MEMORANDUM

TO: Advisory Board on Radiation and Worker Health, Work Group on Carborundum Company
FROM: Robert Anigstein, SC&A, Inc.
DATE: November 28, 2018
SUBJECT: Review of NIOSH Report on Resolution of Site Profile Issues for Carborundum

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On August 16, 2018, NIOSH issued a white paper (Tomes 2018) in response to our reviews of previous NIOSH reports on Carborundum, as well as to discussions at several meetings of the Advisory Board on Radiation and Worker Health (ABRWH) Work Group (WG) on Carborundum Company. We began our review of the white paper with Attachment A, which lists 17 issues raised by SC&A, beginning with our review of the Carborundum Special Exposure Cohort (SEC) petition (Anigstein 2016), and including Anigstein and Mauro (2016, 2017a, 2017b). The first nine of these issues had been closed by the WG as SEC issues. Two of these—external exposure to an x-ray diffraction (XRD) apparatus and use of surrogate external dose data in the second operational period—remained open as site profile issues. Seven of the remaining eight issues also remained open as site profile issues; one issue, dealing with the assignment of doses from medical x rays in example dose reconstructions (DRs), was acknowledged by NIOSH to result from errors and required no further resolution.

The nine unresolved site profile issues are listed in the main body of the white paper (Tomes 2018, Table 1). We will discuss these in the order in which they appear.

1. Dose from x-ray diffraction. NIOSH agreed to adjust the annual exposure duration of an operator of the x-ray diffraction (XRD) apparatus, in light of information furnished to SC&A during an interview with a former Carborundum employee who operated this apparatus. NIOSH also agreed to multiply the exposure rate of 2 mR/h from scattered radiation at the edge of the table reported by Lubenau et al. (1969) by the correction factor of 2.48 for the under-response of the instruments to low-energy photons recommended by Els (1971). NIOSH then calculated an annual exposure rate 1.003 R from this source and converted that value to 8.796 mGy/y air kerma. NIOSH proposed to use the air kerma to organ dose coefficients for 10-keV photons listed by ICRP (1996) to convert this value to doses to affected organs. Since the XRD emits radiation in the 8–8.9 keV range, we believe that this constitutes a valid, claimant-favorable approach. SC&A recommends that this methodology be incorporated in the Carborundum site profile and that the issue then be closed.

2. Use of surrogate external dose data in 2nd Operational Period. NIOSH agreed with SC&A's recommendation to adopt as the external exposure to penetrating radiation from

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uranium metal the personal dose equivalent, $H_p(10)$, rate from a flat plate that is listed by DCAS (2011, Table 6.1). NIOSH further agreed to adopt the beta skin doses from this source recommended by SC&A: a contact dose rate of 77.6 mrem/h and a dose rate at 1 ft of 4.05 mrem/h. SC&A recommends that this issue be closed.

3. **SC&A Finding 4.1.1: Inconsistent work-hours used in residual dose calculations.** "NIOSH has updated all site profiles to agree with work-hours in Battelle-TBD-6000." (Tomes 2018, Table 1) SC&A concurs with the NIOSH resolution of this issue and recommends that it be closed.

4. **SC&A Finding 4.1.2: Incorrect distribution type used for external doses in example DR for 1959 and 1960.** NIOSH attributes this to an error in the site profile spreadsheet. SC&A recommends that this issue be closed once NIOSH corrects the spreadsheet.

5. **SC&A Finding 4.1.3: Incorrect source term and glovebox model used to model dose from plutonium.** SC&A has reviewed the revised NIOSH calculations of external dose rates from plutonium fuel pellets and found errors in the analyses (Anigstein 2018). We recommend that this issue remain open pending NIOSH's response to our review.

6. **SC&A Finding 4.1.5: Workers exposed to glovebox operations should be assigned intakes of both uranium and plutonium.** We reexamined the original air sampling data recorded by the Health and Safety Laboratory (HASL) of the US Atomic Energy Commission (AEC). We concluded that if the HASL inspector believed that uranium and plutonium dust were present in the same locations in potentially hazardous concentrations, he would have sampled for both radionuclides in those locations. The fact that he didn't (to the extent documented in the sample report sheets found in the SRDB) can be taken as indicating that the hazards from these radionuclides were not coexistent. Our belief in the competence of the inspector is strengthened by the fact that the sample sheets were prepared by "[redacted]." This was undoubtedly [redacted], who later became a professor at the [redacted], and whose specialties include air pollution.

Tomes (2018) clarified NIOSH's approach to assigning intakes by stating that the gross alpha air samples in the plutonium cell would be interpreted as either plutonium or uranium, whichever resulted in a higher dose. Given that clarification, we believe that the NIOSH position constitutes a valid approach. SC&A recommends that this issue be closed.

7. **SC&A Finding 4.1.6: Incorrect worker intake category used in one of the Example DRs.** NIOSH agrees that there was an error in the intake value. SC&A recommends that this issue be closed.

8. **SC&A Observation 4.2.1: SC&A commented that the methods to assign residual external dose using only the 30-250 keV energy band in the Example DRs resulted in a small overestimate of dose.** NIOSH is correct in responding that its method makes a small contribution to the *total* dose *in the example DR*, because most of the dose is from other pathways. However, for the pathway in question—external exposure to uranium-contaminated surfaces—the NIOSH prescription for the Carborundum residual periods results in a *three-fold*

increase in dose. Although the increase of the dose to the kidney in the present hypothetical example is only 36 mrem, one could envision situations involving other worksites with heavily contaminated surfaces where the difference could play a significant role in DRs. In fairness to all claimants, NIOSH should aim for consistency in assigning doses. NIOSH recognized the importance of consistency in DRs by commissioning a report on this subject by a former ABRWH member (Griffon 2017).

In the present instance, we suggest that NIOSH utilize dose conversion factors (DCFs) for the three photon energy ranges that reflect the breakdown of the exposure rates in these ranges specified by DCAS (2011) in the text following Table 3.10. Tomes (2018) stated that NIOSH used the method in question to simplify dose calculations. However, since he indicated that NIOSH has prepared a spreadsheet for DRs from this site, we believe it would require but a modest effort to revise the spreadsheet to include this provision in the external dose calculations. Once this is in place, there would be no extra effort required on the part of the dose reconstructor. As an alternative, NIOSH could issue a procedure instructing dose reconstructors to ignore the energy-range breakdown of external exposure to uranium-contaminated surfaces at all worksites and assume that all the exposure is in the 30–250 keV energy range. Either approach would ensure consistency in assigning doses from this scenario.

9. SC&A Observation 4.2.2: SC&A commented that the method NIOSH used to calculate ingestion intakes in the 2nd Operational Period resulted in a slightly lower dose as opposed to the methods described in OCAS-TIB-009. NIOSH has updated the spreadsheet used for the site profile to address this comment. SC&A recommends that this issue be closed.

Conclusions

NIOSH has successfully addressed and resolved all but two issues related to the site profile of the Carborundum site:

1. The doses from external exposure to photons and neutrons from uranium-plutonium fuel pellets handled in a glovebox need to be revised.

2. The method of assigning doses from external exposure during the residual periods plays a small role at Carborundum; however, we suggest that NIOSH address this issue in the interest of consistency across all worksites.

References

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

Anigstein, R. 2018. “Audit of NIOSH Assessment of External Doses from Plutonium Fuel Pellets.” Memorandum to Advisory Board on Radiation and Worker Health, Work Group on Carborundum Company. November 27, 2018.

Anigstein, R., and J. Mauro. 2016. “Review of NIOSH Use of Surrogate Data in the SEC Evaluation Report for Carborundum.” Memorandum to Advisory Board on Radiation and Worker Health, Work Group on Carborundum Company. November 10, 2016.

Anigstein, R., and J. Mauro. 2017a. “Updated Status Report on SC&A Review of NIOSH Response Paper.” Memorandum to Advisory Board on Radiation and Worker Health, Work Group on Carborundum Company. March 12, 2017.

Anigstein, R., and J. Mauro. 2017b. “Final Audit of NIOSH Response Paper and Example DRs.” Memorandum to Advisory Board on Radiation and Worker Health, Work Group on Carborundum Company. June 30, 2017.

Division of Compensation Analysis and Support (DCAS). 2011. “Site Profile for Atomic Weapons Employers that Worked Uranium Metals,” Battelle-TBD-6000, Rev. 1. June 17, 2011.

Els, R. A. “The Response of Various Survey Instruments to Low Energy X Rays.” *In* Moore, T. M., W. E. Gundaker, and J. W. Thomas, Eds. 1971. “Radiation Safety in X-Ray Diffraction and Spectroscopy,” DHEW Publication No. (FDA) 72-8009, BRH/DEP 72-3. Proceedings of a Conference held on January 6-7, 1970, at the University of Pennsylvania, Philadelphia, Pennsylvania. U.S. Department of Health, Education, and Welfare, Public Health Service, Food and Drug Administration, Bureau of Radiological Health, Rockville, Maryland 20852. SRDB Reference ID: 32635.

Griffon, M. A. 2017. “Review of Areas of Professional Judgment in the Dose Reconstruction Process and Approaches for Assuring Consistency.” NIOSH dose reconstruction program. November 5, 2017. https://www.cdc.gov/niosh/ocas/pdfs/dps/dc-drprocrev-110517-508.pdf

International Commission on Radiological Protection (ICRP). 1996. “Conversion Coefficients for use in Radiological Protection against External Radiation,” ICRP Publication 74. *Annals of the ICRP*, *26* (3/4). Tarrytown, NY: Elsevier Science, Inc.

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 Reference ID: 142196.

Tomes, T. P. 2018. “Resolution of Site Profile Issues for the Carborundum Company Niagara Falls, New York,” White Paper. National Institute for Occupational Safety and Health. August 16, 2018.