment
- NIOSH can bound thorium exposures by assuming the subsurface sediments contained equivalent amounts by weight of thorium-232
  - This equates to 1,109 pCi/g

WG Comment 4 – Provide a consolidated list of exposure models cont.

Subsurface Outside

- Subsurface areas were characterized with 2,391 soil samples collected before remediation
  - Of these samples, 1,629 were analyzed for gross alpha, and the remaining 762 were analyzed for isotopic uranium and thorium
- Since frequent maintenance outside could have removed sediments with the highest concentration, NIOSH calculated the 95th percentile uranium concentration
  - This equates to 117.86 pCi/g for uranium and 87.55 pCi/g thorium

WG Comment 4 – Provide a consolidated list of exposure models cont.

Dust Load Factor for Inside and Outside Subsurface Work

- NIOSH examined an excavation at the Mound site and determined it to be a useful general model for dust loading during excavations of soils and plans to include it in the next ORAUT-OTIB-0070 revision
  - This model is directly applicable to M&C's Outside Area excavations and conservatively bounds M&C's Inside Building 10 work
  - There were three areas monitored at Mound: the excavation itself, the staging area, and the support area
  - The excavation area had the highest concentrations at 213 $\mu g/m^3$
  - NIOSH calculated an empirical 95th percentile value of 212 $\mu g/m^3$ and will use that value

WG Comment 4 – Provide a consolidated list of exposure models cont.

Roof and Overhead Area

- NIOSH used the 285 grid average alpha-contamination survey results taken in 1982 to characterize the bldg. 10 roof and overhead environment
  - These were direct probe measurements (fixed and removable)
  - The 95th percentile of the grid survey results is 89.9 dpm/100 cm^2
- NIOSH can assume 10% of the measured activity was associated with removable activity per the guidance in ORAUT-OTIB-0070

WG Comment 4 – Provide a consolidated list of exposure models cont.

Roof and Overhead Area cont.

- The roof and overhead areas required frequent maintenance during the residual period, including the years before the surveys used to characterize these areas
  - Therefore, NIOSH used the 95th percentile removable contamination level (8.99 dpm/100 cm^2)

WG Comment 4 – Provide a consolidated list of exposure models cont.

Roof and Overhead Area cont.

- Maintenance workers often performed aggressive operations (e.g., cutting and drilling) that would disturb the heavy accumulated dust in the overhead
  - Therefore, NIOSH will apply a resuspension factor of 10^{-4} for this work
  - Using the 95th percentile removable contamination level this equates to an air concentration of 0.09 dpm/m^3 that maintenance workers were exposed to during roof and overhead work

WG Comment 4 – Provide a consolidated list of exposure models cont.

Welding Operations

- NIOSH is aware that good work practice requires clean bare metal before welding, which can include wire brushing and grinding
- NIOSH will assume 100% of the activity is resuspended (89.94 dpm/100 cm^2)
- NIOSH believes this weld-preparation work to be the portion of the welding task capable of generating the highest airborne concentration
  - Therefore, NIOSH will increase the resuspension factor and apply a value of 10^{-3} to the 95^{th}-percentile total contamination level
- This equates to an air concentration of 8.99 dpm/m^3 for 48 hrs./yr.

WG Comment 4 – Provide a consolidated list of exposure models cont.

HVAC Maintenance

NOTE: Significant portions of this model developed by SC&A

- The geometric mean (GM, 12.3 dpm/100cm^2) was calculated from 7,765 gross-alpha swipe data collected at the end of AWE operations in 1966 and 1968
- Using this GM surface contamination value and a 10^{-5} resuspension factor, the gross alpha airborne concentration in bldg. 10 was determined to be 0.0123 dpm/m^3.

WG Comment 4 – Provide a consolidated list of exposure models cont.

HVAC Maintenance

- Typical dust loading during normal, non-maintenance-type operations in building 10 was assumed to be 100 µg/m^3
  - This equates to an estimated specific activity of the airborne dust of 1.23E-4 dpm/µg
- NIOSH assumes one hour of exposure because nuisance dust at 100 mg/m^3 would be barely breathable
- Therefore, this equates to a gross alpha air concentration 12.3 dpm/m^3

WG Comment 4 – Provide a consolidated list of exposure models cont.

Remaining Exposures

- For exposures incurred by workers for the balance of the year, NIOSH will use the GM (12.3 dpm/100cm^2) of 7,765 gross-alpha swipe data collected at the end of AWE operations in 1966 and 1968
- Using this GM surface contamination value and a 10^{-5} resuspension factor, the gross alpha airborne concentration in bldg. 10 was calculated to be 0.0123 dpm/m^3
- Source-term depletion adjustments (per the guidance in ORAUT-OTIB-0070) will be considered to determine the non-maintenance exposure rates throughout the residual period

WG Comment 4 – Provide a consolidated list of exposure models cont.

Occupancy Rate

- NIOSH will assume an occupancy rate of two months per year for subsurface work (333.33 hours per year)
- NIOSH will assume 1 month per year for roof and overhead work
- For welding activities, NIOSH will assume 48 hours per year
- In the HVAC exposure model, NIOSH assumed the buildup of particulates on filters continued for one year before filter replacement
- For the remaining exposures, NIOSH will subtract the maintenance work from a 2000-hour work year and assume 1451 hours of exposure

WG Comment 4 – Provide a consolidated list of exposure models cont.

Ingestion

- The method NIOSH used is like OCAS-TIB-009 in that it accounts for any inadvertent hand-to-mouth exposures so that any employees in the plant (e.g., administrative) are included
- Ingestion rates were determined using NUREG/CR-5512 [NRC 1992]; 50 mg/workday will be used for subsurface work
- A factor of 10^{-4} m^2/hour will be used for the other scenarios that are based on surface contamination levels

Nuclide Selection

- NIOSH will use the most claimant-favorable mixture of thorium or uranium when estimating worker doses from gross alpha estimates

WG Comment 4 – Provide a consolidated list of exposure models cont.

External Rates

- Film badges at the end of AWE operations (i.e., 1967) were processed quarterly by Landauer
- NIOSH used all the “X” or “Gamma” exposure results from 1967 to determine the quarterly geometric mean (GM) dose rate and geometric standard deviation (GSD)
- The quarterly GM gamma dose rate was determined to be 12 mrem/quarter (or 4 mrem/month)
- NIOSH used all the Type 2 or “Skin” exposure results from 1967 to determine the quarterly geometric mean dose rate 36 mrem/quarter

WG Comment 4 – Provide a consolidated list of exposure models cont.

Worker Categories

- At the January 9, 2020 WG meeting, NIOSH stated that all M&C workers would be assigned the doses applied to maintenance workers because it is unclear which workers were involved in various maintenance activities

Summary

- Table 4 in NIOSH's response paper summarizes the maximum annual dose estimates (recreated on the following slide)
  - Internal doses are committed effective dose, but will use the annual organ dose for claims

WG Comment 4 – Provide a consolidated list of exposure models cont.

Model	Uranium Internal (mrem)	Thorium Internal (mrem)	External Dose (mrem)
Subsurface inside	17	29	8
Subsurface outside	<1	2	8
Roof and Overhead	<1	<1	4
Welding	6	17	1
HVAC	8	23	<1
Remaining	<1	1	35
Total	33	71	49

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

On January 12th NIOSH received an email and a document, *Burial Site Operations* concerning items to be discussed at the next work group meeting. One of the concerns was whether soil disturbances at the burial ground would compromise the data obtained for the burial ground and whether that would affect any of the models used to bound exposures at M&C

- As stated earlier, NIOSH addressed this question separately in a memo to the work group titled,
  - *Response to comments related to soil disturbances at the burial ground*

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

- NIOSH reviewed the Burial Area operations document
- The document provided some background and operations of the burial ground
- The document provided a number of excerpts from Sowell, 1985 and CPS Report, 1993
  - *The M&C Burial area is located between Bldgs. 11 and 12. Burials were made from 1958-61; site was closed 1967.*
  - *Records indicate two known burials, one in 1958 of contaminated ductwork, and one in 1961 of 28.4 mCi of enriched uranium noncombustible scrap.*

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

- The document provided a number of excerpts from Sowell, 1985 and CPS Report, 1993 (cont.)
  - *The former waste burial site was believed to have operated from approximately 1958 through 1961 however materials found during the 1992 excavation suggest that the first burials may have occurred in the early 1950s*
  - *The topographical study indicates that as much as 3-4 m of dirt may have been removed from the burial area during the construction of Building 12*

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

- The document provided several excerpts from Sowell, 1985 and CPS Report, 1993 (cont.)
  - *<u>Conclusion:</u> Debris buried in the burial site was not representative of radioactive materials (U and Th) handled throughout the AWE operational period (1952-67), but was a selective sample of those materials, largely from 1958-1961 near the top of the burial area trench. Furthermore, the ground covering of the burial site appears to have been disturbed during the construction of Building 12*
    - *Believe this was a work group member's conclusion*

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

NIOSH RESPONSE:

- NIOSH developed six separate exposure models
- The burial ground data was used for the "outside subsurface exposures" model
  - NIOSH used 594 lines of burial-site data from the "Radiological Survey of the Texas Instruments Site, Attleboro, Massachusetts
  - Blended them with data from other outside areas into a 2391-line spreadsheet used to determine exposures
    - burial data contributes a small amount of data to one of our six exposure models

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

NIOSH RESPONSE (cont.):

- NIOSH reviewed the entire outside subsurface model data to determine if the burial ground samples are significantly different from the rest of the samples
- NIOSH found all the outside areas data were consistent, making sense because the site grading in 1968 was responsible for much of the contamination on the other parts of the site.

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

NIOSH RESPONSE (cont.):

- NIOSH reviewed two reports
  - One report indicated that final grading at the conclusion of the Bldg. 12 construction project in 1968 distributed a thin layer of contaminated material in a southeasterly direction from the source at the former Burial Site location
  - The same report indicated contaminated debris was uncovered during the installation of a buried, compressed air line between Bldgs. 11 and 12 in 1980

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

NIOSH RESPONSE (cont.):

- The second report indicated
  - M&C surveyed the area southeast of Building 12 and found slightly elevated levels of radioactivity.
  - M&C determined the contamination was likely from dirt moved from the burial site when the airline was installed underground in 1980.
  - The air line debris area was investigated but did not require remediation because levels of radioactivity detected were below applicable NRC release criteria

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

NIOSH CONCLUSION:

- NIOSH reviewed interview transcripts and SRDB records and identified two documented burial area disturbances:
  - The final site grading after the Building 12 construction project in 1968
  - The installation of a buried, compressed air-line in 1980
- The site grading occurred at the beginning of the residual period
  - This has no adverse affect on the survey data used by NIOSH in developing exposures because the source term remained unchanged

WG Comment 5 – In what way was burial ground data used by NIOSH in determining the claimants' exposures, and was such use appropriate?

NIOSH CONCLUSION (cont.):

- The 1980 air-line disturbance falls into the category of an outdoor subsurface "maintenance" activity, which NIOSH's exposure model is designed to bound
  - Very small footprint of work (see Figure 1)
  - Below applicable NRC release criteria (30 pCi/g)
- The 30 pCi/g is approx. 4 times less than the 95th percentile contamination level NIOSH applied (118 pCi/g) in the exposure model