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Advisory Board on Radiation and Worker Health
National Institute for Occupational Safety and Health

A Review of NIOSH's Program Evaluation Report DCAS-PER-069, "Jessop Steel Company"

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Abbreviations and Acronyms

ABRWH, Board	Advisory Board on Radiation and Worker Health
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DR	dose reconstruction
hr	hour
m	meter
m^2	square meter
m^3	cubic meter
mg	milligram
mrem	millirem
Ni	nickel
NIOSH	National Institute for Occupational Safety and Health
NRC	U.S. Nuclear Regulatory Commission
ORAUT	Oak Ridge Associated Universities Team
pCi	picocurie
PER	program evaluation report
POC	probability of causation
SRDB	Site Research Database
TBD	technical basis document
U	uranium

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 of these 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 (Board) Subcommittee for Procedure Reviews tasked SC&A to review DCAS-PER-069, revision 0 (NIOSH, 2016; "PER-069"), which was issued to address the impacts on previously completed claims of issuing Appendix BL of Battelle-TBD-6000, revision 1 (NIOSH, 2015), the technical basis document (TBD) for Jessop Steel Company. 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, have the potential to be significantly affected by the PER. In behalf of 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

The Jessop Steel Company (Jessop) was located in Washington, PA, and made stainless steel piping for Fernald using uranium (U)-contaminated nickel (Ni) scrap in December of 1952. A request to send two tons of nickel scrap was dated December 2, 1952, and one ton was sent the week of December 5, 1952. The second ton was believed to be sent soon after. The scrap nickel appeared to be in the form of nickel trays from Lake Ontario Storage Area, which likely originated from Harshaw Chemical Company. Jessop also sheared an unknown number of uranium plates for DuPont on March 2, 1954, for just one day. Residual contamination potentially existed between uranium operations as well as after uranium operations. However, due to the low potential for contamination, no residual contamination period was designated for Jessop after March 1954.

3 Subtask 1: Identify the Circumstances that Necessitated DCAS-PER-069

3.1 Chronology of events

NIOSH issued revision 0 of Appendix BL to Battelle-TBD-6000 on May 25, 2007, for Jessop (NIOSH, 2007). As a result of a revision to Battelle-TBD-6000, a change to the U.S. Department of Labor-covered work, and changes to the dose estimate to be more consistent with existing techniques, revision 1 of Appendix BL was issued on October 19, 2015 (NIOSH, 2015). This revision resulted in an increase in inhalation intakes. PER-069 evaluated the effects of using revision 1 of Appendix BL on all previously completed Jessop claims.

3.2 SC&A's comments

Programmatic revisions that may affect the outcome of previously completed DRs and mandate the need for a PER include any revisions to guidance documents that may result in the assignment of a higher dose.

SC&A believes that the issuance of a revision to Appendix BL, which resulted in the potential for Jessop dose estimates to increase due to the increase in inhalation intakes, is justification for reevaluating worker doses, as defined in PER-069. SC&A concurs with NIOSH's decision to issue PER-069 and has no findings.

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

The principal changes in revision 1 of Appendix BL are the elimination of job categories for internal and external dose estimates and revisions to the methodologies for these dose estimates. Since SC&A has not previously reviewed Appendix BL, SC&A's review of PER-069 includes an evaluation of the document to assess the scientific basis and sources of information to ensure the credibility of the corrective action. The internal dose estimates are based on the Huntington Pilot Plant (also known as the Reduction Pilot Plant). SC&A has reviewed a Special Exposure Cohort evaluation report for this facility and believes that none of the dose estimates were considered infeasible.

4.1 Internal dose estimate

NIOSH did not find any data regarding airborne uranium contamination at Jessop. NIOSH considered operations at Jessop to be similar to those conducted at the Huntington Pilot Plant, as the uranium content appeared to be similar. Section 5.1 of the TBD for Huntington Pilot Plant (DCAS-TKBS-0004; NIOSH, 2013) gives the 95th percentile value airborne Ni concentrations, based on personnel exposure data, to be 0.44 milligram nickel per cubic meter (Ni/m^3) (NIOSH, 2013). Therefore, assuming the material is 1 percent by weight uranium, the assumed air concentration during the work with scrap nickel is 0.0044 mg U/m^3, or 11.78 disintegrations per minute per cubic meter (dpm/m^3) assuming a specific activity of 1200 picocuries per milligram (pCi/mg) or 2 percent enriched uranium. Assuming the scrap nickel work took a full week (44 hours), NIOSH calculated a total inhaled activity of 622 dpm.

To evaluate the potential internal dose due to uranium contamination left after completion of the scrap nickel work, NIOSH used the methodology presented in Battelle-TBD-6000, revision 1 (NIOSH, 2011; "TBD-6000"), to calculate a surface contamination level based on the assumed air concentration. NIOSH assumed the settling of airborne contamination happened over 44 hours, resulting in a surface contamination level of 1,399 dpm per square meter (m^2). Using a resuspension factor of 1E-05 m^{-1}, the resulting airborne concentration of 0.014 dpm/m^3 was assumed to be present from December 1, 1952, through the date of uranium plate shearing on March 2, 1954, as well as after the uranium plate shearing.

NIOSH also used TBD-6000 to estimate airborne activity as a result of the uranium plate shearing conducted on March 2, 1954. NIOSH used the value given in table 7.5 of TBD-6000 for cutoff, milling, and slotting as a claimant-favorable assumption, as those activities were believed to produce higher airborne activity than shearing. The geometric mean concentration for cutoff, milling, and slotting is 45 dpm/m^3, with a geometric standard deviation of 5; therefore, NIOSH used the 95th percentile of this distribution (635 dpm/m^3) for estimating the shearing airborne concentration at Jessop. NIOSH assumed the shearing took place for one full day (8.8 hours) and calculated a total inhalation of 6,706 dpm.

To estimate the potential leftover contamination after shearing, NIOSH used the methodology in TBD-6000, assuming a period of 24 hours to account for three full shifts in the workday. This resulted in a surface contamination due to shearing of 41,148 dpm/m^2, which will be considered in addition to the 1,399 dpm/m^2 calculated from the scrap nickel work, for a total surface contamination after shearing of 42,547 dpm/m^2. After applying the resuspension factor, NIOSH calculated an airborne activity of 0.425 dpm/m^3. NIOSH assumed this concentration was present

from March 3, 1954, through the end of March 1954. Table 1 of revision 1 of Appendix BL presents the uranium inhalation rates calculated by NIOSH for December 1952, 1953, and January through March of 1954.

NIOSH also calculated ingestion rates resulting from the assumed surface contamination and the ingestion rate factor of 1.1E-04 from NUREG/CR 5512 (NRC, 1992). NIOSH did not use OCAS-TIB-009 (NIOSH, 2004) to estimate ingestion intakes as the timeframes for uranium operations at Jessop were significantly less than the 30 days assumed by OCAS-TIB-009. Table 2 of revision 1 of Appendix BL presents the uranium ingestion rates calculated by NIOSH for December 1952, 1953, and January through March of 1954.

4.1.1 SC&A's comments

SC&A was also unable to identify any documents in the Site Research Database (SRDB) with airborne uranium data for Jessop and agrees with NIOSH's determination to assign doses based on the Huntington Pilot Plant TBD, as that site also worked with uranium-contaminated nickel. SC&A confirmed the total inhaled activity of 622 dpm. SC&A also confirmed the surface contamination level of 1,399 dpm/m^2 as calculated by NIOSH using TBD-6000 methods and the resuspended airborne concentration of 0.014 dpm/m^3.

Observation 1: Assumed exposure time may be underestimated

NIOSH cited a memorandum dated December 2, 1952, requesting that 2 tons of nickel scrap should be sent to Jessop (Hershman, 1952a), and a weekly progress report for the week of December 5, 1952, stating that one ton was sent to Jessop (Hershman, 1952b). NIOSH then states that the second ton of nickel scrap was presumably sent soon after the first ton. However, the period of time used by NIOSH in the calculations regarding the scrap nickel work was one week (44 hours). If one ton of scrap nickel was sent during the first week of December 1952, and the second ton of scrap nickel was sent after, SC&A questions if it would be more claimant favorable to assume the total time for scrap nickel operations is 2 weeks. SC&A reviewed operational reports for August through December 1952 from the Tonawanda Sub-Office (Tonawanda Sub-Office, 1952) and did not locate information confirming when the second ton of material was received at Jessop. In the absence of information stating that nickel scrap work at Jessop did not proceed until both tons of material were received, SC&A believes it is more claimant favorable to assume the work took 2 weeks.

SC&A confirmed that the 95th percentile of the air concentration distribution used by NIOSH for the uranium shearing period is 635 dpm/m^3. SC&A was able to replicate the inhalation activity of 6,706 dpm for the 8.8-hour workday for uranium plate shearing. SC&A believes that assuming a period of 24 hours for calculating the surface contamination resulting from the uranium shearing is claimant favorable and was able to replicate NIOSH's calculated surface activity of 41,148 dpm/m^2 and the resuspended airborne concentration of 0.425 dpm/m^3 when including the activity from the scrap nickel work.

Observation 2: Additional information should be included to use surrogate uranium operational data and modeling

NIOSH stated that the air concentrations associated with uranium cutoff, milling, and slotting from table 7.5 of TBD-6000 were claimant favorable to use for the uranium plate shearing

estimates, as these activities would be expected to produce a higher airborne activity than shearing. SC&A requests NIOSH to provide additional information or references to support this assumption.

SC&A was mostly able to replicate the uranium inhalations for the different time periods in table 1 of Appendix BL, revision 1.

Observation 3: Clarification on assumed work hours

It is not clear to SC&A how the values in the "Other work hours" column of table 1 in revision 1 of Appendix BL were calculated for December 1952 and January through March 1954. Assuming 8.8 hours per workday, as NIOSH has assumed in other calculations in this appendix, does not yield whole number days. SC&A requests clarification on how these values were determined.

4.2 External dose estimate

NIOSH did not find any data for occupational external doses at Jessop; therefore, NIOSH estimated the external doses using dose rates from Battelle-TBD-6000. The dose rates from TBD-6000 were for uranium metal, so NIOSH adjusted these dose rates to reflect the fact that the nickel scrap was assumed to be similar to the material handled at the Huntington Pilot Plant, which was 1 percent uranium by weight, and 2 percent uranium-235. NIOSH assumed that the specific activity of 2 percent enriched uranium is 1200 pCi/mg, and, therefore, the specific activity of the nickel scrap was assumed to be 12 pCi/mg. NIOSH then used the specific activity of natural uranium (684 pCi/mg) to determine a factor of 0.0175 (equal to 12 pCi/mg divided by 684 pCi/mg) used to reduce the uranium metal dose rates from TBD-6000 (NIOSH, 2015).

NIOSH used the highest 1-foot photon dose rate from table 6.1 of TBD-6000 of 2.08 millirem per hour (mrem/hr). The 1-foot beta dose rate was assumed to be 10 times the 1-foot photon dose rate, and a contact beta dose rate of 230 mrem/hr was used. NIOSH then applied the reduction factor of 0.0175 to calculate the 1-foot photon dose rate, 1-foot beta dose rate, and contact beta dose rate of 0.036 mrem/hr, 0.36 mrem/hr, and 4.04 mrem/hr, respectively (NIOSH, 2015). NIOSH cited a 1953 radiation survey done at Harshaw Chemical of nickel trays that showed a surface dose rate of 0.06 mrem/hr gamma and 1.94 mrem/hr beta plus gamma (McKelvey, 1953) to conclude that the 1-foot estimated dose rate of 0.036 mrem/hr compares well with the 0.06 mrem/hr measured contact dose rate and that the assumed beta plus gamma dose rate of 4.04 mrem/hr is favorable. NIOSH assumed operators were exposed to these dose rates for half of their workday, totaling 44 hours for the month of December 1952 (NIOSH, 2015).

To assess dose for the uranium plate shearing, NIOSH used the values from table 6.1 of TBD-6000 and assumed operators would be exposed for one-half of the day uranium shearing took place, which occurred on March 2, 1954 (NIOSH, 2015).

NIOSH used the surface contamination levels calculated in the internal dose section and the dose conversion factors from table 3.10 of TBD-6000 to determine external dose rates due to residual contamination after completion of work activities. NIOSH only applied these dose rates for the periods of time between uranium operations. Tables 3 and 4 of Appendix BL, revision 1, present

the annual photon and beta doses, respectively, to be assigned for Jessop workers. The doses cover the time period of December 1952 through March 1954 (NIOSH, 2015).

4.2.1 SC&A's comments

SC&A was also unable to identify any documents in the SRDB with occupational external data for Jessop and agrees with NIOSH's determination to assign doses based on values from TBD-6000. SC&A confirmed that the Huntington Pilot Plant TBD states the assumed specific activity is 1,200 pCi/mg for 2 percent enriched uranium and that table 3.1 of TBD-6000 gives a specific activity of 684 pCi/mg for natural uranium. SC&A was able to confirm the factor of 0.0175 for converting TBD-6000 dose rates to dose rates for the scrap nickel plates.

Observation 4: Clarification for adjustments for shielding in external dose modeling

In revision 0 of Appendix BL, the external dose rates for the scrap nickel were also determined by using a calculated factor to apply to TBD-6000 dose rates. However, it appears that NIOSH took into consideration the difference in the atomic numbers of nickel and uranium for shielding purposes in addition to the difference in specific activity when calculating the factor of 0.0549 in revision 0. This factor is approximately three times larger than the factor of 0.0175 used in revision 1 of Appendix BL. SC&A requests clarification on how it was determined that it was no longer necessary to include the difference in atomic number and shielding effectiveness in calculating the external dose rate factor.

SC&A also verified that NIOSH used the correct dose rates from table 6.1 of TBD-6000 for the 1-foot photon and beta dose rates, as well as the contact beta dose rate from section 6.3 of TBD-6000. SC&A confirmed the calculated 1-foot photon dose rate, 1-foot beta dose rate, and contact beta dose rate of 0.036 mrem/hr, 0.36 mrem/hr, and 4.04 mrem/hr, respectively. SC&A believes that the calculated dose rates are reasonable given the measured dose rates from nickel trays at Harshaw Chemical (McKelvey, 1953). SC&A verified that the assumption of an operator spending 50 percent of their workday at a distance of 1 foot from the metal is in accordance with section 6.2 of TBD-6000.

SC&A was able to closely match NIOSH's calculated annual photon and beta doses for December 1952, 1953, and January through March 1954.

4.3 Residual Contamination

NIOSH states that residual contamination potentially existed at Jessop between uranium operations and after, but since the uranium work was limited, the potential was low for contamination to remain after operations ended. Therefore, NIOSH does not assign intakes past March 1954 but does assign intakes from residual contamination for the period between uranium operations.

4.3.1 SC&A's comments

SC&A agrees with NIOSH's determination that residual contamination potentially existed at Jessop between uranium operations and after, but the potential was low and any doses would be minimal from a DR perspective.

4.4 Occupational medical dose estimate

No site-specific guidance for Jessop occupational medical dose exists. Therefore, at the time of PER-069, NIOSH used the guidance in ORAUT-OTIB-0006, revision 04 (ORAUT, 2011), for assigning occupational medical dose in DRs.

4.4.1 SC&A's comments

SC&A reviewed Appendix BL and agrees with the guidance to use ORAUT-OTIB-0006 (ORAUT, 2011) to calculate occupational medical doses. It is understood that DRs for Jessop will use the most current version of ORAUT-OTIB-0006 applicable at the time the DR is completed, which may be more recent than revision 04.

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

5.1 NIOSH's selection criteria

Section 3.0 of DCAS-PER-069 (NIOSH, 2016) describes the criteria NIOSH used to identify previously completed claims requiring reevaluation using revision 1 of Appendix BL (NIOSH, 2015). These criteria included identifying completed claims with verified employment at Jessop that had a POC of less than 50 percent. This resulted in the identification of eight claims.

NIOSH reevaluated these eight claims using revision 1 of Appendix BL, as well as the current revisions of any other applicable documents. All eight claims had a resulting POC of less than 45 percent.

5.2 SC&A's comments

SC&A finds NIOSH's selection criteria for defining the eight claims requiring reevaluation of dose to be sufficient to identify all impacted claims. Additionally, SC&A believes the PER was conducted in a timely manner, as revision 1 of Appendix BL (NIOSH, 2015) was issued in October 2015, and DCAS-PER-069 was issued in April 2016 (NIOSH, 2016). SC&A has no findings associated with subtask 3.

6 Subtask 4: Conduct Audits of a Sample Set of Reevaluated DRs Mandated by DCAS-PER-069

Previous sections of this report describe the changes introduced in revision 1 of Appendix BL (NIOSH, 2015), the TBD for Jessop. The TBD revised numerous exposure pathways that resulted in an increase in dose and have a potential to impact previously adjudicated claims.

For SC&A to satisfy its commitment under subtask 4, SC&A suggests that our case reviews include the rework of an appropriate number of cases necessary to assess all changes introduced in Appendix BL, revision 1, as follows:

- assignment of internal dose
- assignment of external dose
- assignment of residual internal and external dose between uranium operations

7 References

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