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**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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DISCLAIMER

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INTRODUCTION

This document summarizes and discusses the findings presented by SC&A, Inc. (2016) that arose from a review of *SEC Petition Evaluation Report: Petition SEC-00223 Report, Revision 1* (Jessen and Scalsky 2015; hereafter referred to as the “ER”). The seven findings in SC&A’s report are presented as Issues 1–7 in this matrix.

Status Summary

- Issue 1 (x-ray diffraction [XRD] apparatus): *Open*
- Issue 2 (exposure to thorium): *Open*
- Issue 3 (exposure to strontium-90 [⁹⁰Sr] in thickness gauges): *Open*
- Issue 4 (failure to assign doses from medical x rays during the first operational period): *Open*
- Issue 5 (“Example DR” failed to assign doses from medical x rays during second operational period): *Open*
- Issue 6 (inappropriate and incorrect use of Federal Guidance Report [FGR] No. 12 [EPA 1993]): *Open*
- Issue 7 (dose calculations in “Example DR” not reproducible): *Open*

Level of Importance

We have assigned four levels of importance to these issues, which we define in the following manner:

- **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 DRs, 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:

- Issue 1: *High*
- Issue 2, 3, 4 5, and 7: *Medium*
- Issue 6: *Low*

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 milliroentgens per hour at the edge of the table. However, in a personal communication with the author of this matrix, ██████████ (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

NIOSH Response:

Board Action:

Status (4/25/16): Open

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 he produced fuel pellets made from ThO₂ 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:

Board Action:

Status (4/25/16): Open

Issue 3: NIOSH Failed to Account for the Use of ⁹⁰Sr 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 (AEC) licensing documents related to the Industrial Nucleonics Corporation, the supplier of these gauges, indicate that such devices can contain as much as 2 curies of ⁹⁰Sr (AEC 1964). Strontium-90 that has been allowed to age for a month or more is in secular equilibrium with its short-lived progeny, yttrium-90 (⁹⁰Y) ($t_{1/2} = 64$ h), which emits β rays with a maximum energy of 2.28 mega-electron volts. Thus, although both ⁹⁰Sr and ⁹⁰Y are almost pure β emitters, the high-energy ⁹⁰Y β 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

NIOSH Response:

Board Action:

Status (4/25/16): Open

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, Revision 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 his father had physical exams at the site, raising the possibility that medical x rays were performed on site.

Importance: Medium

NIOSH Response:

Board Action:

Status (4/25/16): Open

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

NIOSH Response:

Board Action:

Status (4/25/16): Open

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 (EPA 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, 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 millirem per year (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

NIOSH Response:

Board Action:

Status (4/25/16): Open

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:

Board Action:

Status (4/25/16): Open

References

Allen, D., 2011. *Site Profile for Atomic Weapons Employers that Worked Uranium Metals, Battelle-TBD-6000*, Revision 1, Division of Compensation Analysis and Support, National Institute for Occupational Safety and Health. Available at <http://www.cdc.gov/niosh/ocas/awedocs.html#b6000>

Atomic Energy Commission (U.S.) (AEC) 1964. "Byproduct Material License, Licensee: Industrial Nucleonics Corporation, License Number: GL 136 (D65)." FOIA request via NRC Public Document Room: 8304010153 830131, PDR FOIA, STEPHAN82-619 PDR.

Daniels, C.E., 1944. "T-Metal Fabrication," letter to Dr. G.H. Gehrman, Medical Director, E. I. duPont de Nemours and Company, Incorporated. October 11, 1944. [SRDB Ref. ID 21831]

Division of Compensation Analysis and Support (DCAS) 2010. *Radiation Exposures Covered for Dose Reconstructions under Part B of the Energy Employees Occupational Illness Compensation Program Act*, DCAS-IG-003, Revision 1, National Institute for Occupational Safety and Health. October 5, 2010. Available at <http://www.cdc.gov/niosh/ocas/pdfs/dr/oc-ig3-r1.pdf>

EPA 1993. *External Exposure to Radionuclides in Air, Water, and Soil*, Federal Guidance Report No. 12, EPA 402-R-93-081, K.F. Eckerman and J.C. Ryman, U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, Washington, DC. September 1993. [SRDB Ref. ID. 11997]. Available at <https://www.epa.gov/sites/production/files/2015-05/documents/402-r-93-081.pdf>

Freeman, W.M., 1952. "New Way Devised to Make Abrasives: Carborundum's Process Joins Use of Beta Rays with Fully Automatic Controls." *New York Times*, June 8. Available at <http://query.nytimes.com/mem/archive/pdf?res=9B0DE4D6103CE53ABC4053DFB0668389649EDE>

Guido, J., et al., 2007. "SEC Petition Evaluation Report Addendum: Sandia National Laboratories – Livermore, Petition SEC-00059-Addendum." Available at <http://www.cdc.gov/niosh/ocas/pdfs/sec/sandiaca/snleradd.pdf>

Jessen, K., and E. Scalsky 2015. *SEC Petition Evaluation Report: Petition SEC-00223 Report*, Revision 1, Oak Ridge Associated Universities. June 3, 2015. Available at <http://www.cdc.gov/niosh/ocas/pdfs/sec/carbco/carbcoer-223-r1.pdf>

Lubenau, J.O., J.S. Davis, D.J. McDonald, and T.M. Gerusky 1969. "Analytical X-Ray Hazards: a Continuing Problem," *Health Physics* 16, 739–746. [SRDB Ref. ID 142196]

██████████ 2015. "Re: Radiation exposures from x-ray diffraction," personal email to Robert Anigstein, SC&A, Inc. November 11, 2015.

SC&A, Inc. 2006. *Board Procedures for Review of Special Exposure Cohort Petitions and Petition Evaluation Reports*, Revision 1, SCA-TR-TASK5-0002.

SC&A, Inc. 2016. *Review of the Carborundum Special Exposure Cohort (SEC) Petition-00223 and the NIOSH SEC Petition Evaluation Report*, SC&A-TR-SEC-2016-0001, Revision 1, R. Anigstein. January 27, 2016.