Review of Program Evaluation Report DCAS-PER-078, "Extrusion Plant"

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Subcommittee for Procedure Reviews

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DCAS-PER-078 purpose and review summary

- **Purpose:** Assess the impacts of rev. 01 of the Extrusion Plant (also known as Reactive Metals, Inc.; RMI) technical basis document (TBD) (3/7/2017) on previously completed dose reconstructions (DRs)
- **January 4, 2018:** National Institute for Occupational Safety and Health (NIOSH) issued DCAS-PER-078 ("PER-078")
- **July 28, 2025:** Subcommittee for Procedure Reviews tasked SC&A to review the program evaluation report (PER)
- **March 5, 2026:** SC&A issued its PER subtasks 1–3 review

Extrusion Plant background

- 25 buildings located on 7 acres on a 32-acre site in Ashtabula, Ohio, operating from 1962 to 1988
- Main function: process metals through extrusion, cutting, forging, and chemical treatment
- Metals of interest were primarily uranium and, to a lesser extent, thorium, which were processed for the government
- The plant also did some commercial metal processing of copper, zirconium, titanium, and molybdenum

Federal programs

- Extrusion Plant received uranium primarily from the Feed Materials Production Center (Fernald) and the Weldon Spring Plant for processing; most of the feedstock was billets
- U.S. Department of Energy (DOE):
  - Extrusion of depleted and enriched uranium for the Hanford N-Reactor and the Savannah River Site (SRS)
  - Limited extrusion of thorium
- U.S. Department of Defense (DOD) contractors: depleted uranium (19.05 grams/cubic centimeter) for armor-piercing penetrators

Extrusion Plant timeline

Period	Dates	Activities
Covered	1/1/1962–11/1/2006	Overall plant history
Radiological production – overall	1/1/1962–10/14/1991	Uranium was or could have been extracted under U.S. Nuclear Regulatory Commission license
Radiological production – SRS	1962–1988	SRS production
Radiological production – Hanford	1962–1988	Hanford N-reactor fuel and target production
Radiological production – thorium	5/1/1962–12/31/1971	Intermittent thorium production for DOE
Radiological production – penetrator	1974–1985	DOD armor-piercing penetrator program
Postproduction	10/15/1991–12/2006	Extrusion of radioactive metals ceased and predecommissioning and decommissioning were underway

Uranium receipts for N-reactor and SRS work (metric tons uranium)

Uranium type	1962–1970	1971–1990
Enriched	13,442	11,829
Normal	4,904	330
Depleted	5,094	30,778
All	**23,440**	**42,937**

In addition to the receipts for N-Reactor and SRS work, the Extrusion Plant received 9,488 metric tons uranium (MTU) of depleted uranium from 1974 to 1985 for the DOE penetrator program, for a total uranium receipt of about 75,757 MTU.

General process description

- TBD (rev. 01) attachments B, C, and D provide details of the production processes for the N-Reactor, Savannah River Site, and DOD penetrator programs, respectively.
- In the simplest terms, the Extrusion Plant did metal fabrication through extrusion and forging operations using an extrusion press, a runout table, a cooling table, a cut-off saw, and other equipment. Depending on the processing campaign, there were also different chemical processing steps.

Source terms: uranium and thorium

- Extrusion Plant processed depleted, natural, and slightly enriched (2%) uranium and thorium with the amount of uranium far exceeding the amount of thorium.
- TBD (rev. 01), table 2-7, compares the masses of thorium and uranium from 1962 through 1971.
  - Mass ratios of thorium to uranium processed per year are less than 0.722%.
  - Upper bound is in 1963, when the plant processed 47,320 pounds of thorium and 6,564,477 pounds of uranium.
- Source term consisted primarily of contributions from uranium and members of its decay chain, and a lesser contribution from thorium.

Uranium mixtures, specific activity, and isotopic fractions

Uranium (U) mixture and radionuclide	Activity fraction	Mass fraction	Activity ratio to U-235	Mass ratio to U-235
Slightly enriched (2%), U-234	0.7694	0.0002	28.76	0.01
Slightly enriched (2%), U-235	0.0268	0.02	1	1
Slightly enriched (2%), U-238	0.2038	0.9768	7.618	48.99
Natural U-234	0.4886	5.37E-05	21.4	0.00745
Natural U-235	0.0228	7.20E-03	1	1
Natural U-238	0.4886	9.93E-01	21.4	138
Depleted U-234	0.1546	1.00E-05	14.45	0.00502
Depleted U-235	0.0107	1.99E-03	1	1
Depleted U-236	0.0005	3.11E-06	0.0467	0.00156
Depleted U-238	0.8342	9.98E-01	78	501

Source terms: x-ray equipment

- No evidence that industrial x-ray sources were present at the plant.
- Occupational medical x-rays sources:
  - Exams conducted offsite until transition to onsite in 1981 and, accordingly, not included in DR.
  - Not evident when x-ray equipment might have been removed from the site, so the TBD assumes that x-rays were taken onsite from 1981 to 2006 when the site was decommissioned.

Internal dosimetry for production period

The TBD states:

- Urinalyses were performed quarterly beginning in 1962 (frequency varied during subsequent years) for uranium but there is no evidence that it was also done for thorium.
- Some yearly in vivo chest counts for uranium are available beginning in 1968.
- TBD (rev. 01), table 5-4, provides occupational exposure intakes from uranium dust for 20 job categories.
- Thorium and recycled uranium intakes are derived from uranium intakes.
- Recognizing that technetium becomes airborne more readily than uranium, technetium-99 intakes might have exceeded those derived from TBD (rev. 01), table 5-4, for uranium.

Intake assumptions – uranium

- Uranium intakes are assumed to be type M or S, primarily because the Extrusion Plant received uranium in metallic form.
- Organ doses are calculated assuming the entire uranium intake was U-234.
- Since most of the uranium came from Fernald, the ratio of recycled uranium contaminants to uranium is based on the Fernald TBD.
- TBD, rev. 01, states that "based on a review of available site documentation such as personnel dosimetry files and claim files, it is not evident that site personnel from the remediation contractor . . . , or even RMI, participated in an internal or external monitoring program after 2003."

Intake assumptions – thorium

- In vitro analyses for thorium are unavailable and thorium activity from chest counts was not reported until 1979.
- The maximum percentage of thorium received in any year was less than 1% of the amount of uranium, so the TBD guidance is to assume a thorium-to-uranium mass ratio of 0.01 for the thorium processing period of May 1, 1962, through December 31, 1971.
- The specific activity of normal uranium is a factor of 1.7 greater than that of depleted uranium, but a factor of 2.4 less than that of 2% enriched uranium; it is claimant favorable to assume normal uranium when determining the relative activity of thorium.

Unmonitored internal dose

- Based on breathing zone and general air sampling data, TBD (rev. 01), table 5-4, lists occupational exposure intakes from uranium dust for 20 job descriptions.
- The highest doses are to, as expected, personnel who worked closest to the uranium: rod inspector, stamper, saw man, and extrusion puller.
- Unmonitored uranium intakes are taken from a similar site, Bridgeport Brass, Adrian facility, as that was the predecessor to the Extrusion Plant; both facilities used the same extrusion press, which was moved from Bridgeport Brass to the Extrusion Plant in 1961.

Internal dosimetry for post-production period

- Post-production period began October 15, 1991.
- Workers performing surveys and involved in decontamination, demolition, removal, and other activities were exposed to residual contamination on structures and components as well as contamination in the soil.
- It is not evident that personnel participated in an internal dose monitoring program after 2003.
- Intakes from soil to unmonitored personnel during soil remediation activities beginning in 2004 were calculated assuming that exposures were to average soil concentrations from locations in the main plant area.

External dosimetry

- Extrusion Plant workers were exposed to external radiation from uranium, thorium, and their decay chain progenies.
- Photon energies are assumed in the 30- to 250-kiloelectron volt (keV) range, which is favorable to claimants when considering both organ dose conversion factors and radiation effectiveness factors.
- Shallow or open-window doses are assumed to be from electrons with energies greater than 15 keV.
- Film badge and selected extremity dose information was collected from monitored employees (estimated at greater than 50% of employees) from 1962–1991, the end of the production period, and into the post-production period.
- Penetrating neutron doses were also recorded but discounted as probably spurious, primarily due to contamination from improper handling of the badges and the absence of any neutron sources.
- TBD attachment E summarizes dose assignment values for unmonitored and construction trade workers.

Subtask 1: Changes necessitating PER

- NIOSH produced the current version of the TBD (rev. 01, 3/7/2017) in response to internal NIOSH reviews and procedure revisions which prompted NIOSH to issue PER-078 (1/4/2018) assessing the effect of the changes on prior DRs.
- The Extrusion Plant has never been considered for inclusion in the Special Exposure Cohort and has never been mentioned in any Advisory Board on Radiation and Worker Health (Board) or work group meeting; the only public documents that pertain to the plant are the two revisions of the TBD and the PER.

Subtask 1: SC&A comments

- SC&A assessed NIOSH's evaluation and characterization of the issues addressed in PER-078 and its potential impacts on DR, and SC&A concurs with NIOSH's determination that a PER was required.
- There are no findings associated with subtask 1.

Subtask 2: Assess corrective action methods

- PER-078 reports on NIOSH's evaluation of the effects on prior DRs of revising the original TBD to rev. 01.
- SC&A, which hasn't been tasked with reviewing TBD, rev. 01, or comparing it to rev. 00, but only in assessing the PER, performed a limited review to see how changes might affect assigned doses.
- TBD, rev. 01, made several changes to rev. 00, but the PER confines itself to the treatment of recycled uranium components and environmental dose.

Recycled uranium background

- Both revisions of the TBD contain substantially the same recycled uranium components data, taken from “DOE Ohio Sites Recycled Uranium Project Report” (2000), which addresses the generation and flow of recycled uranium for Fernald, Extrusion Plant, West Valley Demonstration Project, and Weldon Springs.
- The two TBD revisions list the five source terms at the Extrusion Plant as depleted, normal, and slightly enriched uranium; recycled uranium components; and thorium.

Recycled uranium treatment

TBD, rev. 00

- States that NIOSH reviewed recycled uranium components at Hanford and Fernald and provides guidance on assigning organ doses.

TBD, rev. 01

- Explicitly directs that DRs use data from the Fernald occupational internal dose TBD since much of the uranium received at the Extrusion Plant came from Fernald and would have the same recycled uranium contaminants.

Environmental doses – TBD rev. 00

- Does not provide any explicit guidance for including environmental exposures in a DR.
- It is not clear to SC&A how any such exposures would have been accounted for.

Environmental doses – TBD rev. 01

Devotes an entire section (4.0) to unmonitored and environmental dose and refers to two reports:

- 1997 Extrusion Plant site characterization report, created to support development of a site decommissioning plan, incorporates information from a series of investigations from 1985–1995 into radiological surface, groundwater, air, and soil contamination inside and outside the plant
  - Dose estimates were determined to be well below NRC and DOE limits.
- 1994 report providing guidance for assumed average uranium dust air concentrations for unmonitored workers

Subtask 2: SC&A comments

SC&A reviewed rev. 00 and 01 of the Extrusion Plant TBD and referenced material and concurs with the PER that the increased attention to recycled uranium (using Fernald TBD data and guidance) and environmental exposures has the potential to increased assigned internal doses to personnel.

Subtask 3: PER selection criteria

- 348 previously completed DRs identified
- 125 claims removed for having probabilities of causation (POCs) greater than 50%
- 195 claims removed for having the word “Extrusion” in the initial search but not referring to working at the Extrusion Plant
- 8 claims removed for being in process; already completed using TBD, rev. 01; or “pulled” from DR (e.g., Department of Labor administrative actions or claimants withdrawing claim)
- 328 claims were removed in total, leaving **20 claims to reconsider**

Subtask 3: SC&A comments

- SC&A believes the selection criteria used by NIOSH for previously completed DRs that required reevaluation under the PER are sufficient to identify all impacted claims, and NIOSH evaluated all affected noncompensated claims.
- SC&A believes the PER was conducted in a timely manner, as revision 01 of the TBD was issued in March 2017 and PER-078 was issued in January 2018.
- There are no findings associated with subtask 3.

Subtask 4: Audit of reevaluated DRs

- The reevaluation process found that none of the claims with POCs less than 50% now had POCs greater than 45%.
- SC&A recommends that, to the extent feasible, the Board select for additional evaluation two reworked DRs with the highest POCs, preferably from workers with different job titles.

Questions?