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

**SC&A's Review of the White Paper,
"NIOSH Resolution of W. R. Grace Site Profile
Findings 2 and 7"**

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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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Abbreviations and Acronyms

ABRWH	Advisory Board on Radiation and Worker Health
AWE	Atomic Weapons Employer
dpm/d	disintegrations per minute per day
DR	dose reconstruction
NIOSH	National Institute for Occupational Safety and Health
ORAUT	Oak Ridge Associated Universities Team
pCi/d	picocurie per day
TBD	technical basis document
TLD	thermoluminescent dosimeter
WG	work group
WRG	W. R. Grace Company

1 Introduction and Background

W. R. Grace Company (WRG) was an Atomic Weapons Employer (AWE) facility from 1958 through 1970, with an AWE residual contamination period from 1971 through March 1, 2011. The National Institute for Occupational Safety and Health (NIOSH) issued on July 22, 2019, the white paper, “NIOSH Resolution of W. R. Grace Site Profile Findings 2 and 7,” for WRG, Erwin, TN (NIOSH, 2019a; hereafter referred to as the “white paper”). The purpose of the white paper was to address findings 2 and 7 of SC&A’s “Review of the NIOSH Site Profile for the W.R. Grace and Company in Erwin, Tennessee,” SCA-TR-SP2013-0041, revision 0 (SC&A, 2013). Finding 2 was concerned with insufficient uranium bioassay/intake data for assigning uranium doses. Finding 7 was concerned with lack of environmental dosimetry data and intake data for assigning environmental external and internal exposures.

2 Outline of White Paper

2.1 NIOSH’s response to finding 2: Uranium intakes

2.1.1 AWE operational period intakes 1958–1970 (white paper page 6)

Table 1 (page 6) of the white paper provides a summary of the recommended uranium intakes for operators, general laborers, supervisors, and clerical workers. These data were generated from using the uranium intake value of 1.17E3 picocurie per day (pCi/d) from table 3-15 (page 26) of the technical basis document (TBD), ORAUT-TKBS-0043, revision 02, “An Exposure Matrix for W.R. Grace and Company in Erwin, Tennessee” (NIOSH, 2011a). The value of 1.17E3 pCi/d was derived from the 95th percentile value of 528.38 disintegrations per minute per day (dpm/d) from the breathing zone sampling of various operations at WRG in 1961, as summarized in table 3-8 (page 20) of the TBD.

2.1.2 Residual contamination intakes 1971–March 1, 2011 (white paper pages 6–8)

Table 2 (pages 7–8) provides an updated version of the uranium intakes for this period based on job description. Current methods and values for applying deposition rates and resuspension factors were incorporated into this table, as opposed to the previous values listed in table 5-2 (page 33) and table 5-3 (page 34) of the TBD.

2.2 NIOSH’s response to finding 7: Environmental internal dose

2.2.1 Environmental monitoring (white paper pages 9–11)

Figures 1, 2, and 3 (pages 10 and 11) of the white paper provide layouts of the facilities and locations of monitoring stations.

2.2.2 Environmental air monitoring data 1979–2011 (white paper pages 11–14)

Table 3 (page 13) of the white paper provides a summary of the average annual gross alpha site air concentrations by location for the period 1979–1995. Table 4 (page 14) provides the recommended environmental alpha intake rates (dpm/d) for the period 1979–2011. The values in the table were derived from the maximum annual WRG site measurements during 1979–1995 and the maximum recorded gross alpha air concentration during the period 1996–2009, which was 3.9E-15 microcurie per milliliter.

2.2.3 Environmental uranium intakes 1958–1970 (white paper page 14)

The operational-period clerical inhalation intake of 95 dpm/d from table 1 (page 6) of the white paper is recommended for the period 1958–1970.

2.2.4 Environmental uranium intakes 1971–1978 (white paper page 15)

Because the recommended residual-period clerical uranium intake rates listed in table 2 (page 7) of the white paper for 1971–1978 are lower than the environmental derived intakes starting in 1979, NIOSH performed an exponential decrease of the 1970 operational-period clerical intake (95 dpm/d) down to the 1979 environmental intake of 2.31 dpm/d. The results of the calculations and recommended intake values are summarized in table 5 (page 15) of the white paper for 1971–1978.

2.2.5 Environmental plutonium intakes 1965–1978 (white paper pages 15 and 16)

Recommended annual environmental intake values for plutonium are summarized in table 6 (page 16) of the white paper for this period. These intake values were derived by using the clerical rate of 5 percent of the intake values listed in table 8 (page 13) and table 9 (page 14) of NIOSH's white paper, "Internal Dosimetry Coworker Intake and Exposure Model for the W. R. Grace Company, Erwin, Tennessee" (NIOSH, 2019b).

2.2.6 Intake summary

Recommended annual intake values are as follows:

- Environmental uranium intakes for 1958–2011 are summarized in table 7 (page 17) of the white paper. Use clerical intakes to assign environmental uranium. Note that for 1979–2011, alpha intakes are assigned as uranium or plutonium, whichever one produces the greater dose.
- Environmental plutonium intakes for 1965–1978 are summarized in table 6 (page 16) of the white paper.
- Environmental alpha intakes for 1979–2011 are summarized in table 4 (page 14) of the white paper. Alpha intakes are assigned as uranium or plutonium, whichever one produces the greater dose. Note that the environmental (clerical) alpha intake values for 1979–2011 in table 7 (page 17) are the same as the environmental intake values as listed in table 4 (page 14) for 1979–2011.
- Plutonium intakes from plutonium facility entry for 1974–2011 are summarized in table 12 (page 19) of the white paper for any plutonium facility entry, regardless of job description. These intake values are to be used for dose reconstruction (DR) if a worker does not have plutonium bioassay data.
- If plutonium facility or bioassay plutonium intakes are assigned, then assign corresponding uranium intakes from uranium bioassay data, or table 7 (page 17) of the white paper, because the mixed oxide fuel contained both plutonium and uranium.

- Uranium bioassay data should not be used after 1970 because U.S. Department of Energy operations ended in 1970, except when:
 - The bioassay results provide for more limited intakes than the residual intakes.
 - The worker was involved with Burial Grounds remediation after 1990.

2.3 NIOSH's response to finding 7: Environmental external dose

External environmental dose was addressed on pages 20 through 25 of the white paper.

- **Environmental thermoluminescent dosimeters (TLDs)** – Table 13 (page 22) provides a summary of the annual external doses based on environmental TLDs for the period 1979–1995.
- **Dose rates from Burial Grounds** – Table 14 (page 24) provides a summary of the annual dose rates from the Burial Grounds for the period 1958–2011.
- **Bounding environmental external doses** – Table 15 (page 25) provides a summary of the site environmental and Burial Grounds annual dose rates for the period 1958–2011.

2.4 NIOSH's response to secondary finding D: Methods used to derive external doses not provided

This finding was related to the fact that the methods used to derive the external doses in table 5-5 (page 36) of the TBD were not provided in the TBD. The white paper concurs and indicates that because of the revisions that have occurred in calculating residual beta doses since the TBD was issued, the values have changed and are summarized in table 16 (page 27) of the white paper.

3 SC&A's Evaluation of the White Paper

The following is a summary of SC&A's evaluation of the white paper.

3.1 Evaluation of NIOSH's response to finding 2: Uranium intakes

- **AWE operational period intakes (1958–1970)** – During the meeting on August 3, 2015, of the Advisory Board on Radiation and Worker Health work group (WG) on uranium refining AWEs (AWE WG, 2015), NIOSH provided the rationale for the default uranium intake in table 3-15 (page 26) of the TBD. The WG discussed the issue and concurred with NIOSH's approach, but, since it was a bounding approach, the WG recommended NIOSH provide further breakdown of the intakes by work categories. SC&A analyzed the derivation of NIOSH's intake values, which were summarized in section 2.1.1 of this report, in conjunction with recommendations in Battelle-TBD-6000, revision 01, "Site Profiles for Atomic Weapons Employers that Worked Uranium Metals" (NIOSH, 2011b), and concurs with the intake values listed in table 1 (page 6) of the white paper for the operational period.
- **Residual contamination period intakes (1971–March 1, 2011)** – SC&A analyzed the derivation of NIOSH's intake values, which were summarized in section 2.1.1 of this report, in conjunction with recommendations in Battelle-TBD-6000, and concurs with the intake values listed in table 2 (pages 7 and 8) of the white paper for the residual period.

SC&A concurs with the methods used and the derived intake values in this section of the white paper.

3.2 Evaluation of NIOSH's response to finding 7: Environmental internal intake

Environmental internal intakes were addressed on pages 8 through 20 of the white paper. SC&A analyzed the data that were used to derive the recommended annual environmental intakes for the various time intervals during the period 1958–2011. The following is a summary of the results of SC&A's evaluation.

- **Environmental air monitoring data (1979–2011)** – SC&A analyzed the data used to derive the annual average perimeter gross alpha concentrations in table 3 (page 13) for the period 1979–1995 and the conversion to the recommended environmental alpha intake rates (dpm/d) in table 4 (page 14) for the period 1979–2011. SC&A concurs with the methods used and the derived intake values recommended in this section of the white paper.
- **Environmental uranium intakes (1958–1970)** – SC&A analyzed the method and data used to derive the annual operational-period clerical inhalation intake of 95 dpm/d, as listed in table 1 (page 6) for the period 1958–1970. SC&A concurs with the results.
- **Environmental uranium intakes (1971–1978)** – SC&A performed an exponential decrease of the 1970 operational-period clerical intake (95 dpm/d) down to the 1979 environmental intake of 2.31 dpm/d. The results of the calculations and intake values were the same as those summarized in table 5 (page 15) for 1971–1978. SC&A concurs with the methods used and the derived intake values in this section of the white paper.
- **Environmental plutonium intakes (1965–1978)** – SC&A verified that the recommended annual environmental intake values for plutonium, as listed in table 6 (page 16) for this period, were derived by using the clerical rate of 5 percent of the intake values listed in table 8 (page 13) and table 9 (page 13) of NIOSH (2019b). SC&A has previously reviewed that white paper (SC&A, 2019) and concurs with the results.

While SC&A concurs with the methods used and the values derived for environmental internal intakes in NIOSH's response to finding 7, SC&A did have the following observation:

Observation 1. Organized and concise recommendations to DR needed

SC&A found the "Intake Summary" section in the white paper (pages 16–20) lacked organization and concise recommendations for the dose reconstructor's use. This is especially apparent in the "Environmental Intakes" and "Dose Reconstruction Notes" subsections on pages 19 and 20 of the white paper. This lack of organization could result in errors and inconsistencies in DR by different dose reconstructors.

3.3 Evaluation of NIOSH's response to finding 7: Environmental external dose

Environmental external dose was addressed on pages 20 through 25 of the white paper. SC&A analyzed the environmental TLD and Burial Grounds information and concurs with the methods used and the derived dose values in this section of the white paper and the annual dose rate values listed for the general environment and for the Burial Grounds in table 15 (page 25).

3.4 Evaluation of NIOSH's response to secondary finding D: Methods used to derive external doses not provided

SC&A verified the revised calculations for beta dose on page 26 and the entries in table 16 (page 27) of the white paper, using the updated methods to calculate the annual beta doses from residual contamination as recommended in Battelle-TBD-6000. SC&A concurs with the methods used and the derived dose values in this section of the white paper.

4 Summary and Conclusions

SC&A's review of the white paper found that NIOSH's response and recommendations concerning finding 2 (uranium intakes) and finding 7 (environmental intakes and external doses) were reasonable and technically verifiable. SC&A found that the four issues listed under finding 7 (on pages 8 and 9 of the white paper) were encompassed and satisfactorily responded to in the contents of the white paper. SC&A had no finding in this review. However, S&A did have the following observation:

Observation 1. Organized and concise recommendations to DR needed

SC&A found the "Intake Summary" section in the white paper (pages 16–20) lacked organization and concise recommendations for the dose reconstructor's use. This is especially apparent in the "Environmental Intakes" and "Dose Reconstruction Notes" subsections on pages 19 and 20 of the white paper. This lack of organization could result in errors and inconsistencies in DR by different dose reconstructors.

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