Savannah River Site Special Exposure Cohort Petition Evaluation

Status Update

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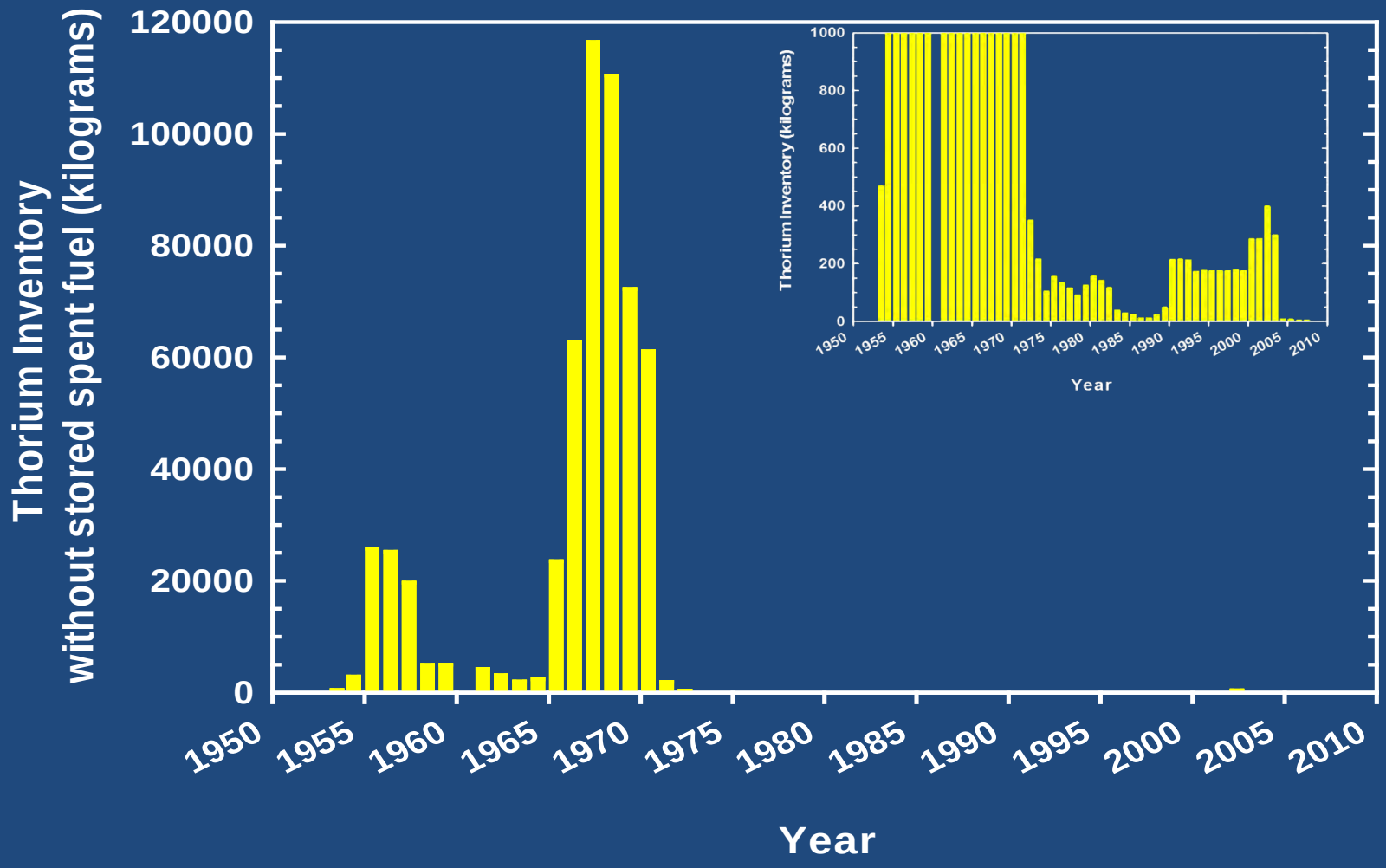
Overview

- Key Issues being addressed
  - Thorium: Oct 1972 - 2007
  - Neptunium: 1972 – 1989
  - Construction Worker
    - Subcontractors monitoring data

Unencapsulated Thorium inventory

not in basins (i.e Receiving Basin for Offsite Fuels (RBOF)



Low Inventory @ Minimal Locations

SRS Thorium Inventory, 1972-2007 (kg) (partial)										
Year	773A	723A	235-F	772-F Lab	M Area	777 M	217-A Storage	100-K Basin	100-L Basin	RBOF
1973	154	---	0	---	57	6	0	52	---	6679
1974	104	---	---	---	---	---	---	52	---	
1975	104	1	1	1	43	5	---	52	---	6757
1976	89	1	1	1	41	2	0	52	---	6757
1977	85	1	1	1	25	2	0	52	---	8329
1978	57	---	4	4	25	2	0	52	---	8729
1979	83	---	4	4	31	2	0	52	---	8729
1980	109	---	5	5	31	---	8.0	52	3	8726
1981	111	---	4	4	23	---	0	55	3	8726
1982	86	---	4	4	23	---	0	55	3	8726
1983	33	---	4		2	---	0	55	3	8726
1984	22	---	4	1	2	---	---	55	3	8726
1985	18	---	4	1	2	---	---	55	3	8726
1986	5	---	4	1	2	---	---	52	3	8726
1987	5	---	4	1	2	---	---	52	3	8726

Process Knowledge
Savannah River Laboratory 773A

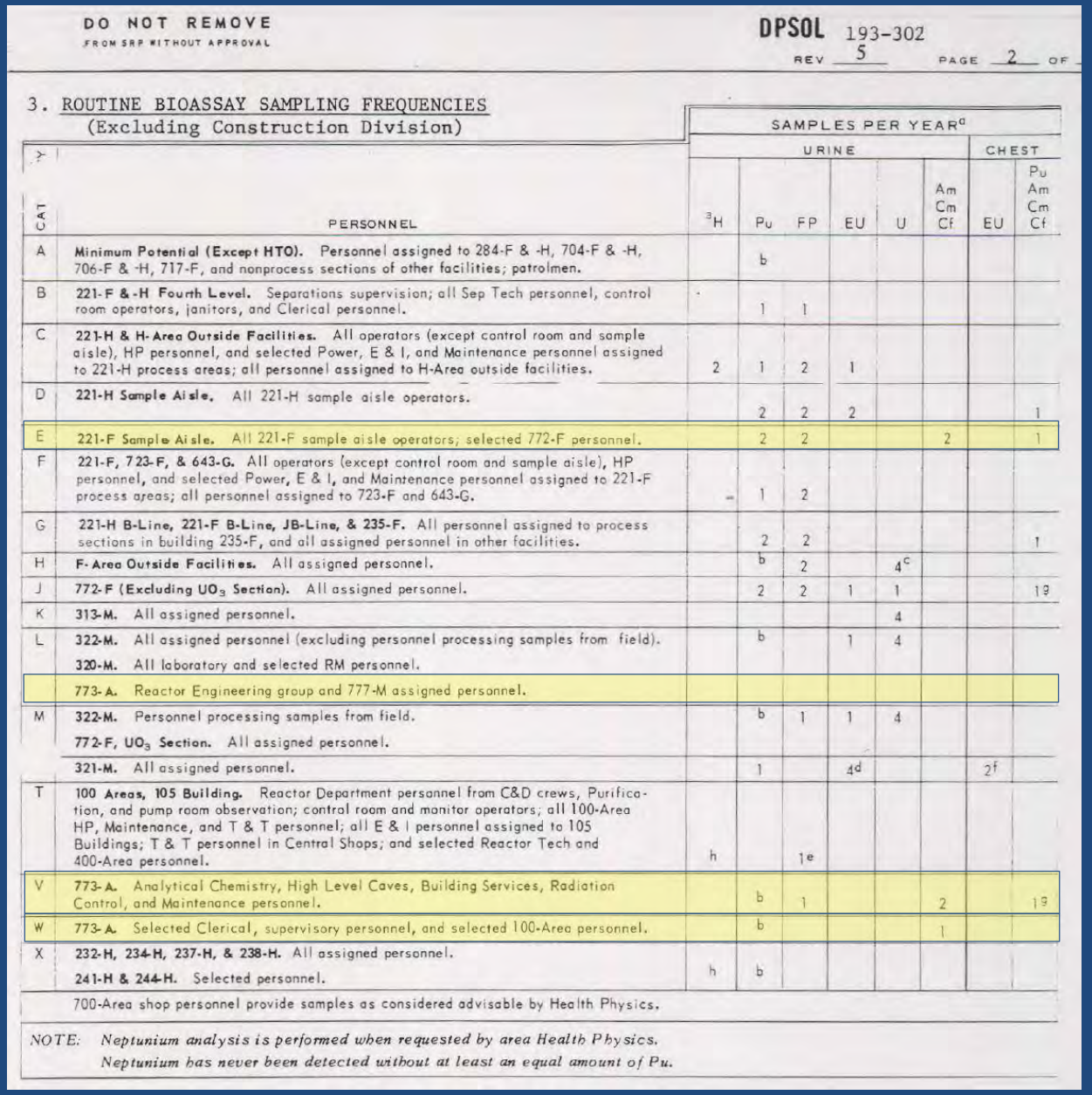
- Thorium used as a surrogate for multiple research efforts such as testing glove boxes, plutonium heat sources, and for waste vitrification studies.
- 1977-1980 Alternate Fuel Cycle Technology Program (AFCT) and Thorium Fuel Cycle Technology Program (TFCT) – multiple research projects
  - SC&A conducted interviews with workers in August 2013 confirmed small quantities (gram) of thorium used

Alternate Bioassay data

- A large number of workers in 773A were monitored for Am, Cm, Cf
- Review of the bioassay method during development of the co-worker model for Am, Cm, Cf revealed that thorium would come through in the analysis and the alpha emissions would be counted as if thorium were Am, Cf, Cm
- Effectively we have alpha urine bioassay sample that doesn't contain plutonium, uranium, or neptunium, but does contain Th, Am, Cm, Cf, Es, Bk

Bioassay Control

- Monitoring based on potential for exposure
- DPSOL 193-302
  - Rev. 5 (1971)



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DPSOL 193-302
REV 5 PAGE 2 OF

3. ROUTINE BIOASSAY SAMPLING FREQUENCIES
(Excluding Construction Division)

CAT	PERSONNEL	SAMPLES PER YEAR[a] URINE ^{3}H	Pu	FP	EU	U	Am Cm Cf	CHEST EU	Pu Am Cm Cf
A	**Minimum Potential (Except HTO).** Personnel assigned to 284-F & -H, 704-F & -H, 706-F & -H, 717-F, and nonprocess sections of other facilities; patrolmen.		b						
B	**221-F & -H Fourth Level.** Separations supervision; all Sep Tech personnel, control room operators, janitors, and Clerical personnel.		1	1					
C	**221-H & H-Area Outside Facilities.** All operators (except control room and sample aisle), HP personnel, and selected Power, E & I, and Maintenance personnel assigned to 221-H process areas; all personnel assigned to H-Area outside facilities.	2	1	2	1				
D	**221-H Sample Aisle.** All 221-H sample aisle operators.		2	2	2				1
E	**221-F Sample Aisle.** All 221-F sample aisle operators; selected 772-F personnel.		2	2			2		1
F	**221-F, 723-F, & 643-G.** All operators (except control room and sample aisle), HP personnel, and selected Power, E & I, and Maintenance personnel assigned to 221-F process areas; all personnel assigned to 723-F and 643-G.		1	2					
G	**221-H B-Line, 221-F B-Line, JB-Line, & 235-F.** All personnel assigned to process sections in building 235-F, and all assigned personnel in other facilities.		2	2					1
H	**F-Area Outside Facilities.** All assigned personnel.		b	2		4[c]			
J	**772-F (Excluding UO_3 Section).** All assigned personnel.		2	2	1	1			1[g]
K	**313-M.** All assigned personnel.					4			
L	**322-M.** All assigned personnel (excluding personnel processing samples from field). **320-M.** All laboratory and selected RM personnel.		b		1	4			
	773-A. Reactor Engineering group and 777-M assigned personnel.								
M	**322-M.** Personnel processing samples from field. **772-F, UO_3 Section.** All assigned personnel.		b	1	1	4			
	321-M. All assigned personnel.		1		4[d]			2[f]	
T	**100 Areas, 105 Building.** Reactor Department personnel from C&D crews, Purification, and pump room observation; control room and monitor operators; all 100-Area HP, Maintenance, and T & T personnel; all E & I personnel assigned to 105 Buildings; T & T personnel in Central Shops; and selected Reactor Tech and 400-Area personnel.	h		1[e]					
V	**773-A.** Analytical Chemistry, High Level Caves, Building Services, Radiation Control, and Maintenance personnel.		b	1			2		1[g]
W	**773-A.** Selected Clerical, supervisory personnel, and selected 100-Area personnel.		b				1		
X	**232-H, 234-H, 237-H, & 238-H.** All assigned personnel. **241-H & 244-H.** Selected personnel.	h	b						
	700-Area shop personnel provide samples as considered advisable by Health Physics.								

NOTE: *Neptunium analysis is performed when requested by area Health Physics. Neptunium has never been detected without at least an equal amount of Pu.*

Bioassay Control - Construction

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DPSOL 193-302
REV 5 PAGE 3 OF 14

4. BIOASSAY SAMPLING FREQUENCIES — Construction Division

a. Routine Urine Samples

- Fission Products and/or Induced Activity — one sample per year and when terminating.
- Tritium — sample frequency is outlined in Radiation and Contamination Control DPSOP 40-1 or Construction Job Plans.
- Plutonium — one sample every 3 years and when terminating.
- Other Nuclides — as specified by area Health Physics in Construction Job Plans.

[NOTE] Construction Division Medical Department annually provides each employee with a sample bottle and label and instructs the employee to submit a one-liter urine sample. Samples are also obtained from new employees who worked in Radiation Zones at another installation where radioactive materials were handled. Personnel Monitoring will forward requests for resamples through Construction Medical.

b. Special Sampling (See Division B and Construction Division Safety Procedure 58)

c. Whole Body or Chest Counting

1) New employees, who worked in Radiation Zones at another installation where radioactive materials were handled, will be required to take a whole body and chest count. This count should preferably be made on the same day as the entry physical examination.

2) A whole body and/or chest count shall be made whenever an employee's bioassay samples (except tritium) indicate he has a confirmed uptake or when he has been involved in a contamination incident and a count is considered necessary by Health Physics supervision.

3) A count (chest or 40 cm arc) will be required when terminating for those employees who have had a previous whole body or chest count at SRP.

DPSOL 193-302 (Rev 5. 1971)

Dose Reconstruction Methodology 1972-1989

- NIOSH proposed to use the Am/Cm/Cf/Th bioassay results to reconstruct thorium doses

- Given a particular cancer, NIOSH will use the radionuclide (Am, Cm, Cf, or Th) that results in the highest dose to the organ of interest

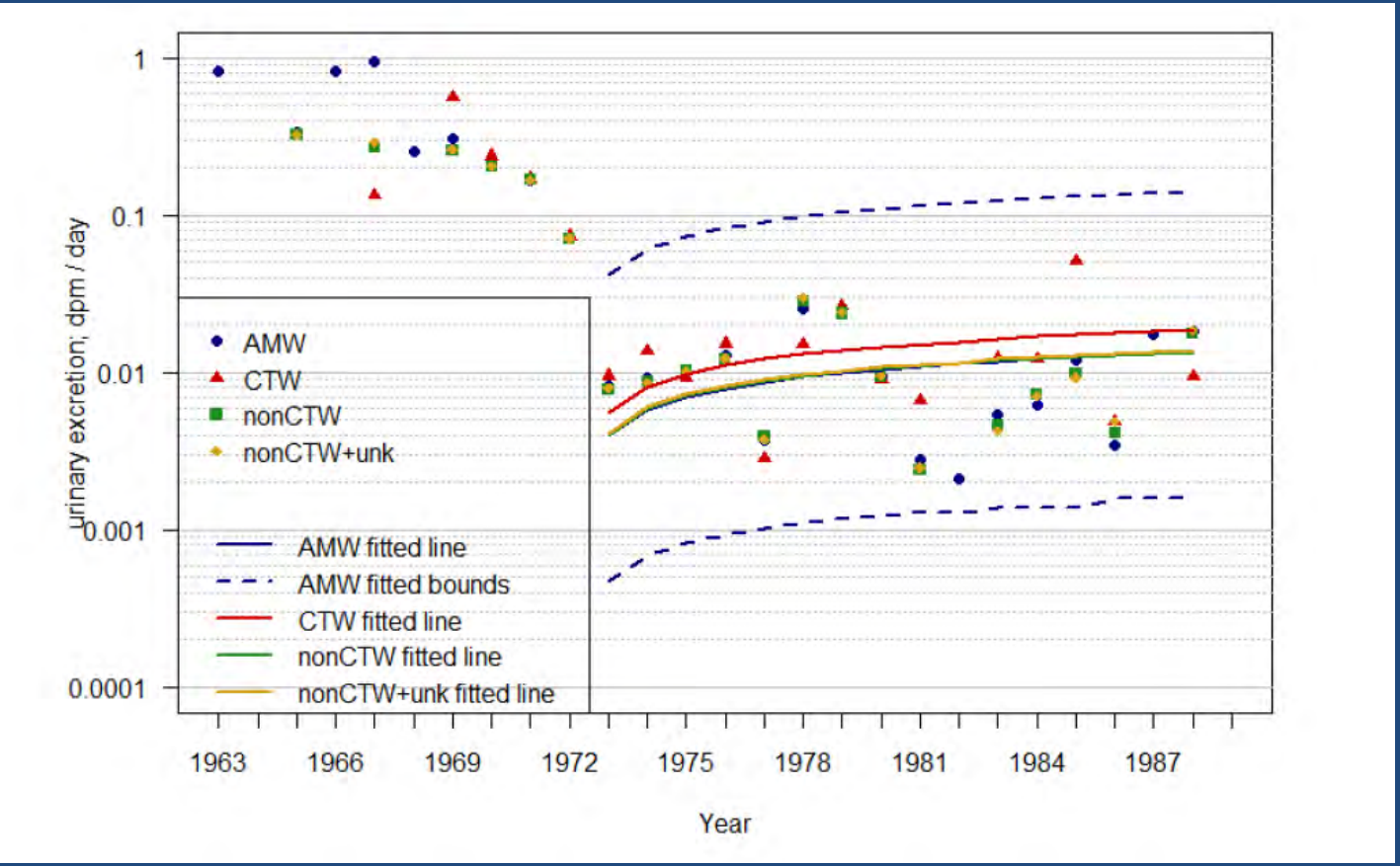
Am/Cm/Cf/Th Bioassay Comparison

- ORAUT-RPRT-0055: *A Comparison of Exotic Trivalent Radionuclide Co-worker Models at the Savannah River Site*
- Comparison is being reviewed by SEC Workgroup
- Three Co-worker Models Developed:
  - Construction Trades Workers (CTW) Coworker Model
  - Non-Construction Trades Workers (nCTW) Coworker Model
  - Non-Construction Trades + unknowns (nCTW+unk) Co-worker Model

Am/Cm/Cf/Th Bioassay Results

Period	AMW		CTW		nCTW		nCTW +unk	
	Total	OPOS	Total	OPOS	Total	OPOS	Total	OPOS
1970	1,955	567	328	124	1,593	451	1,627	461
1971	1,856	663	292	107	1,545	550	1,564	559
1972	1,565	650	208	109	1,312	525	1,357	541
1973	1,249	644	243	115	969	509	1,006	530
1974	1,067	456	162	86	876	357	905	371
1975	831	467	173	94	628	356	658	375
1976	695	450	148	90	523	346	547	360
1977	478	383	87	68	368	292	391	315
1978	306	228	66	49	232	171	240	179
1979	441	322	79	67	337	234	362	255
1980	253	230	44	42	198	178	209	188
1981	341	267	80	44	524	379	586	422
1982	325	307						
1983	330	303	41	39	255	232	289	264
1984	347	275	63	20	234	210	284	255
1985	340	259	42	24	266	214	298	235
1986	399	273	101	26	253	219	298	247
1987	379	305	65	25	598	336	656	371
1988–1989	342	288						

Am/Cm/Cf/Th Coworker Model



Construction Trades Workers

- Am/Cm/Cf/Th Bioassay Samples (1972-1989)
  - Construction Trades Workers – 1602
  - Non-Construction Trades Workers – 7573
  - Unknown occupation – 422
- Recall construction trades workers were monitored based on Job Plans
- If Construction trades workers were never monitored then we would not have 1602 bioassay samples amongst 898 CTW workers

Thorium (1990-2007)

- Originally proposed use of Whole Body Counts to bound thorium Exposures
- Although bounding, the assignment of WBC missed dose would result in some significant doses in the modern era which don't seem possible given the radiological controls in place at the time nor the work being conducted
- NIOSH proposes using an air sample concentration of 2e-13 uCi/cc as a maximum potential exposure
  - 10% of the Plutonium DAC that was used as the cut point for respiratory protection

Thorium Summary

- Very low unencapsulated inventory (source term)
  - More thorium inventory in 1990s and 2000s than 1970s and 1980s
- Minimal use in certain defined locations
  - Mostly 773-A (especially post 1983)
- Knowledge of the processes
  - AFCT/TFCT (1977-1980) - interviews gram quantities
  - Mostly used as a surrogate in post 1990 for research

Summary – cont.

- 1972-1989 Alternate bioassay data
  - Am, Cm, Cf bioassay was effectively gross alpha analysis that included thorium
  - Doses are reasonable
- 1990-2007 Compliant Radiological Control Program
  - Air controlled to <2.0 E-13 uCi/cc
  - Doses are low
- Radiological controls
  - Procedures in place, Routine monitoring (Daily, Weekly) of the workplace
  - Survey data and air monitoring data available electronically in pdf format

Thorium – Status Update

- NIOSH is addressing SRS Workgroup concerns:
  1. Use of 10% of Derived air concentration for 1990-2007 time period
  2. Compare bioassay of workers known to have worked with thorium to the co-worker model
  3. Explain high variability observed in some Am/Cm/Cf/Th bioassay
     - Most are DTPA related and/or low sample volume due to known intake of another radionuclide (i.e. Plutonium)
  4. Develop thoron exposure model

Neptunium Exposures at SRS

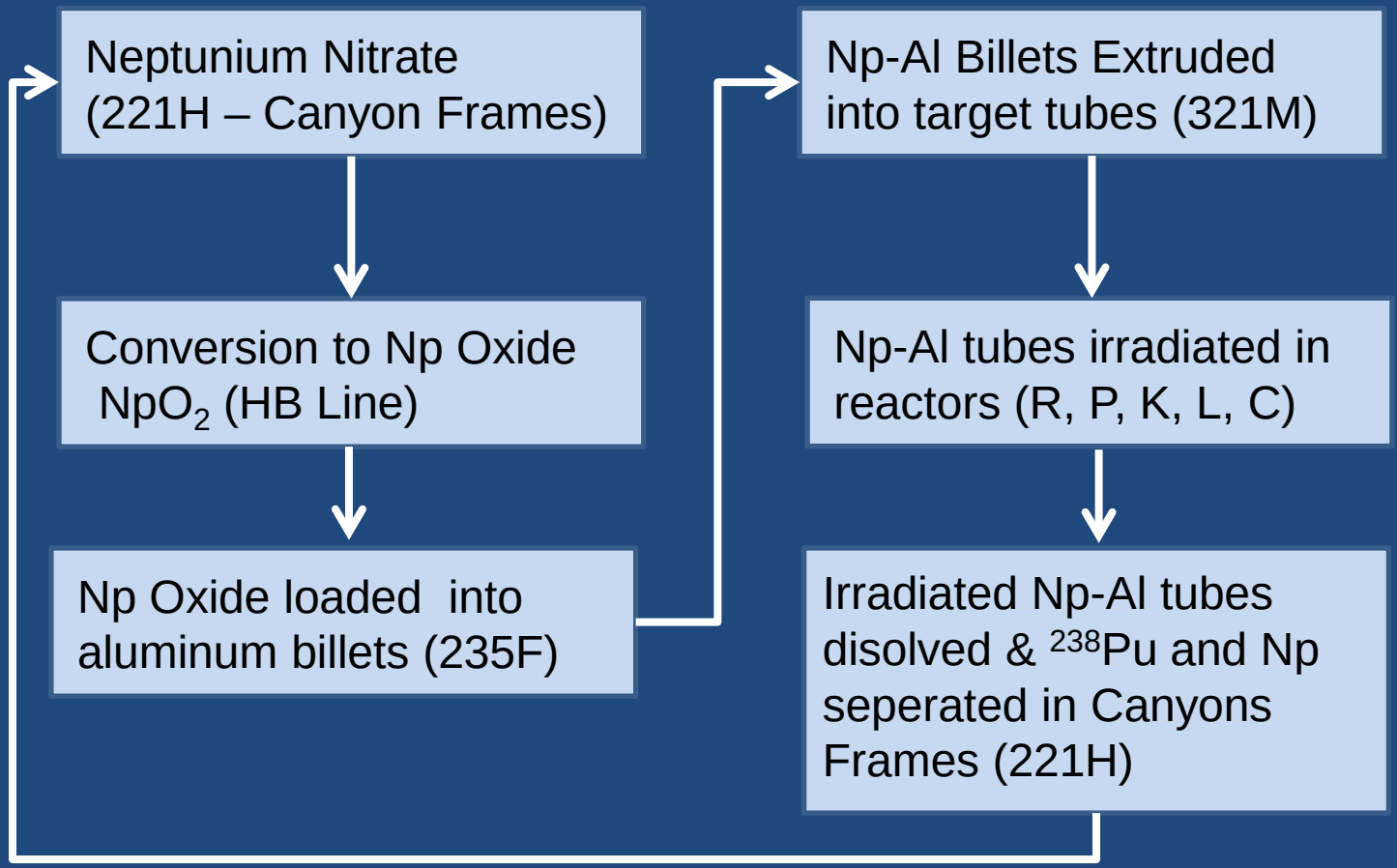
- ***Overall Goal was the production of Pu-238***
  Np-237 (n, γ) Np-238 → Pu-238

- **Production:**
  - **1961 through July 1984**

Neptunium billet line glovebox worker (1978)
SRS at Fifty – Reactor On (2002) (SRDB 24750)

- **Main Processes involving Np**
  - **Manufacture Np-Al targets (200 and 300 area)**
  - **Irradiate targets in reactors (100 area)**
  - **Chemical Separation of ^{238}Pu from Np (200 area)**

Basic Neptunium Flow Diagram

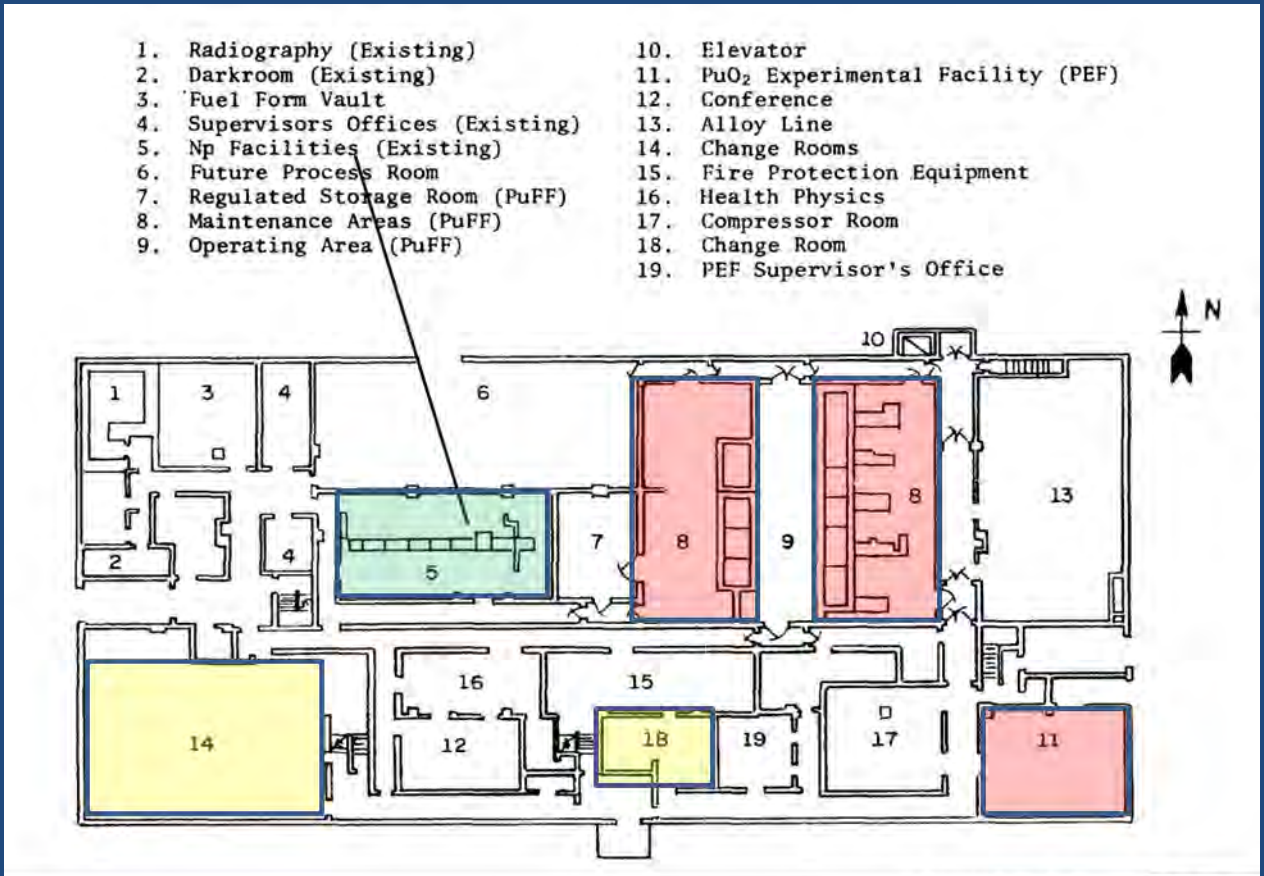


HB-Line Np Process

- Mission: Conversion of Np nitrate to Np oxide
- SRS Workgroup toured HB-Line in 2010
- Two main sources of Np nitrate *(97%)**
  - HM Process from enriched uranium (EU)
    - Approx. 3-4 kg / month (23% of total)*
    - Low plutonium contamination
  - Frames – dissolving irradiated Mk-53 targets
    - Approx. 8-10 kg / month (74% of total)*
    - Significant plutonium contamination

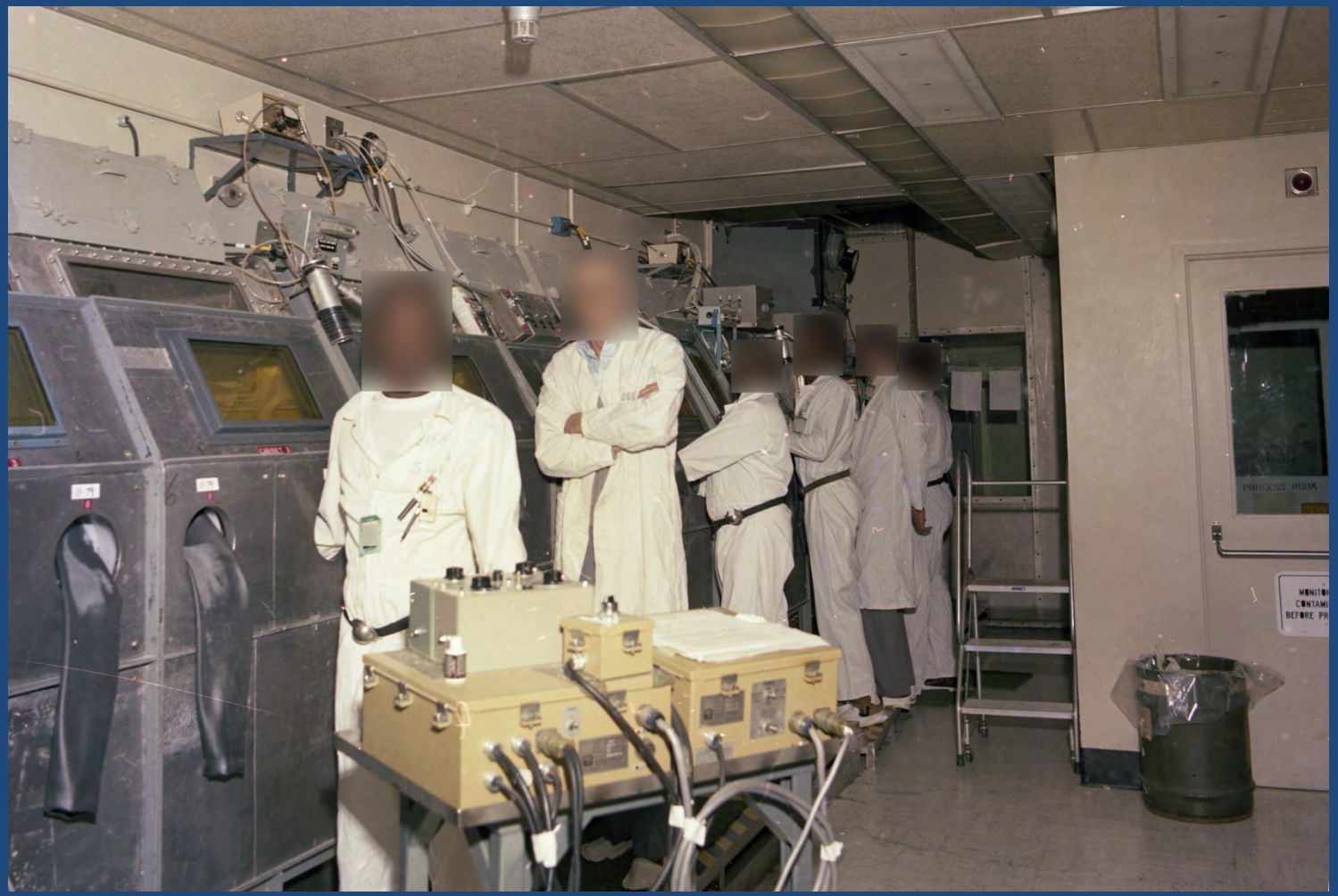
** ESH-HPT-96-117*

Neptunium Billet Fabrication 235F



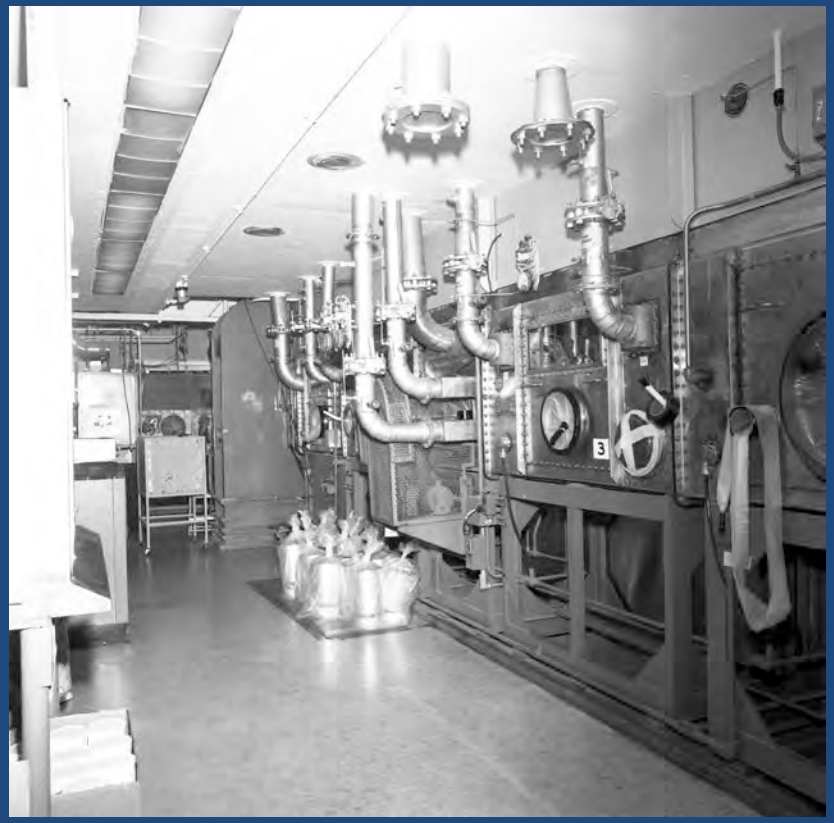
DPSTSA – 200-5

Neptunium Billet Glovebox Line

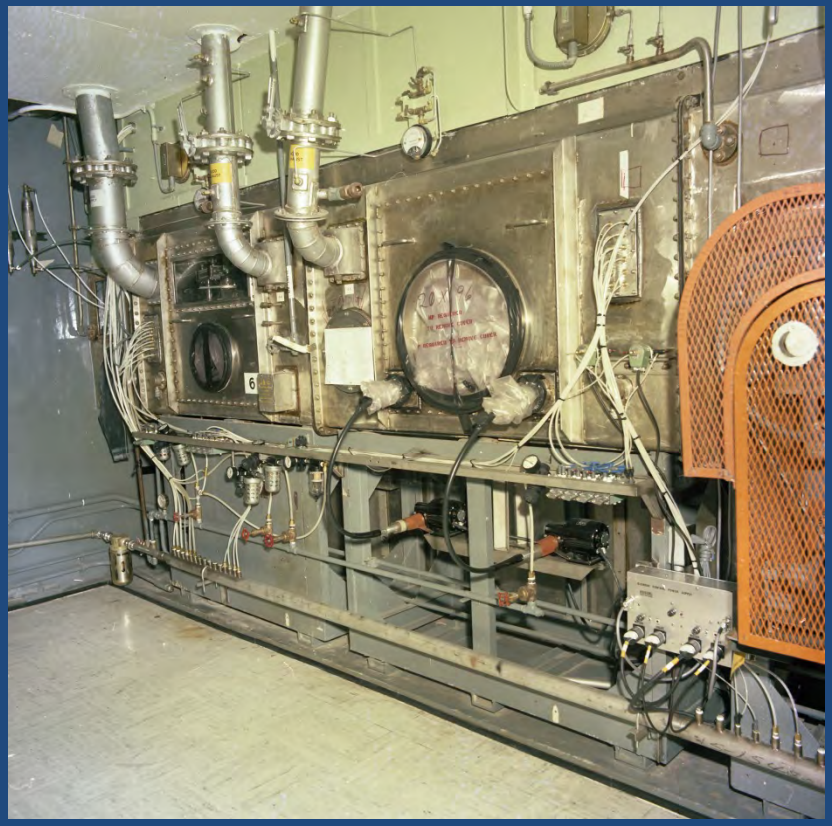


DPSPF 30200-6 (1980)

Neptunium Billet Glovebox Line



DPSPF 20355-1 (1976)



DPSPF 30200-24 (1980)

Maintenance side of glovebox line

235F Summary / Observations

- Relatively small glovebox line
  - (10s of workers not 100s)
- Regulated radiation area
  - Supervisors – White Lab coat shoe covers
  - Operators – White regulated clothing and neutron dosimeters
- Shadow shields due to high gamma dose rate
- Billets are bagged for transfer to 321M

235F Routine Air Monitoring

*Pulled once per week
Friday at 8:30 A.M.

235-F ROUTINE ROOM AIR SAMPLES

Ref. Log Sheet #____

Weekend Sample
21,600 cf of air
Weekly - 50,400 cf
Daily Sample
7,200 cf of air

LOCATION	Date & Time On / Date & Time Off	1-20-67 8:15 A / 1-23-67 8:30 AM		1-23-67 / 1-24-67		1-24-67 / 1-25-67		1-25-67 / 1-26-67		1-26-67 8:30 AM / 1-27-67 8:30 AM	
		FP x 10^{-10}	Alpha x 10^{-12}	FP x 10^{-10}	Alpha x 10^{-12}	FP x 10^{-10}	Alpha x 10^{-12}	FP x 10^{-10}	Alpha x 10^{-12}	FP x 10^{-10}	Alpha x 10^{-12}
1. Rm. 107-A		<1.3	<1.2	<1.3	<1.2	<1.3	<1.2	<.3	<.2	<0.3	<0.2
2. Rm. 107-B (West)*									→	<1.3	<1.2
5. Rm. 107-B (North)*									→	<1.3	<1.2
6. Rm. 107-D		<1.3	<1.2	<1.3	<1.2	<1.3	<1.2	<.3	<.2	<0.3	<0.2
7. Rm. 107-E*									→	<1.3	<1.2
8. Np Line Reg. Corr.*									→	<1.3	<1.2
9. Rm. 162 (South)		<1.3	0.22	<1.3	<1.2	<1.3	0.27	<3	<.2	<0.3	1.6
10. Rm. 162 (North)		<1.3	<1.2	<1.3	<1.2	<1.3	0.39	<.3	<.2	<0.3	0.22
11. Rm. 160 (North)		<1.3	0.3	<1.3	<0.2	<1.3	0.55	<.3	<.2	<0.3	<0.2
12. Rm. 160 (South)		<1.3	0.53	<1.3	0.5	<1.3	0.53	<.3	<.2	<0.3	0.7
18. 1st Level Reg. Corr. (West)*									→	<1.3	<1.2
21. 1st Level Clean Corr. (West)*									→	<1.3	<1.2
23. 1st Level Clean Corr. (East)*									→	<1.3	<1.2
24. H&V Rm. (Southeast)		<1.3	<1.2	<1.3	<1.2	<1.3	0.54	<.3	<.2	<0.3	<0.2
25. West Service Area Filtered*									→	<1.3	<1.2
26. East Service Area Filtered*									→	<1.3	<1.2
28. 2nd Level Storage Cage		<1.3	<1.2	<1.3	<1.2	<1.33	<1.2	<.3	<.2	<0.3	<0.2
CAM Room 162		<1.3	<1.2	<1.3	1.2	<1.3	<1.2	<.3	<.2	<1.3	<1.2

Radiological Controls - 235F

- Neptunium billets surveyed before transfer
  - High gamma dose rate
  - Neutron component is about 1%

Mark 53A Billet ~~[illegible]~~

DATE	Billet #	Radiation level @ 8 CMS MREM/HR γ+N^F	N^F	Fixed α Contamination Top + ~~sides~~ d/m <3000 d/m	Bottom <500 d/m	Sides <1000 d/m	Remarks
8/7/80	NJ 393	710	10	<3000	<500	<1000	Np Storage
8/11/80	NJ 394	702	2	<3000	<500	<1000	Shipment
8/18/80	NJ 395	1010	10	<3000	<500	<1000	Np Storage
8/[illegible]/80	NJ 396	960	5	<3000	<500	<1000	Np storage
8/22/80	NJ 397	1005	5	<4000	<1000	<1000	"
8-22-80	NJ 398	1005	5	<5000	<1000	<1000	"
8-25-80	NJ 399	900	3	<3000	<500	<1000	"
8-26-80	NJ 400	800	5	<3000	<500	<1000	Np Storage

321M Np Billet Extrusion

- **Billet Extrusion Process**
  1. Bagged Billets are received
  2. Billets are surveyed
  3. Billets are helium leak checked
  4. Billets are outgassed
  5. Billets are preheated
  6. Billets extruded into long thin tubes
  7. Tubes are surveyed for shipment to reactors

321M Np Billet Survey - Example

OSR 4-17A (Rev 1-67) HEALTH PHYSICS

RADIATION MULTISURVEY LOGSHEET

SHIFT (CIRCLE ONE)	DATE	NUMBER
12-8 8-4 4-12	2-18-72	A/M 12604

DEPARTMENT	TIME SURVEYED	OPSOL OR SWP NO.	AIR SAMPLED	TIME SPENT ON JOB	BLDG NO.	JOB LOCATION
Prod.	2:00 AM / PM		☐ YES ☒ NO	30 min	321-M	

EXPOSURE RATE ESTABLISHED

A: 90 mrad/mr/hr @ 18"

B: mrad/mr/hr @

The maximum radiation level measured was mrad/mr/hr @

DESCRIPTION OF SURVEY

Four n.p. billets from 235-F 700 mr/hr @ 3"
+ 8 mrem/hr @ 3" 90 mr/hr @ 18" + 1 mrem/hr @ 18"
<10 d/m α <10 d/m β γ Smearable on billets
#3 billet probed on butt end 1500 d/m α
<10 d/m α Smearable.

SURVEYED BY: [signature] AUDITED BY

321M Np Billet Extrusion

A composite billet of uranium-aluminum alloy encased in aluminum enters extrusion press at the left and emerges at far right.

Bebbington (1990) History of DuPont at the Savannah River Plant

321M Np Billet Extrusion

Billet being forced into extrusion die; flames are lubricant ignited by the hot die.

Fuel tube emerging from die.

Bebbington (1990) History of DuPont at the Savannah River Plant

321M Np Tube Survey - Example

DEPARTMENT	TIME SURVEYED	OPSOL OR SWP NO.	AIR SAMPLED	TIME SPENT ON JOB	BLDG NO.	JOB LOCATION
HT	2 45 ~~AM~~ PM	300-102	☐ YES ☒ NO	15 min	321-M	Loading Dock

EXPOSURE RATE ESTABLISHED

A 10 ~~mrad~~/mr/hr @ cab.

B 200 ~~mrad~~/mr/hr @ 3'

The maximum radiation level measured was 700 ~~mrad~~/mr/hr @ 3" caskets.

DESCRIPTION OF SURVEY

12 Np Tubes shipped to 105-P. <10d/m α <10c/m βγ on exterior surfaces. I Analy in 105-P notified.

SURVEYED BY [signature]

AUDITED BY

Personnel Monitoring

- Dosimeters
  - Must wear dosimeter in regulated areas
    - Gamma dose rate was significant on Np Billet line and 321M
    - Interviews indicate workforce swap-out
    - Operators were required to wear neutron dosimeters
- Bioassay
  - DPSOL 193-302 Rev 7, 1976
    - Np analysis are performed on samples from personnel designated by area Health Physics when Pu analysis are positive
  - DPSOL 193-302 Rev 8, 1978
    - Np urinalysis routine for workers in 235F

Pu contamination in NpO_2

Report #	NpO2 (kg)	Minimum Pu wt%	Average Pu wt%	Maximum Pu wt%	# Billets made (235F)	# Tubes Extruded (321M)	SRDB #
DPSP-74-1-1	21.80	<0.05	0.16	0.60	5	12	72893
DPSP-74-1-2	4.84	0.18	0.36	0.53	7	12	72894
DPSP-74-1-3	12.65	0.02	0.18	0.42	5	0	72895
DPSP-74-1-4	5.25	0.01	0.03	0.06	4	14	72896
DPSP-74-1-5	2.25	0.25	0.28	0.32	0	0	72897

Why is Pu contamination important?

- **Specific Activity**
  (alpha activity)
  - **Pu-238 = 17.1 Ci/g**
  - **Np-237 = 0.00069 Ci/g**

Np wt%	Pu wt%	Pu : Np alpha ratio
99.5	0.5	125 : 1
99.9	0.1	25 : 1
99.95	0.05	12 : 1
99.99	0.01	2.5 : 1
99.995	0.005	1.2 : 1
99.999	0.001	0.25 : 1

- **NpO_2 - Plutonium is the main hazard**
- **Requires ultra pure Np for it to dominate exposure**

Bioassay Control

- **DPSOL 193-302**
  - **Rev. 5 (1971)**

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DPSOL 193-302 REV 5 PAGE 2 OF

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(Excluding Construction Division)

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A	**Minimum Potential (Except HTO).** Personnel assigned to 284-F & -H, 704-F & -H, 706-F & -H, 717-F, and nonprocess sections of other facilities; patrolmen.		b						
B	**221-F & -H Fourth Level.** Separations supervision; all Sep Tech personnel, control room operators, janitors, and Clerical personnel.		1	1					
C	**221-H & H-Area Outside Facilities.** All operators (except control room and sample aisle), HP personnel, and selected Power, E & I, and Maintenance personnel assigned to 221-H process areas; all personnel assigned to H-Area outside facilities.	2	1	2	1				
D	**221-H Sample Aisle.** All 221-H sample aisle operators.		2	2	2				1
E	**221-F Sample Aisle.** All 221-F sample aisle operators; selected 772-F personnel.		2	2			2		1
F	**221-F, 723-F, & 643-G.** All operators (except control room and sample aisle), HP personnel, and selected Power, E & I, and Maintenance personnel assigned to 221-F process areas; all personnel assigned to 723-F and 643-G.		1	2					
G	**221-H B-Line, 221-F B-Line, JB-Line, & 235-F.** All personnel assigned to process sections in building 235-F, and all assigned personnel in other facilities.		2	2					1
H	**F-Area Outside Facilities.** All assigned personnel.		b	2		4[c]			
J	**772-F (Excluding UO_3 Section).** All assigned personnel.		2	2	1	1			1[g]
K	**313-M.** All assigned personnel.					4			
L	**322-M.** All assigned personnel (excluding personnel processing samples from field). **320-M.** All laboratory and selected RM personnel. **773-A.** Reactor Engineering group and 777-M assigned personnel.		b		1	4			
M	**322-M.** Personnel processing samples from field. **772-F, UO_3 Section.** All assigned personnel.		b	1	1	4			
	321-M. All assigned personnel.		1		4[d]			2[f]	
T	**100 Areas, 105 Building.** Reactor Department personnel from C&D crews, Purification, and pump room observation; control room and monitor operators; all 100-Area HP, Maintenance, and T & T personnel; all E & I personnel assigned to 105 Buildings; T & T personnel in Central Shops; and selected Reactor Tech and 400-Area personnel.	h		1[e]					
V	**773-A.** Analytical Chemistry, High Level Caves, Building Services, Radiation Control, and Maintenance personnel.		b	1			2		1[g]
W	**773-A.** Selected Clerical, supervisory personnel, and selected 100-Area personnel.		b				1		
X	**232-H, 234-H, 237-H, & 238-H.** All assigned personnel. **241-H & 244-H.** Selected personnel.	h	b						
	700-Area shop personnel provide samples as considered advisable by Health Physics.								

NOTE: Neptunium analysis is performed when requested by area Health Physics. Neptunium has never been detected without at least an equal amount of Pu.

Bioassay Control Summary

- Monitoring prescribed by work area based on potential for exposure
- Monitoring frequency is based on potential for exposure
- Post 1978 - Neptunium urine bioassay for highest exposure potential area
  - Neptunium billet line in 235F working with oxide

Neptunium Monitoring Data

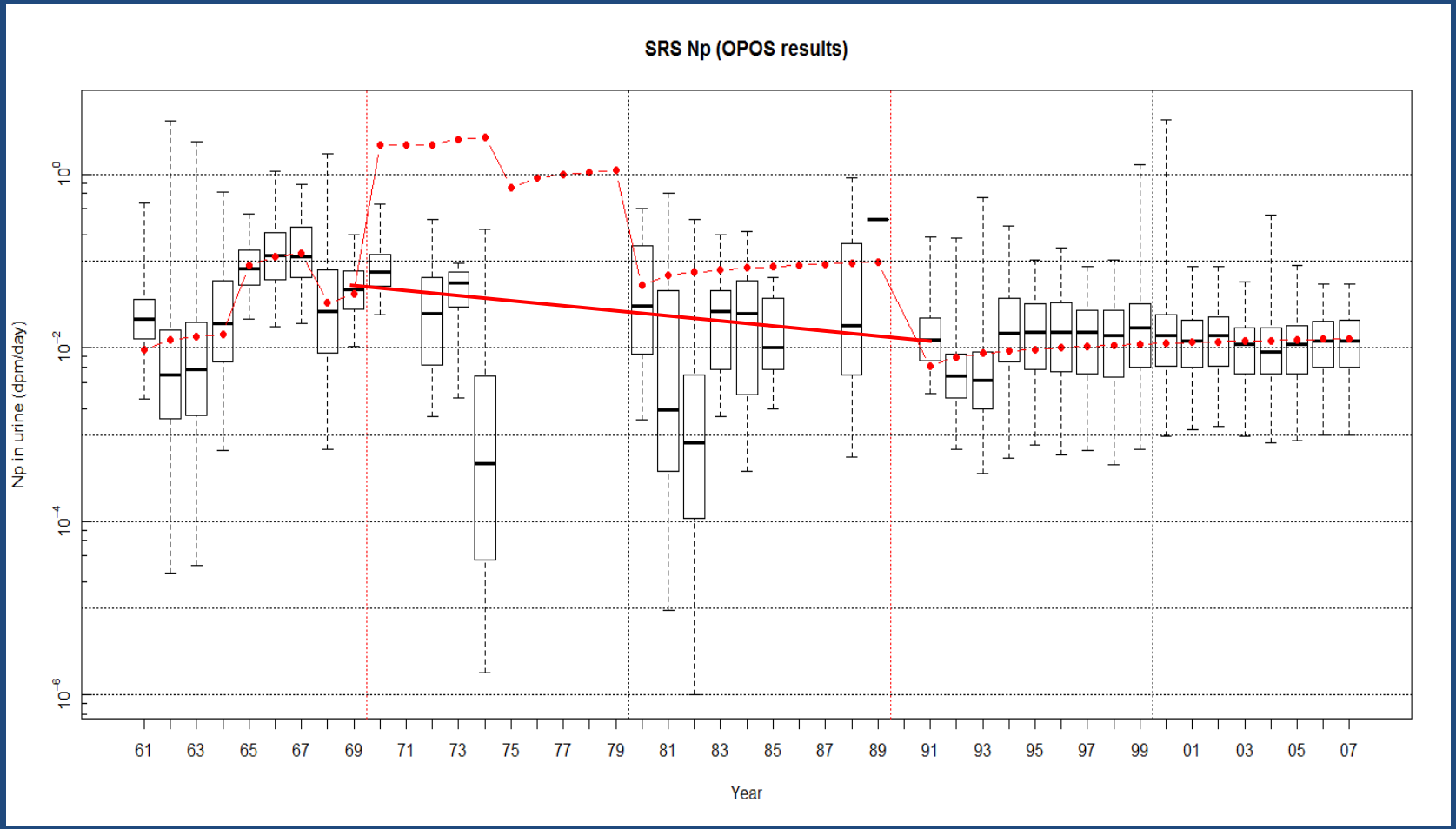
- 333 Np urine samples
- Area frequency based on exposure potential
- Most samples are from 235F

Year	Number of Samples by Area				
	235-F	HB Line	321M	773/772-F	other
1972	20				
1973	16		1		
1974	17			1	
1975					
1976					
1977					
1978					
1979			1		
1980	36		8	3	2
1981	3	2	9	3	2
1982	36	32	6	3	1
1983	12	4		7	2
1984	23	5	16	4	
1985	7	2		3	2
1986					
1987					
1988	5	5		16	4
1989	3			9	2
Total	178	50	41	49	15

Np Dose Reconstruction Methods

- At least four methods that NIOSH could use to develop a co-worker model in order to estimate Np exposures in the 1970 to 1990 timeframe:
  1. Use the limited bioassay (333 samples)
  2. Ratio Np from the Pu bioassay given that the Pu activity is between 2-10 times greater than Np activity (best estimate for an epidemiology studies)
  3. Interpolate between urine bioassay points between 1969 and 1990
  4. Use whole body count data to develop co-worker model (most claimant favorable)

Np Co-worker Model and Bioassay



NIOSH Co-worker Model

- NIOSH chose to use whole body count information because:
  - At the time NIOSH didn't have complete information on the actual Pu:Np ratio (data has now been obtained)
  - NIOSH has confirmed that workers in Np areas were required to have whole body counts
    - Shift employees - 2/year
    - Day employees - 1/year
  - Np doses calculated using WBC (Whole Body Count) are claimant favorable upper bounds but not unreasonably high as to be insufficiently accurate

NIOSH Co-worker Model

- **50 year equivalent doses**

Organ	50-Year Equivalent Dose (rem)
Urinary Bladder	0.352
Breast	0.352
Kidneys	0.958
Liver	4.280
Red Bone Marrow	10.300
Bone Surface	268.000
Stomach	0.352
Lung	6.920

Even the 268 rem / 50 years = approximately 5 rem / year

Np Co-worker Review Status

- Comparing workers with Np urinalysis and WBC to co-worker model
- Calculating the Np dose using Pu contamination in Np and compare to current Np co-worker model
- Researching potential construction trades worker exposures during new construction of the Plutonium Fuel Fabrication Facility (PuFF) in the mid 1970s

Np Co-worker Model Comparision

- 34 workers both Np urinalysis and WBC data

Worker	Cancer	Number of Samples		Dose (rem)		
		Urinalysis	WBC	Urinalysis	WBC	Co-worker
A	Lung	24	9	0.374	3.383	7.099
B	Skin	8	24	0.005	0.080	0.197
C	Bladder	4	3	0.001	0.027	0.007
D	Skin	3	15	0.008	0.105	0.266
E	Prostate	5	27	0.009	0.209	0.235

Subcontractor Records Status

- Reviewing NOCTS to identify Construction Trades Workers that worked for subcontractors (i.e. not DuPont Construction) to evaluate dosimetry record completeness
  - This review also involves comparing electronic datasets HPAREA, FAYERWET, SRPABSTR, and SRSABSTRNIOSH to the original dosimetry printouts.

Questions?