



## MEMO

TO: Procedures Review Subcommittee  
FROM: John Mauro, SC&A  
DATE: January 7, 2014  
SUBJECT: SC&A Position Regarding Skin Exposures Associated with the Direct Deposition of Fine Particles and Flakes of Uranium Oxide onto Skin and Clothing

---

A skin exposure scenario that has been a concern of SC&A for many site profiles and dose reconstruction reviews, and discussed at numerous work group and Subcommittee meetings, is the direct deposition of fine particles of dust and large flakes of airborne uranium oxide on bare skin and clothing. Many AWE facilities, especially those that machine, roll, extrude, grind, or otherwise handle uranium, are known to generate large quantities of airborne uranium dust. Many DOE facilities, such as Fernald and Hanford, have also machined uranium and generated large quantities of dust. A description of the types of activities that have generated large quantities of dust is provided in TBD-6000 (Battelle 2011).

SC&A has reviewed many site profiles, dose reconstructions, and NIOSH procedures where a full range of exposure scenarios are evaluated in depth. However, we have found that exposures associated with the direct deposition of uranium oxide dust and/or flakes onto skin and clothing have not been addressed. This SC&A issue was discussed to some extent at the May 21, 2013, meeting of the Dose Reconstruction (DR) Subcommittee; the Subcommittee recommended that the subject be transferred to the Procedures Review Subcommittee as a generic issue.

Subsequent to the May 21<sup>st</sup> DR Subcommittee meeting, and at the request of SC&A, our Project Officer authorized SC&A to prepare a report presenting SC&A's understanding and position regarding this matter. SC&A presents its position in a report titled, "Discussion Points Regarding Reconstructing Localized Skin Dose Associated with Direct Deposition of Uranium Oxide and Flakes on Skin" (SC&A 2013). This report was subsequently discussed at the July 18, 2013, meeting of the Procedures Review Subcommittee. This memo presents SC&A's understanding of the current status of the issues identified in SC&A 2013 and discussed at the July 18<sup>th</sup> meeting of the Procedures Review Subcommittee. SC&A's recommendations and our understanding of action items that emerged from the July 18<sup>th</sup> meeting are in bold in this memo.

The issues addressed in our report and the two Subcommittee meetings can be conveniently discussed from two perspectives. The first is the chronic direct deposition of fine dust particles directly onto skin and clothing, and the second is the deposition of large visible flakes directly onto skin and clothing.

### Fine Particles

SC&A (2013) presents our concerns regarding exposure to fine particles. As indicated in that report, we agreed with the basic approach adopted by NIOSH, but recommended that NIOSH consider exposure to bare skin and also to skin beneath clothing, and we suggested a method for addressing "attenuated" beta exposures due to the presence of clothing. Our position on this

matter remains unchanged. **SC&A believes that NIOSH concurs with this position, but recommends that this issue remain in abeyance until NIOSH makes appropriate revisions to its procedures related to skin exposures.**

SC&A questions NIOSH's position regarding the limited exposure duration (i.e., 8 hours per working day in a potentially dusty environment) on the premise that (1) the worker showers immediately at the end of each workday along with a change out of **clean clothing**, and (2) contaminated work clothing is successfully washed/decontaminated prior to reuse. This issue was discussed at the July 18<sup>th</sup> meeting of the Procedures Review Subcommittee, and it was acknowledged that acceptable protocols for workers in such environments have been to (1) require protective clothing (i.e., anti-Cs), (2) monitor for contamination, and (3) when contamination is detected, subject the individual to a formal/supervised decontamination protocol. As cautioned during the July 18<sup>th</sup> meeting, even under these protocols, a successful, complete decontamination is frequently not achievable. In addition, during the early years of AWE activities, such protocols may not have been in place, and if they were, they were not always followed. In all likelihood, during the early days of AWE operations, uranium dust was probably considered more of a nuisance than a potential source of radiation exposure. As such, after working with uranium, worker cleanup processes and activities may not have differed substantially from those performed after working with non-radiological materials, such as steel. In light of these discussions, SC&A believes that this issue would benefit from additional inquiry regarding earlier work practices, personnel contamination controls, and the ability to remove uranium contamination from skin and clothing.

This issue was explored to some degree during the July 18<sup>th</sup> meeting, in that NIOSH representatives with actual experience at uranium facilities, such as Fernald, found that uranium was not difficult to remove from skin and clothing. In addition, NIOSH representatives pointed out that the types of radionuclides and the conditions of exposures where it was difficult to remove contamination, such as the exposures that were experienced by the Marshall Islanders, were quite different than the exposures experienced at uranium facilities. **SC&A recommends that NIOSH provide some documentation of this experience with respect to uranium decontamination of skin and clothing so that this issue can be closed.**

During our discussion at the July 18<sup>th</sup> meeting, NIOSH pointed out that NIOSH has, in fact, accounted for skin exposures associated with contaminated clothing by referring to the methods used to reconstruct doses at the Bethlehem Steel facility. NIOSH pointed out that there was documentation that workers' clothing at Bethlehem Steel was often contaminated with difficult-to-remove uranium contamination, and that the dose reconstructions have taken this exposure pathway into consideration. Based on this discussion, it appears that NIOSH is prepared to take this exposure scenario into consideration on a case-by-case basis. In light of this, **SC&A recommends that this issue remain open until NIOSH completes its investigations into this matter [as indicated on page 57 of the July 18<sup>th</sup> transcript (ABRWH 2013b)] and appropriately revises its procedures to address this issue.**

As part of our review of NIOSH's position, we independently checked the dose conversion factor (DCF) employed by NIOSH for deriving dose to skin from the direct deposition of uranium dust onto skin (i.e., *40 mrem per 10,000 dpm/cm<sup>2</sup> per hour*) and concur with this value.

Section 6 of SC&A 2013 also raises questions regarding partial exposures of the body from direct deposition and the statistical distribution of the dose over the entire body, as described in ORAUT-OTIB-0017 (ORAUT 2005). We agree with this approach as long as the input to IREP is an estimate of the exposure to the skin of the entire body, taking into consideration exposure to bare skin and also skin covered by clothing. Our original concern regarding partial body exposure was that we believed, since the risk coefficients imbedded in IREP are for uniform exposure of the skin of the entire body, and the baseline risk of skin cancer is for the entire body, that the input doses for skin exposure should also be an expression of the whole exposure of the skin of the entire body. We now understand that this is, in fact, the approach that NIOSH plans to use, including doses beneath clothing. Given this understanding, our concerns with respect to this matter have been resolved. However, **we recommend holding this issue in abeyance until NIOSH issues a revision to its procedures confirming our understanding of the protocols NIOSH plans to use, especially with respect to skin exposures beneath clothing.**

Before leaving this subject, it should be pointed out that there was an interesting discussion of partial skin exposures beginning on page 56 and extending to page 76 of the July 18, 2013, meeting transcript (ABRWH 2013b). It was generally agreed that this whole matter of partial skin exposure and the IREP baseline risk deserves a little more attention and may, in fact, be beyond our current knowledge regarding risks associated with partial body skin exposures. **SC&A recommends that this subject be addressed as an overarching issue, but should not hold up dose reconstructions, since OTIB-0017 (ORAUT 2005) currently provides for partial skin exposures.**

#### Large Uranium Oxide Flakes

It has been SC&A's position that machining of uranium metal can produce flakes/particles (in the range of 1 to several mm in diameter) of uranium oxide that may deposit unnoticed onto skin and clothing. This position emerged as a result of our review of many site profiles, beginning with our review of the Bethlehem Steel site profile. Based on extensive previous work, we believe that NIOSH would agree that the dose rate to the skin beneath such flakes depends on the size of the flakes, but can be as high as 240 mrem/hr.

Discussion during the May 21, 2013, meeting (ABRWH 2013a) revealed differences of opinion among the Board members regarding the plausibility of such exposures. Some Board members felt that large/mm-size flakes/particles were not necessarily produced because of the oil used to prevent the oxidation and flaking of uranium during machining/grinding, and that workers wore protective clothing and were monitored when leaving work areas. Other Board members believed that, at least in the early years of AWE operations, experience with uranium machining was limited and such scenarios were plausible.

The plausibility issue was also discussed at the July 18<sup>th</sup> meeting and reference was made to the residence time of particles on skin as cited in RESRAD documentation. **SC&A believes that this issue would benefit from additional inquiry into the literature, and recommends that NIOSH provide some written documentation on this matter before the issue is closed.**

It is SC&A's position that such an exposure scenario should be considered at sites and during time periods where controls and protocols involving the machining of uranium metal were limited and there is some evidence that the machining operations could generate uranium oxide flakes. **In light of these discussions, we recommend that the issue of the plausibility of large flake exposures remain open until additional investigations by NIOSH demonstrate that such scenarios are not, in fact, plausible.**

In considering this scenario, one can envision a worker with a skin cancer but no evidence that the worker was contaminated with large flakes. Under these conditions, SC&A recommends using the protocols described in ORAUT-OTIB-0017 (ORAUT 2005), where the skin exposure under a hypothetical flake is averaged over the entire surface area of the body. If, however, the records show surface contamination of the worker is reported as an off-normal event, then the dose to the skin used as input to IREP should not be averaged over the entire surface area of the body; the input to IREP should be based on the exposure rate to the skin under the flake (which could be as high as 240 mrem/hr) and an 8-hour time period of exposure for each incident identified in the worker's records. We believe that this strategy in dealing with exposure to large flakes of uranium oxide is consistent with the approach that NIOSH plans to use when such exposure scenarios arise for individual cases. **If NIOSH concurs with this basic strategy for addressing skin exposures to particles/flakes of uranium, we recommend that this issue be closed or placed in abeyance.**

#### REFERENCES:

ABRWH 2013a. Transcript of the Advisory Board on Radiation and Worker Health, Subcommittee on Dose Reconstruction, Tuesday, May, 21, 2013, convened at 9:00 am in Hebron, Kentucky. ABRWH, National Institute for Occupational Safety and Health, Cincinnati, Ohio. May 21, 2013.

ABRWH 2013b. Transcript of the Advisory Board on Radiation and Worker Health, Subcommittee on Procedures Review, Thursday, July 18, 2013, convened at 8:30 am in Idaho Falls, Idaho. ABRWH, National Institute for Occupational Safety and Health, Cincinnati, Ohio. July 18, 2013.

Battelle 2011. *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*. Battelle-TBD-6000. Rev. 01. National Institute for Occupational Safety and Health (NIOSH); Cincinnati, Ohio; Division of Compensation Analysis and Support (DCAS); effective June 17, 2011; SRDB Ref ID: 101251.

ORAUT 2005. *Interpretation of Dosimetry Data for Assignment of Shallow Dose*, ORAUT-OTIB-0017, Rev. 01. Oak Ridge Associated Universities Team, Cincinnati, Ohio. October 11, 2005.

SC&A 2013. "Discussion Points Regarding Reconstructing Localized Skin Dose Associated with Direct Deposition of Uranium Oxide Dust and Flakes on Exposed Skin," Rev. 0. SC&A, Inc., Vienna, Virginia. June 12, 2013.