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National Institute for Occupational Safety and Health

A Review of NIOSH’s Program Evaluation Report DCAS-PER-078, “Extrusion Plant”

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Prepared by

Stephen L. Ostrow, PhD

SC&A, Inc.
2200 Wilson Blvd., Suite 300
Arlington, VA 22201-3324

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Abbreviations and Acronyms

ABRWH, Board	Advisory Board on Radiation and Worker Health
CDC	Centers for Disease Control and Prevention
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DR	dose reconstruction
EEOICPA	Energy Employees Occupational Illness Compensation Program Act
FMPC	Feeds Material Production Center (Fernald)
hr	hour
ICRP	International Commission on Radiological Protection
keV	kiloelectron volt
μCi	microcurie
μg	microgram
m ³	cubic meter
MDA	minimum detectable activity
MTU	metric tons uranium
NIOSH	National Institute for Occupational Safety and Health
NOCTS	NIOSH claims tracking system
NRC	U.S. Nuclear Regulatory Commission
ORAUT	Oak Ridge Associated Universities Team
OTIB	(ORAUT) technical information bulletin
pCi	picocurie
PER	program evaluation report
POC	probability of causation
RCG	radioactivity concentration guide
RMI	Reactive Metals, Inc. (Extrusion Plant)
RU-DOE	Recycled Uranium in the DOE Complex
SRDB	Site Research Database
SRS	Savannah River Site
TBD	technical basis document
Tc	technetium

Th thorium
U uranium
WSSRAP Weldon Springs Site Remediation Action Project
WVDP West Valley Demonstration Project

1 Statement of Purpose

To support dose reconstruction (DR), the National Institute for Occupational Safety and Health (NIOSH) and the Oak Ridge Associated Universities Team (ORAUT) assembled a large body of guidance documents, workbooks, computer codes, and tools. In recognition of the fact that all supporting elements in DR may be subject to revisions, provisions exist for evaluating the effect of such programmatic revisions on the outcome of previously completed DRs. Such revisions may be prompted by document revisions due to new information, misinterpretation of guidance, changes in policy, and/or programmatic improvements.

A program evaluation report (PER) provides a critical evaluation of the effects that a given issue or programmatic change may have on previously completed DRs. This includes a qualitative and quantitative assessment of potential impacts. Most important in this assessment is the potential impact on the probability of causation (POC) of previously completed DRs with POCs less than 50 percent.

On July 28, 2025, the Advisory Board on Radiation and Worker Health (ABRWH, Board) Subcommittee for Procedure Reviews tasked SC&A to review DCAS-PER-078, revision 0, “Extrusion Plant” (ORAUT, 2018; “PER-078”), which was issued to address the effect of issuing ORAUT-TKBS-0056, revision 1, “Summary of Extrusion Plant Site Information for Dose Reconstruction” (ORAUT, 2016a; “Extrusion Plant technical basis document [TBD]”). In conducting a PER review, SC&A is committed to perform the following five subtasks, each of which is discussed in this report:

- **Subtask 1:** Assess NIOSH’s evaluation and characterization of the issue addressed in the PER and its potential impacts on DR. Our assessment intends to ensure that the issue was fully understood and characterized in the PER.
- **Subtask 2:** Assess NIOSH’s specific methods for corrective action. When the PER involves a technical issue that is supported by documents (e.g., white papers, technical information bulletins, procedures) that have not yet been subjected to a formal SC&A review, subtask 2 will include a review of the scientific basis and/or sources of information to ensure the credibility of the corrective action and its consistency with current/consensus science. Conversely, if such technical documentation has been formalized and previously subjected to a review by SC&A, subtask 2 will simply provide a brief summary and conclusion of this review process.
- **Subtask 3:** Evaluate the PER’s stated approach for identifying the universe of potentially affected DRs and assess the criteria by which a subset of potentially affected DRs was selected for reevaluation. The second step may have important implications where the universe of previously denied DRs is very large and, for reasons of practicality, NIOSH’s reevaluation is confined to a subset of DRs that, based on their scientific judgment, has the potential to be significantly affected by the PER. In subtask 3, SC&A will also evaluate the timeliness of the completion of the PER.
- **Subtask 4:** Conduct audits of DRs affected by the PER under review. The number of DRs selected for audit for a given PER will vary. (It is assumed that the Board will select the DRs and the total number of DR audits for each PER.)

- **Subtask 5:** Prepare a written report that contains the results of DR audits under subtask 4, along with our review conclusions.

2 Relevant Background Information Pertaining to Facility Operations, Potential Source Terms, and Worker Monitoring Protocols

2.1 Facility operations

The Extrusion Plant (also known as Reactive Metals, Inc. [RMI]) TBD (ORAUT, 2017) provides background information on the facility and its operations such as its history, building and equipment layout, manufacturing and other processes, radioactive source terms and locations, and potential for personnel exposure. The 25 Extrusion Plant buildings were located on 7 acres of a 32-acre site in Ashtabula, Ohio. The plant’s main function was to fabricate metals through a series of processes, notably extrusion, cutting, forging, and chemical treatment. The metals of interest are primarily uranium and, to a lesser extent, thorium, which were processed for the government, but the plant also did some commercial metal processing of copper, zirconium, titanium, and molybdenum.

A U.S. Department of Energy (DOE) fact sheet on the site, in support of the department’s legacy management program, succinctly summarizes the site’s history (DOE, 2024):

The Ashtabula, Ohio, Site comprises 42.5 acres of privately owned land adjacent to the city of Ashtabula, about 55 miles east of Cleveland. From 1962 to 1988, Reactive Metals Inc. (RMI) operated a facility on the property that manufactured metallic uranium tubes and rods and experimental quantities of thorium metal for use in the Hanford, Washington, and Savannah River, South Carolina, weapons program reactors. The facility operated under contract to the U.S. Atomic Energy Commission and its successor agency the U.S. Department of Energy (DOE). RMI also extruded depleted uranium under a U.S. Nuclear Regulatory Commission (NRC)-license and extruded nonradioactive materials, primarily copper-based, for the private sector. [DOE, 2024, p. 1]

The Koh (1997) site characterization report, which was developed in support of decommissioning, states: “The RMI Extrusion Plant facility consists of 25 buildings and occupies approximately seven acres of a 40-acre area (Figure 2-3). All facility buildings are surrounded by a perimeter security fence. Of the 25 buildings, RMI owns 13 and the US Department of Energy owns 12” (Koh, 1997, p. 2-1). Although the listed acreage of the overall site differs in the Extrusion Plant TBD (32 acres), the DOE document (42.5 acres), and the Koh document (40 acres), this inconsistency is not material to this review.

The Extrusion Plant TBD, section 2.0 (ORAUT, 2017), contains a lengthy discussion of the licenses and authorizations from various agencies allowing the plant to conduct different activities in the plant’s history. Table 1 summarizes the most relevant information from that section and elsewhere in the Extrusion Plant TBD.

Table 1. Extrusion Plant timeline

Period	Dates	Activities
Covered Period	1/1/1962–11/1/2006	Overall plant history
Radiological Production Period – overall	1/1/1962–10/14/1991	Uranium was or could have been extracted under NRC license

Period	Dates	Activities
Radiological Production Period – SRS	1962–1968	SRS production
Radiological Production Period – Hanford	1962–1988	Hanford N-reactor fuel and target production
Radiological Production Period – thorium	5/1/1962–12/31/1971	Thorium production for DOE
Radiological Production Period – penetrator	1974–1985	DOD armor-piercing penetrator program
Postproduction period	10/15/1991–12/2006	Extrusion of radioactive metals had ceased and predecommissioning and decommissioning were underway

The Extrusion Plant received uranium primarily from the Feed Materials Production Center (FMPC, Fernald) and the Weldon Spring Plant for processing; most of the feedstock was in the form of billets. The Extrusion Plant TBD states the following: “The Extrusion Plant was the successor of the Bridgeport Brass facility in Adrian, Michigan. The work at Adrian was very similar to the work at the Extrusion Plant, and the same extrusion press was used at both facilities” (ORAUT, 2017, p. 10).

DOE work included extrusion of depleted and enriched uranium for the Hanford N-Reactor and the Savannah River Site (SRS). The Extrusion Plant also had a license to extrude thorium and “authorization for use of source material for U.S. Department of Defense (DOD) armor-piercing penetrator work from 1974 through 1985 for DOD contractors” (ORAUT, 2017, p. 11). The penetrator work, which took advantage of uranium’s high density of 19.05 grams per cubic centimeter, utilized depleted uranium in its rounds to attack tanks.

The Extrusion Plant TBD section 2.1; attachment A (detailed site layouts by year); and attachments B, C, and D (details for the N-reactor, SRS, and DOD penetrator production, respectively) describe the facilities and processes at the Extrusion Plant. In the simplest terms, the Extrusion Plant did metal fabrication through extrusion and forging operations using the Loewy extrusion press, a runout table, a cooling table, a cut-off saw, and other equipment.

The process steps varied with different materials but generally consisted of heating the metal in a salt bath for 1.5 hours after extruding, quenching, a degreasing step, packaging, and weighing. A portion of the extruded uranium metal was pickled in a nitric acid solution for the purpose of cleaning the material.

The DOE work supported the N-Reactor at the Hanford Site and the reactors at SRS. The Extrusion Plant also supported armor-piercing penetrator programs for DOD contractors. The plant produced N-Reactor fuel and targets from 1962 to 1988 [and for SRS for the same period]. From 1962 until 1970, uranium processing for N-Reactor consisted of receiving uranium, primarily from the FMPC, extruding the metal, and returning the extrusions and scrap (again primarily to FMPC). In 1971, RMI began using a forge process for N-Reactor fuel, which involved further processing of the extrusions before sending them directly to Hanford (DOE 2000). [ORAUT, 2017, p. 12]

Unclad thorium metal was extruded for DOE from 1962–1971.

The Extrusion Plant TBD, table 2-3, taken from DOE (2000) and repeated here as table 2, lists the amount of uranium sent to the Extrusion Plant for the N-Reactor and SRS work.

Table 2. Uranium receipts for N-Reactor and SRS work (MTU)

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.

2.2 Source terms

RMI processed uranium and thorium, with the amount of uranium processed far exceeding the amount of thorium. Table 2-7 of the Extrusion Plant TBD, revision 01 (ORAUT, 2017), compares the masses of thorium and uranium processed from 1962 through 1971 and shows that the mass ratios of thorium to uranium processed by year is less than 0.722 percent. This upper bound occurred in 1963 when the plant processed 47,320 pounds of thorium and 2,977.6 metric tons (6,564,477 pounds) of uranium. Consequently, the overall source term consisted primarily of contributions from depleted, normal, and slightly enriched uranium and a lesser contribution from thorium. As a result, uranium isotopes and members of their decay chains (also referred to as “progeny” or “daughter products”) were the most important isotopes of concern. For example, uranium-238, with a 4.3-billion-year half-life, has 13 radionuclides in its decay chain, with half-lives ranging from short to very long, eventually ending in stable lead-208. The radioisotopes primarily emit alpha or beta particles and associated photon radiation as they decay.

The Extrusion Plant TBD states that:

Uranium was assumed to be extruded from January 1, 1962, through October 14, 1991 [the Radiological Production period], and thorium was extruded intermittently from May 1, 1962, through December 31, 1971. Depleted, normal, and enriched uranium was processed. Most of the uranium was probably recycled uranium. Uranium factors are listed in Table 2-8. As listed in Tables 2-4 and 2-5, the enrichment of uranium the Extrusion Plant handled was typically well below 2.1%. For dose reconstruction, the default assumption is that the uranium was 2% enriched. [ORAUT, 2017, p. 14]

Table 3, taken from table 2-8 of the Extrusion Plant TBD (ORAUT, 2017), shows the isotopic activity and mass fractions of the various isotopes of slightly enriched (2 percent), natural, and depleted uranium.

Table 3. Uranium mixtures, specific activity, and isotopic fractions

Uranium mixture and radionuclide ^(a)	Activity fraction	Mass fraction	Activity ratio to U-235	Mass ratio to U-235
Slightly enriched (2%), U-234 ^(b)	0.7694	0.0002	28.76	0.01

Uranium mixture and radionuclide ^(a)	Activity fraction	Mass fraction	Activity ratio to U-235	Mass ratio to U-235
Slightly enriched (2%), U-235 ^(b)	0.0268	0.02	1	1
Slightly enriched (2%), U-238 ^(b)	0.2038	0.9798	7.618	48.99
Natural U-234 ^(c)	0.4886	5.37E-05	21.4	0.00745
Natural U-235 ^(c)	0.0228	7.20E-03	1	1
Natural U-238 ^(c)	0.4886	9.93E-01	21.4	138
Depleted U-234 ^(d)	0.1546	1.00E-05	14.45	0.00502
Depleted U-235 ^(d)	0.0107	1.99E-03	1	1
Depleted U-236 ^(d)	0.0005	3.11E-06	0.0467	0.00156
Depleted U-238 ^(d)	0.8342	9.98E-01	78	501

(a) Although listed as a recycled uranium component, U-236 represents <1% of the dose from exposure to uranium (ORAUT, 2016a)

(b) Useful factors: Overall activity of 2% enriched uranium is 1.616 pCi/μg and 80.8 pCi/μg U-235.

(c) Useful factors: Overall activity of natural uranium is 0.683 pCi/μg and 94.9 pCi/μg U-235.

(d) Useful factors: Overall activity of depleted uranium is 0.4021 pCi/μg and 202 pCi/μg U-235.

The Extrusion Plant TBD also considers x-ray sources to personnel and finds that there is no evidence of any industrial x-ray sources used at the Extrusion Plant (ORAUT, 2017, p. 17). However, as described in section 3.0 of the TBD, occupational medical x-ray examinations were conducted offsite until transitioned to onsite in 1981 at the Extrusion Plant (ORAUT, 2017, p. 23). The x-ray dose accumulated from offsite examinations is not included in the DRs per ORAUT-OTIB-0079, revision 02, “Guidance on Assigning Occupational X-Ray Dose Under EEOICPA for X-Rays Administered Off Site” (ORAUT, 2016b). Since it is not evident when x-ray equipment might have been removed from the site, the Extrusion Plant TBD assumes that x-rays were taken onsite from 1981 to start of decommissioning in 2006 (ORAUT, 2017, p. 23).

2.2.1 Internal dosimetry

Section 5 of the Extrusion Plant TBD provides a summary of the internal dosimetry at the Extrusion Plant and provides guidance for DR, with details appearing in the subsequent TBD subsections:

The source term at RMI consisted of depleted uranium, normal uranium, slightly enriched uranium, recycled uranium contaminants, and thorium. Uranium urinalyses were performed, but it appears that urinalysis for thorium was never performed at the Extrusion Plant. Some in vivo chest counts are available beginning in 1968. Uranium intakes should be assessed based on bioassay data. Thorium and recycled uranium contaminant intakes are derived from the uranium intakes. Because of the tendency of technetium to become airborne more readily than uranium (DOE 2004), chronic ⁹⁹Tc [technetium-99] intakes might have higher than the intake that would be derived using Table 5-5 later in this section. Therefore, if in vivo monitoring records indicate ⁹⁹Tc lung count results greater than the in vivo counter minimum detectable activity (MDA) of 0.5 μCi, then in vivo monitoring records should be used to assess ⁹⁹Tc intakes. [ORAUT, 2017, p. 25]

In addition to considering internal dosimetry for the Radiological Production period, the Extrusion Plant TBD also discusses and gives guidance for DR during the Postproduction Period,

beginning October 14, 1991: “Worker exposures and intakes occurred from residual uranium contamination on structures and components and in soil during characterization surveys and sampling, equipment dismantlement and removal, decontamination, demolition, and waste packaging and shipping activities” (ORAUT, 2017, p. 29).

The Extrusion Plant TBD 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 (LATA-SHARP Remediation Services), or even RMI, participated in an internal or external monitoring program after 2003. As stated in Section 2.8, by January 2004, building decontamination was complete and work at the site consisted primarily of soil and groundwater remediation” (ORAUT, 2017, pp. 29–30). The Extrusion Plant TBD follows with guidance on how to calculate any exposures beginning in 2004.

2.2.2 External dosimetry

The Extrusion Plant TBD states: “RMI employees were exposed to radiation from uranium, thorium, and their short-lived progeny. This document assumes that photon energies were in the 30- to 250-keV [kiloelectron volt] range, which is favorable to claimants when considering both organ dose conversion factors and radiation effectiveness factors. Shallow or open-window dose is assumed to be from electrons with energies greater than 15 keV” (ORAUT, 2017, p. 31). Film badge information was collected from monitored employees (a large fraction of the workers was monitored) for the period 1962 to the mid-1980s. Penetrating radiation (photons) and nonpenetrating radiation (electrons) were considered. Penetrating neutron doses were also mentioned but discounted as probably spurious, primarily due to contamination from improper handling of the badges (ORAUT, 2017, pp. 31–32) and the absence of any sealed neutron sources or neutron generating equipment at the plant.

3 Subtask 1: Identify the Circumstances that Necessitated DCAS-PER-078

3.1 Chronology of events

The following outlines the events that led to the revision of the Extrusion Plant TBD from revision 0 (ORAUT, 2007) to revision 1 (ORAUT, 2017), which prompted NIOSH to issue PER-078 (ORAUT, 2018) assessing the effect of the changes on prior DRs.

SC&A consulted the EEOCIPA project public-facing website and determined that the Extrusion Plant has never been considered for inclusion in the Special Exposure Cohort and has never been mentioned in any ABRWH or Work Group meeting. In fact, the only two public documents that pertain to the plant are the two revisions of the Extrusion Plant TBD (ORAUT, 2007, 2017), and this PER.

3.2 SC&A comments

SC&A reviewed each of the documents leading to changes incorporated into revision 1 of the Extrusion Plant TBD (ORAUT, 2017). SC&A agrees with NIOSH that these changes and their potential impacts of Extrusion Plant worker doses mandate the need for PER-078 (ORAUT, 2018).

There are no findings pertaining to subtask 1.

4 Subtask 2: Assess NIOSH's Specific Methods for Corrective Action

4.1 Review of Extrusion Plant TBD Rev. 1

NIOSH produced PER-078 (ORAUT, 2018) to report on its evaluation of the effects on prior DRs of revising the original Extrusion Plant TBD (ORAUT, 2007) to revision 01 (ORAUT, 2017) and to present its plan for any required corrective actions. SC&A had not been tasked with reviewing revision 01 or comparing it to revision 0, but in assessing the PER, performed a cursory comparison to see how changes might affect calculated doses. The Records of Issue/Revisions section of revision 01 summarizes the changes made from revision 0:

Revision initiated to incorporate a rewrite of Section 3.0 – Occupational Medical X-rays, based on revisions to ORAUT-OTIB-0079, Rev. 01, Guidance on Assigning Occupational X Ray Dose Under EEOICPA for X-Rays Administered Off Site [ORAUT, 2016c], and ORAUT-OTIB-0006, Rev. 04, Dose Reconstruction from Occupational Medical X-Ray Procedures [ORAUT, 2011]. Revised Section 4.0 – Unmonitored and Environmental Dose, based on 2016 internal ORAUT and NIOSH comments for unmonitored and environmental dose. Revised Section 5.0 – Internal Dose, for referencing the Fernald Internal Dosimetry TBD section for recycled uranium. Revised neutron discussion, and resolved NIOSH comments from 2008 and 2016 to incorporate the external dosimetry data evaluation in Section 6.0 – External Dose. Revised Attachment E – External Data Evaluation of Doses to give the 95th and 50th percentile doses to be used for unmonitored workers. Constitutes a total rewrite of the document. [ORAUT, 2017, p. 2]¹

Of the several cited revisions made in the Extrusion Plant TBD revision 01, the PER confines itself to recycled uranium and environmental dose: “Several changes were made in Revision 01 of the TBD. The changes include the addition of recycled uranium components that would increase the dose from uranium intakes if they were not previously considered and the addition of environmental doses” (ORAUT, 2018, p. 1). SC&A looked at the two ORAUT technical information bulletins (OTIBs) related to x-ray doses and did not find anything of note and confined its review to these two areas.

4.1.1 Uranium

SC&A reviewed the two Extrusion Plant TBD revisions with respect to recycled uranium components. Table 2-2 of the Extrusion Plant TBD, revision 0, and table 2-3 of the Extrusion Plant TBD, revision 01, “Uranium receipts for N-Reactor and SRS work (MTU),” present the same data (ORAUT, 2007, 2017). Similarly, table 2-3 of the Extrusion Plant TBD, revision 0, “Annual recycled uranium receipts at RMI,” and table 2-4 of the Extrusion Plant TBD, revision 01, “Annual recycled uranium receipts,” also present the same data, for a total of 76,722 MTU of

¹ This report cites the revisions of the OTIBs related to x-rays in the quotation as referred to in Extrusion Plant TBD, revision 01. Future dose reconstructions performed by NIOSH will use the current revisions of all technical documents.

recycled uranium received at the plant from 1962 through 1993 (ORAUT, 2007, 2017). All data in these tables were taken from DOE (2000).

Since the recycled uranium information provided in the Extrusion Plant TBD, revision 01, comes from *DOE Ohio Sites Recycled Uranium Project Report* (DOE, 2000), SC&A examined that report to learn its purpose:

This document addresses the historical generation and flow of recycled uranium in the DOE complex for four facilities, the Fernald Environmental Management Project, the RMI Environmental Services Site (RMI), the West Valley Demonstration Project (WVDP), and the Weldon Springs Site Remediation Action Project (WSSRAP). [DOE, 2000, p. ES-1]

and

The overall objective of the DOE mass balance project entitled Historical Generation and Flow of Recycled Uranium in the DOE Complex (RU-DOE) is to identify where recycled uranium could have created an exposure hazard to workers and to estimate the numbers of workers potentially exposed. [DOE, 2000, p. 1-1]

The DOE report explains why recycled uranium (uranium remaining after plutonium was extracted from the DOE production reactors) was of concern and states that trace amounts of residual transuranic elements, fission products, and reactor-produced uranium isotopes in recycled uranium may have been more radioactive than natural uranium (DOE, 2000, p. 1-3).

The internal dose sections of both Extrusion Plant TBD revisions (section 3.0 of revision 0 and section 5.0 of revision 01) are similar and state that “The source term at RMI consisted of [five components] depleted uranium, normal uranium, slightly enriched uranium, recycled uranium contaminants and thorium” (ORAUT, 2007, p. 22; ORAUT, 2017, p. 25).

The Extrusion Plant TBD, revision 01, section 5.3.1, provides guidance on uranium intake assumptions and states:

For calculating annual organ doses, the uranium intake (in disintegrations per minute) can be assumed to be entirely ^{234}U [uranium-234]. Because most of the uranium came from Fernald, the ratio of the recycled uranium contaminants to uranium is based on Section 5.5.1.4 of ORAUT-TKBS-0017-5, *Feed Materials Production Center – Occupational Internal Dose* (ORAUT 2016a). Recycled uranium intakes should be assigned by applying the contaminants and ratios from the table containing contaminant intakes per unit activity of uranium. The selected material types for the contaminants should be assigned using the direction in ORAUT-OTIB-0060, *Internal Dose Reconstruction* ([ORAUT, 2014]). [ORAUT, 2017, p. 27]

This represents a departure from the Extrusion Plant TBD, revision 0, section 3.3.1, guidance which states:

Uranium intakes are assumed to be type M or S. For calculating annual organ doses, the intake (in disintegrations per minute) can be assumed to be entirely ^{234}U . Table 3-4 shows an estimate of recycled uranium contaminants that might have contributed significantly to internal doses beginning in 1962. The numbers are based on a review of recycled uranium contaminants at Hanford and FMPC. (The relative internal dose contributions from ^{99}Tc , ^{228}Th [thorium-228], and ^{232}Th were low enough to be excluded). In addition, the activity fractions assume that the uranium specific activity is based on depleted uranium, which increases the proportion of the contaminants by activity. The contaminant levels for depleted uranium overestimate the contaminants in uranium of normal enrichment by about 40%. Plutonium is assumed to behave as absorption type M or type S material and neptunium as absorption type M. If *in vivo* monitoring records indicate ^{99}Tc lung count results greater than 0.5 uCi [microcuries], the ^{99}Tc intake should be assessed assuming a type M intake. [ORAUT, 2007, p. 25]

The Extrusion Plant TBD, revision 0, states that it reviewed recycled uranium contaminants at Hanford and Fernald (ORAUT, 2007), but the Extrusion Plant TBD, revision 01, explicitly directs that DRs use data from the Fernald Occupational Internal Dose TBD (ORAUT, 2016a; “Fernald TBD”). SC&A examined the relevant sections in the Fernald TBD and observed that they include substantial data and DR guidance related to recycled uranium contaminants. Since much of the uranium received at the Extrusion Plant came from Fernald, SC&A believes it appropriate to apply the latter plant’s data and guidance to the former plant. As previously noted, SC&A assumes that any new dose reconstruction will use the latest revision of the Fernald TBD.

4.1.2 Environmental

The PER and Extrusion Plant TBD, revision 01, Records of Issue/Revisions (both quoted earlier in this report) state that revision 01 added environmental doses. The Extrusion Plant TBD, revision 0, does not provide any explicit guidance for including environmental exposures in a DR and it is not clear to SC&A how any such exposures would have been accounted for. The Extrusion Plant TBD, revision 0, references the Bridgeport Brass plant TBD, ORAUT-TKBS-0030, rev. 01 (ORAUT, 2013), for the external dose methodology to use “to reconstruct dose for unmonitored workers or unmonitored periods when another method is not specified” (ORAUT, 2007, p. 31). Table 4-4 of the Extrusion Plant TBD, revision 0, presents external dose assumptions for different types of radiation as a function of monitoring method; it also presents accompanying energy and exposure assumptions, assumed detection thresholds, and notes. Perhaps it was intended that any environmental exposures would be subsumed in the overall dose for monitored workers.

The Extrusion Plant TBD, revision 01, devotes an entire section to unmonitored and environmental dose. The section begins:

An extensive data evaluation of externally monitored workers was conducted and the results are given in Attachment E. In accordance with ORAUT-OTIB-0020, *Use of Coworker Dosimetry Data for External Dose Assignment* [ORAUT, 2020], unmonitored employees with low potential for exposure (those not working in hot areas) can be assigned the values in Table E-4 at the 50th percentile for gamma as a constant distribution from 1962 to 2004. [ORAUT, 2017, p. 24]

In addition to the 50th percentile gamma doses, table E-4, which is similarly applicable to missed dose, also contains data for 95th percentile gamma doses and 50th percentile and 95th percentile beta doses.

The Extrusion Plant TBD refers to a 1997 Extrusion Plant site characterization report (Koh, 1997) that was created to support development of a site decommissioning plan with the goal of rendering the site available for unrestricted use. The characterization effort encompassed separate investigations conducted from 1985 to 1995 into radiological and non-radiological surface, groundwater, air, and soil contamination inside and outside the plant. The report provides much information about the history, licensing, processes, and layout of the plant that was incorporated into the Extrusion Plant TBD. The report concludes: “For both dose assessment scenarios (current site conditions and remediation activities), the dose estimates were determined to be well below the NRC and DOE limits. Therefore, the doses received by the receptors are low, and, as such, do not pose a significant health risk” (Koh, 1997, p. 5-11).

The TBD refers to another report, Breslin and Glauberman (1964), which provides guidance for assumed average air concentrations of uranium dust for unmonitored workers:

the internal environmental exposure for operating personnel such as draftsmen and secretaries . . . was less than 0.1 of the radioactivity concentration guide (RCG), which was <28 dpm/m³ [disintegrations per minute per cubic meter]. Although the report shows that the average air concentrations from uranium dust were less than 10% of the RCG, an intake rate based on 10% of the RCG is considered bounding and should be assigned to nonradiation workers. For the International Commission on Radiological Protection (ICRP) Publication 66 breathing rate of 1.2 m³/hr [cubic meters per hour] for an 8-hour workday (ICRP, 1994) this is 184 dpm per calendar day. [ORAUT, 2017, p. 24]

4.2 SC&A comments

SC&A reviewed revisions 0 and 01 of the Extrusion Plant TBD and backup references and concurs with the PER that the increased attention to recycled uranium and environmental exposures has the potential to increase assigned internal doses to personnel. However, since NIOSH looked at all claims previously evaluated and, after eliminating some for a variety of reasons, as described in section 5.1 of this report, recalculated all the remaining ones to determine doses using the entire revision 01 data and methodology, this is immaterial.

5 Subtask 3: Evaluate the PER Stated Approach for Identifying the Number of DRs Requiring Reevaluation of Dose

5.1 NIOSH's selection criteria

As recounted in section 3.0 of the PER, NIOSH searched in the NIOSH claims tracking system (NOCTS) to identify all claims with Extrusion Plant employment and also conducted a keyword search on DR reports with the words "Extrusion" and "TKBS-0056." This search yielded 348 unique claims, which was the starting point for eliminating claims to consider for a variety of reasons. This process is summarized below:

- 348 previously completed DRs identified
- 125 claims removed for having POC greater than 50 percent
- 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 presently in process, already completed using revision 01 of the Extrusion Plant TBD, or for having been "pulled" from DR (e.g., Department of Labor administrative actions or claimant withdrawing the claim)

This winnowing process left 20 claims remaining for consideration. The doses for each of these claims were recalculated using the Extrusion Plant TBD, revision 01, as well as the then current revisions of any other applicable documents. All recalculated DRs yielded a POC below 45 percent.

The PER stated that: "NIOSH will provide the Department of Labor with the list of all the claims evaluated under this PER. Since none of the claims would now result in a probability of causation greater than 50%, NIOSH will not request the return of any of these claims" (ORAUT, 2018, p. 2).

5.2 SC&A's 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. Additionally, SC&A believes the PER was conducted in a timely manner, as revision 1 of ORAUT-TKBS-0056 (ORAUT, 2017) was issued in March 2017, and PER-078 was issued in January 2018 (ORAUT, 2018).

There are no findings associated with subtask 3.

6 Subtask 4: Conduct Audits of a Sample Set of Reevaluated DRs Mandated by DCAS-PER-078

Previous sections of this report described changes introduced in revision 01 of the Extrusion Plant TBD that might have raised the assigned internal doses. In recognition that most of the uranium processed at the Extrusion Plant came from Fernald, the Extrusion Plant TBD bases the ratio of recycled uranium contaminants to uranium on guidance provided in the Fernald TBD and also explicitly considers potential environmental dose.

NIOSH considered all previously performed DRs and, after reducing the population for various considerations previously enumerated, 20 claims remained for reevaluation. The reevaluation process found that none of the claims with POCs originally less than 50 percent now had POCs greater than 45 percent. 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.

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