



MEMORANDUM

TO: Uranium Refining Atomic Weapons Employers Work Group
FROM: SC&A, Inc.
DATE: September 26, 2017
SUBJECT: SC&A's Evaluation of NIOSH's White Paper, "Neutron Dose Assignment for Plutonium Fuel at W.R. Grace" (Site Profile Finding 4)

Introduction and Background

The documents most relevant to the evaluation of W.R. Grace site profile Finding 4 are:

- ORAUT-TKBS-0043, Revision 02, *An Exposure Matrix for W.R. Grace and Company in Erwin, Tennessee*, September 16, 2011 (NIOSH 2011)
- SC&A 2013 report, SCA-TR-SP2013-0041, Revision 0, *Review of the NIOSH Site Profile for the W. R. Grace and Company in Erwin, Tennessee*, January 16, 2013 (SC&A 2013)
- SC&A 2017 report, pages 22–26, *Review of Revision 03 to the Site Profile for Nuclear Materials and Equipment Corporation, Apollo and Parks Township, Pennsylvania*, SCA-TR-2017-SP001, Revision 0, February 6, 2017 (SC&A 2017)
- National Institute for Occupational Safety and Health (NIOSH) white paper, *Neutron Dose Assignment for Plutonium Fuel at W.R. Grace*, May 1, 2017 (NIOSH 2017a)

The current status of W.R. Grace site profile Finding 4 ("Lack of neutron dose assignment") on the Board Review System is as follows:

- SC&A – January 1, 2013

SC&A did not locate any recorded neutron doses in the claimants' files reviewed to date. The TBD [technical basis document] concludes (page 28) that there were potential neutron exposures, but "No attempt should be made to estimate neutron dose for workers not monitored for neutrons during the operational period." Site profiles for other uranium- and plutonium-handling facilities incorporate neutron doses in the DR [dose reconstruction] process, usually using the neutron-to-photon ratio (n/p) method, for workers potentially exposed to neutrons. Further investigation of the potential neutron exposures and methods to assign appropriate neutron doses is needed for the WRG [W.R. Grace] facility.

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- NIOSH – January 1, 2013

NIOSH agrees that further investigation is necessary. The timeframe for when neutrons are assigned to be based on the results of the assessment of plutonium exposures from both the AWE [Atomic Weapons Employer] and the residual contamination periods, (1958–March 1, 2011) from Issue #3. The NP ratio(s) from the assessment can be used to estimate neutron dose from the WR Grace source term.

- SC&A – August 13, 2015

This finding was discussed during the Work Group on Uranium Refining AWEs teleconference on August 3, 2015. SC&A agrees that this approach is reasonable and will evaluate the data and recommended method(s) when they are available. Status changed to in progress.

On May 1, 2017, NIOSH issued a white paper, *Neutron Dose Assignment for Plutonium Fuel at W.R. Grace* (NIOSH 2017a).

NIOSH's Recommendations

In the white paper (NIOSH 2017a), NIOSH analyzed the neutron-to-photon (N:P) ratios at other U.S. Department of Energy (DOE) sites that processed plutonium in a similar manner and of similar composition as at W.R. Grace. These included Hanford, Savannah River Site (SRS), Rocky Flats, and the Nuclear Materials and Equipment Corporation (NUMEC). NIOSH elected to use the N:P ratios from NUMEC because the fuel composition and process most closely matched those at W.R. Grace.

NIOSH recommended an N:P ratio geometric mean (GM) value of 0.34 (with a geometric standard deviation [GSD] of 1.71) for non-glovebox workers in Buildings 234 and 110, and an N:P ratio GM value of 1.00 (with a GSD of 1.49) for glovebox workers in Buildings 234 and 110. The photon dose is to be assigned as 100% 30–250 kiloelectron volt (keV) photons, and the derived neutron dose is to be assigned as 100% 0.1–2 mega-electron volts neutrons.

NIOSH recommended that if a high shallow-to-deep-dose ratio (> 2.0) is noted, this could be an indication of glovebox work (DCAS 2011), and the glovebox N:P ratio should be used. NIOSH further recommended that the guidance in OCAS-TIB-007, Revision 1¹, *Neutron Exposures at the Savannah River Site* (NIOSH 2007); the computer-assisted telephone interview; and information in the worker's bioassay records be used to identify potential neutron exposure from plutonium.

¹ The References section of NIOSH 2017a states that the October 15, 2007, version of OCAS-TIB-007 is Revision 0. However, this is the date of Revision 1, not Revision 0; therefore, SC&A has assumed the intended reference was to Revision 1.

SC&A's Evaluation of NIOSH's White Paper

SC&A reviewed N:P ratios used at other DOE sites that processed plutonium and found them to range from 0.21 to 1.1 for non-glovebox workers, and to range from 1.0 to 1.7 for glovebox workers. SC&A has reviewed Revision 03 to the NUMEC site profile (SC&A 2017)² and concurred with NIOSH's recommended N:P ratio GM value of 0.34 for non-glovebox workers and N:P ratio GM value of 1.00 for glovebox workers at NUMEC. The plutonium composition and processes at W.R. Grace were similar to those at NUMEC. Therefore, SC&A concurs with NIOSH's recommendation of an N:P ratio GM value of 0.34 for non-glovebox workers and an N:P ratio GM value of 1.00 for glovebox workers.

However, SC&A did not find that NIOSH's recommendations for the determination of potential plutonium exposure (as provided in the last paragraph on page 6 of NIOSH 2017a) to be applicable or adequate. The NIOSH recommendations for determining potential plutonium exposure at SRS that should be used when the work location and or activities are not clear are listed on page 3 of OCAS-TIB-007 (NIOSH 2007):

- 1. If an energy employee was monitored for neutron exposure in 1971 or later, and he or she did not change jobs or work area, the energy employee should be considered to have been exposed to neutrons prior to 1971. The monitoring for neutrons increased dramatically after the implementation of the TLND [thermoluminescent neutron dosimeter] in 1971, thus contemporary monitoring is a good indicator of potential for neutron exposure.*
- 2. External dosimetry records indicate the 17 keV calibration curve was used for interpretation of the shallow dose. This is an indication of exposure to plutonium and therefore neutrons.*
- 3. Neutron exposure indicated in external dosimetry records between 1958-1962...*

None of these items is applicable at W.R. Grace because there was no significant neutron monitoring before, during, or after the processing of plutonium at W.R. Grace, and detailed photon dosimetry calibration information is not available for W.R. Grace. Although the plutonium fuel was similar in composition, the facility layout and scale of operation were different at W.R. Grace from those at SRS. Therefore, the recommendations for SRS in OCAS-TIB-007 (NIOSH 2007) are not very useful for application at W.R. Grace.

Unless there are consistent DOE records for W.R. Grace workers indicating that they have worked, or not worked, with plutonium, it may be necessary to assign neutron dose to each production worker in Buildings 234 and 110 during the plutonium production era (1965–1972), unless the worker's record indicates otherwise. Additionally, potential for neutron exposure from plutonium needs to be addressed during the standby (storage) phase (1973–1987) and during the

² Revision 04 to the NUMEC site profile (NIOSH 2017b) recommends the same N:P ratios as Revision 03 (NIOSH 2016); therefore, there is no inconsistency and SC&A's review is applicable to Revision 04 concerning N:P ratios.

decontamination phase (1987–1994) for workers involved in those operations. Neutron exposures from uranium (as discussed in ORAUT-TKBS-0043, Revision 02, page 28) were not included in this white paper and have yet to be addressed.

References

DCAS 2011. *Best Estimate External Dose Reconstruction for Glovebox Workers*, DCAS-TIB-0010, Revision 04, Division of Compensation Analysis and Support, Cincinnati, Ohio. November 28, 2011.

NIOSH 2007. *Neutron Exposures at the Savannah River Site*, OCAS-TIB-007, Revision 1, Office of Compensation Analysis and Support, National Institute for Occupational Safety and Health, Cincinnati, Ohio. October 15, 2007.

NIOSH 2011. *An Exposure Matrix for W.R. Grace and Company in Erwin, Tennessee*, ORAUT-TKBS-0043, Revision 02, National Institute for Occupational Safety and Health, Cincinnati, Ohio. September 16, 2011.

NIOSH 2016. *Site Profile for Nuclear Materials and Equipment Corporation, Apollo and Parks Township, Pennsylvania*, ORAUT-TKBS-0041, Revision 03, National Institute for Occupational Safety and Health, Cincinnati, Ohio. August 25, 2016.

NIOSH 2017a. *Neutron Dose Assignment for Plutonium Fuel at W.R. Grace*, White Paper, National Institute for Occupational Safety and Health, Cincinnati, Ohio. May 1, 2017.

NIOSH 2017b. *Site Profile for Nuclear Materials and Equipment Corporation, Apollo and Parks Township, Pennsylvania*, ORAUT-TKBS-0041, Revision 04, National Institute for Occupational Safety and Health, Cincinnati, Ohio. March 13, 2017.

SC&A 2013. *Review of the NIOSH Site Profile for the W. R. Grace and Company in Erwin, Tennessee*, SCA-TR-SP2013-0041, Revision 0, SC&A, Inc., Vienna, Virginia, and Saliant, Inc., Jefferson, Maryland. January 16, 2013.

SC&A 2017. *Review of Revision 03 to the Site Profile for Nuclear Materials and Equipment Corporation, Apollo and Parks Township, Pennsylvania*, SCA-TR-2017-SP001, Revision 0, SC&A, Inc., Vienna, Virginia, and Saliant, Inc., Jefferson, Maryland. February 6, 2017.