



Fernald SEC Petition and Site Profile Review Status Update

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Background – Fernald (Feed Materials Production Center [FMPC]) Operations and Processes

- The FMPC was located near the unincorporated village of Fernald in the Great Miami River Valley, about 20 miles northwest of Cincinnati in southwestern Ohio. The FMPC site covered an area of 1,050 acres. The production area encompassed approximately 136 acres in the center of the site.
- Fernald began operations in 1951 and was fully operational by the end of 1954; production ceased in 1989. **Its primary function was to convert uranium ore concentrates and recycled materials to either uranium oxides or highly purified uranium ingots and billets for machining or extrusion into tubular forms of assorted uranium enrichment.** These products were prepared for use as production reactor fuel cores and target fuel elements. In addition, thorium was processed, but in small proportion to uranium.
- Production area facilities included nine separate plants, the pilot plant, ancillary buildings, and administrative buildings that were connected with a network of roadways. These facilities, along with concrete storage pads, gravel ground cover, railroad access, sanitary landfill, and metal scrap piles, were surrounded by security fencing.
- Outside the fenced production area, the Waste Storage Area included six low-level radioactive waste storage pits, two earthen-bermed concrete silos containing K-65 residues (high specific activity radium-bearing residues), one concrete silo containing metal oxides, and all affected adjoining areas.

Historical Overview – November 2006–Present

- **Site Profile Review – November 10, 2006**
 - Identified 33 findings
- **SEC Petition 00046: Proposed class qualified for evaluation (April 2006)** – All employees of DOE, DOE contractors, and subcontractors employed at FMPC from January 1, 1951, through December 31, 1989
- **SEC ER Review – July 2, 2007**
 - Six principal SEC issues were identified:
 - Issue 1: Coworker model for uranium internal exposures
 - Issue 2: Validation of the HIS-20 database
 - Issue 3: Recycled uranium (RU)
 - Issue 4: Use of radon breath data for reconstructing doses from inhalation of Ra-226 and Th-230
 - Issue 5: Review of radon emissions from the K-65 silos and associated exposures
 - Issue 6: Reconstruction of internal exposures from inhalation of Th-232 – daily weighted exposures (DWEs) (Issue 6A) and chest counts (Issue 6B)
 - SEC 4.5-1: Absence of performance standards/quality assurance for personnel dosimeters
- **See Fernald issues matrix, Rev. 5, for detailed narrative on finding resolution**

Historical Overview (cont.)

- **24 Work Group Meetings (August 2007–August 2018)**
 - Many white paper exchanges and Work Group discussions
- **After July 28, 2017, Work Group meeting:**
 - Three classes have been added to the SEC
 - **June 2012:** *All employees of DOE, DOE contractors, or subcontractors who worked at all locations at the FMPC in Fernald, Ohio, from **January 1, 1968, through December 31, 1978; based on inability to reconstruct internal doses to thorium from chest count data reported in milligrams thorium***
(<https://www.cdc.gov/niosh/ocas/pdfs/sec/ferald/fmpchhsdes-46.pdf>)
 - **September 2013:** *All employees of the FMPC in Fernald, Ohio, who were not employed by National Lead of Ohio, NLO, or the Department of Energy or its predecessor agencies, who worked at the FMPC from **January 1, 1951, through December 31, 1983; based on insufficient internal monitoring data for other-than-prime contractor and DOE employees during that time***
(<https://www.cdc.gov/niosh/ocas/pdfs/sec/ferald/fmpchhsdes-46b.pdf>)
 - **September 2013:** *All employees of DOE, DOE contractors, or subcontractors who worked at all locations at the FMPC in Fernald, Ohio, from **January 1, 1954, through December 31, 1967; based on inability to reconstruct internal doses to thorium from time-weighted airborne radioactivity concentration values termed daily weighted exposure (DWE)***
(<https://www.cdc.gov/niosh/ocas/pdfs/sec/ferald/fmpchhsdes-46c.pdf>)

SEC Issue 1: Coworker Model for Uranium Internal Exposures

■ Description of Issue:

- Completeness and adequacy of uranium bioassay data for dose reconstruction and to support ORAUT-OTIB-0078, Fernald internal dosimetry coworker model

■ Issue Resolution:

- OTIB-0078 was revised 3 times from 2009 to 2016; the coworker model was incorporated into the occupational internal dose technical basis document (TBD-5), Rev. 03 (May 2016), and the TIB was then cancelled
- Issues related to the applicability of the uranium coworker model to Fernald construction workers were the basis for the addition of a class of workers to the SEC (non-NLO/NLO, Inc. employees from 1951 to 1983)

SEC Issue 2: Validation of the HIS-20 Database (Issue 2 has two parts: 2A and 2B)

■ Description of Issue 2A:

- Complete the validation of the accuracy with which hardcopy dosimetry data were converted into electronic data for the HIS-20 database.
 - Canberra™ HIS-20 database used in uranium bioassay (coworker) study

■ Status of Issue:

- On December 3, 2010, NIOSH delivered a complete validation study that resolved all of SC&A's concerns.
- At the February 8, 2011, Work Group meeting, it was recommended that Subpart A of Issue 2 be closed.

SEC Issue 2: Validation of the HIS-20 Database (cont.)

■ Description of Issue 2B:

- Concerns about the integrity of the hardcopy bioassay data, as raised by the petitioner

■ Status of Issue:

- Although SC&A prepared a report that describes strategies for investigating data integrity issues that could adversely affect the ability to reconstruct internal doses, the WG agreed that any such investigations would require considerable time and costs and will likely be inconclusive – **not tasked; issue closed**

Issue 3: Recycled Uranium

■ Description of Issue 3:

- **Concern:** Default concentrations (on U mass basis) of Pu-239 (100 ppb U), Np-237 (3,500 ppb U), and Tc-99 (9,000 ppb U) associated with RU at Fernald may not be bounding for some classes of worker activities, buildings, and time periods.
 - Dosimetric significance: Pu dose 2–5 times U dose (bone surfaces, liver, red marrow)
 - Three periods of interest (1953–1985*)
 - **1953–1960:** 45 MT storage; little exposure potential
 - **1961–1972:** RU processed but data suggest most was “within specification” (nominally 10 ppb U)
 - **1973–1985:** RU with high concentrations received from GDPs (termed POOS for “plutonium out of specification”)
 - **Post-1986:** In 1986, WMCO replaced NLO as Fernald M&O and instituted comprehensive improvements in HP/IH programs

* Although SC&A’s SEC concerns about RU end in 1985, exposure potential to RU for Fernald workers continued throughout the life of the facility.

Issue 3: Recycled Uranium (cont.)

- **Eight WG meetings from October 2008 to August 2018**
 - Many white paper exchanges and discussions (2008–2012)
 - February 2012: NIOSH and WG agreed to the following RU contaminant concentrations and moved the RU issue to site profile status

RU Contaminant	1961–1972	1973–present
Pu-239	100 ppb U	400 ppb U
Np-237	3,500 ppb U	11,000 ppb U
Tc-99	9,000 ppb U	20,000 ppb U

Issue 3: Recycled Uranium (cont.)

■ Status of Issue as of August 2018

- Determined to be a site profile issue (2012). TBD-5, Rev. 03 (March 2017): NIOSH proposes lower constituent concentrations than agreed upon by the WG for 1961–1972.
 - **Pu-239 (100 ppb U → 10 ppb U), Np-237 (3,500 ppb U → 400 ppb U), Tc-99 (9,000 ppb → 6,000 ppb U)**
 - SC&A analyzed the RU constituent data utilizing the sample “Lot ID sequence” to determine which samples were prior to 1973 and concluded that revised concentrations did not represent bounding values (SC&A memorandum dated June 2018).
 - NIOSH reexamined the RU constituent data and concluded the “Lot ID sequence” was not a reliable indicator of the date and thus the RU constituent data could not be used (Hinnefeld email, July 2018, and NIOSH white paper, August 2018).
 - Issue discussed at 8/10/2018 Work Group teleconference and concluded: While considerable uncertainty exists for the period 1961–1972, the value of 10 ppb represents a reasonably conservative best estimate for the purposes of partial dose reconstruction. **Issue closed.**

SEC Issue 4: Use of Radon Breath Data for Reconstructing Doses from the Inhalation of Ra-226 and Th-230

- **Description of Issue 4:** SC&A agrees – radon breath analysis is a scientifically valid method for reconstructing the intake of Ra-226 and Th-230 when the intake ratios of the two radionuclides are known and the impacted worker population can be identified.
 - Remaining Issue – Reconstructing Th-230 dose in uranium- and radium-poor raffinates
 - WG agreed that potential intakes could be bounded and moved this issue to site profile status.
- **Status of Issue as of August 2018:**
 - Many white papers have been exchanged and discussed in previous WG meetings.
 - August 10, 2018, WG meeting: NIOSH examined DWE data for the time period and location of interest (NIOSH white paper, July 2018) and concluded that using a ratio method to uranium bioassay bounded the intake estimate when compared to DWE data when evaluating potential Th-230 intakes.
 - SC&A and the Work Group concurred with NIOSH's evaluation that potential intakes were sufficiently bounded. **Issue closed.**

SEC Issue 5: Review of Radon Emissions from the K-65 Silos and Associated Exposures

■ Description of Issue 5: SC&A Position

- Radon release rate from the K-65 silos as estimated by NIOSH is substantially underestimated.
- Method to derive the atmospheric dispersion factors, given the source term, is scientifically flawed but results in an overestimate of the atmospheric dispersion factors at receptor locations (still doesn't compensate for underestimated source term).

■ Status of the Issue:

- Many white papers have been exchanged; both sides “agree to disagree.”
- As a practical matter, NIOSH believed that this issue has little significance with respect to the dose reconstruction for actual claimants, and **both parties (i.e., NIOSH and SC&A) agreed that this is not an SEC issue.**
- April 2011: Board agreed to move from SEC issues to TBD issues.

■ Status as of August 2017

- TBD-4, Rev. 01 (December 2015): NIOSH has incorporated the 95th percentile of the modeled doses in the RAC report, as agreed upon by the WG.
- **Issue closed** (TBD issues 25 and 26).

SEC Issue 6A: Reconstruction of Internal Exposures from the Inhalation of Th-232 (DWE Data)

- **Description of Issue 6A:** Use of breathing zone (BZ) and GA sampling data and associated time-weighted air concentrations (DWEs) to reconstruct Th-232 intakes pre-1968
- **Status of Issue:**
 - Many white papers exchanged and discussed over several WG meetings
 - July 2013: SEC voted for all workers 1954–1967 based on inability to reconstruct intakes of Th-232 with sufficient accuracy from DWE data
 - Most DWE air sampling based on gross alpha activity was not focused on thorium work occurring at the site but rather on uranium work; thus, the samples contained unknown proportions of uranium and thorium.
 - Workers could not reliably be placed in thorium-processing facilities during the periods of interest.

Issue 6B: Reconstruction of Internal Exposures from the Inhalation of Th-232 (Chest Count Data)

- **Description of Issue 6B:** Use of chest counts to reconstruct Th-232 exposures (1968–1988)
 - Two periods of interest
 - **1968–1978:** Results reported in milligrams thorium
 - April 2012: SEC voted for all workers from 1968 to 1978 based on inability to place a sufficiently accurate upper bound on intakes based on results reported in milligrams thorium
 - empirical equation used to get mg thorium from count data
 - Not applicable to forms and varying equilibrium conditions at Fernald
 - Extremely large uncertainties
 - **1979–1988:** Reported in nCi thorium (based on Pb-212)
 - WG accepted NIOSH methodology for reconstructing doses based on activity measurements of Pb-212

Finding 4.5-1: Absence of Performance Standards/Quality Assurance for Personnel Dosimeter

- Description of Finding 4.5-1:
 - SC&A did not question the merits/use of the dosimetry data but implied the need to consider the quality of these data in context with stated limitations. SC&A recommended expanding the range of uncertainty that is normally afforded to personnel dosimeters that were used at the time to account for these deficiencies.
 - More an issue of uncertainties introduced by human error:
 - Control badges not routinely processed with badges worn by workers
 - Did not have a bona fide official training program for the technicians who assessed the badges
- Finding Disposition:
 - Because there was really no way to rectify the deficiencies, the **WG agreed to close this out** at the September 2014 WG meeting.

Fernald WG Recommendation on SEC-00046

- The Fernald WG recommended that the Board find radiation doses could be estimated with sufficient accuracy for National Lead of Ohio (NLO) and NLO, Inc. and Westinghouse Materials Company of Ohio (WMCO) employees from 1979 through 1989, and for covered employees other than NLO and NLO, Inc. employees from 1984 through 1989. The Board voted to accept this position at the August 2017 meeting. This completed the Board's consideration of SEC Petition 00046.

Site Profile Status Update

- Original Site Profile Review – November 10, 2006
 - Of the 33 original findings, 27 are closed, 4 are in progress, and 2 were transferred to Subcommittee for Procedure Reviews (SCPR)
- November 24, 2014: SC&A review of NIOSH white paper, *Fernald Dose Reconstruction Methodology for the Post Special Exposure Cohort (SEC) Period, 1979–2006*, Revision 2, June 23, 2014
 - 7 findings and 7 observations
- May 12, 2016: SC&A review of *Internal Dosimetry Coworker Data for the Feed Materials Production Center*, ORAUT-OTIB-0078, Revision 03, August 19, 2015
 - 2 findings and 6 observations

Findings In Progress or Transferred from 2006 Site Profile Review

■ Findings 7 and 8 (raffinates poor in uranium and radium)

- August 10, 2018, WG meeting: WG accepts NIOSH's proposed method for bounding doses to uranium- and radium-poor raffinates. **Issue closed.**

■ Findings 9 and 11 (RU)

- August 10, 2018, WG meeting: WG accepts NIOSH's approach using 10 ppb Pu as a sufficiently conservative best estimate for partial dose reconstruction.

■ Findings 17 and 19 (correction factors for extremity beta exposures measured by film badges) Transferred

- July 28, 2017, WG meeting: Determined that the treatment of extremity doses is a program-wide issue currently under review by the SCPR. These finding to be transferred to the SCPR as part of the review of ORAUT-OTIB-0013 and closed as they relate to the Fernald TBD review.

Post-SEC Thorium Methods

- 1979–1989:
 - Monitored workers: use individual Mobile in Vivo Radiation Monitoring Laboratory (MIVRML) results
 - Unmonitored workers: coworker intakes developed from MIVRML results
- 1990–1994:
 - Monitored workers: use individual In Vivo Examination Center (IVEC) monitoring records
 - Unmonitored workers: assign 10% of the derived air concentration (DAC) to all “radiological workers”
- 1995–2006:
 - Monitored workers: use individual IVEC results or BZ data as appropriate
 - Unmonitored workers: no coworker dose assignment

Post-SEC Thorium Review

- **Findings 1, 3, and 5:** NIOSH to assign unmonitored thorium intakes to all radiological workers (1979–1994)
 - July 28, 2017, WG meeting: **WG recommends closure**
- **Finding 2:** Intake Assignment
 - SC&A recommended assignment of the 95th percentile to all radiological workers
 - Fernald Work Group determined the 50th percentile with associated GSD is sufficient for most radiological workers
 - 95th Percentile Exceptions: workers who submitted baseline fecal sampling and workers employed by IT Corporation (subcontractor handling repackaging activities)
 - July 28, 2017, WG meeting: **WG recommends closure**
- **Finding 4:** NIOSH to investigated the use of higher Class Y DAC value for 1990–1994 instead of currently proposed Class W DAC for application of 10% DAC values used in unmonitored thorium dose reconstruction
 - March 15, 2018, WG meeting: SC&A concurred with NIOSH's conclusion that the site utilized the Class W DAC in controlling airborne contamination levels. **WG recommends closure.**

Post-SEC Thorium Review (cont.)

- **Observation 1:** In vivo monitoring program focused on high exposure potential (primarily uranium) jobs such as the chemical operators. **No action required.**
- **Observation 2:** Workers with positive in vivo results for thorium daughters (Pb-212/Ac-228) were resampled 10 times as often as rest of monitored population. **No action required.**
- **Observation 3:** SC&A concurs with the following claimant-favorable assumptions discussed at December 2014 WG meeting; **No action required:**
 - Triple separation of thorium prior to intake
 - Bias adjustment for chest counts of Ac-228 and Pb-212
 - Criteria for unsupported radium exposure (see Post-SEC Thorium Finding 7)
- **Observation 4:** Notes that review of in vivo coworker distributions not performed at the time of review due to SEC discussions of time-weighted OPOS (TWOPOS) methods. **No action required.**

Post-SEC Thorium Review (cont.)

- **Observation 5:** Review of 22 unmonitored claimants (1990–1994) indicated chronic exposure to thorium above 10% of the DAC is highly unlikely. **No action required.**
- **Observation 6:** SC&A requested clarification on BZ “codes” used to identify thorium results. These location codes are discussed in Attachment E of the internal dose TBD update. **No action required.**
- **Observation 7:** Temporal collection and measurement criteria for BZ samples not apparent in the Fernald database. NIOSH provided additional information specifying that BZ data were collected on a daily basis but generally reported on a weekly basis. **No action required.**

Thoron and Unsupported Radium

- NIOSH modeled thoron exposures in Building 65 for comparison with site-wide model. In addition, NIOSH provided additional justification for parameters selection of the site-wide model (subject of SC&A Finding 6).
 - March 15, 2018, WG meeting: Aside from one calculation error to be fixed, SC&A concurred with the proposed thoron dose reconstruction approach. **WG recommends closure.**
- NIOSH to assign intakes of unsupported radium only in the rare case where the in vivo result for Ac-228 is a factor of 1.5 or higher than the associated Pb-212 result (subject of SC&A Finding 7).
 - July 28, 2017, WG meeting: **WG recommends closure; Board accepted.**

Uranium Coworker Model

- Methods developed in OTIB-0078, Rev. 03, and integrated into Attachment C of Fernald internal TBD
- Uranium intakes derived using 400,000+ bioassay results
- Unmonitored intake assignment
 - All prime contract workers 1952–2006
 - All construction trade subcontract workers 1984–2006 (SEC-00046 established for subcontractors 1951–1983)

Uranium Coworker Model (cont.)

- SC&A Review of OTIB-0078 (2 findings)
 - **Finding 1:** Treatment of negative and zero bioassay results is inconsistent with guidance in ORAUT-RPRT-0053.
 - Finding 1 Resolution: Future revisions of the coworker model will use RPRT-0053 methods. Effect likely not significant.
 - July 28, 2017, WG meeting: **WG recommended this finding be put In Abeyance.**

Uranium Coworker Model (cont.)

- SC&A Review of OTIB-0078 (2 findings)
 - **Finding 2:** Paired bioassay measurements for the same worker are different by 1–3 orders of magnitude on the same day.
 - Finding 2 Resolution: NIOSH investigation determined the higher result was correct, and the lower results were removed from analysis.
 - July 28, 2017, WG meeting: **WG recommended closure.**

Uranium Coworker Model (cont.)

- SC&A Review of OTIB-0078 (6 observations)
 - **Observation 1:** SC&A could not recreate NIOSH's calculation for some years in the late 1980s and early 1990s.
 - Resolution: SC&A and NIOSH exchanged calculation files and found that different procedures were used. NIOSH used correct procedure for those years. **WG recommended closure.**
 - **Observation 2:** As expected, use of TWOPOS methods reduced the variability in derived distributions but did not significantly affect the geometric mean.
 - Resolution: TWOPOS methods behaved as expected. **WG recommended closure.**

Uranium Coworker Model (cont.)

- SC&A Review of OTIB-0078 (6 observations)
 - **Observations 3–6:** additional information in bioassay database “comments column” was not utilized in coworker calculations, including:
 - Reported analytical results below control limit (Obs. 3)
 - Notations that sample represents a pre-employment sample (Obs. 4)
 - Indications of contaminated or otherwise invalid samples (Obs. 5)
 - Identification of solubility type and intake route (Obs. 6)
 - NIOSH acknowledges that in future revisions such comments in the Fernald database will be considered.
 - **WG recommended Observations 3–5 be put In Abeyance until future revisions.** The effect on overall doses is not likely to be significant (low priority).
 - The accuracy of information designating solubility type and intake route could not be confirmed, thus will not be used. **WG recommended closure of Observation 6.**

Conclusions – Site Profile Review

- All of the remaining site profile issues have been closed by the Fernald Work Group as of the August 10, 2018, meeting
- The Fernald Work Group recommends that the Advisory Board on Radiation and Worker Health close the Fernald site profile review



Questions?