

# **Fernald SEC Petition Review**

SC&A Status Update since Advisory Board Meeting held  
December 7-8, 2011 in Tampa, Florida

Presented by John Stiver, SC&A

Presented to the Advisory Board on Radiation and  
Worker Health

Full Board Meeting Held in Oakland, California,

February 28-29, 2012

# 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 → February 2012: Twelve Work Group meetings
- May 24, 2011, ABRWH Meeting: SC&A presents detailed summary of SEC issues (as of April 2011)

# 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) – **closed\***
  - 6B: Chest Counts (1968 – 1989) - **open**
7. Recycled Thorium (RT) – moved to site profile discussions (Feb 9, 2012)

(\* recommended by SC&A and/or Work Group concurrence)

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

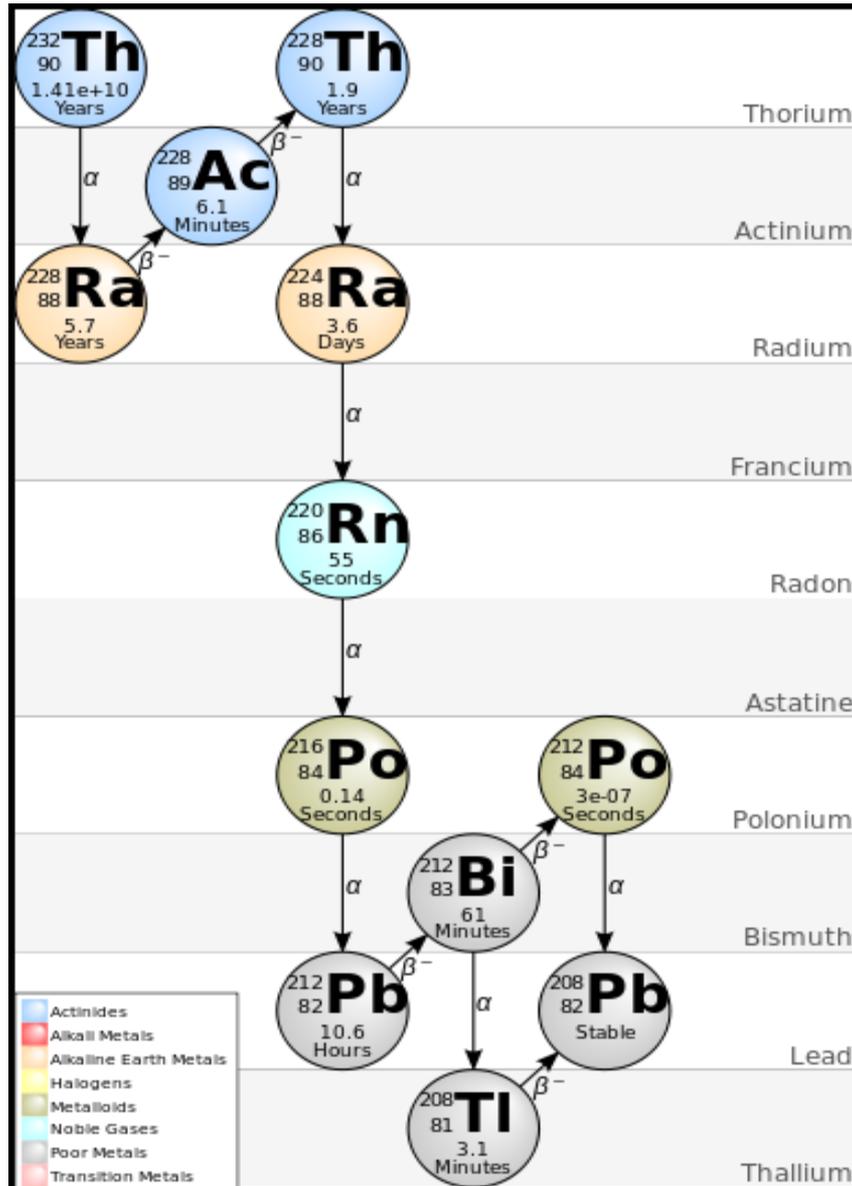
Description of Issue 6B: Use of chest counts to reconstruct Th-232 exposures

- No DWE data after MIVRML introduced in 1968 – therefore completely dependent on integrity of chest count data thereafter
- 1968-1978 – results reported in mass units (milligrams thorium) with no raw data
- 1979-1989 – results reported in activity of progeny (nCi Pb-212 and Ac-228)

Status of issue:

- White papers exchanged; issue first discussed in detail at the April 19, 2011, Work Group meeting. Discussed again in detail at August 11, 2011 and February 9, 2012 WG meetings
- SC&A Position: Two unresolved issues exist related to sufficient accuracy in data for 1968-1978 (data reported in milligrams thorium) that may render those data inadequate for DR (SEC)
  1. Large uncertainties related to how the mg thorium data were derived (potentially underestimated by factor of 100)
  2. Suitability of the MIVRML as used for accurately determining mg Th-232 lung burdens at Fernald (technical shortfall issue)

# Thorium-232 Decay Chain



MIVRML measured gammas:  
Was Ac-228 and/or Pb-212 used  
to derive Th-232 burdens in mg?

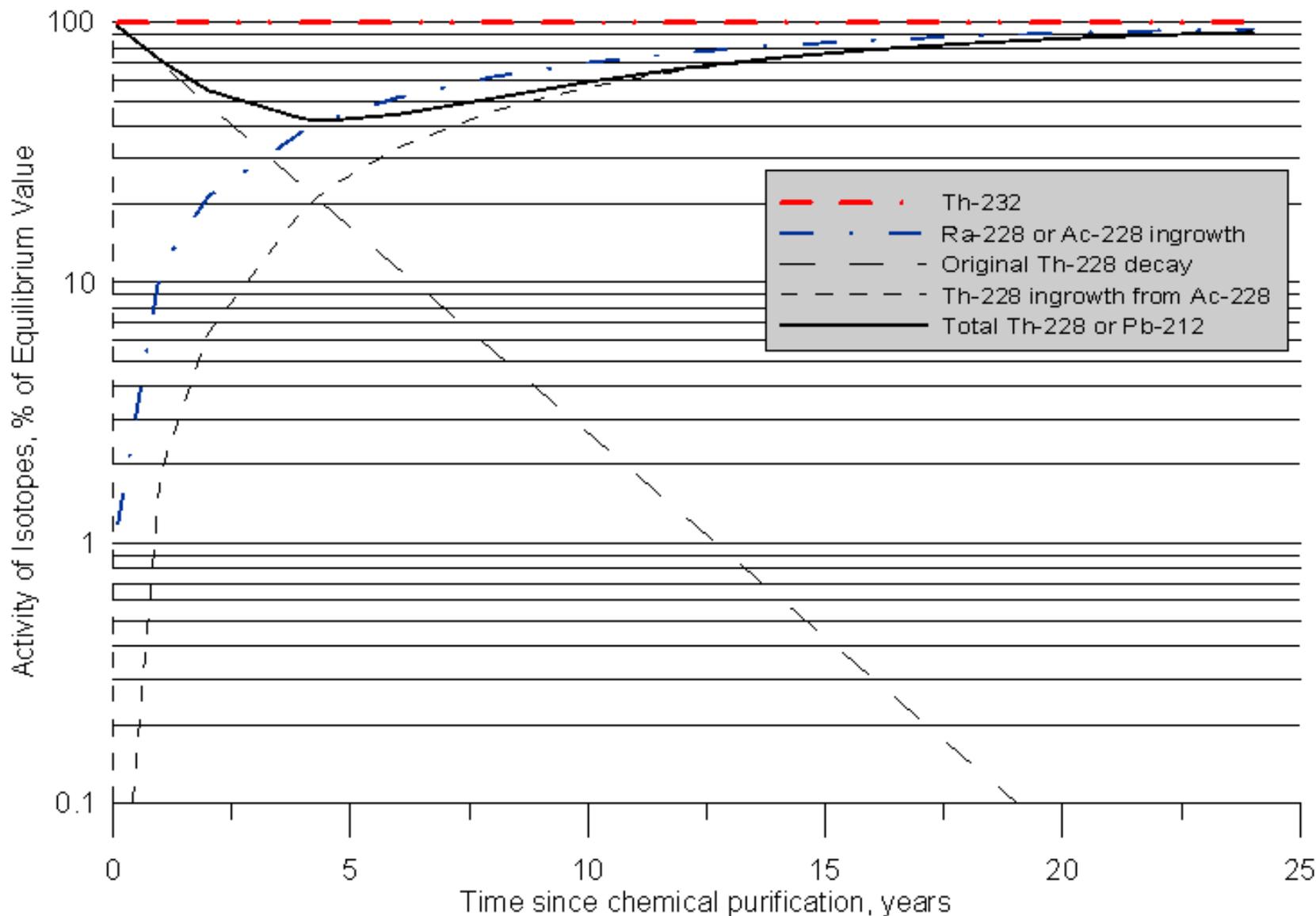
Ac-228 in Sec Eq.  
With Ra-228

Pb-212 in Sec. Eq.  
with Th-228

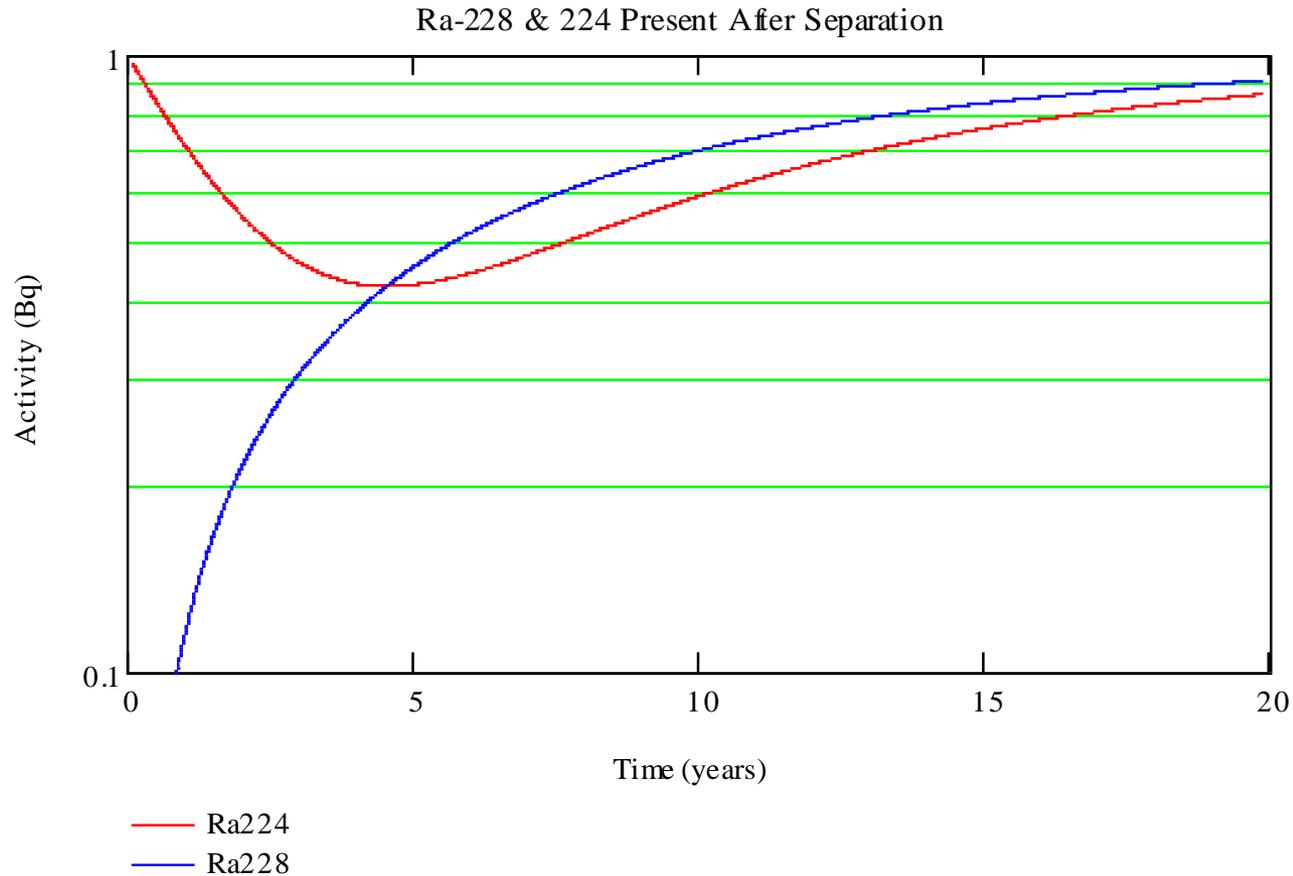
Source: Wikipedia

# Activity of Natural Thorium Following Removal of Impurities

Minimum Value of Th-228 is 42% at 4.5 Years



# Ac-228 (Ra-228) and Pb-212 (Ra-224) Buildup Following Single Chemical Purification of Thorium



Source - White Paper: Calculation of Chronic Intake IRFs for Th-232 Assuming Shared Kinetics, T. LaBone

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

## Sub-issue #1: Combination of uncertainties and variability in mg thorium data could result in underestimates of intake by up to a factor of 100

- Th-232 source terms at Fernald were at varying levels of disequilibrium
- Don't know the age(s) of the source(s), whether age corrections were made based on Ac-228 and Pb-212 or if simplifying assumptions such as presuming secular equilibrium were invoked to 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 5 for a closed system using Pb-212; Factor of 100 or more if Ac-228 used)
  - Historical reference (*Counter Thorium Calibration Runs, March 26, 1976 (Author Unknown 1976)*) recommended using process knowledge obtained from health physics staff and process engineers and/or multiple measurements of Ac-228 and Pb-212 to determine age of source
    - No evidence has been provided by NIOSH or located by SC&A to suggest that these steps were taken and the available data and references suggest that they were not
    - **SC&A examined claimant files for > MDA (6mg) results (79 results for 59 workers) – found only 30% had more than 1 measurement within 6 months and no correlation between magnitude of 1st result and sampling frequency**

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

## Impacts of uncertainties and variability - 2

- NIOSH methods assume that Pb-212 was used to derive mg Th-232 but has presented no hard evidence to support that assertion
  - Example from *Counter Thorium Calibration Runs, March 26, 1976* indicates Ac-228 used to derive mg of Th-232, with various equilibrium assumptions – very sensitive to age of source
- Burden of proof is on NIOSH to show that Pb-212 was used pre-1978 (tasking by Work Group 2/9/2012)
- Inconsistencies between mg Th-232 and nCi Pb-212 for period of overlap (1978, 1979) suggest that Pb-212 was not used to derive mg Th-232 (next slide)
  - Three highest mg Th-232 correspond to negative Pb-212 results
  - 9 values in 1979 reported as 2.9 mg but Pb-212 ranged from 0.19 to 0.40 nCi and Ac-228 from 0.33 to 0.7 nCi. These data are suspect. Only 1 Pb-212 result was less than the stated MDL of 0.23 nCi (1987).
  - **Expect proportionality between Th-232 and progeny in 1979 data (divided by plant work and by dates) because the source was probably the same**
  - **Results highlighted green:** workers co-located and measured in June, yet results of pb-212 varied from 0.25 to 0.40 nCi with the same result in mg of th-232.
  - **Results highlighted pink:** workers in plant 4 monitored in October, yet results varied from 0.19nci of Pb to 0.40nci, with the same result in mg of th-232. Also, no proportionality with ac results.

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

## Impacts of uncertainties and variability - 3

Reported Thorium Result (mg)	Reported Pb-212 Activity (nCi)	Reported Ac-228 Activity (nCi)	Monitoring Date	Location or Plant #
-5.00	-0.04	-0.02	8/29/1974	7 or Pilot
-0.60	-0.08	0.03	06/08/88	Maintenance
-0.54	-0.18	-0.01	06/12/86	5
-0.16	-0.16	-0.09	06/23/87	5
-0.12	0.06	0.01	07/10/73	6
-0.05	-0.05	0.02	05/02/87	Maintenance
-0.01	-0.01	0.05	12/09/86	No Information
0.01	-0.06	-0.08	05/02/77	Mech
0.30	0.15	0.06	04/06/77	6
1.81	-0.10	0.04	08/09/85	5
<b>2.10</b>	<b>0.25</b>	<b>0.35</b>	<b>06/02/79</b>	<b>7 or Pilot</b>
<b>2.10</b>	<b>0.30</b>	<b>0.5</b>	<b>06/09/79</b>	<b>7 or Pilot</b>
<b>2.10</b>	<b>0.40</b>	<b>0.7</b>	<b>06/12/79</b>	<b>7 or Pilot</b>
<b>2.10</b>	<b>0.40</b>	<b>0.65</b>	<b>06/19/79</b>	<b>7 or Pilot</b>
<b>2.10</b>	<b>0.40</b>	<b>0.5</b>	<b>10/08/79</b>	<b>4</b>
<b>2.10</b>	<b>0.19</b>	<b>0.33</b>	<b>10/22/79</b>	<b>4</b>
<b>2.10</b>	<b>0.27</b>	<b>0.33</b>	<b>10/29/79</b>	<b>4</b>
<b>2.10</b>	<b>0.28</b>	<b>0.41</b>	<b>10/17/79</b>	<b>4</b>
<b>2.10</b>	<b>0.29</b>	<b>0.39</b>	<b>10/15/79</b>	<b>4</b>
<b>2.20</b>	<b>-0.10</b>	<b>-0.1</b>	<b>04/13/77</b>	<b>Mech</b>
<b>4.30</b>	<b>-0.04</b>	<b>0.05</b>	<b>04/26/71</b>	<b>Inspection</b>
<b>5.10</b>	<b>-0.04</b>	<b>0.01</b>	<b>06/04/80</b>	<b>Mech</b>

Source: Table 1. SC&A Final Position on the Th-232 In-vivo Data Quality and Adequacy for FEMP Workers

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

## Impacts of uncertainties and variability - 4

- Uncertainties in resident time in the lung prior to measurement (progeny in-growth and translocation) Progeny physico-chemical behavior does not follow the parent nuclide. Even in its most soluble form, there is generally a long-term retention of thorium in the lungs following intake. In contrast, thorium daughter products, such as radium and lead, are more readily absorbed from the respiratory tract into systemic circulation. This fact was known at the time measurement took place.\*
- Data for individual workers inconsistent with accepted biokinetic processes (SC&A Memo to NIOSH; April 6, 2011)
  - SC&A final position paper Section 3.1 (p. 9) demonstrate that high values (10 and 25 mg) followed by low values weeks to months later (0.2 and 0.03, respectively) are inconsistent with accepted biokinetic modeling processes.
  - NIOSH suggested that potential clothing contamination could have resulted in such large discrepancies. While SC&A acknowledges that possibility, no follow up measurements taken on the same day, as expected for clothing contamination (Fig 12 from NIOSH Nov 2011 response)

\* West; calibration of WB in Mallinckrodt using calibration source of Th-232 in equilibrium daughters (1966, ref. number 099712)

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

## Sub-issue #2: Suitability of the MIVRML as used for accurately determining mg Th-232 lung burdens (technical shortfall issue)

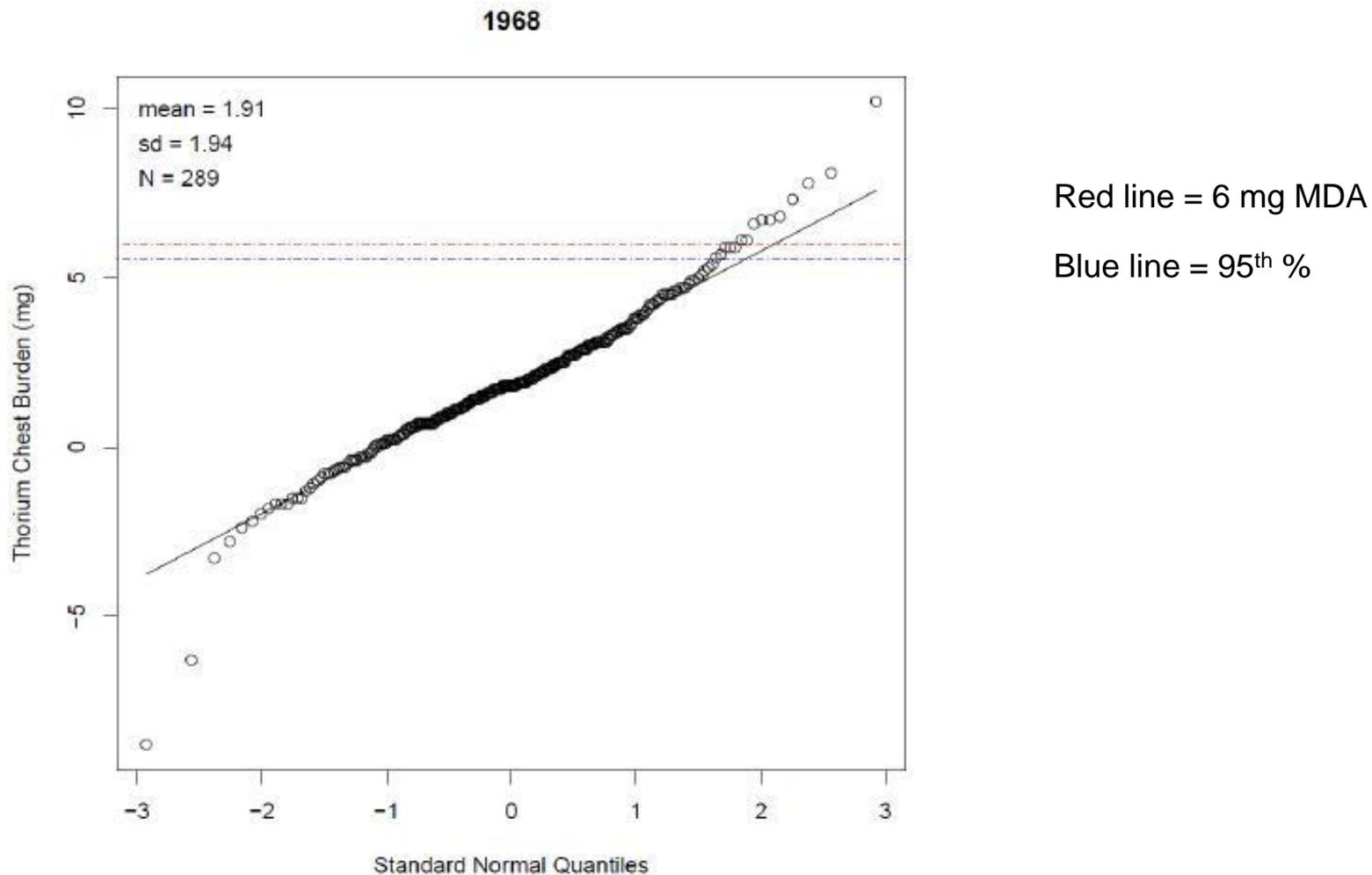
- Historical references (West 1965; 1976 Counter Calibration document, SRDB 3292 and 3521) indicate that the MIVRML results could be made quantitative only by accurately determining the age of the source (since separation) and the time lag between exposure and measurement (related to Issue #1)
- mg Th-232 data are consistent with non-quantitative methods (categorical data). This is the position still held by FMPC, as seen on the Technical Basis for Internal Dosimetry at FEMP (1997 (RSDB 003521) and 2001(RSDB 003292)
  - ***Currently [1997], in vivo measurements for Th-232 are performed by determining the amount of Ac-228 and Pb-212 present in a measurement and assuming radioactive equilibrium with the parent. Since the degree of equilibrium is rarely known, this technique is only useful for screening type measurements and should not be used as the only indication of a Th-232 intake***

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

## Sub-issue #2: Suitability of the MIVRML -2

- Figures 1-11 of NIOSH November 2011 response: demonstrate categorical nature of mg Th-232 data. 97% of results are below the stated MDA of 6 mg (next slide)
  - Small number of results in upper tail above normal probability line likely represent real but highly uncertain (unquantifiable) results while majority represent electronic background
  - NIOSH position in November 1, 2011 response was that the preponderance of results  $<$  stated MDA are indicative of background level exposure (null distribution) and confirms that only a handful of workers were actually exposed.
  - SC&A verified that normal thorium lung content in non-exposed populations is around 3  $\mu$ g, 3 orders of magnitude lower than the mg amounts reported.

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



Source: Response to SC&A Response to NIOSH White Paper on FMPC MIVRML Calibration, Nov 2011

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

## Sub-issue #2: Suitability of the MIVRML - 4

- SC&A final position paper demonstrated that intakes consistent with 6 mg or lower chest burdens could result in Sv-level dose commitments to organs of concern for thorium exposure (e.g., bone surfaces).
  - Assumed 30-day chronic intake resulting in 6 mg (stated MDA) lung burden
  - Tabulated doses are lifetime organ dose commitments that would be assigned to the year of intake under 10 CFR 835.202(a)(2)

<b>Monitored (days post-exposure)</b>	<b>Committed Dose Equivalent (bone surfaces)</b>	<b>Committed Dose Equivalent (lung)</b>
<b>30</b>	<b>130 rem</b>	<b>10 rem</b>
<b>60</b>	<b>170 rem</b>	<b>15 rem</b>
<b>150</b>	<b>320 rem</b>	<b>30 rem</b>
<b>240</b>	<b>560 rem</b>	<b>50 rem</b>
<b>235</b>	<b>970 rem</b>	<b>80 rem</b>

Dose commitments calculated by Dr. Joyce Lipsztein using AIDE

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

## Suitability of the MIVRML - 5

- SC&A also demonstrated that intakes consistent with lung burdens at ½ the stated MDL (nominally 3 mg) could result in up to Sv-level **compensable** doses (e.g., bone surfaces, liver, red marrow, lung).
  - Example Scenario (lowest intake considered)
    - Caucasian male born 1948
    - Chronic exposure during 5 years to freshly separated Thorium (1968-1972)
    - Chest Monitoring taken 1 month after last day of exposure: Result 3mg of Th-232 (12.24 Bq)

Type	Bone		Liver		Leukemia (AL)		Lung	
	CDE	IREP	CDE	IREP	CDE	IREP	CDE	IREP
Diagnosed	Bone Surf	99%	Liver	99%	red marrow	99%	lung	99%
1978	217.14	94.00%	6.31	62.25%	15.58	85.43%	62.13	88.60%
1982	294.24	95.27%	7.74	67.04%	19.20	86.28%	62.29	88.11%
1987	363.34	95.87%	8.88	68.89%	21.88	87.45%	62.46	86.50%
1992	428.84	95.89%	9.90	68.88%	24.13	87.44%	62.65	86.09%

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

## Suitability of the MIVRML - 6

- System limitations for Th-232 measurement were known at the time and methods identified by which quantitative measurements could be made yet there is no indication that such methods were implemented at FMPC for mg Th data
- Claimant information and historical documentation indicate that the MIVRML was used primarily to measure uranium lung burdens and that thorium measurements were a secondary concern
  - Only one attempt to measure thorium workers (1968) and roster was incomplete
  - Hardcopy NOCTS files of 15 claimants identified from the list of 59 workers that had results above 6 mg of thorium.
    - None of the worker files contained any attempt to calculate the % of MPLB for thorium.
    - Conversely, almost all the workers had calculations of the % of MPLB for uranium.
    - Furthermore, almost all of the in-vivo monitoring results that were repeated within a period of 6 months were geared to the calculation of % of the uranium MPLB

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

## Concluding statements – 1968-1978 mg thorium data

- **SC&A interpretation of NIOSH position (February 9, 2012 WG meeting)**
  - High intakes based on the MIVRML background distribution are acceptable for a coworker model given a stable counting system that yields reproducible results
  - Actual burdens were probably in the mg range. Therefore the assignment of high doses is plausible and claimant favorable
    - Plots show small groups with real lung burdens in the mg range (slide 14)
  - Consistent with other bounding “one-size-fits-all” models
- **SC&A Position on mg thorium data**
- Limited sensitivity of MIVRML (high MDL) combined with the large uncertainties in the mg Th data suggest that from 1968-1978 the counting system was not used in a manner that resulted in sufficiently sensitive or accurate results for ascertaining Th-232 lung burdens (and intakes) in an SEC context
  - Likely that a limited number of workers received Th-232 intakes (categorical)
  - Range of dose commitments from an intake consistent with an MDA lung burden can be from 0→1000 rem for bone surfaces.

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

## Concluding statements – 1968-1978 mg thorium data - 2

- **SC&A Position - continued**
  - Upper end of dose range is far in excess of regulatory limits (10 CFR 835 organ dose limit of 50 rem CDE/yr) and likely compensable for most specified cancers yet is based on a distribution of electronic background noise
  - **>MDA burdens could have been more than an order of magnitude higher than 6 mg**
    - **How can that be bounded? Look for deterministic effects?**
  - Coworker model will compensate a large number of Fernald workers (no constraint based on building/year as with DWE) yet lacks a defensible technical basis.
  - Fairness considerations for workers outside timeframe or at other sites?
- **SC&A and NIOSH have reached divergent conclusions based on their respective interpretations of the facts regarding mg Th-232**
  - We both acknowledge large uncertainties and very high doses that result from using the mg thorium data. Disagreement is in regard to whether the data meet the intent of sufficient accuracy as applied to SEC determinations under EEOICPA
- **SC&A believes that the technical issues regarding the use of the 1968-1978 have been fully explored and debated and that this is now a policy decision to be taken up by the Board**

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

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

- **Uncertainty and variability**
  - “Raw data” (nCi Pb-212 and Ac-228) are available – allows quantification of source age since separation within reasonable limits
  - Other sources as stated for mg thorium (1968-1978)
  - New NIOSH paper (*White Paper: Calculation of Chronic Intake IRFs for Th-232 Assuming Shared Kinetics*, T. LaBone) reviewed by SC&A
    - A good theoretical paper that shows a method to calculate IRF for chronic intakes (not available in IMBA)
    - Appendix A is very useful for bounding doses for the period after 1979 when results of Pb-212 are explicitly given
      - Worst case adjustment factor of about 5.3 based on 3 sequential chemical separations
    - Formal white paper response to be delivered to WG
- **Conclusion: Can probably assign plausible upper bound intakes based on these data**

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

## 1979–1988: nCi thorium - 2

- **Suitability of the MIVRML methodology**
  - About 96 percent of the data are less than the Pb-212 MDA of 0.23 nCi
    - May still have issues regarding sufficient accuracy for results based on sub-MDL data when combined with high (compensable) organ doses
  - Not until 1990s when better urine bioassay techniques using ICP mass spectroscopy were employed to yield results in ug Thorium (actual background levels)
  - The issue of technical shortfalls in historic measurement techniques as applied in dose reconstruction and SEC determinations may be an overarching issue to be considered by the Board

# 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/subcontract 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 response delivered January 23, 2012

# Issue #1: Co-worker Model for Uranium Internal Exposures-2

## SC&A Observations – January 23, 2012 response

- NIOSH concluded that most construction worker bioassay records in the database are coded with sample “Type 50” (meaning “special sample”)
- These "special" records were not included in the original coworker model because they were presumed to not reflect normal worker intakes
- 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
  - If directly compared, data for subcontractors would be much higher than the factors they found (5→8). How much higher depends on the relative sample sizes
  - Basis for rejecting direct comparison in lieu of a “pooled” approach is not substantiated
- The paper contains minimal 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) to substantiate their position

# Issue #1: Co-worker Model for Uranium Internal Exposures-3

## February 9, 2012 WG meeting

- NIOSH concluded that many of the “Type 50” bioassay records in the database are for construction workers. It has not been established how many “Type 50” records actually represent subcontractors vs. site employees
- NIOSH analysis adds these “Type 50” samples to the coworker dataset to determine a ratio between the new and old coworker doses but does not perform a direct comparison (subcontractors versus rest of workers)
- NIOSH rationale for “pooling” the data:
  - Observation 1: many samples appear to be contaminated with large differences in “end of shift” samples and samples taken following morning
  - Observation 2: given the smaller sample size for ‘Type 50’, direct comparisons can be greatly influenced by outlier values
  - Observation 3: ‘Type 50’ records represent acute intakes over short duration. Without knowing employment start dates, intakes based on such measurements could be implausibly high
    - Therefore “pooling” the data with the original coworker model and assigning chronic intakes would be plausible yet bounding for subcontractors

# Issue #1: Co-worker Model for Uranium Internal Exposures-4

## February 9, 2012 WG meeting

- Observations and rationale have not yet been quantified (number of suspected contaminated samples, actual employment periods, effect of outliers, etc.)

### SC&A Action Items:

- Obtain from NIOSH the complete urine bioassay spreadsheet (not previously provided) and hardcopy subcontractor bioassay records (from Table 1 references in NIOSH white paper) and identify records that pertain to these subcontractors only. Revise January 2012 white paper comparison accordingly.
- If NIOSH determines that intake determinations are feasible for individual subcontractors, they will prepare a white paper comparison of subcontractor and site employee intake distributions over specified employment periods. SC&A will review that document when it becomes available.

# 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. **Moved to site profile discussions at February 9 WG meeting**

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; MgF<sub>2</sub>)

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 MgF<sub>2</sub> 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 - continued

NIOSH “Downblender” assessment delivered November 2011

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

SC&A response provided February 6, 2012

SC&A Observations on NIOSH report:

- Estimates that any single worker would have spent at most **8 percent** of their annual work hours handling unblended POOS\* (Group 10A) materials
- Relies on documented time to repackage 5 hoppers into drums in April-May 1982 (SRDB 33730) and assumes sufficiently bounding for subsequent steps
  - SC&A concurs that this is an acceptable approach given weight of evidence
- 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)

\*Plutonium Out Of Specification

# Issue #3: Recycled Uranium - concluded

## SC&A Observations on NIOSH report, continued:

- SC&A estimates that any single worker could have spent up to **14 percent** of their annual work hours handling unblended Group 10A materials based on:
  - Average plutonium concentration in the 16 hoppers on a U mass basis was about 1,122 ppb
  - Assumed baseline concentration for less exposed workers (other than Plant 5 metal workers and Plant 1 millwrights) = 100 ppb
  - Shift time = 8 hours (no reduction for protective measures and respirators)
  - Average mass processed per shift = 11,875 kg/19 shifts = 675 kg/shift
  - Given 8 hours per shift, it would take about 288 hours in 36 shifts to process all 16 hoppers
  - Maximum percentage of annual time allotted to POOS handling =  $288/2,080 = 13.86\%$

Weighted average Pu concentration over a year:

$$Pu_{avg} = ((1,792 \text{ hr} \times 100\text{ppb}) + (288 \text{ hr} \times 1,122 \text{ ppb}))/2,080 \text{ hr} = 242 \text{ ppb}$$

**Conclusion: 400 ppb is probably bounding for workers handling Group 10A materials – Move to SP discussions**

# 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)
- SC&A delivered a paper for discussion at the February 9, 2012 WG meeting
  - Determined that presence of RT at Fernald does not significantly contribute to unmonitored external exposures
  - Internal exposures from RT are predominantly from thorium. However, determined that U-232 and U-233 intakes at bounding levels can result in rem level organ doses
  - NIOSH may wish to further investigate the impact of uranium contaminants in RT when assigning internal dose commitments from intakes of thorium at Fernald (SP issue)

# Summary

## Issues remain to be dispositioned with NIOSH and SC&A

- Work Group deferring action on thorium chest count data (1978-1988) pending further assessment
  - SC&A to provide formal responses to NIOSH white paper *Calculation of Chronic Intake IRFs for Th-232 Assuming Shared Kinetics*
- Work Group deferring action on adequacy of uranium urine bioassay coworker model as applied to subcontractors pending further assessment
  - SC&A to revise January 2012 white paper comparison based on identification and analysis of records that pertain to these subcontractors only.
  - If NIOSH determines that intake determinations are feasible for individual subcontractors, they will prepare a white paper comparison of subcontractor and site employee intake distributions over specified employment periods. SC&A will review that document when it becomes available.

Questions?