

Fernald SEC Petition Review

SC&A Status Update since Advisory Board Meeting held
August 23-25, 2011 in Richland, Washington

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Presented to the Advisory Board on Radiation and
Worker Health

Full Board Meeting Held in Tampa, Florida,

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Work Group Review: Overview

- April 19, 2006: SEC Petition qualified
 - “All employees who worked in all facilities at the Feed Materials Production Center (FMPC) in Fernald, Ohio, from Jan 1, 1951 through Dec 31, 1989”
- Nov 3, 2006: NIOSH Evaluation Report issued
 - “NIOSH found no part of the class under evaluation for which it cannot estimate radiation doses with sufficient accuracy.”
- Nov 10, 2006: SC&A Site Profile Review
- July 2, 2007: SC&A SEC PER Review
- August 2007 → August 2011: Eleven Work Group meetings
- May 24, 2011, ABRWH Meeting: SC&A presents detailed summary of SEC issues (as of April 2011)
- One final WG meeting to be scheduled before February Board meeting
 - SC&A believes that the Work Group can soon reach closure on the remaining SEC issues
 - Move to SP discussions or bring before the Board for SEC determination

Work Group SEC Issues

1. Coworker Model for Uranium Internal Exposures – **open**
2. Validation of the HIS-20 database – **closed***
3. Recycled Uranium (RU) – **open**
4. Use of radon breath data for reconstructing doses from inhalation of Ra-226 and Th-230 – **closed***
5. Review of radon emissions from the K-65 silos and associated exposures - moved to site profile discussions
6. Reconstruction of internal exposures from inhalation of Th-232
 - 6A: DWE Data (1953 – 1967) – **closed***
 - 6B: Chest Counts (1968 – 1989) - **open**
7. Recycled Thorium (RT) – new issue
 - Identified in SRS discussions (August 2011) as potentially significant SEC issue
 - Preliminary investigations suggest this may be tractable for Fernald (SP issue)

(* recommended by SC&A)

Open Issue (#1): Co-worker Model for Uranium Internal Exposures

Description of Issue –

Concerns regarding the completeness and adequacy of the uranium bioassay data available for dose reconstruction and supporting the Fernald internal dosimetry co-worker model (OTIB -0078, dated November 6, 2007)

Status of Issue –

Resolved except for matters related to the applicability of the co-worker model to Fernald construction workers

Open action Items –

NIOSH to perform an analysis of construction worker (CW) vs. non-CW uranium bioassay data for TIB-0078 and deliver a report

- Report delivered November 4, 2011

SC&A is reviewing the report and will prepare a response (before next WG meeting)

Issue #1: Co-worker Model for Uranium Internal Exposures, concluded

Preliminary SC&A Observations –

- NIOSH concluded that most of the “Type 50” bioassay records in the database are for contractors
- These "special" records were not included in the original coworker model because they were presumed incident-related
- New analysis: when these records are considered, the coworker model estimates go up by a factor around 1.25 or 1.6, depending whether it's annual or quarterly data
- Not clear if NIOSH is comparing the construction workers as a group with the group of non-construction workers or added in the type 50 records not in the earlier model. The "pooled" data would be about 1.25 as high as the earlier model
 - If pooled, data for construction workers ALONE would be much higher than the factors they found. How much higher depends on the relative sample sizes
- The paper contains no details of the analysis, only a graph with the final results
- SC&A believes that NIOSH should provide a new revision with details (e.g., sample sizes, fitted distributions by time periods)

Open Issue (#3): Recycled Uranium (RU)

Description of Issue: Concern that default concentrations of Pu-239, Np-237, and other isotopes associated with RU at Fernald may not be bounding for some classes of worker activities, buildings, and time periods.

Status of issue: Numerous white papers have been exchanged where NIOSH provides its technical basis in support of its default values and SC&A provides the reasons it believes that the default values may not be bounding for all workers and time periods.

Recap: August 11, 2011, Work Group Meeting New NIOSH Position on Default Values

1953-1960: Proposes no RU constituent intakes

1961-1972: Proposes “original” defaults

Pu-239 (100 ppb U) Np-237 (3500 ppb U) Tc-99 (9000 ppb U)

1973-1989: Proposes increased default values (value, basis)

Factor of 4 for Pu-239 (100 ppb U → **400 ppb U**) (Subgroup 8; MgF₂)

Factor of 3 for Np-237 (3500 ppb U → **11,000 ppb U**) (Subgroup 11; Waste Residues)

Factor of 2 for Tc-99 (9000 ppb U → **20,000 ppb U**) (Subgroup 6B; LEU products)

Based principally on MgF₂ concentration in metal reduction (Plant 5) → highest continuous worker exposures

Issue #3: Recycled Uranium - continued

SC&A position on new proposed NIOSH default values (August 2011)

1953-1960:

- This period can be bounded (site profile); however, SC&A believes that a default of zero may not be adequate in an SEC context

1961-1972:

- This period can be bounded (site profile); questions remain as to what the default should be (original vs. some higher value)
 - Impact of MgF_2 concentration with low feed levels – factor of 10 increase from < 10 ppb appears to support 100 ppb chronic intake as bounding

1973-1989:

- Proposed higher defaults; probably bounding for the highest continuously exposed subgroup of workers (Plant 5 metal workers and associated millwrights)
- Subgroup 10A feed concentrations could have impacted handlers and down-blenders; also indirect exposures (bystander effect) (SEC issue 1973-1985 (1980-85); 1986-1989 – good HP/IH program)
 - Small subset of workers but cannot identify based on work records
 - Intermittent exposures - covered by 400 ppb chronic intake? Intervals not quantified

NIOSH Action Item: quantify down-blending intervals; assess impact

SC&A action item: review NIOSH assessment

Issue #3: Recycled Uranium - concluded

NIOSH “Downblender” assessment delivered November 2011

“Rationale for 400 ppb U Pu for 10A Process Stream at Fernald,” November 1, 2011 (Rich)

Preliminary SC&A Observations

- Estimates that any single worker would have spent at most **8 percent** of their annual work hours handling unblended POOS* (Group 10A) materials
- No data located that defined the down-blending and front-end handling intervals
 - However, can narrow to 1982-1985 timeframe, based on process knowledge
- Relies on documented time to repackage 5 hoppers into drums in April-May 1982 (SRDB 33730) and assumes sufficiently bounding for subsequent steps
- Relies on unsubstantiated assumptions regarding shift time and number of hoppers handled (8 hoppers > 400 ppb measured Pu) to reach 8% estimate
 - Does not consider variability in measured Pu content/hopper (up to a factor of 3 based on DOE mass balance reports)
 - Time fraction could be higher based on reasonable alternative assumptions (e.g., all hoppers considered, 8-hour shifts)
- **Nonetheless, SC&A’s initial impression is that the problem is tractable**

SC&A to prepare response for Work Group prior to next Board meeting

*Plutonium Out Of Specification

Open Issue (#6B) Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989)

Description of Issue 6B: Use of chest counts to reconstruct Th-232 exposures (1968 -1989)

- No DWE data after MIVRML introduced in 1968 – therefore completely dependent on integrity of chest count data thereafter
- SC&A believes that large uncertainties in data may render them inadequate

Status of issue: White papers exchanged; issue first discussed in detail at the April 19, 2011, Work Group meeting

- August 11, 2011, Work Group meeting: NIOSH to provide formal responses to SC&A concerns regarding data adequacy and completeness
 - Responses delivered in November 2011
 - *“Response to SC&A Response to NIOSH White Paper on FMPC MIVRML Calibration”*
 - *“Response to SC&A Report on In-Vivo Thorium Coworker Model Data Completeness”*
 - SC&A reviewing NIOSH responses and will provide final response for WG meeting prior to next Board meeting

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

Recap: SC&A Concerns - Data Adequacy

1968–1978: Reported in milligrams (mg) thorium (period of thorium processing)

- MIVRML method appropriate for screening; not quantitative
- Questionable calibration source used to derive MDL - contaminated with Ra-228
- Questionable method to evaluate age of source and transform Ac-228/Pb-212 activity into mg Th-232 – No raw data, just mg thorium reported
 - **Uncertainty in age of source(s) at time(s) of intake (factor of about 2 for a closed system using Pb-212; orders of magnitude if Ac-228 used)**
 - Examples indicate Ac-228 used – very sensitive to age of source
- Uncertainties in the resident time in the lung (progeny in-growth and translocation; factor of 2.5 or more)
- Predates OTIB-0044 (data less than MDL)
- Inconsistencies between mg Th-232 and nCi Pb-212 for period of overlap (1978). Highest mg Th-232 correspond to negative Pb-212 results (SC&A white paper – June, 2010, Table 1)
- Data for individual workers inconsistent with biokinetic processes (SC&A Memo to NIOSH; April 6, 2011)
- Large variability and uncertainty in mg Th-232 data and lack of knowledge on derivation may preclude ability to bound intakes 1968 - 1978 (SEC issue)

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

Recap: SC&A concerns - Data Adequacy, concluded

1979–1988: Reported in nCi thorium (based on Pb-212 and Ac-228) (period of stewardship)

- Measurement variability (nCi Pb-212 and nCi Ac-228) on derived result (cited example - factor of about 2)
- Uncertainties in the resident time in the lung (progeny in-growth/translocation)
- Predates OTIB-0044 (data less than MDL)
- Uncertainties in the REMAB phantom (up to a factor of 3, pre-1983)
- Equilibrium factor (EF) of 0.42 for Pb-212 measurements based on a closed system (no translocation out of lung)
 - Experimental data indicate EF could be lower
- Raw data are available - nCi thorium data may be adequate to bound intakes (site profile)
 - NIOSH coworker model uses a GSD of 7
 - Does not appear to address measurement uncertainties
 - Possibly adequate when applied to a distribution of results for multiple workers over a year, but not quantified

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

Preliminary SC&A Observations: Response to SC&A Response to NIOSH White Paper on FMPC MIVRML Calibration” (data adequacy)

- General Issue #1: Large variability and uncertainty in mg Th-232 data and lack of knowledge on derivation
 - Original SC&A Position
 - Large uncertainties and imprecisions in the data may render them inadequate for bounding intakes
 - NIOSH position
 - SC&A arguments surrounding the lack of usefulness of the thorium lung counting data due to large uncertainties in the data are invalid
 - Large uncertainties in source data result in larger GSDs in model
 - Large proportion of sub-MDL data indicative of minimal exposure potential to thorium
 - SC&A Observation
 - SC&A’s concerns regarding disequilibrium of thorium source term(s) in absence of raw data for 1968-1978 stand (factor of 200 for Ac-228 measurements)
 - High MDL indicative of limitations in the counting system. Still has significant exposure potential at sub-MDL intakes (MDL intakes can result in Sv-level organ doses)
 - NIOSH model uses a GSD of 3 based on spread of all annual data – does not consider uncertainties in individual measurements

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

Preliminary SC&A Observations: *Response to SC&A Response to NIOSH White Paper on FMPC MIVRML Calibration” (data adequacy)*

- General Issue #2: Appropriateness of MIVRML (Y-12) method for quantitative estimates of thorium intake (SRDB 011596)
 - Original SC&A Position
 - The method used to estimate thorium burdens in mg carries many uncertainties and should only be used for qualitative assumptions about thorium burdens
 - NIOSH position
 - NIOSH does not agree with SC&A that the in-vivo counting data are only useful for screening (selected quotes from SRDB 011596)
 - Cites SC&A data completeness paper as evidence of tacit acceptance
 - SC&A Observation
 - SC&A's position stands on limitations of the Y-12 method (e.g., pp. 21, 25-26 SRDB 011596)
 - SC&A completeness study based on assumption of adequate data (completeness and adequacy studies done in parallel)

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

Preliminary SC&A Observations: *Response to SC&A Response to NIOSH White Paper on FMPC MIVRML Calibration” (data adequacy)*

- SC&A Summary Position
 - NIOSH wants to use the results in mg of thorium without knowing what those results mean
 - Do not know which daughter (Ac-228 or Pb-212) was measured
 - Do not know how the results from the daughters were transformed into thorium lung burdens
 - Do not know the sensitivity of the measurements
 - Few individuals had results in mg of thorium and results in Pb-212. Those results do not match, using NIOSH assumptions
 - Weldon Springs precedent: (pp 55-56 of NIOSH ER) disregard chest counts due to uncertainties as to when intakes occurred (disequilibrium)
 - *“The cases where such use of the in-vivo counts would be necessary would be limited to those with very specific circumstances and information”*
 - SEC Issue remains for mg thorium data (1968-1978)

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

Recap: SC&A Concerns - Data Completeness (presuming adequate data)

SC&A tasking – formal response (February and April 2011 Work Group meetings):

- Are thorium workers and their associated exposure potential adequately represented in the dataset?
- If not, do chemical operators provide a reasonable surrogate for thorium workers for use in a coworker model?
- Were the workers with the highest exposure potential to thorium targeted more frequently for monitoring?

Preliminary SC&A Observations: *“Response to SC&A Report on In-Vivo Thorium Coworker Model Data Completeness”* (1968-1978; mg thorium data)

- Issue #1: Identification of thorium workers and their relative exposure potential
 - Original SC&A Position
 - Identified thorium workers in 1968 had higher recorded lung burdens than chemical operators who were not associated with thorium work as well as the “all worker” group
 - To characterize subsequent years, a separate comparison was made which assumed that the thorium worker population was constant (1968-1978) → reached similar conclusions

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

- Issue #1, continued
 - NIOSH position
 - Analyzed empirical 1968 data using the Kolmogorov-Smirnov (KS) test and concluded thorium workers identified in Starkey memo are not from a different parent worker population
 - Does not feel comparisons assuming a constant thorium worker population are valid
 - SC&A Observation:
 - SC&A agrees that thorium workers do not constitute an independent worker population. However, SC&A's position remains that workers who handled thorium had a higher exposure potential to thorium than workers who did not
 - SC&A feels the constancy assumption would only act to underestimate the actual thorium worker exposures and so the comparisons are meaningful
- Issue #2: Number of Positive Results Identified During the Production Period
 - Original SC&A Position
 - Less than 3% of the chest counts (mg of Th) were at or above the stated MDA of 6 mg; questionable data set for developing a viable coworker model (MDL intakes can result in rem → Sv organ doses)
 - Percentage of samples >MDL for workers who handled thorium >non-thorium by factor of 2 (7% vs. 3%)

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), continued

- Issue #2, continued
 - NIOSH position
 - Coworker models use uncensored data and so the number of records below the MDA is irrelevant
 - SC&A Observation
 - NIOSH model predates OTIB-0044 and relies on OTIB-0095. Problem with large fraction of data <MDL rectified by OTIB-0044. If mg thorium data deemed adequate for DR, may need to update model (Site Profile)
 - Large proportion of lung burdens >MDL for “thorium workers” suggests that workers who handled thorium had higher exposure potential than workers who did not
- Issue #3: Monitoring Criteria for Inclusion in the MIVRML Lung Count Program
 - Original SC&A Position
 - Aside from 1968, the thorium in-vivo monitoring program was not focused on thorium workers but rather on the much larger uranium operations at the site
 - Thorium chest counts are always coupled with uranium lung counts, the reverse is not always true
 - In-vivo monitoring showed no bias towards plants with thorium operations and appeared to concentrate on Plant 5 (no known thorium operations)

Issue #6B: Use of Chest Counts to Reconstruct Th-232 Intakes (1968-1989), concluded

- Issue #3, continued
 - NIOSH position and SC&A Observation
 - Specific site interview indicates no preferential sampling was conducted for thorium workers after 1968. “People chosen for lung counts were chosen for overall exposure potential, not necessarily thorium exposure potential” (SC&A agrees)
 - Concludes that there is no correlation between a worker’s monitoring frequency and thorium lung burden (SC&A agrees)
- Summary of SC&A position on data completeness (presuming adequate data)
 - In-vivo monitoring records for thorium are essentially complete
 - No significant chronological gaps were identified
 - No evidence that highest exposed worker population was systematically excluded from the monitoring program
 - SC&A believes NIOSH should assign a sufficiently bounding intake rate (e.g., 95th percentile) to assure claimant favorability
 - ORAUT 2008 provides no guidance as to how the coworker model should be applied to assure claimant favorability
 - New NIOSH response on data adequacy suggests lower bound of 50th percentile but no guidance is provided for determining an upper bound

Recycled Thorium (new issue)

- SC&A first became aware of receipts of recycled thorium at Fernald at the SRS teleconference on August 12, 2011
- SRDB review - hundreds of metric tons of recycled thorium were received at Fernald from mid-1960s to late 1970s (most from SRS)
- Principal concern is exposures to U-233, U-232, Th-234, Pa-233, and fission products during processing, handling, and storage of RT (similar to RU)
- Previous investigations of thorium intakes have focused on proposed NIOSH coworker models based on air sampling and chest count data (SEC issue #6) and intakes of Th-230 from raffinates (SEC issue #4)
 - Ability to reconstruct intakes of RT constituents is predicated on the veracity of the thorium coworker models (SEC issue)
- Sparse data on source term configurations and periods of concern - may require data capture/review
- Accommodating RT will likely result in changes to the TBD
 - Primary constituents of interest are uranium isotopes and progeny (U-232, U-233).
 - Fernald has an abundance of U bioassay data; principal concern will be external dose (gamma from U, Th progeny; U-232, U-233 n/p ratios) and bounding internal DCFs to accommodate U-232
- SC&A to deliver a paper for discussion at the WG meeting before the next Board meeting

Summary

Issues remain to be dispositioned with NIOSH and SC&A

- Work Group deferring action on recycled uranium for 1973 through 1985 pending SC&A response to NIOSH down-blender assessment
 - Quantified front-end handling intervals to bound periods during which down-blenders (and bystanders) may have been exposed to subgroup 10A concentrations
 - Are new higher defaults bounding for those years when 10A materials handled?
 - If so, we can move this issue to Site Profile discussions?
- Work Group deferring action on thorium chest count data (1968-1978) pending further assessment
 - SC&A to provide formal responses to NIOSH on the November 2011 data adequacy and completeness reports
 - SEC concerns remain (1968-1978)
- SC&A to provide white paper on recycled thorium
- SC&A believes that the remaining SEC issues should be resolved in one final Work Group meeting

Questions?