ADVISORY BOARD ON
RADIATION AND WORKER HEALTH

National Institute for Occupational Safety and Health

ISSUE RESOLUTION MATRIX FOR SC&A FINDINGS ON CARBORUNDUM SPECIAL EXPOSURE COHORT (SEC) PETITION-00223 AND THE NIOSH SEC PETITION EVALUATION REPORT

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INTRODUCTION

The present document summarizes and discusses the findings presented by Anigstein (2016) that arose from our review of "SEC Petition Evaluation Report: Petition SEC-00223 Report," Rev.1 (Jessen and Scalsky 2015) (ER). The seven findings in our previous report are presented as Issues 1–7 in this matrix. The matrix is current as of the last meeting of the Work Group on Carborundum Company on August 18, 2016.

Status Summary

- Issue 1 (x-ray diffraction [XRD] apparatus): *Closed* by action of the Work Group on Carborundum Company.
- Issue 2 (exposure to thorium): *Closed* as an SEC issue by action of the work group, *In Abeyance* as a site profile issue.
- Issue 3 (exposure to ^{90}Sr in thickness gauges): *Closed* by action of the work group.
- Issue 4 (failure to assign doses from medical x rays during the first operational period): *Closed* by action of the work group.
- Issue 5 ("Example DR" failed to assign doses from medical x rays during second operational period): *Closed* by action of the work group.
- Issue 6 (inappropriate and incorrect use of Federal Guidance Report [FGR] No. 12 [Eckerman and Ryman 1993]): *Closed* by action of the work group.
- Issue 7 (dose calculations in "Example DR" not reproducible): *Closed* as an SEC issue by action of the work group, *In Abeyance* as a site profile issue.

Levels of Importance

We have defined four potential levels of importance for these issues:

- **High:** Information presented in the ER is insufficient or questionable, impacting the ability of the National Institute for Occupational Safety and Health (NIOSH) to reconstruct doses.
- **Medium:** NIOSH dose reconstruction (DR) methodology presented in the ER is scientifically incorrect or inconsistent with generally accepted DR procedures. However, there is sufficient information in the ER or elsewhere to allow this issue to be resolved in a scientifically correct and claimant-favorable manner.
- **Low:** Technical improvements are needed to improve the accuracy of dose reconstructions, but these are unlikely to have major impacts in most cases.
- **N/A:** Not applicable because the issue was closed by action of the work group or SC&A recommends that the issue be closed or be in abeyance.

We have assigned the following levels of importance to these issues:

- Issues 1, 3, 4, 5, and 6: *N/A*
- Issues 2 and 7: *Medium*

Issue Resolution Matrix for SC&A Findings on Carborundum SEC Petition-00223 and the NIOSH SEC Petition Evaluation Report

Issue 1: NIOSH Failed to Prescribe a Methodology to Assess Doses to Skin of Hands and Forearms from X-Ray Diffraction (XRD) Apparatus

SC&A Finding: The ER does not present a detailed, quantifiable, verifiable description of how NIOSH intends to assess doses to operators of XRD equipment. The ER cites Lubenau et al. (1969) to suggest that the dose rates would not exceed 2 mR/h at the edge of the table. However, in a personal communication with the author of this matrix, Lubenau (2015) stated that the dose rates on top of the table, where the operator might place his hands and forearms, would "surely be higher." The ER refers to a methodology adopted by NIOSH to limit the exposures to such an apparatus at Sandia National Laboratory—Livermore (Guido et al. 2007), but then observes that "the method was site-specific, based on detailed accounts of the equipment and technical factors; however, the same level of detail has not been found for Carborundum." Nevertheless, the ER then presents a set of assumptions which, according to NIOSH, would allow it to apply the Sandia methodology to Carborundum. (According to a former operator of XRD equipment at Carborundum who was interviewed by SC&A, there was no positive interlock that would prevent the operation of the equipment with an unshielded port.) Absent a more detailed discussion and/or an example calculation, we cannot determine how NIOSH intends to bound the doses from XRD at Carborundum.

Importance: High.[a]

NIOSH Response (6/08/2016) (Tomes 2016):

> NIOSH reevaluated dose from XRD. . . . NIOSH concludes that the exposure to a Rad Production Support personnel as specified in the DR methodology (10.8 R/yr shallow dose to skin and 115 R/yr to the hands and extremities) would be assigned to XRD technicians as a bounding estimate of dose.

Board Action (8/18/2016): During a meeting by teleconference, the Work Group on Carborundum Company concluded that Finding 1 is closed.

Status (8/18/2016): **Closed.**

Issue 2: NIOSH Failed to Address Thorium as a Possible Radiation Source

SC&A Finding: The ER cites information on the use of thorium at Carborundum obtained during an interview with a former worker but makes no further mention of this material except in citing two documents in Table A1-1: "Data Capture Synopsis for Carborundum Company." The former worker, who was interviewed by the author of this matrix on January 11, 2016, reported that [redacted] fuel pellets made from ThO_2 and ThC. This apparently took place prior to the second operational period. The use of thorium at Carborundum needs to be further investigated. If these pellets were weapons related, there would be reason for NIOSH to inform the U.S. Department of Energy and the U.S. Department of Labor that the period of covered operations needs to be extended.

In any case, the work areas were potentially contaminated with thorium, inasmuch as, in the latest interview, the former worker said that the thorium was provided as a powder and confirmed that spills were likely. Since there is no record of a cleanup prior to the second operational period, workers employed during that period could have been exposed to residual thorium contamination. Such exposures should be addressed in evaluating doses during the second operational period.

Importance: Medium

NIOSH Response (6/08/2016) (Tomes 2016):

> Based on available information, it appears that non-covered uranium work was performed for several years prior to the 2nd AWE period, and some thorium work may have been done in 1955. Any alpha emitting radionuclides in the air from both AEC operations in 1959 (and contamination from previous non-covered work) are reflected in the reported uranium (gross alpha) airborne radioactivity measurements. External dose from residual contamination would be insignificant in comparison to the doses assigned for the AEC contract work starting in 1959.

SC&A Reply (8/18/2016): During a meeting by teleconference of the Work Group on Carborundum Company, Robert Anigstein (SC&A) agreed with NIOSH, but noted that the dose conversion factors (DCFs) for ^{232}Th are significantly higher than those for ^{234}U. Consequently, the internal doses to workers exposed to intakes of radioactive aerosols should reflect the possibility that some of the airborne activity was ^{232}Th.

NIOSH Reply (8/18/2016): During the work group meeting, James Neton (NIOSH/DCAS) stated that NIOSH needs to give further thought on how to deal with this issue.

Board Action: During the meeting, the work group concluded that Finding 2 is closed as an SEC issue but needs to be considered as a site profile issue.

Status (8/18/2016): **Closed** as an SEC issue, **In Abeyance** as a site profile issue.

Issue 3: NIOSH Failed to Account for the Use of ^{90}Sr in Thickness Gauges at Carborundum

SC&A Finding: The 1952 acquisition of five thickness gauges by Carborundum for quality control in the manufacture of sandpaper was reported in the *New York Times* (Freeman 1952). However, NIOSH was unaware of this information. Atomic Energy Commission licensing documents related to the Industrial Nucleonics Corporation, the supplier of these gauges, indicate that such devices can contain as much as 2 Ci of ^{90}Sr (AEC 1964). Strontium-90 that has been allowed to age for a month or more is in secular equilibrium with its short-lived progeny, ^{90}Y ($t_{½}$ = 64 h), which emits ß rays with a maximum energy of 2.28 MeV. Thus, although both ^{90}Sr and ^{90}Y are almost pure ß emitters, the high-energy ^{90}Y ß rays create a strong source of bremsstrahlung x rays, which can contribute to doses from penetrating radiation, in addition to posing a radiation hazard to the skin of a worker. NIOSH needs to obtain more information on the use of such sources at Carborundum—failing that, it needs to adopt a strategy for assigning doses to potentially affected workers.

Importance: Medium.[a]

NIOSH Response (6/08/2016) (Tomes 2016):

> The 1952 *New York Times* reference that SC&A discussed in the report indicates the sources were used in the "coated products division plant" to automatically control the thickness of sandpaper. As part of a reorganization and modernization program, Carborundum opened a new plant in 1947 for its Coated Abrasives Division, one of four divisions of the company at that time. The plant was located in Wheatfield, NY, in Niagara County, not at the Buffalo Avenue complex headquarters in Niagara Falls. . . . One of the people interviewed for the Evaluation Report also said sandpaper was not made at the Buffalo Avenue Plant. . . .
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> NIOSH concludes the Sr-90 sources . . . were mostly likely at the Coated Abrasives Division Plant in Wheatfield, which is not a listed facility under EEOICPA. Therefore, assessment of dose from those sources is not applicable.

Board Action (8/18/2016): During a meeting by teleconference, the Work Group on Carborundum Company agreed that Finding 3 is closed.

Status (8/18/2016): **Closed.**

Issue 4: NIOSH Failed to Assign Doses from Medical X Rays During the First Operational Period

SC&A Finding: NIOSH decided not to assign medical x rays during the first operational period on the basis of internal correspondence at du Pont, a wartime government contractor, that said that the grinding of uranium at Carborundum did not require medical supervision (Daniels 1944). This is irrelevant to routine physical examinations, which might have included medical x rays. According to DCAS-IG-003, Rev. 1, (DCAS 2010), doses from screening x rays are to be assigned if they were part of a required annual physical examination, not because they were related to a particular job assignment. The ER is inconsistent in prescribing the assignment of medical x rays during the second operational period but not the first. Furthermore, one of the petitioners stated that [redacted] had physical exams at the site, raising the possibility that medical x rays were performed on site.

Importance: Medium[a]

NIOSH Response (6/08/2016) (Tomes 2016):

> The example DR report reviewed by SC&A had a statement indicating "No medical x-ray doses were assessed." The First Operational Period covers June 1943 through September 1943. The Evaluation Report (section 7.3.2) cites a reference that stated there were no health surveillance requirements for the 1943 work. SC&A mentioned a claimant indicated Carborundum required x rays during that time, and dose should be assigned whether or not required by the AEC. NIOSH agrees that dose from a single x-ray examination should be assigned in dose reconstructions for claimants with employment in 1943.

SC&A Reply (10/03/2016): To be exact, Anigstein (2016) reported that the [redacted] of a deceased Carborundum employee stated that [redacted] had physical exams at the site, but the [redacted] did not know if they included medical x rays.

Board Action (8/18/2016): During a meeting by teleconference, the Work Group on Carborundum Company agreed that Finding 4 is closed.

Status (8/18/2016)**: Closed.**

Issue 5: "Example DR" Failed to Assign Doses from Medical X Rays During the Second Operational Period

SC&A Finding: According to the ER, "NIOSH will assume that pre-employment, annual, and termination PA radiographic chest x-ray screenings were performed for workers during the second operational period." However, "Example DR," a document in support of the ER that is posted on the Division of Compensation Analysis and Support (DCAS) restricted website, explicitly states that no medical x-ray doses were assessed to the hypothetical worker who was employed during both operational periods. This inconsistency needs to be resolved.

Importance: Medium.[a]

NIOSH Response (6/08/2016) (Tomes 2016):

> The example DR report reviewed by SC&A had a statement on the last line indicating "No medical x-ray doses were assessed." To clarify, the example DR Report did not say they were not applicable; they were just not provided with the example calculations. NIOSH agrees that x-ray doses are applicable, as indicated in ER section 7.3.2.

Board Action (8/18/2016): During a meeting by teleconference, the Work Group on Carborundum Company agreed that Finding 5 is closed.

Status (8/18/2016)**: Closed.**

Issue 6: Inappropriate and Incorrect Use of FGR 12

SC&A Finding: The ER used several scenarios described in Battelle-TBD-6000 (Allen 2011; hereafter referred to as "TBD-6000") to estimate internal and external doses from intakes of uranium dust and from exposure to uranium metal. However, NIOSH used FGR 12 (Eckerman and Ryman 1993) to calculate doses from submersion in a cloud of radioactive dust and from exposure to contaminated surfaces instead of using the values listed in TBD-6000 Tables 3.9 and 3.10. The photon dose coefficient from a surface contaminated with uranium is entered in "Methodology.xlsx," a document in support of the ER that is posted on the DCAS restricted website. This value is only ~29% of the value in Table 3.10. This procedure is inconsistent with the use of TBD-6000 for other pathways and for DRs at other work sites. Furthermore, it is not scientifically correct, since NIOSH does not have a prescribed method of deriving organ dose equivalents from effective dose equivalents (EDEs), the dosimetric quantities listed in FGR 12. However, in the case of Carborundum, the external doses from penetrating radiation displayed in "Methodology.xlsx" for the residual periods are a few mrem/y (not <1 mrem/y, as stated in the ER), so these discrepancies are not highly significant.

Doses to the skin from nonpenetrating radiation from uranium-contaminated surfaces are on the order of a few hundred millirem during the first few years of the first residual period. Consequently, the value derived from FGR 12 skin doses that is entered in "Methodology.xlsx," which is only ~72.5% of the value in TBD-6000 Table 3.10, could affect the outcome of a DR.

Importance: Low.[a]

NIOSH Response (6/08/2016) (Tomes 2016):

> NIOSH concurs with SC&A that the factors provided in TBD-6000 . . . for external dose from contamination and air immersion provide higher doses than the factors in the example DR, which were derived from Federal Guidance Report Number 12. Therefore, the methods will be revised to use the TBD-6000 factors.

Board Action (8/18/2016): During a meeting by teleconference, the Work Group on Carborundum Company agreed that Finding 6 is closed.

Status (8/18/2016)**: Closed.**

Issue 7: Dose Calculations in "Example DR" Are Not Reproducible

SC&A Finding: SC&A audited doses to four of the five organs presented in "Example DR." Our audit exhibited significant differences in both internal and external doses. NIOSH did not show details of its calculations—"Example DR" simply listed annual intakes and external dose rates during the relevant periods and the final organ doses but did not present the details of the intermediate calculations used to obtain these doses. Consequently, it was not possible for us to identify the reasons for the different results. The ABRWH procedures for reviews of NIOSH SEC petition evaluation reports recommend that NIOSH include in its evaluation a demonstration that it is feasible to reconstruct individual doses for the cohort, including sample DRs (SC&A 2006). Until we can verify the results of sample DRs, we cannot conclude that NIOSH can reconstruct doses to Carborundum workers.

Importance: Medium

NIOSH Response (6/08/2016) (Tomes 2016):

> The doses provided by NIOSH were not precise best estimates. . . . NIOSH employed some efficiency measures in the example DR, some of which resulted in marginally higher dose. . . . NIOSH can provide an updated example dose calculation showing details of the annual dose calculations. However, SC&A also had comments on interpretation of data to estimate both internal and external doses. Those comments, while not at the level of a finding, should be resolved before NIOSH provides an updated example calculation.
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> As noted by SC&A, NIOSH used the higher exposure (R) organ DCFs for calculating certain doses from uranium metal when the lower personal dose equivalent DCFs (H_p10) factors should have been used. NIOSH agrees with SC&A's comment on the appropriate factors to use for exposure to uranium metal. NIOSH also employed some efficiency measures that resulted in some other marginal overestimates.
>
> . . .
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> The large discrepancy in the internal dose to the skin, liver, and kidneys is due to the NIOSH example DR incorrectly using solubility Type *F* as one of the possible solubility types for intakes from the 1943 uranium metal grinding work (Type *S* was correctly used for the lungs). NIOSH agrees with ER section 7.2.2.1 that only uranium solubility Types *M* and *S* should be considered for the metal grinding work in 1943, thus the reported internal doses in the example DR for the skin, liver, and kidneys are too high.

NIOSH Response (8/18/2016): During a meeting by teleconference of the Work Group on Carborundum Company, James Neton (NIOSH/DCAS) stated that NIOSH would address observations made by SC&A that would affect dose calculations. However, all participants agreed that these are site profile, not SEC, issues.

Board Action: During the meeting, the work group concluded that Finding 7 is closed as an SEC issue and should be considered to be a site profile issue.

Status (8/18/2016)**: Closed** as an SEC issue, **In Abeyance** as a site profile issue.

[a] This is the importance originally assigned to this issue—it is listed here to maintain continuity. Since the issue has been closed, the importance is no longer relevant.

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