Rocky Flats Plant
Special Exposure Cohort Petition
Evaluation Report Rev. 1

LaVon B. Rutherford, CHP
National Institute for Occupational Safety and Health
Division of Compensation Analysis and Support

October 2013
Westminster, CO

Background

- September 5, 2012 - SEC-00192 Evaluation Report (ER) Rev. 0 for Rocky Flats Plant (RFP) issued

- September 18, 2012 - NIOSH presented ER at the Advisory Board meeting in Denver, CO
  - NIOSH's recommendation was not to add a class
  - Advisory Board concluded follow-up required, including classified interviews and classified document review

Background–cont.

- Since the ER presentation, NIOSH conducted a variety of follow-up efforts that identified additional issues
- Three work group meetings held in 2013 to discuss these issues (Feb. 20, July 8, and Sept. 12)
- NIOSH revised the ER to incorporate the new findings
- September 30, 2013 - DCAS sent the revised ER to the Advisory Board
- October, 4, 2013 ER cleared Authorized Derivative Classifier (ADC) review, sent revised ER to petitioner

Follow-up Efforts

- Additional Data Captures (classified and unclassified) – Los Alamos National Laboratory, Office of Scientific and Technical Information, Environmental Management Consolidated Business Center, and Department of Energy (DOE)-Legacy Management
- Secure Discussions
- Secure Interviews and other interviews (19)
- Additional dose reconstruction modeling

Post Evaluation Issues

- Follow-up efforts on RFP Tritium Issues
- Evaluation of petitioner concerns about data falsification and/or data Invalidation
- U-233/Thorium Strikes
- Neptunium
- Other Thorium Activities – evaluation included in ER

Issues that Resulted in Evaluation Report Revision

- U-233/Thorium Strikes
  - Classified interviews indicated the number of strikes were greater than previously evaluated in SEC-00030
  - Hanford infeasibility associated with U-233
- Neptunium
  - Not clearly evaluated under SEC 0030
  - Hanford infeasibility associated with Neptunium
- Other Thorium Activities
  - Classified review indicated there may have been additional work with thorium not previously evaluated

Tritium

- **Follow-up Efforts on SEC-00192 RFP Tritium Issues**
  - **Issued whitepaper on June 25, 2013**
    - **Concluded tritium dose reconstruction feasible**
  - **Provided to the work group on June 26, 2013 and the petitioners on July 3, 2013 (after ADC review)**
  - **Presented to the work group and petitioners on July 8, 2013 during the RFP work group meeting**
    - **Preliminary follow-up questions identified by the work group and Sanford Cohen and Associates (SC&A)**
  - **Work Group and SC&A discussed paper during the work group meeting on September 12, 2013**

Tritium–cont.

- **Tritium Related Operations**
  - Tritium contaminated materials from returned units
  - Neutron Generator Targets
    - Sealed units
    - Maintenance performed by factory authorized reps
  - Potential for the production of tritium from various radioactive materials present onsite
    - Determined not to be a significant source or contributor to exposure

Tritium–cont.

- **Additional Data Captures and Interviews:**
  - **Identified and confirmed potential for tritium exposure from contaminated shipping containers**
  - **Supported our previous finding that all known incidents involving a tritium release were below the release levels from 1973 incident**
  - **Did not identify any other sources of tritium exposure beyond previously evaluated other than from the shipping containers**

Tritium–cont.

- Tritium exposure time periods evaluated:
  - From 1959 through 1972
  - During 1973
  - Post 1973

Tritium Exposure 1959 - 1972

- Based on interviews and document review, NIOSH believes the most likely chronic exposure scenario from opening and working with shipping containers that contained units returned from other sites
- Exposure scenario developed from August 30, 1974 incident where 1.5 curies of tritium released from a shipping container

Tritium Exposure 1959 – 1972–cont.

- **Basis for using 1974 incident:**
  - **Background levels prior to the incident were being measured and were dosimetrically insignificant prior to the release**
  - **Quantity released was probably more typical of a release from a shipping container**
  - **Tritium was released to the workplace environment and not in a glovebox**

Tritium Exposure 1959 – 1972-cont.

- **Basis for using 1974 incident:**
  - **The release involved elemental tritium and not tritium oxide**
  - **The incident occurred close enough to the 1973 incident that work place controls were likely similar to prior to 1973**
    - **SC&A questions the basis for believing this is a reasonably bounding scenario**

Tritium Exposure 1959 - 1972–cont.

- **Monitoring Data from 1974 incident:**
  - **Air samples from June through September 1973**
    - **Average concentration prior to Aug. 30, 1974 were 5343 + or - 4518 pCi/m^3**
    - **Concentration Aug. 30 was 37, 676, 609 pCi/m^3**
  - **Bioassay samples taken indicated a high result of 32, 320 pCi/L**
  - **Work Areas Smears were taken (>200)**

Tritium Exposure 1959 – 1972–cont.

- Dose Assessment from 1974 incident:
  - The largest reported urine sample was 32, 320 pCi/L with a start date of August 30, 1974
  - Using IMBA, the resulting dose was < 1 mrem (0.15 mrem)
  - Assuming 1 incident per day for 250 per year results in 37.5 mrem/year
- Therefore, all unmonitored workers for tritium will be assigned 37.5 mrem for all years prior to 1973

Tritium Exposure 1973

- **Annual Dose Assigned based 1973 incident:**
  - **The incident occurred April 9 through April 25, 1973 when a shipment of scrap plutonium from LLNL was processed at RFP in bldg. 779A**
  - **The incident was not immediately identified so individual monitoring did not begin until September 1973**
  - **Approximately 250 people were bioassayed for tritium**
    - **Initially 19 people were identified with elevated tritium**
    - **Upon recheck only 5 were above 10,000 pCi/L action level**

Tritium Exposure 1973–cont.

- The five cases (Case A, B, C, D, and H) exceeding 10,000 pCi/L were reviewed from the final incident report:
  - All cases were modeled to determine the best fist for the urine data which then would give the most likely dose
  - Case H best fit exposure scenario resulted in the highest dose of 84 mrem
    - Limited information therefore assumed acute intake first day of event
- Tritium doses will be assigned to all unmonitored workers

Tritium Exposure post 1973

- Co-worker analysis was performed using 1974 and 1975 tritium bioassay data
  - 38 individuals with tritium data 1974
  - 37 individuals with tritium data 1975
- Because tritium was only present as a potential contaminant, groups of individuals were not placed on routine bioassay for tritium
- One-tenth of the urine samples collected for plutonium were analyzed for tritium
- Also, samples were required when there was a concern

Tritium Exposure post 1973–cont.

- Dose Assessment for 1974 and 1975:
  - It was assumed each worker had potential for exposure throughout the year
  - The 95th percentile was used because only one-tenth of the population was sampled
- The co-worker study for 1974-1975 period yielded doses of 0 mrem for everyone
- For post 1974 the same dose will be assigned for unmonitored workers based on the limited bioassay data being consistent with the 1974 and 1975 data

Thorium

- In SEC-0030 evaluation the NIOSH position was that documents supported that Thorium quantities present at Rocky Flats were not in high enough quantities to contribute significantly to internal dose potential

- As stated in NIOSH's original SEC-0030 evaluation, beginning in 1952, Thorium was used on site in quantities small enough that effluents were not routinely analyzed for Th. Thorium quantities varied from as little as none to as much as 238 kilograms (kg) in a given month

Thorium–cont.

- Thorium was used in a variety of processes including:
  - Fabrication of metal parts from natural thorium or thorium alloys
  - Use of oxide (“thoria”) as a mold-coating compound
  - Numerous analytical procedures and research and development
  - As a substitute for U or Pu components in research and development
  - Removal of Th-228 from U-233
  - Mg-Th alloy work (This is still being evaluated)

Thorium–cont.

- Most of the work associated with Thorium during the SEC-0030 evaluation was focused on specific activities that occurred in the 1960s
- Based on interviews and document review, NIOSH decided to re-evaluate the Thorium issue

Thorium–cont.

- During NIOSH's review documents supported that:
  - Activities involving thorium occurred as far back as 1952
  - A concern with exposure or the need to monitor personnel as far back as 1954
- Changing Inventories in these early years supported that work with Thorium was occurring during this period
  - Activities and processes involving Thorium were not well documented in the early years nor was the throughput
- Based on NIOSH's review of the NMMS database, no significant inventories of Thorium existed at Rocky Flats after 1971
  - Documents do indicate that thorium solutions (thorium nitrate) existed up through 1974

Thorium–cont.

Personnel and Area Monitoring Data

- RFP developing personnel monitoring approach for thorium through the 1950s into the 1960s
- No routine monitoring for thorium existed at RFP
  - Personnel and area air samples from 1960, but no activity results
  - Two bioassay samples in 1966
  - Some Thorium Specific Personnel and Area monitoring data

Thorium–cont.

Surrogate Data

- During review of SEC-00030 NIOSH used surrogate data air samples for the thorium ingot operation in 1960
  - This was vetted in 2007 before surrogate data criteria (IG-004) was established in 2008
  - Data was from a study conducted at the Albany Research Center. This was a one-time operation conducted under experimental laboratory conditions

Thorium–cont.

Feasibility Determination

- Activities involving thorium in the 1950s and early 1960s were not well defined
- Lack sufficient personnel and area monitoring
- Surrogate data used does not meet the criteria for using surrogate data established in IG-004

Thorium–cont.

Feasibility Determination-cont.

- Therefore, NIOSH finds it's not feasible to reconstruct thorium exposure from 1952 through 1966
- NIOSH intends to use any relevant internal monitoring data that may become available for individual claims

U-233/Thorium Strikes

- Exposure during U-233/Thorium strikes was originally evaluated under the SEC -0030 evaluation
  - Re-opened under SEC-0192 after indications this may have occurred more than the two times (1965 and 1967) previously identified
- U-233 was being evaluated for its use in the weapons program
- Problems with U-233 was a contaminant U-232
  - U-232 progeny pose a significant external hazard
- A chemical process called a “Thorium strike” was used to remove the Th-228 and its progeny

U-233/Thorium Strikes–cont.

- SEC-0030 assumed U-233 exposure covered with uranium bioassay
- During the deliberation of SEC-0030 the bounding Thorium dose was based on air sampling taken during the strike in 1965
  - This strike was considered bounding because it had the highest concentration of U-232 of the two strikes
  - No credit was taken for ventilation, hoods or time limits

U-233/Thorium Strikes–cont.

- Interviews and documents indicated additional strikes occurred other than the two previously evaluated
  - Were the potential exposures from other strikes bounded by the 1965 exposure analysis?
- Other questions came up based on recent addition of a class at Hanford based on inability to reconstruct doses to U-233
  - Were the activities similar?
  - Were the material quantities similar?
  - How much monitoring data do we have in comparison?

U-233/Thorium Strikes–cont.

Reasons to believe 1965 Strike is still bounding for Thorium

- Most documents indicate the U-233 was to be processed or shipped off site prior to the 90 day period to prevent the hazard from the ingrowth and therefore a strike would not be required
- Documents indicate the concentration of U-232 did not exceed 8 ppm after 1965
- Although NIOSH determined the 1965 exposure was still bounding, it's not clear how this would be applied if additional strikes are assumed

U-233/Thorium Strikes–cont.

Determining U-233 exposures

- The quantity of U-233 on site at RFP varied from 1964 to the end of U-233 operations in 1983
- Estimates from available documents indicate quantities could have been from 1 kg up to 150 kg from 1965 through 1983
  - Highest quantities from 1965 through 1968
- Bioassay data for uranium exists and a uranium co-worker model exists for the period of concern

U-233/Thorium Strikes–cont.

Determining U-233 exposures

- Initial idea was to give a corrected uranium dose to all workers with uranium bioassay
  - Assumption based on all workers who worked on U-233 activities would have uranium bioassay

- A review was conducted to determine if any of the Operators (46) listed in logbook for U-233 operations were existing claimants in NOCTS
  - There were 18 of the 46 who are claimants
  - Of the 18 claimants, 17 had uranium bioassay; no clear reason why this claimant did not have bioassay

U-233/Thorium Strikes–cont.

Determining U-233 exposures

- NIOSH cannot assume all workers working on U-233 operations necessarily had uranium bioassay
- NIOSH cannot identify all workers who worked with U-233 through the years of operations
- If NIOSH used the uranium co-worker, NIOSH would have to assume all workers could have been exposed and a correction factor for exposures to U-233/U-232 and progeny applied
  - Factor could vary significantly depending on mass based analysis or activity based
- U-233 Specific Activity is approx. 140 times U-235
  - U-233 operations would have been handled differently than other uranium operations. Therefore, using the uranium co-worker would not necessarily have been indicative of U-233 exposures.

U-233/Thorium Strikes–cont.

Personnel and Area Monitoring Data

- No U-233 specific bioassay data
- No Th-228 specific bioassay data
- One set of U-233 specific air samples in 1965 (Highest RCG 39%)
- Uranium co-worker cannot be used

U-233/Thorium Strikes–cont.

Feasibility Determination

- NIOSH finds it's not possible to completely reconstruct internal U-233, U-232, and Th-228 radiation dose for the period from 1964 through 1983
- NIOSH intends to use any related internal monitoring data that may become available for individual claims

Neptunium

- General conclusion under SEC-0030 was Neptunium was used in small quantities for research type work and had limited exposure potential compared to Uranium and Thorium
- A determination was made to re-explore this exposure situation based on interviews and recent determination associated with Neptunium at Hanford

Neptunium

- Records indicate that Neptunium was processed at Rocky Flats as early as 1962 and inventories existed until 1988
- Neptunium was processed to produce pure Neptunium oxide, metal, and metal alloys
- Processes employed included dissolution, anion exchange, precipitation, filtration, calcination, conversion to fluoride, and reduction to metal

Neptunium–cont.

- Fabrication steps such as casting and rolling were performed to produce metal shapes and foils
- Neptunium was also recovered from residual materials including sand, slag, crucibles, casting skulls, and alloys
  - The residues were not only from Rocky Flats operations, but residues were sent from other sites
- Based on documents and inventories it appears most work with Neptunium was completed by the end of 1983

Neptunium–cont.

- Annual on site inventories were typically maintained around 1 kg
  - Does not address throughput
- Batches involving Neptunium typically did not exceed 300 grams
- Buildings having Neptunium inventories included 371, 559, 707, 771, 776, 777, 779, 779A, and 991

Neptunium–cont.

Neptunium Exposure

- Documents indicate some early work was conducted in open hoods, but most work was performed in glove boxes
- Based on NIOSH's review, Neptunium exposure potential existed at every processing step, including extraction and purification, hydrofluorination, reduction to metal, alloying, casting, and rolling

Neptunium–cont.

Personal Monitoring Data

- There are only two bioassay samples for Neptunium
- They were both taken in 1966
  - One "Below Significant Level" and the other 0.9 dpm/24hr
- Gross Alpha bioassay samples existed up until 1970s

Workplace Monitoring Data

- NIOSH has found no workplace monitoring records (e.g., air sample, surface contamination samples) specific to Neptunium

Neptunium–cont.

Feasibility Determination

- Can we use gross alpha samples as indicator for Neptunium?
  - NIOSH interviewed two former Rocky Flats Plant employees involved with the Radiological Controls program and the Bioassay lab
  - Interviews indicated that it would be questionable based on the chemistry whether you would see the Neptunium in the sample
  - Interviews indicated that the intent of co-precipitation process used after 1961 for “Gross Alpha” analysis was to focus the analysis on specific radionuclides typically Uranium and possibly plutonium

Neptunium–cont.

Feasibility Determination-cont.

- Little to no personal or area monitoring data
- Gross Alpha bioassay samples not a viable means for estimating Neptunium exposures
- Too many different types of activities including wet and dry processes to develop an exposure model
- Additionally, the source term varied in amount and chemical form

Neptunium–cont.

Feasibility Determination-cont.

- Quantities and activities associated with Neptunium at Rocky Flats are similar to Hanford during the same time period
- Based on this, NIOSH has concluded dose reconstruction is not feasible for Neptunium exposures for 1962 through 1983

Neptunium–cont.

Why stop at end of 1983?

- Based on NIOSH's review of documents very little to no work occurred with Neptunium after 1983
  - Inventories relatively constant
- A 1981 Documents indicates that early work was done in open hoods but later "Alpha containment" was used
- In vitro bioassay techniques improved by 1981 and in vivo techniques improved by 1976
- NIOSH will continue to evaluate the 1984-1988

Current SEC Classes

Employees of DOE, its predecessor agencies, or DOE contractors or subcontractors who were monitored or should have been monitored for neutron exposures while working at the Rocky Flats Plant in Golden, Colorado, for a number of work days aggregating at least 250 work days from April 1, 1952, through December 31, 1958, …..

Employees of DOE, its predecessor agencies, or DOE contractors or subcontractors who were monitored or should have been monitored for neutron exposures while working at the Rocky Flats Plant in Golden, Colorado, for a number of work days aggregating at least 250 work days from January 1, 1959, through December 31, 1966, ….

Feasibility of Dose Reconstruction

- **NIOSH -**
  - **finds that internal doses cannot be estimated with sufficient accuracy from April 1, 1952 through December 31, 1983**
  - **intends to use any related internal monitoring data that may become available for individual claims; and**
  - **will continue to evaluate potential Neptunium exposures for the 1984-1988 time period.**

Summary

Feasibility Findings for SEC 0192 (Rev. 1) Rocky Flats April 1, 1952 – December 31, 1983		
Source of Exposure	**Reconstruction Feasible**	**Reconstruction NOT Feasible**
Internal		
Tritium	**X**	
Thorium		**X (1952-1966)**
U – 233		**X (1964-1983)**
Neptunium		**X(1962-1983)**
External – Not evaluated in this report (See SEC – 0030)		

Recommended Class

All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Rocky Flats Plant in Golden, Colorado, from April 1, 1952 through December 31, 1983, 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

Remaining Issues

- Data Falsification question
  - Classified Interview to be conducted with individual who has information concerning data falsification
- Continue to evaluate 1984-1988 period for Neptunium exposure potential
- Evaluate the use and exposure potential for Mg-Th alloy at Rocky Flats
- Resolve open questions with SC&A and the work group concerning tritium