SC&A DRAFT REVIEW OF NIOSH'S WHITE PAPER DATED OCTOBER 24, 2018

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Major Perspectives

1. SEC Issues
2. Site Profiles Issues

Major Scenarios

1. Building 10 HVAC maintenance
2. Building 10 roof and overhead
3. Subsurface inside Building 10
4. Subsurface areas outside Building 10

Building 10 HVAC Maintenance

NIOSH has fully adopted SC&A's suggested approach to this exposure scenario as described in SC&A 2018. This scenario should be discussed by the work group as a site profile issue and perhaps also as an SEC issue to the extent that the work group believes that the approach used by SC&A is scientifically sound and claimant favorable.

Building 10 Roof and Overhead

- NIOSH explains that, in 1982, the NRC performed swipe surveys of "the roof of Building 10, near the exhaust from the high-efficiency filter system and the exhaust from the fuel manufacturing area and the ceiling, walls, and columns of the general manufacturing area (outside the fuel manufacturing area) (NRC and Texas Instruments 1982-1983, PDF pg 16)."

- Hundreds of alpha, beta, and gamma surveys were performed, including 154 wipes for removable alpha and beta contamination.

- Using the alpha survey data and a 10% removable contamination assumption, NIOSH determined that the surveys revealed removable surface contamination in these areas had a geometric mean of 1.09 dpm/100 cm^2, a GSD of 3.61, and selected a 95th percentile value of 8.99 dpm/100 cm^2 for use in deriving bounding exposures of workers involved in these types of maintenance activities.

- For the purpose of deriving inhalation exposures due to dust resuspension during these maintenance activities, NIOSH used a resuspension factor of 1E-4/m, thereby deriving an airborne concentration of 4.05E-14 microcuries/ml, and assumed an occupancy time of 173 hours per year. This concentration of U-234 corresponds to about 0.01 mrem/hr to the lung for type S U-234,[1] an extremely small dose rate.

- SC&A independently evaluated these data and obtained different but comparable results.

[1] 0.0899 dpm/cm^2 ÷ (60 dpm/dps × 3.7E4 Bq/Ci × 1E6 ml/m^3) = 4.05E-14 μCi/ml

4.05E-14 μCi × 1.0E6 ml/m^3 × 3.7E4 Bq/μCi × 1.2 m^3/hr × 7.81E-5 Sv/Bq × 1E5 mrem/Sv = 0.014 mrem/hr

Subsurface Building 10

TABLE 1. INTERNAL EXPOSURES

Parameter	**SC&A 2018**	**10/24/2018 White Paper**
Contamination level	5,878.1 pCi/g	6,887.84 pCi/g
Dust loading	200 μg/m^3	220 μg/m^3
Breathing rate	2.5 m^3/hr	1.2 m^3/hr
Exposure Duration	184 hr/yr	173 hr/yr
U Inhalation rate	20 Bq/yr	Not provided
Dose	15.6 mrem/yr effective dose commitment	Not provided

Substitute (Surrogate) Data Issues

On January 31-February 2, 1983, the NRC performed a closeout inspection of facilities formerly engaged in AWE operations, including a review of the licensee's survey report and independent measurements in Building 10. The inspection involved 43 direct inspection hours by two NRC region-based inspectors and included verification surveys of the former fuel vault ceiling and walls. Nine hundred thirty-eight individual, direct alpha, beta-gamma, and gamma radiation measurements were taken in the AWE areas. Direct alpha measurements did not exceed 175 dpm/100cm^2 (92.6% < 50 dpm). ***The NRC concluded that fixed and removable contamination levels inside the AWE areas, measured during their inspection, were comparable to those in the M&C closeout survey (NRC & Texas Instruments 1982-1983, PDF pp. 6-9).***

Substitute (Surrogate) Data Issues, continued

A number of important points can be made for using the 1990 data, as follows:

- NIOSH is using the high end of the 1990 data (95th percentile data), which comports with surrogate data criterion 2, exclusivity constraints.

- Relatively high chronic dust loading (220 µg/m^3) was assumed, especially considering that there is evidence that the soil beneath Building 10 was moist.

- NIOSH is assuming that the same person is performing subsurface maintenance and repurposing activities, when our worker interviews revealed that many different M&C workers performed subsurface work during the residual period.

- The data collected by the NRC in 1983 compare well with the data collected in the 1990s.

- Notwithstanding these bounding assumptions, the doses are extremely small.

- The actual bioassay data collected for workers performing the surveys in the 1990s reveal internal exposures that are well below the doses associated with the modeling assumptions used in the white paper (i.e., in Table 1 above, SC&A estimates an internal dose for subsurface exposures of M&C workers of 15.6 mrem/yr effective dose commitment, as compared to the exposure limits for cleanup workers in the 1990s of 20 mrem/quarter, which were never exceeded.

Subsurface Building 10

EXTERNAL EXPOSURES

- NIOSH used film badge data collected during the AWE operations period as the underpinning for reconstructing external exposures during the residual period. SC&A does not agree with this approach because there was no fuel or fuel-handling operation ongoing on site during the residual period.

- SC&A suggest that NIOSH supplement the film badge strategy by modeling the external exposures associated with the radionuclide concentrations used to derive internal exposures associated with subsurface activities beneath Building 10, for reasons similar to those described above for internal exposures. This would involve using MCNP or other external dosimetry models where it is assumed that M&C workers during the residual period were in close proximity to the upper end concentrations of radionuclides in the subsurface environment in Building 10 (e.g., the upper 95th percentile values).

Areas Outside of Building 10

INTERNAL EXPOSURES

- Considerable surface and subsurface data were collected in many outdoor areas in 1984 by the NRC and again in the early 1990s in support of license termination. Page 8 of the white paper states that 2,391 soil samples were collected prior to remediation, and that 1,629 samples were analyzed for gross alpha, and 762 samples were collected for uranium and thorium and analyzed using isotopic identification.

- For above ground internal exposures, SC&A suggests assuming average soil contamination, 2,000 hours/yr exposure duration, and a chronic dust loading of about 200 micrograms/m^3.

- For subsurface exposures, SC&A suggests that NIOSH derive the upper 95th percentile of the radionuclide concentrations observed in subsurface samples, along with an exposure duration of perhaps 200 hours per year and a dust loading of about 200 µg/m^3as the basis for estimating internal doses associated with outdoor subsurface work.

- The NIOSH white paper effectively adopts this strategy.

Areas Outside of Building 10, continued

EXTERNAL EXPOSURES ABOVE GROUND

- SC&A collected all the outdoor surface and subsurface data collected in the 1980s and 1990s. For above- ground external exposures, we used 473 sets of surface soil sample analyses for ^{235}U, ^{238}U, ^{232}Th, and ^{226}Ra. We calculated an annual effective dose of 5.32 mrem to a worker exposed to the soil having the average concentrations of these four radionuclides and their radioactive progenies, based on the external dose coefficients listed in FGR 12 for soil of infinite extent contaminated to an infinite depth.

EXTERNAL EXPOSURES BELOW GROUND

- We also determined the external dose rates to a worker in an excavation at the burial ground. We first calculated the weighted average concentrations of radionuclides reported by Sowell (1985) for core samples collected at 28 locations for which core sample data were reported at two or more depths. We then calculated the dose rates that would be experienced by a worker exposed to an infinite layer of soil contaminated at the concentrations equal to those of the core samples, again using the FGR 12 external dose coefficients. We then selected the 95th percentile of these 28 results. Assuming a worker was exposed for 200 h/yr, their annual effective dose from this pathway would have been 2.08 mrem. If we assume that they spent 90% of working hours on the surface and the remaining 10% in an excavation, the total annual external effective dose would have been 6.87 mrem.

Conclusions

SC&A concludes that doses to M&C workers during the residual period, including workers involved in maintenance and repurposing activities, can be reconstructed in a scientifically sound and claimant-favorable manner by using upper-end values of the contamination levels measured during the 1980s and 1990s, along with appropriately conservative assumptions regarding airborne dust loadings and exposure durations.