Savannah River Site Special Exposure Cohort Petition Evaluation Report Addendum #2 – Thorium

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Petition Overview

- November 2007: Petition received
- December 2008: Evaluation Report presented to the Advisory Board
- May 2010: Evaluation Report Addendum – Thorium presented to SRS Work Group
- January 2011: Work Group/SCA comments received
  - Significant Work Group finding: Potential thorium work in other areas not discussed in the Evaluation Report Addendum

Petition Overview—cont.

- February 2011: SRS status update presented to the Advisory Board
- SRS update on priority issues—thorium
  - Discussed the isotope development and production process
- Laboratory research
- Semi-works
- Fuel target fabrication
- Reactor irradiation
- Chemical separations

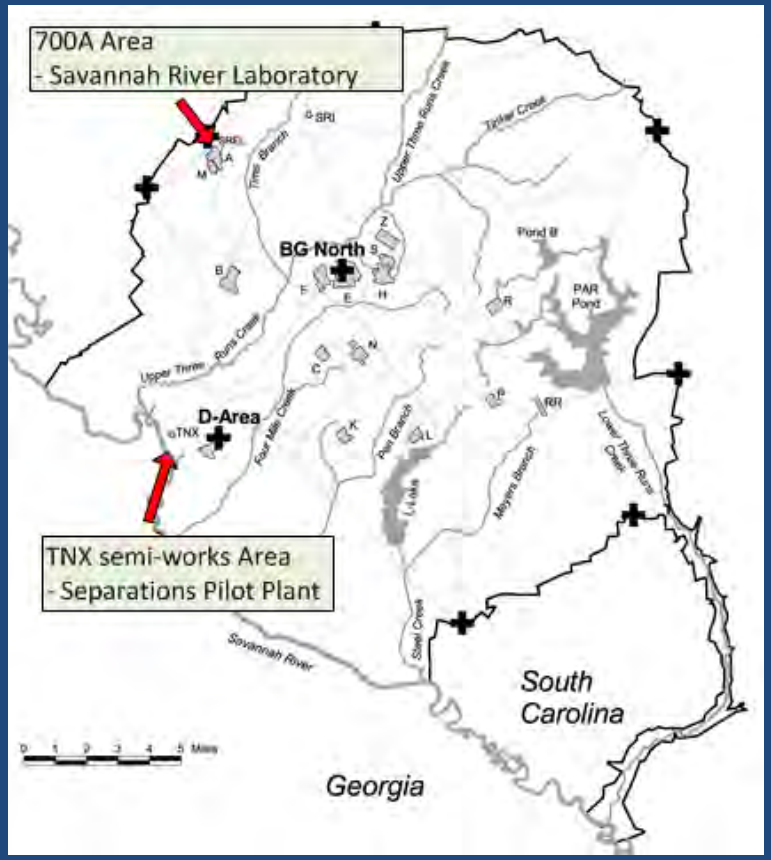
Recommendation to the Advisory Board

- A class be added to the Special Exposure Cohort based on internal thorium exposures in 773A and the TNX facilities

- Class definition based on external monitoring
  - Workers likely exposed
  - Workers who may have been exposed
  - Workers who were not exposed

Thorium Research and Development

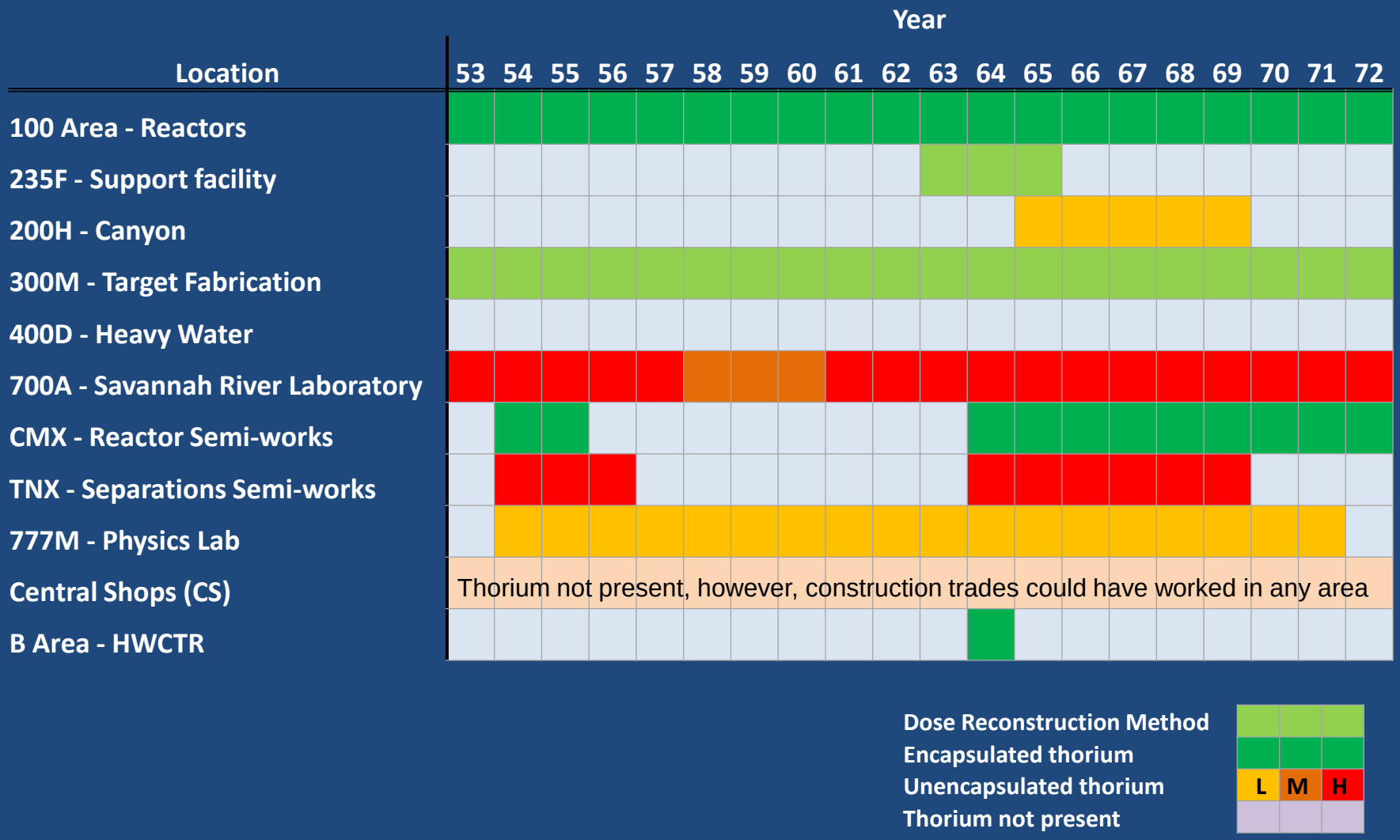
- Lab work (700A)
- Semi-works (CMX/TNX)
- Fuel and target fabrication (300)
- Reactor irradiation (100)
- Chemical separations (200)
- Heavy water production (400)



Thorium Work at SRS

- Dose reconstruction methods for 300 area
  - Potential for internal exposure, but dose reconstruction method can bound the dose
- Encapsulated = no internal exposure potential
- Unencapsulated = potential for internal exposure

Thorium Dose Reconstruction



Additional Research Conducted

- Reviewed
  - Inventory reports
  - Monthly technical reports
  - Health Physics Logbooks (773A & CMX/TNX)
- Conducted interviews
- Other areas
  - Savannah River Laboratory (773A)
  - Semi-works plants (CMX/TNX)
  - Burial grounds
  - Separations area (200H)

Savannah River Laboratory 773A

- Generally research in SRL was with small quantities of thorium
- A report indicating center sections cut from 12 irradiated slugs using an underwater saw.
  - Sections dissolved and two 8 mL samples were analyzed
    (DPST-55-412, SRDB: 94565)

Dry box for the electrolysis of thorium compounds (DPST-55-388, SRDB: 70791)

Savannah River Laboratory 773A—cont.

- Exception was the metal fabrication lab
  - D wing or Part III of SRL
- Intense research activities 1953 into 1957 and then, they appear to stop
  - Neptunium research began using thorium as a surrogate starting in 1959
- Research picked back up in the mid 1960s and continued until 1971

Savannah River Laboratory 773A—cont.

Savannah River Laboratory 773A—cont.

- Active radiological protection program
  - Routine surveys of corridors
    - —Most indicated “no contamination detected”
  - Documented “spills” and incidents
    - —One spill indicated 37cpm highest smearable
    - —Others spills several thousand cpm
  - Routine surveys of special work and materials leaving the building
- Researchers conduct of operations
  - Sometimes less than formal and documented by Radiation Control Technicians

Savannah River Laboratory 773A—cont.

- Bioassay data
  - 1956 only
  - 225 samples for 175 workers
  - Indication in logbook of beginning to compile list of workers who ever worked with thorium
- Air sampling
  - Not breathing zone representative (interviews)
  - Could not locate significant air sample data
    - —Apparently different recording practice for the technical area as opposed to production areas

Savannah River Laboratory 773A—cont.

- Smear data
  - Data available in Health Physics logbooks
  - Tremendous effort to locate all logbooks, code all of the data to develop an exposure model
  - Not clear where routine samples were taken within the labs—some samples indicate edge of hood, but others do not indicate location
  - Most (not all) routine data stated as “no contamination detected” with no further information
  - After the analysis, still not sure exposure model would be reasonable

Savannah River Laboratory 773A—cont.

- Source-term (modeling)
  - Different chemical and physical forms in every laboratory and within laboratory
  - Constant movement of material between laboratories
  - Cannot place people in specific laboratories (especially construction workers)

Semi-Works (TNX)

Swanson, 2006

Semi-Works (TNX)—cont.

- Scaled up dissolving experiments from lab scale to semi-production scale
- Inventories indicate intermittent work with thorium
  - August 1954 – December 1956
  - September 1964 – December 1969
- Inventories indicate significant quantities of thorium (few tons)
  - Some information about quantity of material in dissolvers (few tons)

Semi-Works (TNX)—cont.

- Internal radiation monitoring data
  - No bioassay although some of the workers moved between 773A and TNX
  - No air sample data located for TNX
  - Health Physics logbooks similar to 773A
    - —Surveys note levels but not exact locations
  - Source-term data
    - —Similar issues to 773A but not as complex

Burial Grounds

- Material going to burial grounds was surveyed for contamination
  - 300 area radiation survey log sheets
  - 773A Health Physics logbooks
  - TNX Health Physics logbooks
- High level cave waste was encapsulated in concrete and sent to burial ground

200H Separations

- Uranium-233 was the product
- Due to extremely high photon dose rate (R/hr), minimal potential for internal exposure
- Wet process dissolving irradiated thorium in canyons
- Transfer from hold-up tank to railroad cars
- Rail cars equipped with filters to prevent particulate contamination during filling and thermal expansion
- Due to high photon dose rate, rail cars were roped off and inspected via binoculars for leaks

NIOSH Proposed Class

All externally monitored employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Savannah River Site from January 1, 1953 through December 31, 1957, and whose records have dosimetry codes A, G, CMX, or TNX; and all externally monitored employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Savannah River Site from January 1, 1958 through September 30, 1972, and whose records have dosimetry codes 5A, 5C, 6B through 6Z, 12D through 12H, or 12J through 12Z for a number of work days aggregating at least 250 work days, occurring either solely under this employment or in combination with work days within the parameters established for one or more other classes of employees included in the Special Exposure Cohort.

Thorium Feasibility Summary 53-57

Function	Area Designation	HP Area Code	Unencapsulated Thorium	Encapsulated Thorium	Inclusion in SEC
Separations	200F	F	No	No	No
	200H	H	No	No	No
Manufacturing	300M	M	Yes	Yes	No
Heavy Water	400D	D	No	No	No
Laboratory	773A	A	Yes	Yes	Yes
Physics Lab	777M	M	Yes	Yes	No
Semi-works	CMX/TNX	A,G,CNX,TNX	Yes	Yes	Yes
A Area support		A			Yes
Reactors	100R	R	No	Yes	No
	100P	P	No	Yes	No
	100L	L	No	Yes	No
	100K	K	No	Yes	No
	100C	C	No	Yes	No
Central Shops	CS	G			Yes

Thorium Feasibility Summary 58-72

Function	Area Designation	HP Area Code	Unencapsulated Thorium	Encapsulated Thorium	Inclusion in SEC
Separations	200F	1A	No	Yes	No
	200H	2A	Yes	Yes	No
Manufacturing	300M	3A	Yes	Yes	No
Heavy Water	400D	4A	No	No	No
Laboratory	773A	5A	Yes	Yes	Yes
Physics Lab	777M	5B	Yes	Yes	No
Semi-works	CMX/TNX	5C	Yes	Yes	Yes
A Area support		6B-6Z			Yes
Reactors	100R	7A	No	Yes	No
	100P	8A	No	Yes	No
	100L	9A	No	Yes	No
	100K	10A	No	Yes	No
	100C	11A	No	Yes	No
Central Shops	CS	12D-12H 12J-12Z			Yes

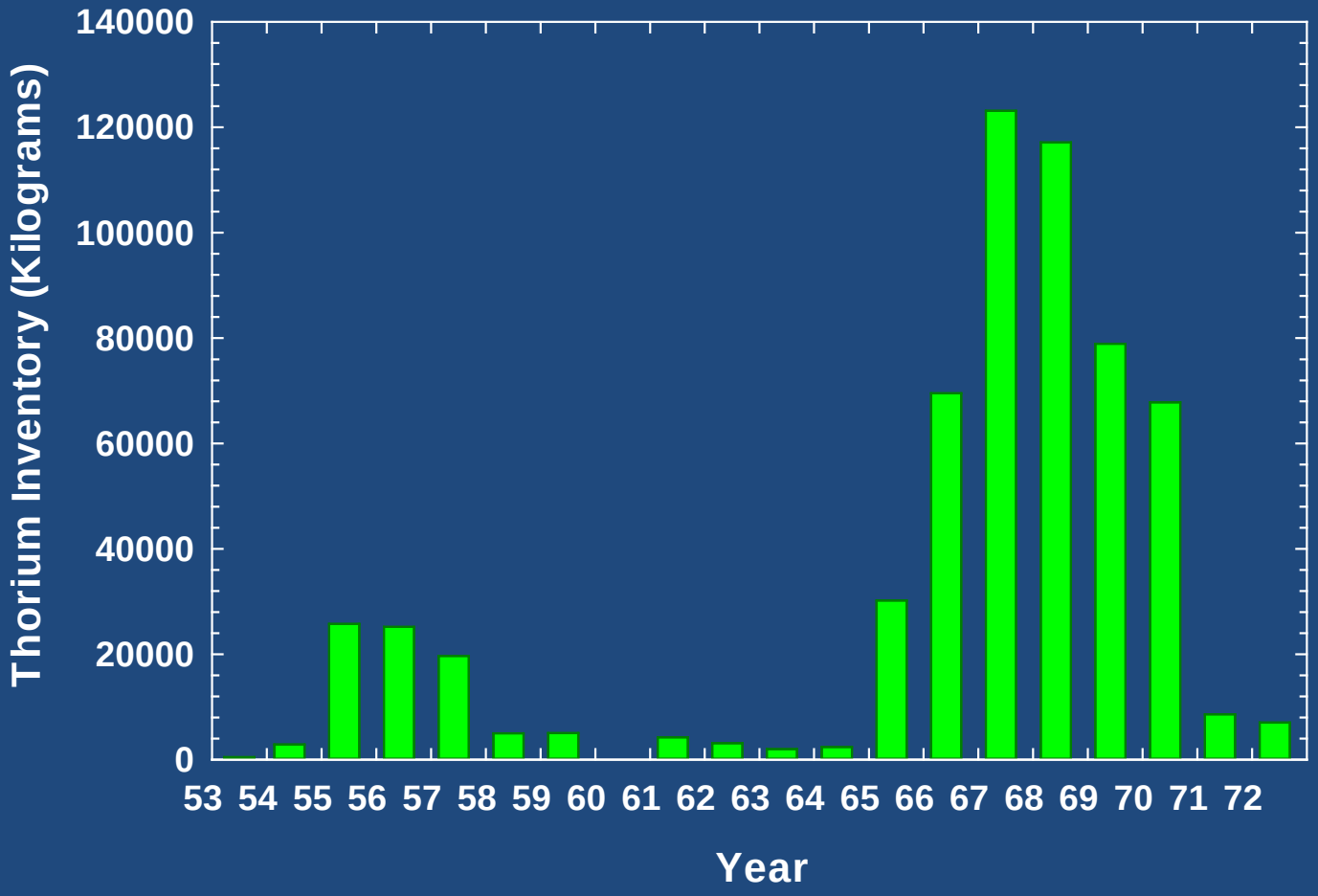
Recommendation to the Board

- All workers had to wear a dosimeter to enter a regulated area (radiation area)
- Class definition based on external monitoring
  - Workers *likely* exposed
    1953-1957 Dosimeter Codes = A, CMX, TNX
    1958-Sept. 1972 Dosimeter Codes = 5A, 5C
  - Workers who *may have been* exposed
    1953-1957 Dosimeter Codes = G
    1958-Sept. 1972 Dosimeter Codes = 6B-6Z, 12D-12H, 12J-12Z
  - Workers who *were not* exposed
    All other dosimeter codes

SEC End-Date Determination

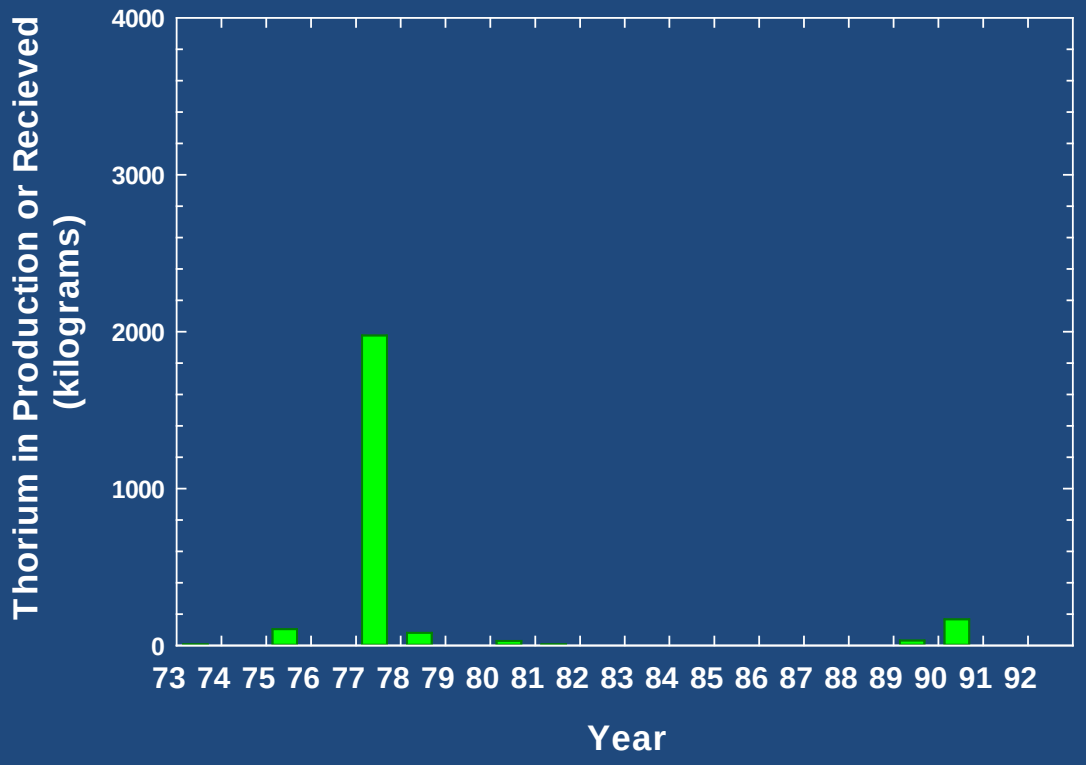
- Major drop in thorium inventory
  - 773A less than 225 kilograms
  - TNX no inventory after June 1969
- End-date coincides with D&D of 300M area thorium oxide room signifying end of production and effectively research
- Whole body count information more readily available after 1971

Thorium Inventory

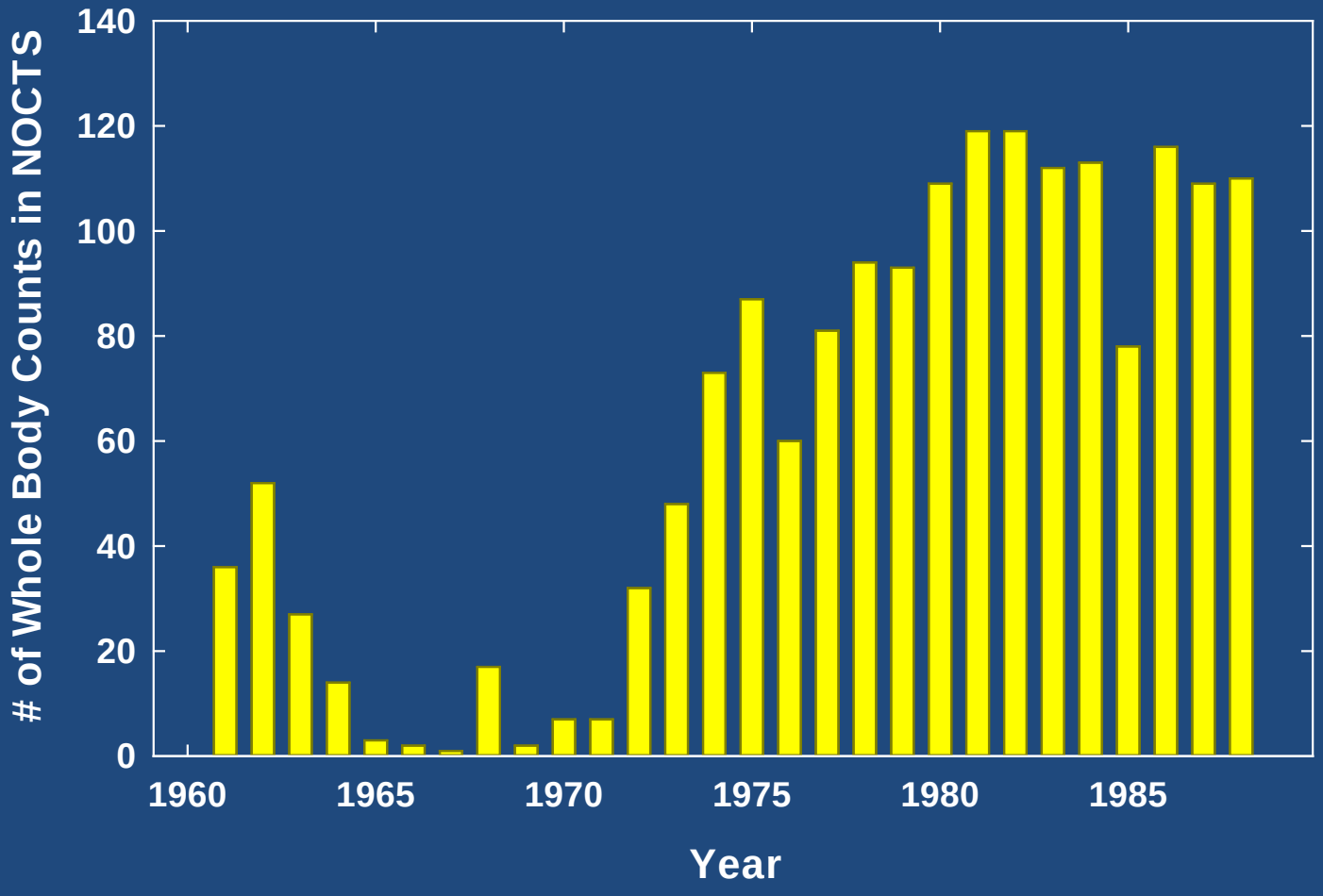


Additional SEC End Date Research

- Inventories indicate some <u>small</u> thorium work in later years



Whole Body Count Data



Feasibility Summary

Feasibility Findings for SEC-00103 (Thorium)		
Source of Exposure	**Dose Reconstruction Feasible**	**Dose Reconstruction NOT Feasible**
Internal		
- Thorium **(1953 – 1957) A,G,TNX,CMX** **(1958 – Sept 1972) 5A, 5C 6B-6Z & 12C-12H & 12J-12Z**		**X**
External		
- Beta-Gamma	**X**	
- Neutron	**X**	
- Occupational Medical X-ray	**X**	

Health Endangerment

- The evidence reviewed in this evaluation indicates that some workers in the class may have accumulated chronic radiation exposures through intakes of thorium.
- Consequently, NIOSH is specifying that health may have been endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

Recommendation

- For the period January 1, 1953 through September 30, 1972, NIOSH finds that radiation dose from exposure to thorium in 773A and TNX facilities cannot be reconstructed for compensation purposes

Class	Feasibility	Health Endangerment
January 1, 1953 – September 30, 1972	No	Yes