Status of Pinellas Plant SEC-00256 Evaluation Report Review

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Presentation and review qualifications

- This presentation is a snapshot as of mid-November 2022 of SC&A's ongoing review of the October 13, 2021, Pinellas SEC-00256 evaluation report (ER)
- Any SC&A observations, opinions, or statements in this presentation are subject to revision as the review continues
- SC&A is working with DCAS/NIOSH and their contractor ORAUT to perform targeted keyword searches so that ORAUT can provide necessary documents directly to SC&A and expedite completion of SC&A's SEC ER review

Pinellas Plant background

- Located on ~100-acre site in Clearwater, FL
- Constructed in 1956 and operated though 1994 by General Electric to manufacture neutron generators
- After 10 years, expanded to include other specialized electronic equipment for the nuclear weapons program
- At peak operations, the plant employed ~2,000 people
- Decontamination & decommissioning activities from 1994 through 1997
- Remediation activities in 1999, 2008, and 2009

Advisory Board and SEC-00256 background

- NIOSH worker outreach began in 2004, and work group meetings started in 2008
- The initial Special Exposure Cohort (SEC) petition (83.13 basis) was submitted on December 16, 2019, and later twice revised by the petitioners: on May 20, 2020, and August 17, 2020
- NIOSH qualified the August 17 petition for evaluation with a modified class definition:
  - "All employees of the Department of Energy, its predecessor agencies, and their contractors and subcontractors who worked at the Pinellas Plant in Clearwater, Florida for the period from January 1, 1957 through December 31, 1990."

Class definition and petition qualification

- NIOSH qualified the petition for evaluation under the F.4 basis
  - "scientific or technical report . . . that identifies dosimetry and related information that are unavailable . . . for estimating the radiation doses of energy employees covered by the petition."
- DOE Tiger Team report (1990) documented that some dosimetry information (uncollected bioassay samples) might not be available for the period before 1990
- NIOSH determined that Pinellas had adequately and promptly addressed the bioassay compliance issues raised in the Tiger Team report
  - NIOSH terminated the class definition period on December 31, 1990, rather than on December 31, 1997, as proposed in the petition
  - SC&A is reviewing dosimetry information and assessing this cutoff date

SEC-00256 evaluation report

- NIOSH issued the Pinellas SEC-00256 ER on October 13, 2021, and presented it to the Board at its December 8, 2021, meeting.
- "NIOSH concludes that it has access to sufficient information to estimate the maximum radiation dose, for every type of cancer for which radiation doses are reconstructed, that could be incurred in plausible circumstances by any member of the class under evaluation. Therefore, NIOSH does not recommend adding the NIOSH-evaluated class to the SEC."
- At its December 8, 2021, meeting, the Board tasked SC&A to assess the ER.

SC&A's approach to assessing the ER

SC&A's review objectives

1. Give information to the Board to determine whether doses can be reconstructed with sufficient accuracy, as defined in 42 CFR Part 83
2. Provide a technical evaluation of the scenarios, data assumptions, models, and other information given or referenced in the ER for reconstructing doses

To the extent currently feasible, SC&A is assessing how NIOSH:

- recognizes, addresses, and resolves petitioner concerns
- has access to sufficient data (e.g., bioassay data)
- adequately identifies and models all significant internal and external sources of radiation, including from radiation incidents, that might have affected employees during the SEC period

Reliance on Pinellas technical basis documents

- SC&A reviewed the original 2005–2006 technical basis documents (TBDs)
  - submitted assessment to the Board in 2006
  - identified 11 primary and 8 secondary issues
- NIOSH has since revised the TBDs, beginning in 2011
- After SC&A, NIOSH, and Pinellas Work Group (WG) exchanges, the final status of the issues resolution process was reported at the August 9–10, 2016, ABRWH meeting
  - "SC&A and the Pinellas Work Group agree that all of the primary and secondary issues raised in SC&A's site profile review have been adequately addressed and resolved."

Source characterization

- Radioactive materials (sealed or unsealed sources) vs. radiation generators
- Potentially dispersible vs. nondispersible radioisotopes

Potential sources of exposure: Radioactive materials

- Accelerator-type neutron generators – containing tritium targets
- Radioisotope-powered thermoelectric generators (RTGs) – containing plutonium dioxide
- Borosilicate glass structures – containing uranium
- Leak-testing systems – containing krypton (Kr)-85
- Tritium storage systems – which may also contain uranium beds
- Check sources and analytical standards for lab analyses

Potential sources of exposure: Radiation generators

- Neutron generators, when energized:
  - produce neutrons through deuterium-deuterium or deuterium-tritium fusion reactions
  - produce secondary radiation
- Ion accelerators for ion implantation
- Occupational x-ray exposures

Potentially dispersible radioisotopes

- **Tritium**
  - low-energy beta emitter (5.7 keV average, 18.5 keV max energy)
  - four forms: tritiated water, tritium gas, organically bound tritium (OBT), metal tritides
- **Carbon (C)-14**
  - beta emitter (49.5 keV average, 156.5 keV max energy)
  - used in small amounts in the plant as a tracer in some solvents
- **Kr-85**
  - beta-emitting noble gas (251 keV average, 687 keV max energy)
  - used in leak detection systems

Potentially nondispersible radioisotopes

- **Plutonium (Pu-238 and Pu-239):** emits alpha, beta, photons and neutrons (spontaneous fission)
- **Uranium (U-234, U-235, U-238, and depleted uranium):** emits alpha, beta, x-radiation, and neutrons (spontaneous fission)
- **Nickel-63:** beta emitter used in krytrons (sealed gas-filled glass tubes used as very high-speed switches in nuclear weapons)

External exposures: Photon radiation

- **Neutron Generator Production Area:** testing neutron tubes and generators
- **RTG Production Area:** (Pu-238)O_2 heat sources
- **Chemistry Lab:** ion implanter accelerator

External exposures: Beta radiation

- **Tritium:** not considered to be an external exposure hazard due to the low energy and very short range of its beta particles
- **Kr-85:** considered a potential hazard because:
  - its beta particles have sufficient energy to cause skin damage
  - some of the gas might have escaped from the leak detectors
- **C-14:** Although present in small amounts, it is considered a beta hazard

External exposures: Neutron radiation

- Producers of neutrons and secondary radiation:
  - neutron generators (intermittent)
  - RTG heat sources (continuous)

Petitioner-identified potential internal exposure sources

- Tritium
- Uranium
- Plutonium
- Carbon-14
- Krypton-85
- Strontium (Sr)-90, cobalt (Co)-60, thallium (Tl)-204

Internal dosimetry monitoring data

- **Tritium urine bioassays:** based on exposure potentials
- **Plutonium urine bioassays:** for RTG project workers
- **Area air monitoring:** for areas with potential for tritium release and for plutonium in RTG area
- **Smear surveys:** for areas with potential for tritium release and for plutonium in RTG area

Tritium internal exposure potential

- ER asserts tritium is the only source of internal exposure risk
- ER references the internal dosimetry TBD for methods to reconstruct internal doses from soluble tritium (gas, oxide, OBT) from bioassays
  - Calculates exposures to both 100% tritium gas and 100% OBT and selects the most claimant favorable
  - Assumes workers exposed to insoluble tritium compounds (i.e., metal tritides) were also exposed to soluble tritium, which was monitored
  - Although workers probably had limited exposure to insoluble tritium compounds, NIOSH assesses all workers monitored for soluble tritium as though they were exposed to insoluble tritium at the same time

Tritium exposure review

- Potential tritium exposure and how to determine dose has been a subject of discussion since SC&A reviewed the first Pinellas TBDs in 2006, resulting in two primary and one secondary issues related to tritium.
- Subsequent discussions, papers, and reviews closed all issues as of 2016 except for issue 2 (potential doses from insoluble metal tritides not sufficiently addressed), which was put in abeyance pending NIOSH revising the internal dosimetry TBD.
- SC&A and the Pinellas WG accepted NIOSH's methods.

Metal tritides

- Metal tritides, also known as stable metal tritides (SMTs), are examples of special tritium compounds, which are treated in ORAUT-OTIB-0066, “Calculation of Dose from Intakes of Special Tritium Compounds” (rev. 01, October 15, 2020)
- The revised OTIB-0066 removed its recommendation to use ORAUT-OTIB-011 for assessing OBT exposures and added a discussion on interpretation of urinalysis results following assumed intake of SMTs
  - Current internal dose TBD (rev. 03) was issued in 2016
  - Pinellas ER was issued soon after OTIB-0066, rev. 01
  - Consequently, neither reflect its guidance

Stable metal tritides in ORAUT-OTIB-0066, rev. 01

OTIB-0066, rev. 01, states:

> "Stable metal tritides (SMTs) are a class of tritium compounds that cannot be detected by urine bioassay as easily as tritium oxide. 'Stable' is used to indicate that the tritium is not easily separated from the metal matrix in which it is bound. This material is more strongly retained in the lung, resulting in much smaller fractions of the intake excreted in urine. Therefore, a relatively small amount of tritium in a urine sample can indicate a large intake of an SMT."

Potential ER issue

- SC&A completed a focused review of rev. 01 of OTIB-0066 in 2021
- The ABRWH Subcommittee for Procedure Reviews closed all open issues and accepted the OTIB's methodology at its November 3, 2021, meeting
- SC&A's continuing review of the ER will consider whether the absence of OTIB-0066, rev. 01, methodology significantly affects dose reconstruction (DR)

Uranium internal exposure potential

- Depleted uranium (DU) was used in tritium storage beds. Issue 8 from the original SC&A TBD review concerns the potential for missed DU intakes from inhalation of loose DU from cutting and machining of the beds.
  - A NIOSH investigation and SC&A review established that such activities were conducted off site at a GE plant in Milwaukee, not at Pinellas.
- Pinellas used borosilicate glass containing 1.5% by weight of naturally occurring uranium oxide (U_3O_8).
  - As part of plant operations, this glass was cut and chemically etched. Site health physicists evaluated the exposure risk and determined that minimal external and no internal hazards were present.

Plutonium internal exposure potential

- The issue of plutonium monitoring has been discussed since SC&A's initial review of the site profile in 2006. After consideration by the WG, SC&A documented the final resolution in its 2016 update of the issues resolution matrix:
  - Pinellas received triply encapsulated RTGs and did not open them, so the only chance of exposure was from surface contamination.
  - Surface contamination levels of the capsules were quite low.
- The WG, at its October 2011 meeting, considered the issue resolved and that no further consideration is necessary unless new information becomes available.

Carbon-14 internal exposure potential

- According to the State of Florida Dept. of Health and Rehabilitative Services, approximately 0.00034 curies of C-14 were released from plant stacks 1979–1983.
- The potential for C-14 internal exposure was identified by SC&A in its site profile review and discussed at the June 2009 Pinellas WG meeting.
  - The quantity of material released was determined to be negligible and contributed less than 1 mrem/year dose.
  - At the meeting, the issue was considered resolved by Pinellas WG.
  - Unless new information is identified, SC&A believes the potential for C-14 intakes has been resolved. C-14 does not contribute significantly to the internal dose hazard on site.

Krypton-85 internal exposure potential

- According to the State of Florida Dept. of Health and Rehabilitative Services, approximately 846 curies of Kr-85 were released from plant stacks 1963–1992.
- As a noble gas, Kr-85 does not react chemically within the body and, when it is breathed in, it is then soon breathed out.
- Since only a very small amount of β-decay might take place in the lungs, the ER asserts that Kr-85 is not a significant internal exposure hazard.
- SC&A is reviewing the ER's assumption.

Strontium-90, cobalt-60, and thallium-204

- The petition requests that Pinellas be added to the SEC partly based on the claim of incomplete radiological characterization of Sr-90, Co-60, Tl-204, and beryllium.
  - Beryllium is an element, not a radionuclide, and is not a radiological hazard.
- SC&A's preliminary review finds that these three radionuclides in the Pinellas inventory did not present a sufficient internal exposure risk that should have been monitored by the plant.
  - All Co-60 and Tl-204 sources were sealed (not loose), so there was no potential for direct exposure unless there was leakage, which SC&A is investigating.
  - Sr-90 was present in both sealed and unsealed forms. However, the unsealed sources were small.
  - While these radionuclides can be used in RTGs, no evidence has been found so far that such was the case at Pinellas.

Radiation monitoring data

- SC&A is conducting a preliminary review of the radiation monitoring data available during two time periods:
  - SEC period 1957–1990
  - post-SEC period 1991–1997
- SC&A is currently attempting to acquire through NIOSH five Pinellas cases previously reviewed by the Subcommittee for Dose Reconstruction Reviews to identify any issues with the DR that were identified in those reviews and to evaluate their relevance to the feasibility of dose reconstruction for the SEC period.

Radiation monitoring data: 1957–1990 (ER)

- "[The ER] finds that the Pinellas Plant did monitor potentially exposed personnel and did not find indications of lack of monitoring for the class under evaluation. NIOSH concludes that it has sufficient data to perform dose reconstruction."
- The ER states that NIOSH examined many different types of in vitro urinalysis record sources and that:
  - "NIOSH reviewed NOCTS claimant files in early 2020 and found over 20,000 tritium bioassay results for 230 individuals."

Radiation monitoring data: 1957–1990 (SC&A)

- SC&A was able to review the list of ~2,500 documents available for Pinellas on NIOSH's internal Edge Computing Platform (ECP).
- SC&A reviewed documents that, based on their titles, could potentially contain bioassay or external dose data.
  - The data contain tritium and some plutonium bioassay results as well as external monitoring records for photons, betas, and neutrons as applicable.
- SC&A is examining whether there are any indications of inadequate monitoring data that would preclude dose reconstruction.

Radiation monitoring data: 1991–1997 (ER)

- Although the SEC petition requested the evaluated period extend through 1997, NIOSH ended it in 1990. Among NIOSH's reasons:
  - the plant's rapid and effective response following the Tiger Team findings, including improving its radiation monitoring program
  - tables 6-2 and 6-4 of the ER summarize, respectively, internal monitoring data for tritium for 1986–1995 and external monitoring data for 1985–1995
- The ER cites the "1990 Annual ALARA Report for Ionizing Radiation" to show that the bioassay program average participation increased to almost the target of 80%, supporting the claim that Pinellas greatly improved its monitoring program post 1990.

Radiation monitoring data: 1991–1997 (SC&A)

- SC&A is reviewing the ER's arguments for terminating the SEC evaluation period in 1990 rather that the petitioner-requested end date of 1997.
- Based on the information available to date, SC&A has not found indications that there are issues with exposure records that would prevent DR feasibility for the 1991–1997 period; SC&A continues to evaluate.

Tritium monitoring for 1991

- Reviewing the transition year of 1990:
  - The Tiger Team assessment was conducted in January and February 1990
  - Pinellas initiated corrective action during FY 1990
  - Table 6-4 of the ER indicates a significant decrease in external doses when moving from 1990 to 1991
  - However, table 6-2 shows an increase in internal doses from tritium from 1990 to 1991, then a gradually decreasing trend from 1992 to 1995
- SC&A notes that, according to the "1991 Annual ALARA Program Report for Ionizing Radiation," the increase in tritium doses for 1991 was due an incident and recovery operations that influenced the tritium doses for only that year; hence, it was not systemic.

Petitioner concerns

Issues addressed in ER

- Section 7.4 of the ER summarizes the 9 issues it identifies as petitioner concerns and gives a response to each.
- SC&A is examining the petition and other petitioner submissions to the Board to determine if the ER identifies and addresses adequately all relevant petitioner concerns.

Issues identified by SC&A

- In addition to the 9 issues addressed explicitly in the ER, SC&A identified several others.
- To date, SC&A has not found any petitioner issues not adequately addressed in the ER, but the examination continues.
- The following slides list the 16 issues identified by SC&A so far.

Petitioner issues identified in the ER (1–4)

1. Former Pinellas workers were not monitored for all the radionuclides described in the “Radioactive Material Inventory for the Pinellas Plant” document referred to in ER section 7.4.1.
2. Only a small fraction of the workers were monitored for radioactive exposures. The plant failed to monitor all workers for all radionuclides as described in the 24-hour heavy metal urine tests.
3. Incidents described in the Tiger Team report, the Holliday 1989 report, and the Department of Labor site exposure matrices are not explicitly addressed in the ER, particularly the leaking Co-60 source.
4. Employees falsely identifying urine samples.

Petitioner issues identified in the ER (5–9)

5. Tiger Team found deficiencies in detecting plutonium in the air and soil.
6. Majority of workers never monitored for Pu-238/239.
7. Radioactive materials or emissions regarding the Radioactive Materials Management Area located in Building 100.
8. Rooms within Building 100 were not self-contained, resulting in potentially contaminated air to circulate.
9. Majority of the workers were not afforded occupational x-ray exams.

Petitioner issues identified by SC&A (10–13)

10. No comprehensive radiological surveys of areas with radioactive contamination, including certain rooms in Building 100, several hoods in Buildings 200 and 800, and areas of Buildings 550 and 1000, as described in “Independent Technical Review of the Pinellas Plant” (1994).
11. Insufficient environmental monitoring and record keeping, as described in ”Pinellas Plant Feasibility Study” (1994).
12. Dose reconstructions only reflect one location, not the “full range of employment locations held by these workers.”
13. Dose reconstructions only reflect one job category, not the “full range of labor categories held by these workers.”

Petitioner issues identified by SC&A (14–16)

14. Dose reconstructions only reflect one work process, not the “full range of work processes held by these workers.”
15. Dosimetry records after 1981 were missing from all the DOL and DOE files.
16. Inconsistent monitoring and dosimetry record keeping, as described in the Tiger Team report.

Path forward

- Continue evaluating available material, particularly sources relied upon in the ER, incident reports, health physics investigation reports, worker statements, and all petitioner submissions and associated material.
- Evaluate any new data made available from data collection activities.
- Look at 5 previous DR cases in context of monitoring records.
- Assess data completeness concerns over potential gaps in records.
- Assess annual tritium inventories and device production records to see if there is a correlation to dosimetry records.
- Continue to utilize ORAUT's search capabilities to locate relevant documents via targeted document keyword searches.
- Access NOCTS, BRS, and CATI reports to determine any additional SEC-related issues.

Questions?