

Fernald SEC Petition Review

Status Update

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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”
- November 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.”
- November 10, 2006: SC&A Site Profile Review
- July 2, 2007: SC&A SEC PER Review
- August 2007 → July 2013: 16 Work Group meetings
- May 24, 2011, ABRWH Meeting: SC&A presents detailed summary of SEC issues (as of April 2011)
 - [O:\AB Document Review\Fernald\SC&A Work Products for SEC Issues Resolution](#)

Status - Work Group SEC Issues

1. Coworker Model for Uranium Internal Exposures – **open**
2. Validation of the HIS-20 database – **closed***
3. Recycled Uranium (RU) – **closed***
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) – **conditional closure****
 - 6B: Chest Counts (1968–1989) – **closed*****

* Work Group recommendation.

** New coworker model introduced by DCAS since closure recommendation in 2011.

*** SEC: 1968–1978 for all workers (based on mg thorium data). 1979–1989 moved to site profile discussions March 2013 WG meeting.

Open Issue (#1): Coworker Model for Uranium Internal Exposures – Subcontractor Employees

Original Description of Issue –

Concerns regarding the completeness and adequacy of the uranium bioassay data available for dose reconstruction and supporting the Fernald internal dosimetry coworker model (OTIB-0078)

Status of Issue –

Numerous white paper exchanges and Work Group meeting discussions from inception to July 1, 2013, Work Group teleconference

At July 1, 2013, Work Group teleconference, the Work Group passed a motion to recommend to the Board that a class of workers comprising subcontractor employees at Fernald from January 1, 1951, through December 31, 1983, be added to the SEC

Coworker Model for Uranium Internal Exposures – Subcontractor Employees, continued

Central Issues

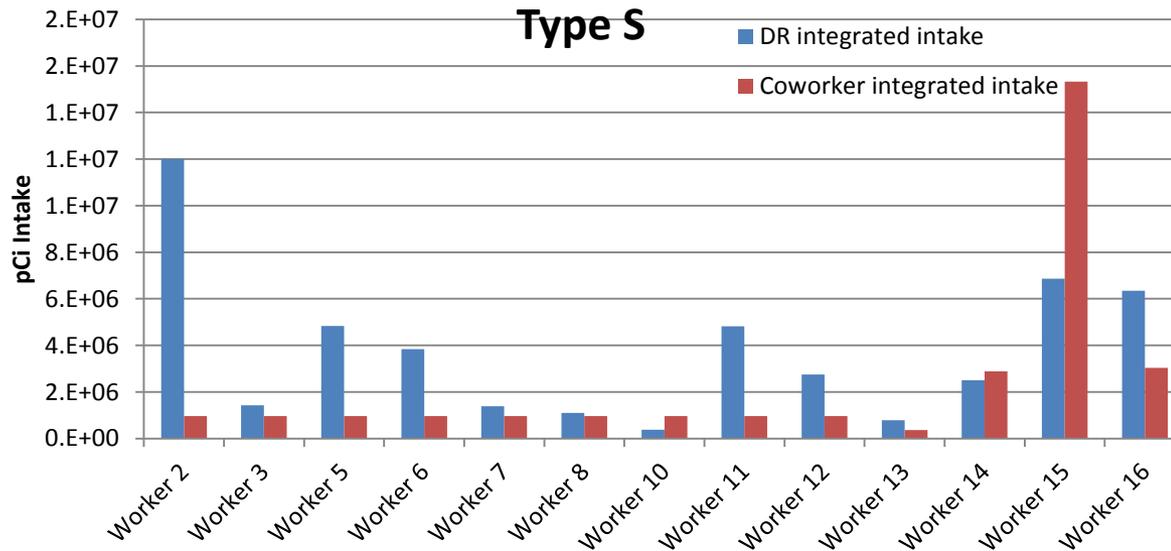
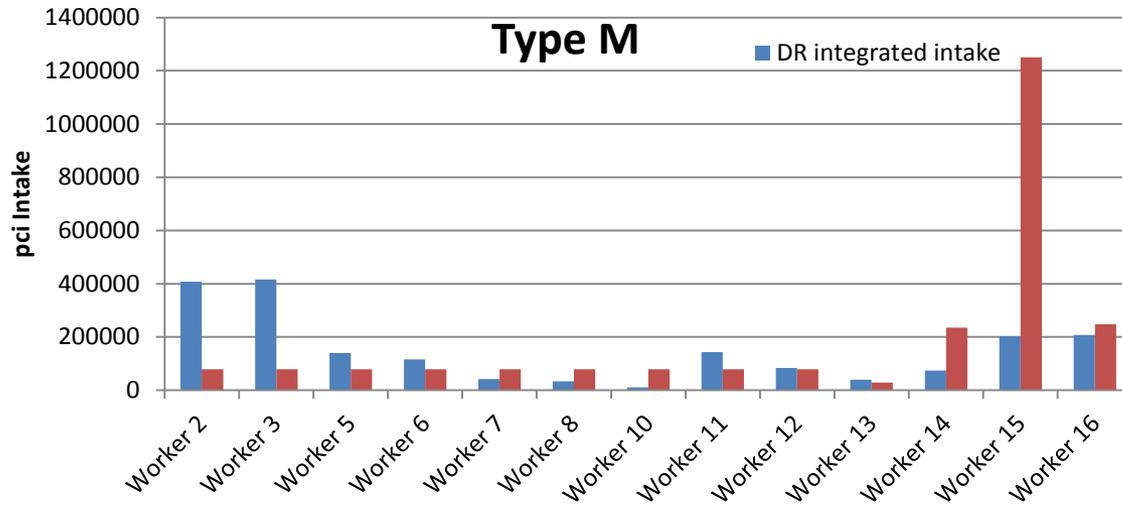
- Subcontractors were employed at Fernald from the beginning of operations in 1951
- Subcontractors were not included in the routine bioassay program until 1986, when Westinghouse took over the M&O contract from NLO
- The uranium bioassay coworker model does not include subcontractor samples prior to 1986
- Prior to the March 2013 WG meeting, DCAS located 939 hardcopy bioassay records for about 180 subcontractors collected over a 9 -year period from 1969 to 1985
- These uranium bioassay data are extremely limited and there aren't enough data to make meaningful OPOS comparisons for these earlier years
- SC&A observed bioassay records for a group of subcontractors from 1969 that appeared to be very high compared to the prime contractor data

Coworker Model for Uranium Internal Exposures – Subcontractor Employees, continued

March – July 2013 key activities and findings

- As proof of principle, the WG asked DCAS to perform “best-estimate” intake evaluations for these subcontractors using their data and compare this to what they would have received from the 95th percentile of the coworker model
- The second aspect of this comparison exercise was for DCAS/ORAUT to identify subcontractor claimants from the pre-1986 era with employment data
- If the best-estimate intake values were all bounded by what would have been assigned via the coworker model, this would be a very powerful piece of evidence that the surrogate data in the coworker model were appropriate for subcontractors
- NIOSH’s response showed that depending on the solubility class, the 95th percentile of the coworker model would bound intakes for some of the subcontractors, but not all
- SC&A observed that the NIOSH coworker doses for claimants extended far beyond the periods of bioassay intake, which biased results in favor of the coworker model
- SC&A also observed that the assumptions used for the non-claimants were arbitrary and constrained potential intake, again favoring the coworker model
- Even so, the comparison strongly suggests that the coworker model is not bounding

Coworker Model for Uranium Internal Exposures – Subcontractor Employees, continued



Coworker Model for Uranium Internal Exposures – Subcontractor Employees, continued

March – July 2013 key activities and findings

- At the July 1, 2013, WG teleconference, DCAS agreed that the uranium coworker model was not bounding for the subcontractors prior to the mid -1980s
- It was determined that the hardcopy data supported a separate coworker model for subcontractors in 1984 and 1985, but not prior

Table 1: Fernald CW Subcontractor Results in Hardcopy		
Year	No. of Individuals	Results
1969	12	52
1971	13	85
1972	6	17
1973	3	4
1981	16	35
1983	38	164
1984	82	275
1985	67	307
1986	79	370

Coworker Model for Uranium Internal Exposures – Subcontractor Employees, continued

March – July 2013 key activities and findings

- Research revealed that uncontrolled subcontractor uranium exposure potential existed as early as mid-1952 and likely since the beginning of uranium handling in 1951:
- (SRDB 3230, pg. 118) Dated August 7, 1952:

*[Redacted] has the difficult problem of getting management and supervisors educated in the fields of good housekeeping practices, general health and safety supervision and enforcement procedures which will insure proper control of uranium contamination with **hundreds of contractor and subcontractor personnel running around “loose” in the work areas.** However, the sooner National Lead of Ohio management and the top management of the construction contractor know the AEC requirements for health and safety in the plant, the sooner bad practices will be curtailed. [Emphasis added.]*
- At July 1, 2013, WG teleconference, the WG passed a motion to recommend to the Board that a class of workers comprising subcontractor employees at Fernald from January 1, 1951, through December 31, 1983, be added to the SEC

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

- **Description:** Use of BZ and GA sampling data and associated daily weighted exposures (DWEs) to reconstruct Th-232 intakes
- **Central Issues**
 - Data Adequacy and Completeness
 - Sufficient DWE Data to Bound Internal Doses from Th-232 in all Thorium buildings from 1954–1967
 - Given Adequate Data, are NIOSH’s Proposed Methods Sufficiently Robust to Reconstruct Doses in Accordance with 42 CFR 83 Accuracy Requirements?
- **Status**
 - March 2008 – June 2013
 - Numerous white papers exchanged
 - NIOSH produces 5 Revisions of the DWE Coworker Model

Review: Daily Weighted Exposure (DWE) Concept

- Introduced by AEC HASL in 1953
- Monitoring concept was transferred to the FMPC staff; used at FMPC since the beginning of site operations since 1954
- DWE reports - summaries of data prepared by the FMPC Industrial Hygiene and Safety (IH&S) staff for use by management
 - Provided Estimate of Average Worker Exposure by Job Type
 - Used to Assess and Control Radioactive Dust Levels in a Plant (not to assess intakes)
 - Provided a Standardized Methodology through FMPC History
- Based on Gross Alpha Air Activity Concentration (AAC) Measurements
 - Applicable to Workplace Alpha Emitters (U, RU, Th, U, and Th Progeny)

Review: DWE Description

- Time-Weighted Alpha Air Concentration (AAC)
 - Job- and Building-specific
 - Several Tasks per Job (3 to >20)
 - High, Low, and Average AAC in dpm/m³ Reported for Each Task Associated with a Job
 - Time to Complete Each Task Reported
 - Sample Type (BZ, GA)
 - BZ – Most Job-specific Tasks
 - GA – Ambient, Typically Less Contributor to Dose (e.g., cafeteria, washroom)

DWE Reports - Summary

- Job-Specific DWE Represents:
 - Task-weighted Average Air Concentration of Given Alpha Emitter (e.g., Th-232)
 - For Specific Day(s)
 - For the Monitored Worker(s)
 - Time Weighting is Crucial
 - Link between the AAC at a location and time to potential worker exposure
- In Reality - have a Distribution of DWEs for Workers in Any Given Job (key concept)
 - There was Spatial and Temporal Variation in AAC Experienced by Any Given Worker
 - **No Uncertainty Analysis**

DWE Uncertainty Analysis

Davis and Strom 2008 – Highlights

- Reviewed six HASL reports covering five sites that were visited between 1948 and 1955 to characterize radiological hazards arising from the use of U, U ore, Th, or Ra-226/Rn-222
- 63 job titles for which DWEs are reported. Each job title was held by 1 to 12 employees from a total of 165 employees across the sites
- Job titles involve from 1 to 13 operations, and each operation is characterized by 1 to 27 air samples. A total of 428 air samples are reported.
- A significant fraction of workers (i.e., 104 of 165, or 63%) were exposed above the contemporary *MACs*
- Focused on variability in observations as evidenced in the air sample data themselves, which dominates the *DWA uncertainty*
- ***Sources of uncertainty and variability:***
 - measurement uncertainty, variability, and mistakes in data processing and communication, and the representativeness of air samples to what a worker actually breathed
 - Variability arises due to uncertainty in aerosol particle size distributions, process variability, placement of air samplers, changes in ventilation
- Ran Monte Carlo simulations to generate distributions of discrete DWE and log-normal fits to DWE

Davis and Strom 2008 – Highlights (continued)

- Log-normal fits allow for the possibility that exposures can be larger or smaller than those actually observed
- Upper 95th percentile of the *GSD value is about 4, and the upper 99th percentile is between 7 and 8.*
 - **Supports a GSD of 5 when a concentration measurement is available, but there is no information on uncertainty.**
- Using the distribution of all air samples from a plant without time weighting or assignment to specific jobs does not produce a DWE or GSD that is representative of any individual worker for that site.
- The means of unweighted site-wide average concentrations exceed the *DWAs for all workers* in 60 of 63 cases.
- The site-wide average concentration *is a biased estimator of exposure*, but it can be used in making compensation decisions when it is required to be favorable to a claimant.

Fernald Thorium Buildings and Timeline

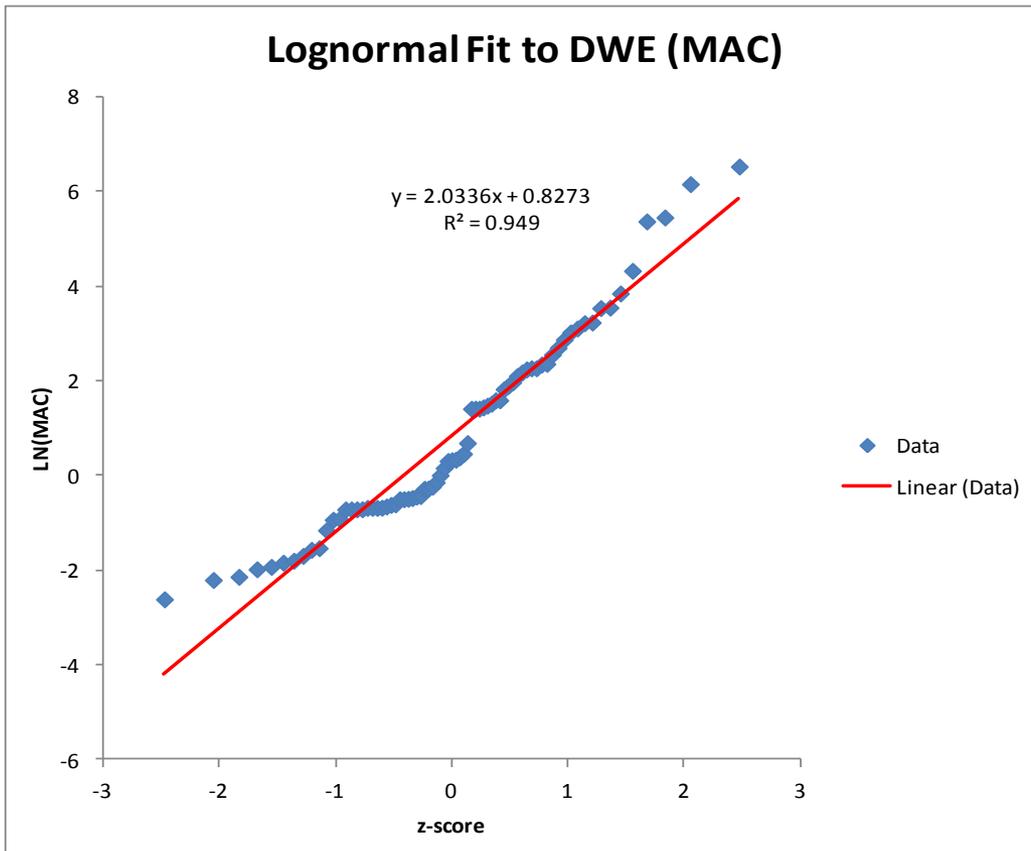
Figure 1. Graphical illustration of where and when thorium was processed at FMPC prior to 1968. "X" indicates thorium was processed, "NA" indicates that thorium is not known to have been processed in that facility at that time.

	54	55	56	57	58	59	60	61	62	63	64	65	66	67
Plant 1	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Plant 4	X	X	X	N/A										
Plant 6	N/A	N/A	N/A	N/A	N/A	X	X	X	X	X	N/A	N/A	N/A	N/A
Plant 8	N/A	X	N/A											
Plant 9	X	X	X	N/A										
Pilot Plant	X	X	X	N/A	X	X	X	X						

Reference - White Paper on the Use of FMPC DWE Reports for Estimation of Chronic Daily Intake Rate, Rev. 3, Robert Morris, Oak Ridge Associated Universities Team, Cincinnati, Ohio. October 2010.

Fernald DWE Data and Coworker Models

- March 2008 – NIOSH Posted for Review
 - 160 DWE Reports for the plants identified in the previous slide
 - Spreadsheets with Sample DWE Data for Th-232 Plants for 1955, 1966, Plant 6 for 1960



Sample data for 1955				
Data used				
Plant	Year	Workers	Job DWE	Tasks
1	1955	12	12	45
4	1955	66	45	94
9	1955	119	31	273
Totals		197	88	412

Fernald DWE Data and Coworker Models

- **March 2008 – June 2013**

- Numerous white papers exchanged
- NIOSH produces five Revisions of the DWE Coworker Model
- **March 2009 NIOSH CW Model Rev. 2**
 - Questionable statistical approach, unwarranted level of granularity (year, building, job)
 - July 2009: SC&A Review – 20 findings related to uncertainty and modeling approach
- **October 2010: NIOSH CW Model Rev. 3**
 - Incorporated uncertainty from Davis and Strom (2008)
 - Assigns the highest DWE for a given building in a given year to all workers in that building/year combination with a GSD of 5
 - SC&A agreed in principle with that approach, with the caveat that NIOSH demonstrate the feasibility of implementation
- **November 2012** – SC&A analysis demonstrates it was not possible to place workers in a given facility in a year
- **June 2013 NIOSH CW Model Rev. 5** – Like Rev. 3, it is a one size model, but assigns the highest DWE for the entire site to all workers for each year of thorium production (no attempt to place workers in particular buildings)

Fernald DWE Data and Coworker Models (continued)

Rev. 5 DCAS Coworker model uses limiting DWE for each year

Limiting Daily Weighted Exposure (MAC) for Plants and Years Where Thorium was Processed														
Location	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Plant 1	N/A*	23.4	6.1	2.2	1.4	3.0	0.7	0.9	1.5	0.9	1.0	0.9	1.4	1.7
Plant 4	6.4	4.5	1.3	-	-	-	-	-	-	-	-	-	-	-
Plant 6	-	-	-	-	-	2.6	6.2	25.0	4.0	22.3	-	-	-	-
Plant 8	-	-	-	-	-	-	-	-	-	-	-	-	10.1	-
Plant 9	N/A	215.1**	N/A	-	-	-	-	-	-	-	-	-	-	-
Pilot Plant	5.9	N/A	2.0	-	-	-	-	-	-	-	5.9	N/A	N/A	N/A

*N/A = No daily weighted exposure reports are available.

**The highest DWE value in 1955 was 686 MAC but included dust loads above the physiological tolerance level for unprotected breathing. Application of a respiratory protection factor would decrease this DWE value to less than 20 MAC. 215 MAC was adopted as the limiting case since it involved jobs within the physiological tolerance level for unprotected breathing and did not require a respiratory factor correction.

Fernald DWE Data and Coworker Models (continued)

NIOSH has Th air sampling data from the Pilot Plant from 1965 and 1967 and planned to use the 95th % of BZ samples for each year and the higher for 1966. They would then compare to Plants 1 and 8 DWE and use the highest for that year

Year	# Total Samples	Concentration (dpm/m ³)			Corresponding Intake (nCi/d)	# Total Thorium BZ Samples	Concentration (dpm/m ³)			Corresponding Intake (nCi/d)
		GM	GSD	95 th Percentile			GM	GSD	95 th Percentile	
1964	63	31.8	4.1	330.1 (4.7 MAC)	1.04	16	43.7	2.4	574.3 (8.2 MAC) ¹	1.80 ¹
1965	67	73.7	7.1	1852.4 (26.5 MAC)	5.82	21	117.0	2.4	484.6 (6.9 MAC)	1.52*
1966 ²	N/A									
1967	61	69.8	4.1	705.5 (10.1 MAC)	2.22	43	118.2	3.7	1027.3 (14.7 MAC)	3.23*

*These values do not bound the current 95th percentile values presented in ‘Summary of Thorium Intake Rate Guidance DRAFT TO DCAS 05-30-13.docx’ found at [O:\AB Document Review\Fernald\Items from Mar03_2013 WG mtg\Item 10 Method for Using DWE]. Thus, Plants 1 and 8 DWEs are bounding.

^[1] Per the NIOSH text document, they plan to use the 95th percentile of thorium breathing zone samples only.

^[2] NIOSH does not plan to use these data, but rather use the DWE values for the Stokes Furnace Operator in 1964 (4.1 N.C.G. or roughly 5.85 MAC – 1.3 nCi/d).

^[3] NIOSH plans to use the higher of the DWE values for 1965 or 1967 for this year unless bounded by Plant 1.

Fernald DWE Data and Coworker Models

- July 1, 2013, WG teleconference meeting
 - WG requested summary data for limiting DWEs proposed in Rev. 5 coworker model

Year	# of Job Types Evaluated in Thorium Plants	Limiting Plant/DWE	# of DWE's for Limiting Plant	Duration of Limiting Plant Study	Duration days
1954	14	Plant 4	14	Unspecified	
1955	59	Plant 9	32	5/17/1955 – 10/31/1955	167
1956	51	Plant 1	20	Jan-Dec 1956	365
1957	22	Plant 1	22	Unspecified	
1958	12	Plant 1	12	Aug – Nov 1958	92
1959	67	Plant 1	12	8/26/1959 – 10/1/1959	36
1960	70	Plant 6	58	3/1/1960 – 6/22/1960	113
1961	82	Plant 6	70	Aug-Oct 1961	61
1962	83	Plant 6	72	Feb-Mar 1962	28
1963	81	Plant 6	72	Oct-Nov 1963	31
1964	19	Pilot Plant	2	3/1/1964 – 10/31/1964	244
1965	16	Plant 1	16	Feb-Sept 1965	212
1966	29	Plant 8	14	Unspecified	
1967	17	Plant 1	17	Unspecified	
Average	44		31		135

Summary – Issue 6A Th-232 Coworker Model for 1954–1967 Based on DWE

- DWE data adequacy and completeness do not appear to be a problem for thorium buildings from 1954–1967 for purpose of constructing a bounding coworker model for Th-232
 - Job types appear to be well represented
 - Sufficient DWEs exist for each year and limiting plant to ascertain bounding job type
 - GSD of 5 accounts for uncertainties
 - Air dust study duration per year available for 10 of 14 years
 - Ranges from 28 to 356 days, average of 135 days
 - 1965–1967: “proof of concept” comparison shows that 95th percentiles based on DWE data from Plants 1 and 8 are bounding
 - High dust loads identified in historic communications reflected in AAC samples
 - Does not appear to be systematic suppression of high results
 - Dust studies used for process improvement, not intake assessment

SUMMARY

- Work Group recommends full Advisory Board review and action regarding dose reconstructability of subcontractor exposure at Fernald for:
 - **Uranium** from 1951 through 1983, when the uranium bioassay coworker model is not bounding for subcontractors
- Work Group recommends acceptance of NIOSH's ability to reconstruct thorium exposures from 1954 through 1967 based on the thorium coworker model based on DWE.
- Completes remaining SEC issues for petition period.
- Work Group will continue to focus on resolving remaining site profile issues.

Questions?