Review of NIOSH's Program Evaluation Report DCAS-PER-070, "Nuclear Metals Inc."

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November 8, 2024

DCAS-PER-070 purpose

- Address the impacts of issuing DCAS-TKBS-0010 for Nuclear Metals, Inc (NMI) on previously completed cases
- Dose reconstructions (DRs) had previously been conducted using site research summarized in a Special Exposure Cohort (SEC) evaluation report

NMI background

- Beginning in 1958, NMI activities included:
  - Producing depleted uranium (DU) products
  - Supplying copper-plated uranium billets for Savannah River reactors
  - Manufacturing metal powders for medical applications, photocopiers, and other applications
  - Handling thorium and thorium oxide under NRC license
- Two classes of workers added to SEC (SEC-0195)
  - 10/29/1958–12/31/1979 and 1/1/1980–12/31/1990
  - Internal dose from thorium and enriched uranium could not be estimated with sufficient accuracy

NMI timeline

- EEOICPA covered period from October 29, 1958, to December 31, 1990
- Residual period from January 1, 1991, through March 1, 2011

Subtask 1: Changes necessitating PER

- NMI dose reconstruction had been conducted using site research compiled in an SEC evaluation report
- The NMI technical basis document (TBD), DCAS-TKBS-0010, was issued on April 24, 2015

Subtask 2: Assess corrective action methods

- SC&A has not previously reviewed DCAS-TKBS-0010
- Therefore, SC&A's subtask 2 review of PER-070 is primarily a review of DCAS-TKBS-0010 for its guidance on dose reconstruction

Occupational internal dose estimate

- Internal dosimetry believed to exist for most NMI workers
  - Uranium urinalyses (fluorometric)
  - Assumed minimum detectable activity of 0.005 mg/L
  - Use specific activity of 683 pCi/mg for natural uranium (NU)
- For workers without internal dosimetry records, use ORAUT-OTIB-0084, the NMI coworker internal dosimetry guidance document

SC&A comments on internal dose

- SC&A agrees that internal dosimetry records should be used for dose reconstructions if available, and ORAUT-OTIB-0084 used if no records available
- OTIB-0084 has not yet been reviewed by SC&A and was not reviewed as part of this PER review
- SC&A also notes that the co-exposure model in OTIB-0084 has not been updated to meet the newer guidance in DCAS-IG-006, revision 00

Observation 1

Clarification needed on type of uranium assumed for exposures of monitored and unmonitored workers

- DCAS-TKBS-0010 suggests using a specific activity for NU of 683 pCi/mg
- ORAUT-OTIB-0084 states that NIOSH used a “uranium-specific activity” of 0.36 pCi/µg (360 pCi/mg), which is consistent with DU
- SC&A requests clarification on the reasoning behind assumptions monitored workers were exposed to NU and unmonitored workers were exposed to DU
- Specific activities of NU and DU used in DCAS-TKBS-0010 and ORAUT-OTIB-0084 differ from table 3.1 of Battelle-TBD-6000

Observation 2

Additional information needed regarding other bioassay measurements NMI workers could have received during operations

- SEC-0195 petition evaluation report addendum states the first in vivo bioassay for NMI was conducted in April 1981
- NMI acquired a whole-body counter for uranium lung counting and performed over 800 lung counts from 1982 through 1990
- DCAS-TKBS-0010 does not discuss any lung counting or information for how the measurements may be used in a dose reconstruction
- DCAS-TKBS-0010 would benefit from a discussion of all other possible bioassay techniques that may be included in an NMI worker's dosimetry records

Occupational external dose estimate

- Majority of NMI workers had external dosimetry
- Table 1 of the TBD describes the different dosimeter types, minimum detectable sensitivity (MDS), manufacturer, and exchange frequency
- For a worker without external dosimetry, an over- or underestimating approach could be used, or a co-exposure model could be developed

SC&A comments on occupational external dose

- Agree that dosimetry records should be used in dose reconstructions when available
- Agree that if records are unavailable, using over/underestimating assumptions is appropriate
- It should be noted an external co-exposure model has not yet been developed for NMI

Observation 3

Missing guidance on the energy ranges for assigned doses

- DCAS-TKBS-0010 does not provide guidance on the energy ranges to use for assigning doses
- SC&A assumes 30–250 keV photons are appropriate but believes the document would benefit from this information

Observation 4

SC&A is unable to verify the minimum detectable sensitivities in table 1 of DCAS-TKBS-0010

- Table 1 of DCAS-TKBS-0010 includes dosimetry information such as providers, time periods, exchange frequency, and MDS values
- SC&A reviewed several SRDB documents and was not able to verify all MDS values listed in table 1 of DCAS-TKBS-0010

Observation 5

Additional clarification needed regarding shallow and deep dose for post-1983 dosimetry records

- In 2019, SC&A reviewed a dose reconstruction for a former NMI employee
- SC&A noted that starting in 1983, the reported shallow dose included deep dose in the dosimetry records
- NIOSH indicated that SC&A was correct, and that NIOSH would provide additional instructions to health physicists conducting dose reconstructions for NMI
- The TBD was written before the dose reconstruction was reviewed, but SC&A reiterates our concern to ensure the issue is not lost

Observation 6

Discussion needed on the presence of industrial radiography at the site and potential doses to workers

- Page 46 of SRDB document 25090 describes two industrial x-ray machines that were kept at the site
- Used at the site for “x-ray of metal specimens and parts”
- SC&A believes the TBD would benefit from a discussion of the potential external extremity dose to workers from industrial radiography used at the site

SC&A comments on external dose: Neutrons

- SEC 195 evaluation report states that neutron monitoring not performed at NMI, but potential for neutron exposure existed (α,n reactions, interactions with oxides, spontaneous fission)
- SEC evaluation report also states that ORAUT-OTIB-0024 should be used to assign unmonitored neutron dose
  - TBD does not discuss external neutron dose
  - Issue has been discussed by the Board for other sites
  - The potential dose is small, and further consideration of neutron dose may not be needed
  - However, SC&A maintains that the neutron dose issue, even if negligible, should be included in the TBD

Residual period internal dose estimate: Uranium

- NIOSH used maximum uranium intake rate of 574 pCi/day from OTIB-0084 and guidance from TBD-6000 to calculate surface contamination level of 169,700 pCi/m^2
- Resuspension factor of 1E-05 m^{-1} to calculate uranium inhalation intake rate of 11.2 pCi/day
- No uranium ingestion since values from OTIB-0084 based on urinalysis results
- Intake rates decrease each year due to source term depletion, per ORAUT-OTIB-0070

Residual period internal dose estimate: Thorium

- No thorium bioassay or contamination measurements
- Site thorium contamination guideline of 5,000 dpm/100 cm^2 total alpha
  - Divided by 3 to account for 3 alpha decays in Th-232 chain
- Similar to uranium, NIOSH calculated a resuspended thorium concentration, then the thorium inhalation intake rate of 11 dpm/day
- Thorium ingestion calculated using surface contamination value
  - 100.5 dpm/day
- Intake rates applied for each of the 5 radionuclides in Th-232 decay chain
  - Th-232, Ra-226, Ac-228, Th-228, Ra-224
- Intake rates decrease each year due to source term depletion, per ORAUT-OTIB-0070

SC&A comments on internal dose estimates

- SC&A was able to match NIOSH's calculated intakes for uranium inhalation, thorium inhalation, and thorium ingestion
- Also confirmed the values in TBD table 3, which lists the intake rates each year as the source term depletes, per OTIB-0070

Observation 7

Discussion needed on the potential for overtime at the site

- Calculations for residual period internal and external dose are based on working 2,000 hours per year
- If workers routinely worked overtime, it may be appropriate to adjust the residual period dose estimates accordingly
- During worker outreach activities in 2012, workers repeatedly mentioned the overtime policy

Residual period external dose estimate

- Uranium
  - Surface contamination of 169,700 pCi/m^2 based on intake, uranium dose conversion factors from TBD-6000, 2,000 hours per year
    - 0.3 mrem/yr photon; 28.8 mrem/yr beta
- Thorium
  - Surface contamination of 5,000 dpm/100 cm^2 based on surface contamination limits, dose conversion factors from EPA Federal Guidance Report No. 12, 2,000 hours per year
    - 1.9 mrem/yr photon; 9.6 mrem/yr beta

SC&A comments on residual period external dose estimate

- Matched NIOSH's calculated uranium external dose rate
  - Dose conversion factors from table 3.10 of TBD-6000
- Matched NIOSH's calculated thorium external dose rate
  - Contaminated ground surface dose conversion factors from EPA Federal Guidance Report No. 12

Occupational medical dose

- No site-specific guidance for NMI occupational medical dose
- Use OTIB-0006 to assign occupational medical dose
  - Assumed pre-employment, annual, and termination examinations
- SC&A agrees with the guidance of using OTIB-0006 in the absence of NMI-specific information, and the assumed examination frequency

Subtask 3: PER selection criteria

- All completed claims with verified employment at NMI with a probability of causation (POC) less than 50%
  - 21 claims
- Three claims used DCAS-TKBS-0010 already and were removed from further evaluation
  - 18 claims

NIOSH's evaluation of impacted claims

- 18 claims reevaluated using DCAS-TKBS-0010
  - 16 claims POC below 45%
  - 2 claims POC between 45% and 50%
    - IREP run 30 times at 10,000 iterations, POC still below 50% for both claims
- SC&A agrees with NIOSH's selection criteria and that they are broad enough to capture all potentially affected claims
- PER was conducted in a timely manner
  - DCAS-TKBS-0010 issued in April 2015
  - PER-072 issued in April 2016

Subtask 4: Audit of reevaluated DRs

- SC&A recommends that the Board select one of the cases evaluated by NIOSH with a POC between 45% and 50%, provided that case contains all exposure pathways discussed in the PER

Questions?