



ORAUT-RPRT-0091

Evaluation of Savannah River Site Americium-241 Source Terms Between 1971 and 1999 Using Bioassay Frequency Tables

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SRS / SEC Working Group Meeting

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Acknowledgements

- ORAUT SRS SEC Team members
 - Mike Mahathy, HP Lead Savannah River Site
 - Roger Halsey, CHP

Overview

- Background
- RPRT-0091 Outline
 - Section 1: Introduction (What was the driver for this report?)
 - Section 2: Internal Dosimetry Program Self-Assessment
 - Section 3: In Vivo and In Vitro Bioassay Monitoring
 - Section 4: Am/Cm/Cf Source Terms from Bioassay Frequency Tables
 - Section 5: Dose Reconstruction Considerations
 - Section 6: Conclusions
 - Responses to 5 SC&A Questions



Background

- **November 14, 2017:** SRS Workgroup meeting, SC&A stated concerns that workers were enrolled in incorrect bioassay programs prior to 1999 and that some workers were exposed to unrecognized Am-241 sources.
- **January 11, 2018:** SC&A memo, Missing or Incomplete Radiological Source Terms (includes 5 questions) [SRDB Ref ID: 171543]
- **June 10, 2019:** ORAUT-RPRT-0091, response to issues raised in January 11, 2018 memo (includes response to 5 questions) [SRDB Ref ID: 176723]
- **January 23, 2020:** SC&A memo, a review of Report 91 (no observations or findings, new concerns DuPont / Westinghouse, review of responses to 5 questions) [SRDB Ref ID: 179245]
- **October 2, 2020:** NIOSH memo, addressed concerns in January 23, 2020 memo

Section 1: Introduction

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Evaluation of Savannah River Site Americium-241 Source Terms Between 1971 and 1999 Using Bioassay Frequency Tables dated 6/19/2019

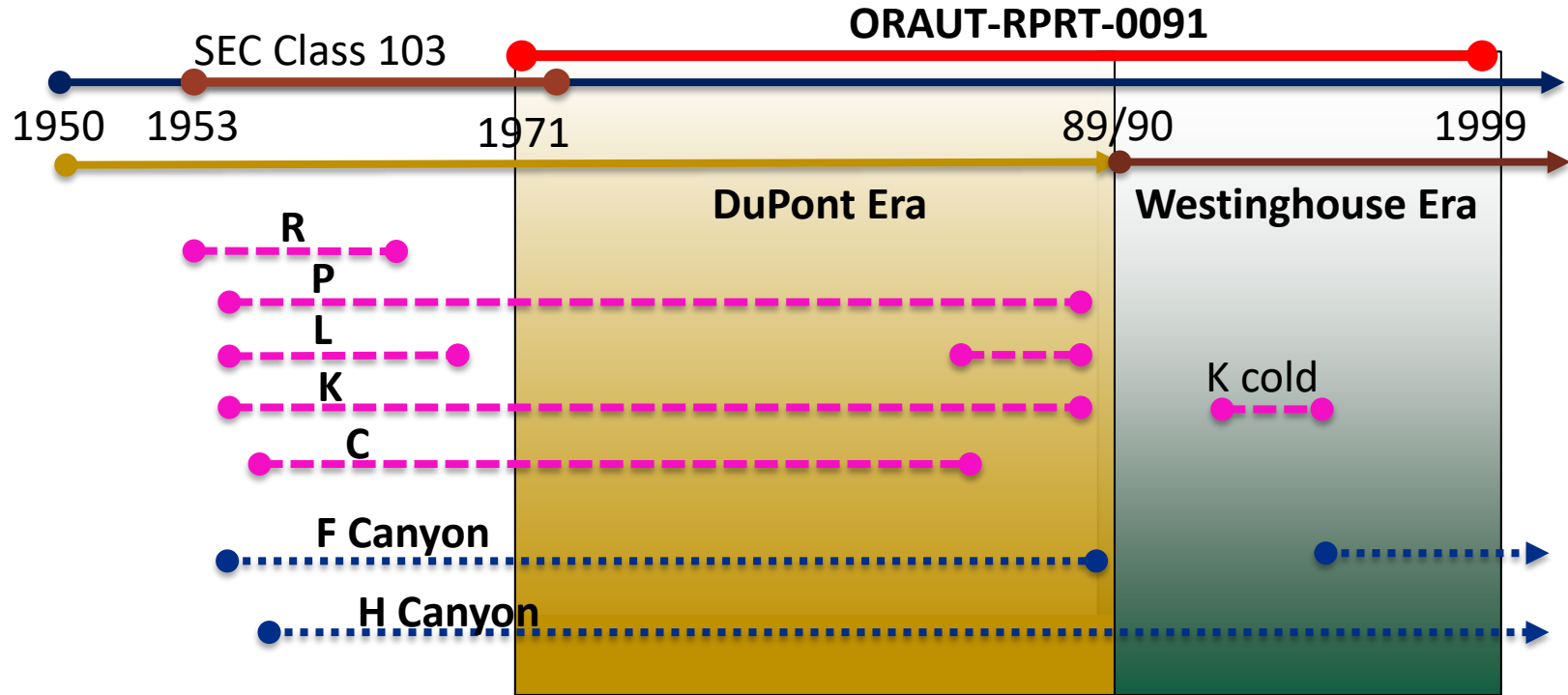
What was the driver for RPRT-0091?

January 11, 2018 Memorandum to Savannah River Site Work Group from SC&A

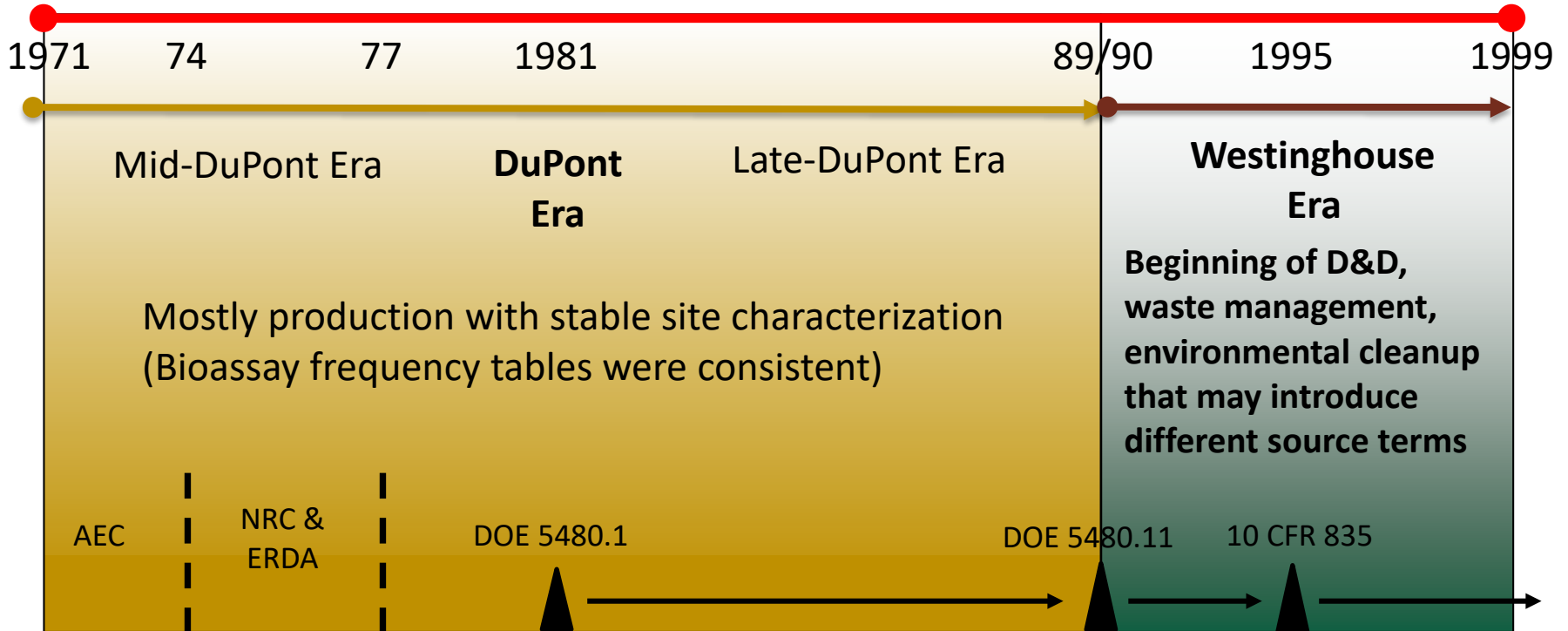
“SC&A believes that based on the foregoing WSRC documentation for 1998–1999, there was a clear deficiency recognized that may have impacted the proper bioassay enrollment of workers under RWPs prior to the implementation of a new site-wide formal policy, ‘Specifications of Urine Bioassay Requirements on Radiological Work Permits,’ issued on March 10, 1999. Lack of proper specification of radionuclides of significance for internal dosimetry may have led to unmonitored exposures for which dose reconstruction with sufficient accuracy may not be feasible. This concern should be investigated further to ascertain its significance, scope, and implications for dose reconstruction.” (emphasis added)

SRDB 171543, PDF p. 7

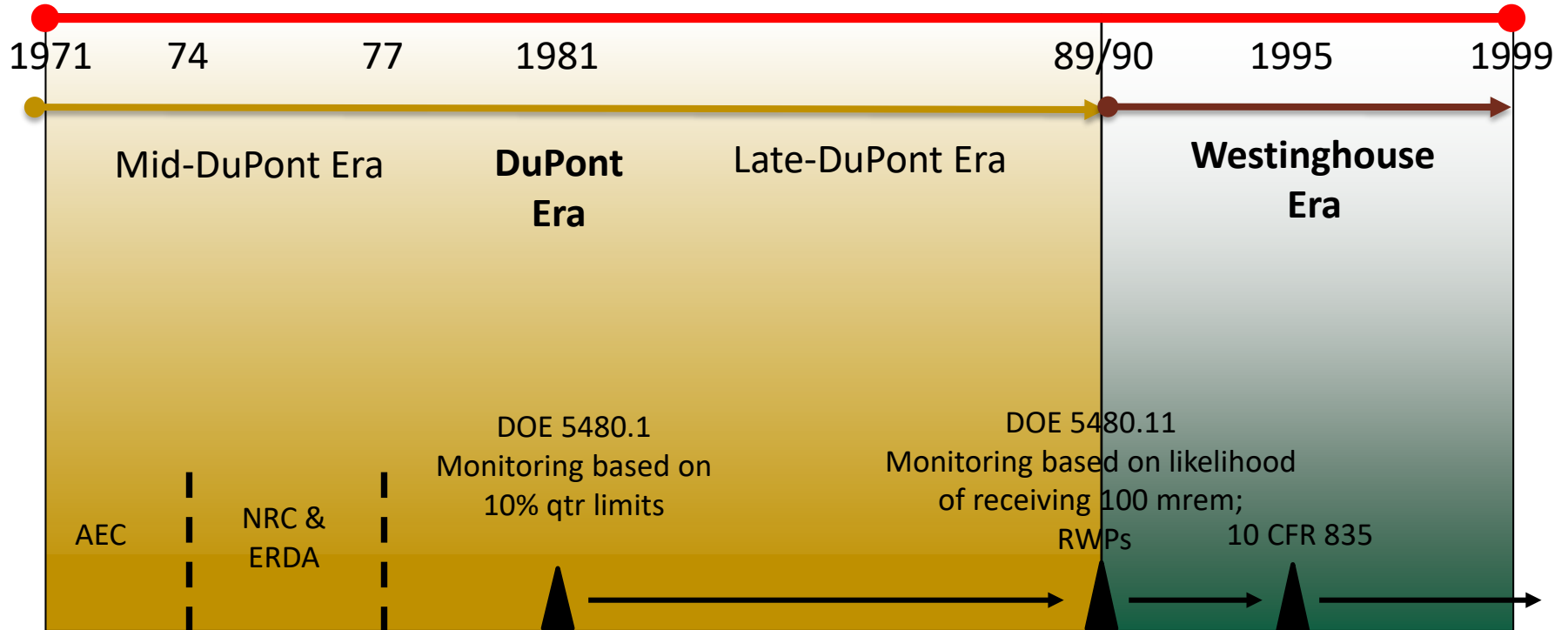
ORAUT-RPRT-0091 Timeline (reactors and canyons)



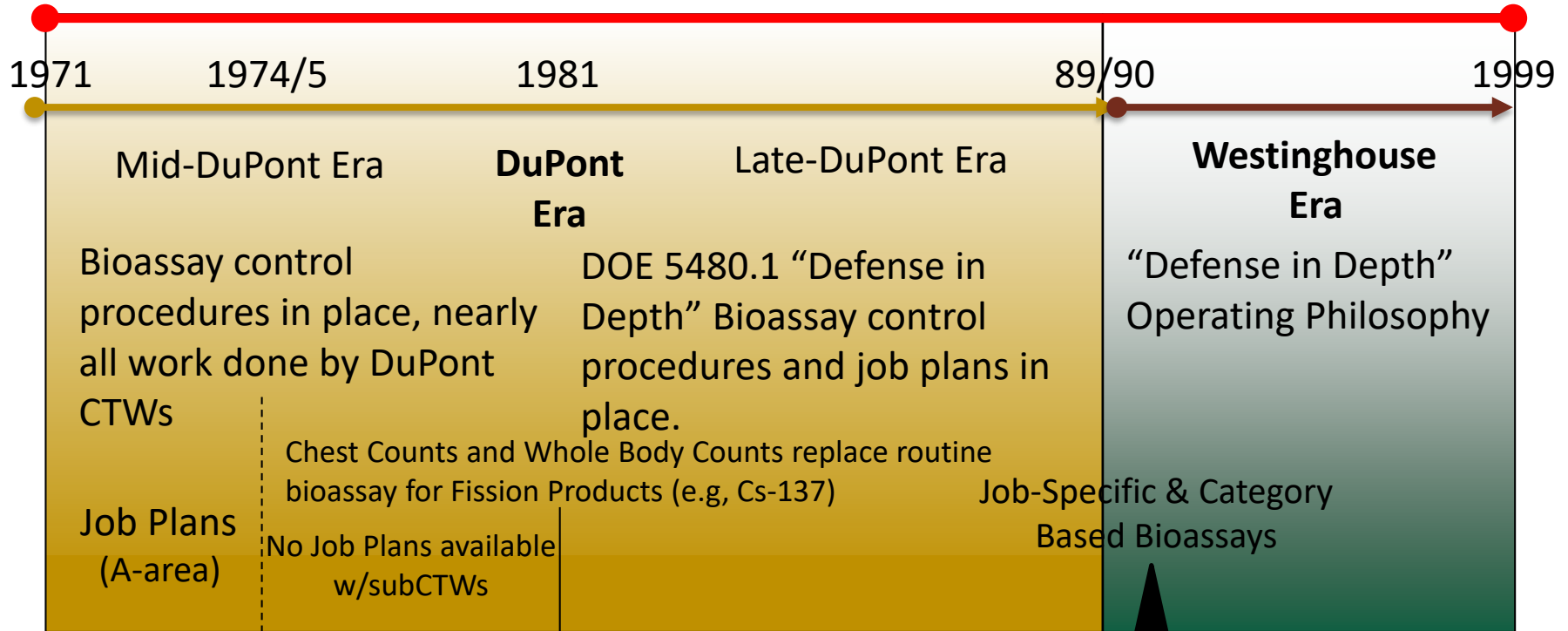
RPRT-0091 timeline expanded (production vs. D&D)



RPRT-0091 timeline expanded (regulatory changes)



RPRT-0091 timeline expanded (radiological control measures)



Section 2: Internal Dosimetry Program Self-Assessment

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DOE-wide Dose Evaluation Program Review

- DOE Office of Enforcement and Investigation (OEI) Issued list of 31 general deficiencies in July, 1999 and asked **all contractors** to review their programs against this list
 - List Item B.8 - “Workers enrolled in incorrect routine bioassay program.”
- SRS response for B.8
 - SRS previously identified some workers potentially exposed to Americium not included on RWPs
 - SRS team recommended changes in identifying RWP bioassay types
 - Memo “Specification of Urine Bioassay Requirements on Radiological Work Permits” [SRDB 167754]

Ingrowth of Am-241 to a Pu mixture

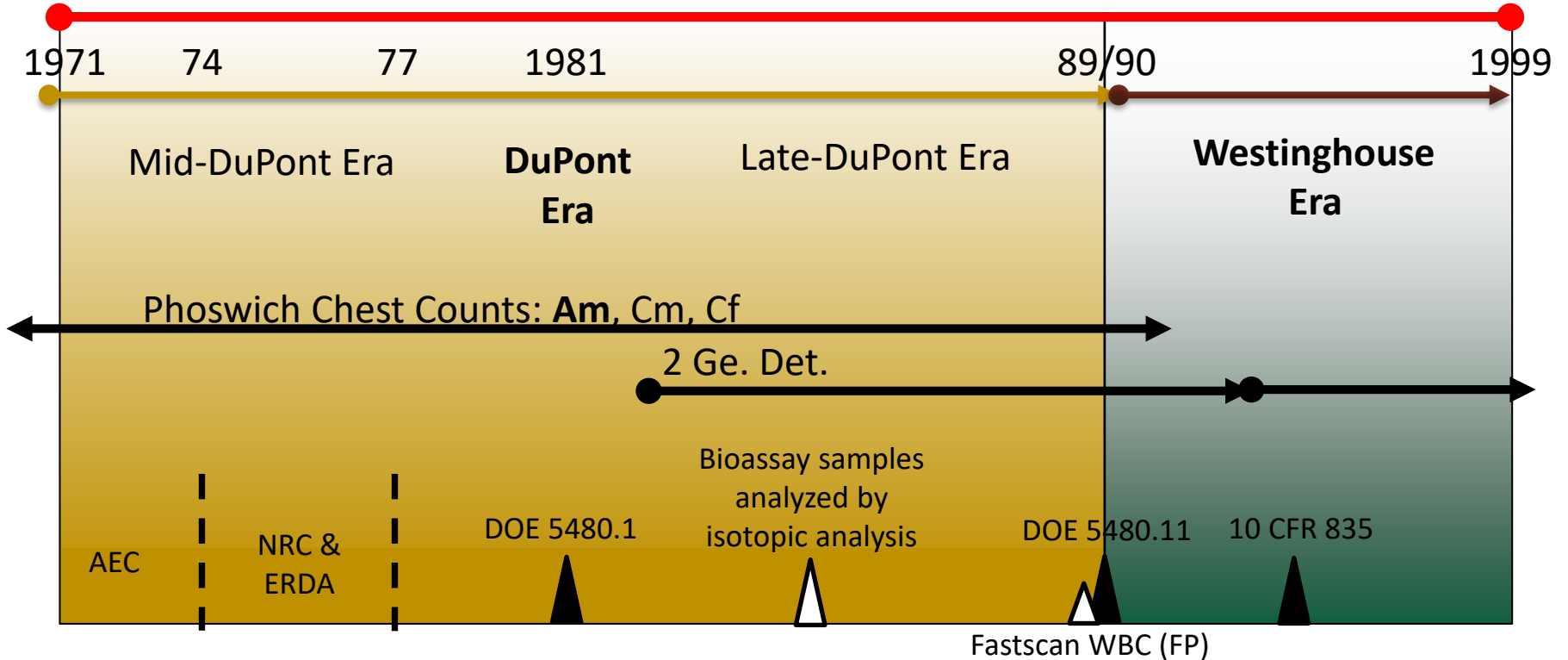
- Pu-241 decays to Am-241
 - Weapons grade Pu: after 5 years Am-241 ingrowth contributes at least 10% of the committed effective dose
 - Fuel grade Pu: after 10 years Am-241 ingrowth contributes at least 10% of the committed effective dose
- Per the ORAUT Technical Basis Document [SRDB 20176]
 - Anyone with a Pu urine bioassay, the most claimant favorable option is to assume 10 yr (weapons grade Pu) Am-241 ingrowth.
 - Am-241 is an inherent part of the DR process, whether the worker was monitored for it or not.
- Separated Am existed in a few areas (MPPF & 773-A), where Pu is not the primary dosimetric concern

Section 3: In Vivo and In Vitro Bioassay Monitoring

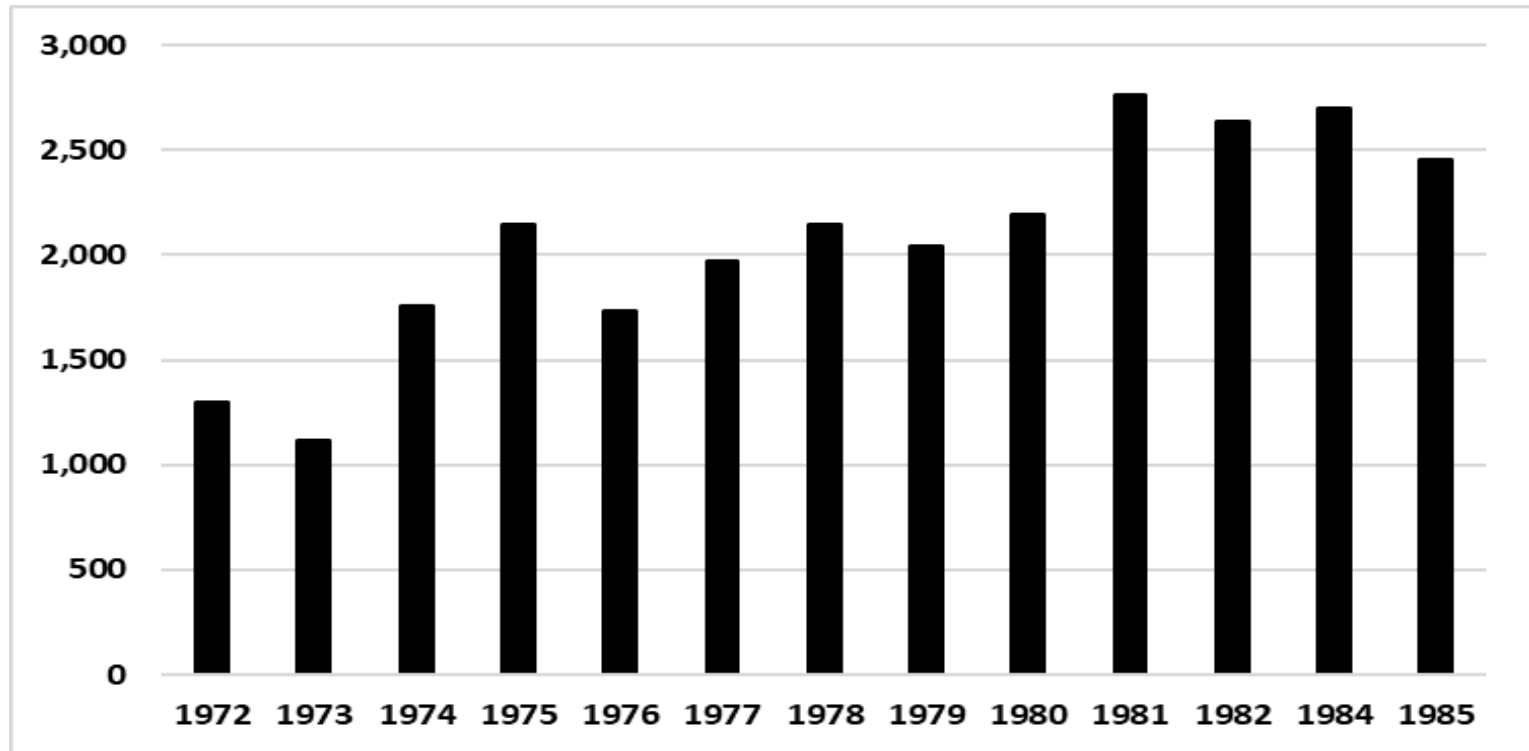
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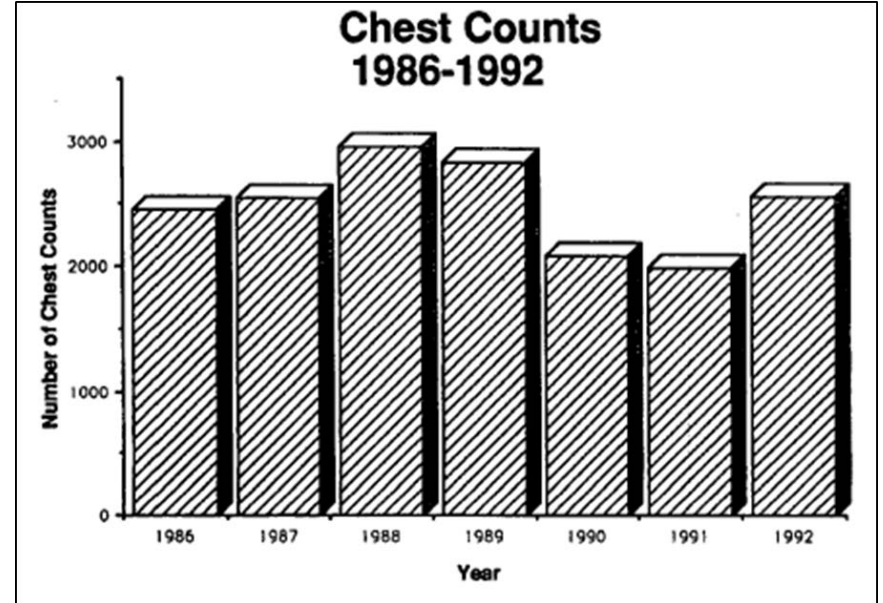
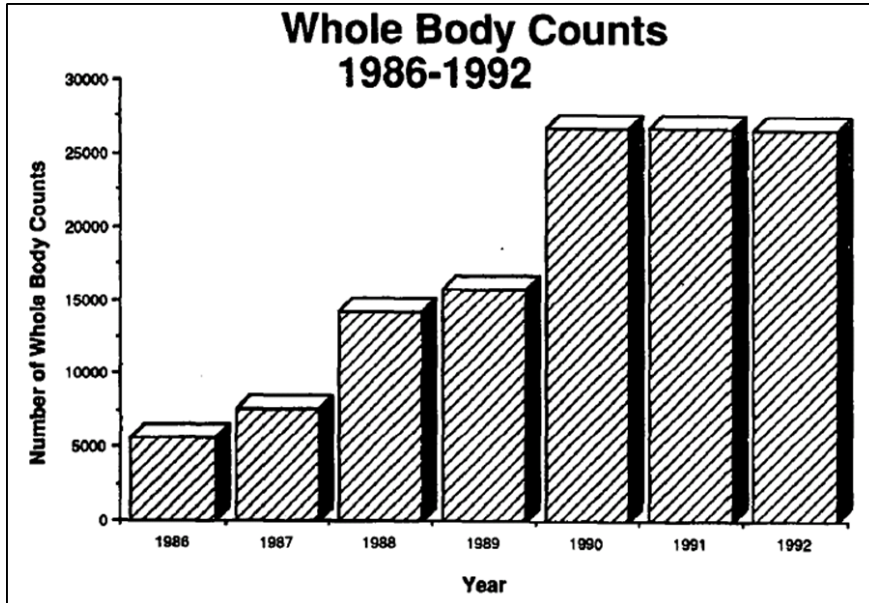
RPRT-0091 timeline expanded (Chest Count Capabilities)



Chest and Whole-Body Counts, 1972- November 1985



Chest and Whole-Body Counts, 1985 - 1992



[SRDB 49381, PDF pp. 7-12]

Purpose of the SRS Routine Bioassay Programs

- Not used to assign dose
- Used to monitor program effectiveness
- Program included
 - engineering controls,
 - air monitoring,
 - surface contamination
 - personal monitoring (frisk/nasal/injury)
- Any positive result triggered Special Bioassay Program

SRS Routine Bioassay Program (1971 – 1999)

- Bioassay Frequency Tables in Procedures
 - Tables of locations, analytes, frequencies, and participants
 - Typically annually, more frequent for Tritium
 - H3, Pu, Sr, Np, U, EU, FP, and Am/Cm/Cf
 - Whole-body Counts and Chest Counts
 - Category-based Bioassay Program (started in 1992)
- RWPs listed required bioassays (started in 1992)
 - Workers' responsibility to follow through
 - Some did not

1992, Manual 5Q1.1, Proc. 506, Rev. 0

- **Category I Bioassay Program:** personnel who wore respiratory protection, or who routinely performed hands-on work in posted Contamination or Airborne Radioactivity Areas.
- **Category II Bioassay Program:** personnel who did not routinely wear respiratory protection or work in posted Contamination or Airborne Radioactivity Areas, but who regularly entered RCAs where protective clothing was required.
- **Category III Bioassay Program:** personnel who were not required to routinely enter RCAs where protective clothing was required, and who were not performing tasks requiring work in Contamination or Airborne Radioactivity Areas.

Purpose of the SRS Special Bioassay Program

- Used to assess worker exposures and assign dose
- Triggered by Routine Bioassay results, air sample results, contamination, incident, etc.
- Designed to assess “inadvertent intakes”
- Required investigation to establish source term
- Did not use Bioassay Frequency Tables
- Special bioassays required isotopic analyses after 1986

Section 4: Am/Cm/Cf Source Terms from Bioassay Frequency Tables

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Americium-241 ROUTINE Urine Bioassay Requirements

Year	Buildings
1971	773-A, 221-F
1976	773-A, 221-F, 211-F
1985	773-A, 221-F
1989	773-A
1992	773-A, 776-A
1996	773-A, 776-A
1999–773-A	776-D Waste Stream (773-A 776-5A), B-Process Waste Stream (773-A), F-Wing Boot Waste Stream, ADS-1 Waste Stream (Analytical Development System Laboratories), Non-Canyon Waste Stream (773-A non-CHTS, ADS laboratories), Californium Waste Stream (773-A F Wing Cf facilities)
1999–not 773-A	MPPF, 221-H/Outside Facilities, F- & H-Area Tanks, RBOF, K- and L-Areas, C-, P-, and R-Areas, Casks Waste Stream (HLW sludge), CLAB Waste Stream E, CLAB Waste Stream G , CLAB Waste Stream H, and CLAB Waste Stream J

Section 5: Dose Reconstruction Considerations

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Am-241 Dose Reconstruction Considerations

- Am-241 is a decay product of Pu-241, monitoring one monitors both (assuming Am has not been separated from the mixture)
- The 1999 memo listed three sources where Am/Cm/Cf was a listed routine bioassay requirement and plutonium did not contribute >10% of the dose in those areas
 - Californium Waste Stream in 773-A F Wing.
 - 773-A had Am/Cm/Cf requirements
 - F-Wing Boot Waste Stream in 773-A
 - MPPF in 221-F
 - 221-F did not have Am/Cm/Cf requirements after 1989

Multi-Purpose Processing Facility (MPPF)

- In Building 221-F, no Americium requirements in the Bioassay Frequency tables between 1989 and 1999
- Used in 1995 for demonstration of Americium and Curium vitrification project
- Review of 8 RWPs for the MPPF for work in 1996 and 1998
 - All had Am, Pu, and Sr listed as routine Bioassay Requirements
 - 34 individuals signed on to the RWPs
 - 29 had Am routine bioassays within 4.5 years of the RWP
 - 5 had no Am bioassays
 - Each of the 5 had coworkers on the same date, same RWP with Am bioassay

Dose Reconstruction Considerations (1 of 2)

- Air Sampling (used to trigger special urine bioassay sampling)
 - Pu was the controlling and limiting radionuclide for dose
 - 1970s – 1980s: Radiation Concentration Guides (RCG)
 - 1990s: Derived Air Concentrations (DAC) (>10% DAC) would lead to a special bioassay sample.
- **NOCTS** Chest Count Data is available if needed
 - Used to reconstruct doses for Am
 - >1,000 chest counts (Am); 469 workers; (1990-2000)

Dose Reconstruction Considerations (2 of 2)

- Routine or Special Urine Bioassay
 - 14,531 urine bioassay results (1971-1990); majority were routine.
 - 5,090 urine routine results (1991-1999)
 - 1,497 special bioassay results (1991-1999)
- Routine Bioassay not Required in Bioassay Procedures (1990s)
 - Areas with Am contamination but not listed in Bioassay Procedures, but were covered by the RWPs.
 - MPPF

Section 6: Conclusions

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Conclusion from ORAUT-RPRT-0091

- *SC&A Statement: “Lack of proper specification of radionuclides of significance for internal dosimetry may have led to unmonitored exposures for which dose reconstruction with sufficient accuracy may not be feasible.”*
- This report focused on potential americium, a decay product of plutonium, exposures (1971-1999)
- Both radionuclides were detected by various methods (air, surface, skin, and nasal contamination monitoring, routine or special urinalyses, and in vivo counting)
- Dose reconstruction is feasible with sufficient accuracy for compensation purposes due to the availability of such data

SC&A Responses on ORAUT-RPRT-0091 (dated January 23, 2020; SRDB 179245)

NIOSH Responses on SC&A responses (dated October 2, 2020; SRDB 183485)

Joint Presentation

SC&A brief overview and Question 1

1. Ramifications to dose reconstructions
2. Completeness of pre-March 1999 bioassays
3. Worker enrollment in bioassay programs
4. Facility source term characterization and adequate internal dose
5. Ramifications of missed radionuclides

SC&A Responses to RPRT-0091, Question 1

Q1: Responses to SC&A January 23, 2020 Memo

Q1: Ramifications to dose reconstructions

- 1. What are the ramifications to dose reconstruction with sufficient accuracy if RWP job-specific bioassays neglected to include relevant radionuclides, particularly for certain facilities where complex, mixed, or unusual radioactive sources existed, e.g., SRTC, solid waste, burial grounds, tank farms, and decontamination and decommissioning projects?*

The relevant radionuclides were included in the bioassay program. There were relatively few changes in the bioassay monitoring by area from 1971 through 1999 with the exception of americium as discussed in Section 4.0 of this report. NIOSH believes that dose reconstructions can be done with sufficient accuracy for compensation purposes.

SC&A Responses to RPRT-0091, Question 2

Question 2

Q2: Responses to SC&A January 23, 2020 Memo (1 of 2)

Completeness of pre-March 1999 bioassays

2. *If WSRC instituted such a policy in March 1999 requiring the RCOs to base bioassay monitoring on actual, updated workplace characterization versus expert judgment or longstanding facility knowledge, how incomplete were bioassays (including RWPs) prior to this date with regard to appropriately targeted radionuclides?*
 - SC&A accepted NIOSH response for Westinghouse era (>1989) but rejected it for the DuPont era (<1989)
 - NIOSH believes that, prior to 1990, the radiological source terms at SRS were adequately characterized with sufficient accuracy for dose reconstruction purposes. This is addressed in Finding 2 in our responses to SC&A comments regarding ORAUT-RPRT-0092 “Evaluation of Bioassay Data for Subcontracted Construction Trade Workers at Savannah River Site.”

Q2: Responses to SC&A January 23, 2020 Memo (2 of 2)

Completeness of pre-March 1999 bioassays

The following applies to the DuPont era (<1990)

- SRS maintained inventories of radioactive materials
 - Isotope production records
 - Transuranic radionuclides and enriched uranium controlled as special nuclear materials
 - Monthly Works Technical Reports from 1953–1989
- SRS HP monitored routine and non-routine work
- SRS HP monitored contamination incidents
- Bioassay Control Procedures

SC&A Responses to RPRT-0091, Question3

Q3: Responses to SC&A January 23, 2020 Memo (1 of 2)

Worker enrollment in bioassay programs

- 3. How does this impact dose reconstruction with sufficient accuracy if workers were incorrectly enrolled in bioassay programs, with potential exposure to key radiological sources not evaluated?*

Our report originally stated that there was no indication workers were enrolled incorrectly in the **routine** bioassay programs based on the 1999 site-wide characterization. However, SRS management in response to the 1998 DOE Notice of Violation discussed during the November 14, 2017 WG meeting showed that less than 2.5% of 4,000 monitored workers were impacted.

Q3: Responses to SC&A January 23, 2020 Memo (2 of 2)

Worker enrollment in bioassay programs

ORAUT-RPRT-0091 quotes a Westinghouse site policy stating, *“An occasional mismatch between the routine bioassay program and the source term is to be expected and is not an indication of an inadequate bioassay program.”* [SRDB 167846, PDF p. 3]

- >10,000 bioassay samples in 1997
- There is no new information that would modify NIOSH’s earlier conclusion that dose reconstructions are feasible with sufficient accuracy by using personal monitoring data and co-exposure models.

SC&A Responses to RPRT-0091, Question 4

Q4: Responses to SC&A January 23, 2018 Memo (1 of 2)

Facility source term characterization and adequate internal dose

4. *What is the significance of an apparent lack of ongoing facility source term characterization to adequate internal dose monitoring during the 1990s with the advent and growth of new activities and programs involving new and complex radiological sources, e.g., decontamination and decommissioning (D&D), solid waste management, environmental cleanup, and SRTC?*

SC&A stated that they found the NIOSH response to this question to be nonresponsive because it focused on the 1999 guidance and the impact it had on source-term characterization but did not address the implications for prior years in the 1990s (Westinghouse era). NIOSH provided a detailed discussion about the radiological policies, procedures, and practices that occurred in the early 1990s in our response to SC&A comments on Report 92, Observation 1.

Q4: Responses to SC&A January 23, 2018 Memo (2 of 2)

Facility source term characterization and adequate internal dose

- DOE Order 5480.11 (1989/90) & 10 CFR 835 (1995) required monitoring for potential exposures above 100 millirem per year.
 - No worker at SRS met this criteria for bioassay monitoring.
- Source term characterizations were ongoing via routine workplace protective measures (e.g., air monitoring). Any elevated results would trigger special bioassays or investigations to determine the source term.
 - Examples of **Decontamination & Decommissioning (D&D)**, **Environmental Cleanup**, and **Waste Management** projects were provided in our response memo to demonstrate source term characterization efforts.

SC&A Responses to RPRT-0091, Question 5

Q5: Responses SC&A January 23, 2020 Memo (1 of 2)

Ramifications of missed radionuclides

5. *If key radionuclides such as americium had been missed, what other sources were not reflected on RWPs over time and what are the ramifications for dose reconstruction with sufficient accuracy for those workers potentially affected?*

- Source terms contributing at least 90% of dose were:
 - plutonium (Pu-238 and Pu-239)
 - uranium (U-234, U-235, and U-238)neptunium (Np-237)
 - americium (Am-241, Cm-244, Cf-252)
 - strontium (Sr-90)
 - tritium (H-3)

Q5: Responses SC&A January 23, 2020 Memo (2 of 2)

Ramifications of missed radionuclides

- SRS monitoring philosophy through the 1970s, 1980s, and 1990s.
 - Engineering and procedural controls
 - Workplace air sampling
 - Radiological surveys
 - Personal protective equipment
 - Personal worker monitoring (frisking)
 - Routine whole body & chest counts
 - Routine urine and fecal bioassays
- NIOSH's original conclusion has not changed. Doses can be reconstructed with sufficient accuracy for compensation purposes.