Draft

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

A Review of NIOSH's Program Evaluation Report DCAS-PER-036, "Blockson TBD Revision"

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SC&A, Inc. technical support for the Advisory Board on Radiation and Worker Health's review of NIOSH dose reconstruction program

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Table of Contents

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Abbreviations and Acronyms

ABRWH, Board	Advisory Board on Radiation and Worker Health
AEC	U.S. Atomic Energy Commission
AWE	Atomic Weapons Employer
BCC	Blockson Chemical Company
DCAS	Division of Compensation Analysis and Support
DR	dose reconstruction
EE	energy employee
NIOSH	National Institute for Occupational Safety and Health
OCAS	Office of Compensation Analysis and Support
PER	program evaluation report
POC	probability of causation
Ra	radium
Rn	radon
SEC	Special Exposure Cohort
SPR	Subcommittee for Procedure Reviews
TBD	technical basis document
Th	thorium
U	uranium

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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 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.

During a teleconference by the Advisory Board on Radiation and Worker Health (Board) Subcommittee for Procedure Reviews (SPR) on March 14, 2024, the Board tasked SC&A to review DCAS-PER-036, revision 0, "Blockson TBD Revision" (NIOSH, 2012), which was issued to address the impacts on previously completed claims of issuing DCAS-TKBS-0002, revision 03 (NIOSH, 2010), the technical basis document (TBD) for Blockson Chemical Company (BCC). 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.

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- **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.

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

2.1 Facility operations

Blockson Chemical Company in Joliet, Illinois, is an Atomic Weapons Employer (AWE) facility that was under contract to the U.S. Atomic Energy Commission (AEC) to manufacture wet-process phosphoric acid, which was subsequently used to manufacture other chemicals. Blockson received phosphate ore concentrates from Florida mining operations. The BCC operational period was from 1951 through June 1960 with a residual radiation period ending in October 2009.

At BCC, phosphate rock was loaded into a large calciner (furnace), where it was heated at high temperatures to break down organic material. The calcined phosphate feed was transferred to Building 40, where it was oxidized with chlorine and digested with sulfuric acid. This produced phosphogypsum and phosphoric acid, which was transferred as feed material to Building 55, which housed the uranium recovery operations. In addition, covered work activities occurred in an AEC-funded laboratory and pilot plant, where the oxidation processes were performed. Due to uranium extraction operations on site, calcining operations were also considered a related activity at the site.

BCC operations processed about 6,000 net tons of phosphate rock per week, which contained an average of 0.014 percent U_3O_8, and produced about 50,000 pounds of uranium oxide per year in the form of a dry powder containing 50 to 60 percent U_3O_8. The uranium oxide product was deposited into 55-gallon drums, each containing about 1,000 pounds of uranium product.

2.2 Source terms

Radiological characteristics of typical Florida phosphate mine products include uranium-238 (U-238), uranium-234 (U-234), uranium-235 (U-235) and the dosimetrically significant progeny of thorium-230 (Th-230), radium-226 (Ra-226), radon (Rn-222), as well as background concentrations of Th-232.

Significant radionuclides that did not following the uranium recovery process were radium and polonium. These radionuclides were precipitated and filtered off with calcium during phosphoric acid production in Building 40.

The tailings, which were stored onsite, represented a source of exposure of all workers to Ra-226 and Rn-222 and its progeny, and to lower concentrations of uranium and thorium.

2.3 Worker monitoring at BCC

The only monitoring records that are known to exist at BCC are bioassay results for uranium from 1954 through 1958. There is no indication that external dosimetry was used at Blockson.

A class of employees has been added to a Special Exposure Cohort (SEC) at BCC because the Secretary of Health and Human Services determined the dose from exposure to radon cannot be reconstructed from March 1, 1951, through June 30, 1960 (Petition SEC-00058; NIOSH, 2007d).

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3 Subtask 1: Identify the Circumstances that Necessitated DCAS-PER-036

3.1 Chronology of events

OCAS-TKBS-0002, revision 0: On September 11, 2006, NIOSH issued a TBD entitled, "Technical Basis Document for Atomic Energy Operations at Blockson Chemical Company, Joliet, Illinois" (NIOSH, 2006)

OCAS-TKBS-0002, revision 01: On June 20, 2007, NIOSH issued revision 01 of OCAS-TKBS-0002 (NIOSH, 2007a), which addressed internal as well as external review comments and resulted in expanded site descriptions, new radiological data, and the addition of several radionuclides.

OCAS-PER-020, revision 0: On July 31, 2007, NIOSH issued OCAS-PER-020 to evaluate the impact of issuing revision 01 of OCAS-TKBS-0002.

SC&A's review of OCAS-PER-020, revision 0: On March 23, 2009, SC&A issued its review of OCAS-PER-020, which included a review of OCAS-TKBS-0002, revision 01. This review identified the following three potential issues that were not adequately addressed in OCAS-TKBS-0002, revision 01:

(1) For Building 55 workers, exposure to uranium may have involved low solubility or Type S uranium compound(s).

(2) Equally, a lower solubility uranium material, if ingested, would imply the assumption of a lower f_1 value.

(3) Estimates of indoor radon concentrations employed surrogate data that are considered inappropriate and resulted in low exposure values.

OCAS-TKBS-0002, revision 02: On November 21, 2007, NIOSH published revision 02 of the BCC TBD (NIOSH, 2007b), which included (1) changes to footnotes in table 4a and table 12a that now require consideration of Type M and Type S thorium in Building 55, (2) correction of errors contained in table 7 and the resulting graph in figure 6, and (3) correction to the liver dose in table 8.

DCAS-TKBS-0002, revision 03: On December 20, 2010, BCC TBD revision 03 was issued to incorporate (1) the SEC determination, (2) changes to the dates of the AWE operational covered period, which eliminate the second half of 1960 and 1961, (3) increases in radon exposure during most of the residual contamination period, and (4) changes to modeled external doses from drums of uranium concentrates, which lowered external doses due to correction of an error made in modeled photon flux.

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.

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SC&A believes that the issuance of a revision to the TBD for Blockson dose estimates is justification for reevaluating worker doses, as defined in DCAS-PER-036. SC&A concurs with NIOSH's decision to issue DCAS-PER-036 and has no findings pertaining to subtask 1.

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

The description section of DCAS-PER-036 provides a chronology of revisions issued for the BCC TBD as identified in section 3 of this report. A summary of these revisions follows:

> Revision 0 (September 11, 2006) – All claims completed using revision 0 were requested to be returned under OCAS-PER-020.
>
> Revision 01 (June 20, 2007) – No claims were completed using this revision.
>
> Revision 02 (November 21, 2007) – The subject of the PER.
>
> Revision 03 (December 20, 2010) – The version of the TBD that was current when DCAS-PER-036 was issued.

Based on this information, DCAS-PER-036 was issued to evaluate the impact of changes on cases that were adjudicated between revision 02 and revision 03.

Revision 03 of DCAS-TKBS-0002 included changes that both decreased and increased doses. Changes that resulted in a decrease in doses included:

1. The SEC designation for BCC between March 1, 1951, and June 30, 1960, based on the inability to estimate radon dose
2. A change in the covered operational period, which eliminated the second half of 1960 and the entire year of 1961
3. The correction of an error made in the modelling of photon flux to calculate external doses from drums of uranium concentrates

Revision 03 changes that resulted in increased doses included:

1. An increase in radon exposure during the residual contamination period for years 1963 through the end of the residual period in October 2009
2. An increase in particulate intakes during the residual period starting in 1978

For completeness, it should be noted that revision 04 of the BCC TBD was issued May 19, 2014, to update instruction on inhalation and ingestion intakes from work in Building 55 and resulted in the issuance of DCAS-PER-060 (NIOSH, 2015). SC&A has reviewed DCAS-TKBS-0002, revision 04 (NIOSH, 2014) as part of its review of SEC Petition Evaluation Report No. 00225 (SC&A 2016a). SC&A has also performed a subtask 4 (case review) of DCAS-PER-060 (SC&A 2016b).

In instances where the PER involves technical issues that are supported by a document that was previously reviewed by SC&A, subtask 2 will simply provide a summary/conclusion of this review process. Since the topic of discussion in this report is DCAS-PER-036, our review process summary will identify concerns raised in our review of OCAS-PER-020. SC&A's subtasks 1-3 review of OCAS-PER-020 was performed in March 2009 after revisions 01 and 02 of the TBD had been issued, and this review includes an evaluation of these TBD revisions (SC&A 2009). In addition, SC&A evaluated two reworked cases under our subtask 4 review of

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OCAS-PER-020 (SC&A 2013). These reviews identified three findings associated with the subtasks 1–3 review and 3 findings under its subtask 4 review, as follows.

> **Finding 1:** NIOSH's assigned solubility class Type M for uranium and its use for converting urine excretion data to inhalation quantities for Building 55 may be inappropriate.
>
> **Finding 2:** NIOSH's assigned f_1 value of 0.02 for uranium and its use for converting urine excretion data to inhalation/ingestion quantities may be inappropriate.
>
> **Finding 3:** The assigned radon exposure value of 0.112 working level months (WLM) per year as a bounding value for Blockson may be inappropriate.
>
> **Finding 4:** Internal dose calculation inconsistent with guidance provided in OCAS-TKBS-0002, revision 02.
>
> **Finding 5:** Calculation of inhalation dose was not consistent with OCAS-TKBS-0002, revision 02 guidance.
>
> **Finding 6:** Identification of a potential error in the Blockson Building 55 inhalation tool.

Findings 1 and 2 were discussed and closed by the SPR at the July 31, 2012, meeting. Finding 3 was resolved with the issuance of Petition SEC-00058. Findings 4 and 5 were resolved by the issuance of revision 04 of the TBD in May 2014. In April 2014, NIOSH issued a revised Blockson Bldg. 55 Inhalation Tool, which corrected the error and resulted in the SPR closing the finding.

4.1 SC&A's comments

SC&A reviewed each of the documents leading up to changes incorporated in revision 02 of OCAS-TKBS-0002 and revision 03 of DCAS-TKBS-0002 (NIOSH, 2007b; 2010). In addition, SC&A performed a side-by-side comparison of the BCC TBD revisions 02 and 03 to confirm that changes described in DCAS-PER-036 and the *Record of Issue/Revisions* section of DCAS-TKBS-0002, revision 03 were effectively updated. Based on these reviews, SC&A has no findings associated with subtask 2.

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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-036 describes NIOSH's approach to identify previously completed claims requiring reevaluation using guidance in revision 03 of DCAS-TKBS-0002 (NIOSH, 2010) and mandated by DCAS-PER-036 (NIOSH, 2012). Since the revised TBD includes two pathways where doses increased, two separate populations of potentially affected claims were identified.

5.1.1 Population 1: Increase in radon exposure

For increased dose due to radon exposure during the residual period, NIOSH used the following selection criteria:

1. POC less than 50 percent;
2. The DR was approved by the Division of Compensation Analysis and Support (DCAS) on or prior to December 20, 2010 (issue date of DCAS-TKBS-0002, revision 03);
3. Employment at BCC after 1962 (residual period dates impacted); and
4. Verified cancer of a respiratory tract organ.

These criteria generated a list of four potentially affected claims.

Three of the four claims identified in the first population met the criteria for inclusion in the SEC for BCC and none of these three cases had additional cancers for which medical benefits could be sought. The one remaining claim was reworked by NIOSH, and the POC for this case increased to 11.11 percent.

5.1.2 Population 2: Changes in particulate intake

For selecting claims potentially affected by the increase in particulate intake after 1977, NIOSH use the following criteria:

1. POC less than 50 percent;
2. The DR was approved by DCAS on or prior to December 20, 2010 (issue date of DCAS-TKBS-0002, revision 03); and
3. Employment at BCC after 1977.

The criteria used to generate the second population resulted in the identification of 32 potentially affected claims.

For the second population of potentially impacted claims, NIOSH determined that particulate intakes were lower between TBD revision 02 and revision 03 through 1977 and higher starting in 1978 due to the residual period start date changing from April 1, 1962, to July 1, 1960. The larger intakes are associated with the earliest years. Therefore, the total intake for a particular

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claim could result in an increase or decrease depending on the energy employee's (EE's) employment period.

To establish the employment periods where TBD revision 03 would result in a higher intake, NIOSH compared integrated intake rates for both versions of the TBD from varying start dates. This comparison determined that EEs with employment starting after 1974 and continuing to the end of the residual period would have a higher intake under revision 03. Employment start dates earlier than 1975 would have a lower intake due to lower intake rates prior to 1978. NIOSH also noted that EEs with employment ending prior to the end of the residual period would have a lower intake than that demonstrated in their analysis.

An evaluation of the 32 identified claims with employment after 1977 had a start date prior to 1975. Twenty-nine of the claims had employment prior to April 1, 1962, where intake rates in revision 03 are lower than revision 02. Therefore, NIOSH determined that the particulate intake for all of the 32 claims would decrease with TBD revision 03 and no further evaluation was necessary.

5.2 SC&A's comments

Due to the Cybersecurity Modernization Initiative, SC&A does not have access to the NIOSH DCAS Claims Tracking System to review the data used to identify and quantify those cases that qualify for reevaluation. Therefore, SC&A's evaluation is limited to the methodology and criteria employed by NIOSH to identify cases potentially impacted by DCAS-PER-036.

For populations 1 and 2, SC&A finds NIOSH's screening criteria to be scientifically sound. To verify NIOSH's assessment of the impact of the 32 claims identified under population 2, SC&A copied the inhalation and ingestion tables (tables 12a and 12b) into an Excel spreadsheet and performed a comparison of integrated intake rates for various years from TBD revisions 02 and 03. Based on this comparison, SC&A was able to confirm that EEs with employment dates prior to 1975 would have total particulate intakes derived from TBD revision 03 that are lower than those calculated with revision 02. Therefore, SC&A concurs with NIOSH's evaluation of the impact on the population 2 claims and agrees that no case reworks were necessary.

There are no findings associated with subtask 3.

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6 Subtask 4: Conduct Audits of a Sample Set of Reevaluated DRs Mandated by DCAS-PER-039

For SC&A to satisfy its commitment under subtask 4, SC&A is recommending that the single reworked case associated with the increase in radon dose during the residual contamination period (population 1) be reviewed.

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