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**ADVISORY BOARD ON  
RADIATION AND WORKER HEALTH**

*National Institute for Occupational Safety and Health*

**SC&A's Review of the NIOSH Document Issued July 29, 2015,  
Titled, *NIOSH Response to SC&A Review of the Ames Site Profile  
Document Regarding Uranium Internal Exposure***

**Contract No. 211-2014-58081  
Revision 0**

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**S. COHEN & ASSOCIATES:** *Technical Support for the Advisory Board on Radiation & Worker Health Review of NIOSH Dose Reconstruction Program*

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## ABBREVIATIONS AND ACRONYMS

Advisory Board	Advisory Board on Radiation and Worker Health
AEC	Atomic Energy Commission
ALRR	Ames Laboratory Research Reactor
ERDA	Energy Research and Development Administration
FMPC	Feed Materials Production Center
GSD	geometric standard deviation
m	meter
m <sup>3</sup> /d	cubic meter per day
NIOSH	National Institute for Occupational Safety and Health
ORAUT	Oak Ridge Associated Universities Team
pCi/d	picocuries per day
R&D	Research and Development
Th	thorium
SC&A	S. Cohen and Associates (SC&A, Inc.)
SEC	Special Exposure Cohort
SRDB	site research database
TBD	Technical Basis Document
U	uranium

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## **1.0 CHRONOLOGY AND SUMMARY OF RELEVANT BACKGROUND INFORMATION PERTAINING TO THE AMES SITE PROFILE, ORAUT-TKBS-0055, REV. 03**

Revisions to the Ames Site Profile. The first Site Profile for Ames Laboratory, ORAUT-TKBS-0055, Rev. 00 (ORAUT 2007) was issued on June 22, 2007. Since then, the Ames Site Profile has been revised four times: Rev. 00 PC-1 on August 20, 2008 (ORAUT 2008); Rev. 01 on December 18, 2009 (ORAUT 2009); Rev. 02 on January 14, 2011 (ORAUT 2011); and Rev. 03 on January 3, 2012 (ORAUT 2012a).

While some of the aforementioned revisions resulted in an increase in assigned dose, others decreased the dose, and still others decreased in an earlier revision and increased in a subsequent revision, as summarized below:

Special Exposure Cohort (SEC) Classes Added. During this time period, NIOSH added classes to SEC-00038 in 2006 (NIOSH 2006), SEC-00075 in 2007 (NIOSH 2007), and SEC-00166 in 2010 (NIOSH 2010) to cover three separate groups of employees based on work location and job description. While the classes added in 2006 and 2007 included specific workers performing specific tasks in designated buildings, the 2010 class determined that the information available about worker job description, work location, or movement about the site was insufficient to determine if an employee worked in the affected area(s).

In 2011, NIOSH designated a fourth class [SEC-00185 (NIOSH 2011)] that encompasses all previous Ames SEC periods from August 13, 1942, to December 31, 1970, and designates all Ames employees (including predecessor agencies, contractors, and subcontractors) who were employed for a number of workdays aggregating at least 250 workdays.

In behalf of these four SEC classes, NIOSH in Rev. 03 of ORAUT-TKBS-0055 (ORAUT 2012a) provided the following statements and guidance for the dose reconstruction of Ames workers who were employed after December 31, 1970, as well as for workers who were employed prior to 1970, but who are not eligible for inclusion in SEC-00185:

*Although NIOSH cannot bound doses for certain areas and periods as described in the SECs, internal and external data that become available for an individual claim (and that can be interpreted using existing NIOSH dose reconstruction processes or procedures) and applicable dose reconstruction methods that are defined in Sections 4, 5, and 6 of this site profile, will be used to complete partial dose reconstructions for workers who worked during the SEC periods but are not eligible for the SEC. [Emphasis added.]*

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## 2.0 SC&A'S REVIEW OF ORAUT-TKBS-0055, REV. 03

In a teleconference held by the Advisory Board on February 7, 2013, SC&A was tasked to review/evaluate the Site Profile for Ames Laboratory, ORAUT-TKBS-0055, Rev. 03 (ORAUT 2012a), which was issued on January 3, 2012. On August 14, 2013, SC&A submitted to the Advisory Board the draft document, *Review of the NIOSH Site Profile for the Ames Laboratory*, SCA-TR-SP2013-0044, Rev. 0 (SC&A 2013).

The purpose of this review was to provide NIOSH and the Advisory Board with an independent assessment of issues that surround the Ames Site Profile in behalf of energy employees with non-presumptive cancers and/or fewer than 250 workdays. Findings identified in SC&A's review provided NIOSH and the Advisory Board with a **preliminary** overview of potential issues that may impact the feasibility of dose assessment.

SC&A's review of ORAUT-TKBS-0055, Rev. 03 (ORAUT 2012a) principally focused on the following three sections of the Ames Laboratory Site Profile:

- Section 4.0 – Occupational Environmental Dose
- Section 5.0 – Occupational Internal Dose
- Section 6.0 – Occupational External Dose

Of the 22 preliminary findings identified by SC&A, 9 findings pertained to Occupational Environmental Dose, 11 to Occupational Internal Dose, and 2 to Occupational External Dose. These findings are briefly summarized in Sections 2.1, 2.2, and 2.3 below.

### 2.1 OCCUPATIONAL ENVIRONMENTAL DOSE

**Finding #1:** Derived environmental intakes of U and Th, as given in Table 4-7 of the Technical Basis Document (TBD), are improperly referenced and appear without technical basis.

**Finding #2:** NIOSH provides no basis for the “**assumed**” losses of 0.1% of U and Th to the environment and fails to identify a value for resuspension.

**Finding #3:** NIOSH's selection of personnel at the Ames Laboratory Research Reactor (ALRR) Facility as the target population is inappropriate and results in dose estimates that are not claimant favorable.

**Finding #4:** NIOSH's selection of data from the 1961 survey conducted at the Synchrotron Facility defines fenceline dose rates that are 1 to 2 orders of magnitude lower than other measurements reported in the survey when beam direction was shifted from a **westerly** to **easterly** direction.

**Finding #5:** SC&A concludes that the 1961 survey measurements, which were limited to gamma dose rates, were incomplete and may have substantially underestimated total exposure by excluding the contribution of particulate radiation.

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**Finding #6:** Statements in Section 4.3 of the Ames Site Profile are factually incorrect. For all years for which Voss reported environmental sampling data (1974, 1975, 1976), there were two sampling sites (not one, as stated by NIOSH) that provided data in behalf of air concentrations and corresponding dose estimates.

**Finding #7:** The nearly “instantaneous” 100-fold reduction of U and Th environmental intakes that represent the transition of the uranium and thorium metal production facilities at the end of 1953 to research and development (R&D) facilities in 1954 are improperly modeled. Also not included in the model are the contribution of blowouts to environmental contamination and the persistence of these radionuclides in the environment post-1953.

**Finding #8:** Environmental intakes cited in Table 4-7 of the Ames TBD are based on unsupported assumptions and model parameters, which moreover are inconsistent with parameter values used to model worker intakes inside the hot laboratory described in Section 5.0 of the TBD.

**Finding #9:** Uranium and Th blowouts represent significant environmental events that should be included in Section 4.5 of the Ames TBD for the assessment of environmental exposures.

## 2.2 OCCUPATIONAL INTERNAL DOSE

**Finding #10:** Available empirical bioassay and air-sampling data for Annex 1 workers are substantially higher than modeled/surrogate data assigned by NIOSH.

**Finding #11:** NIOSH further minimized the intake value of 853 pCi/d for Annex 1 production workers by assigning the “distribution” as a constant.

**Finding #12:** Default intake rates defined in Table 5-8 of the Ames TBD are improper for absorption Types F or S.

**Finding #13:** The scaling of uranium intake values based on (1) facility and (2) job function is without technical support and conflicts with statements given in the Ames Site Profile.

**Finding #14:** Although NIOSH briefly acknowledged the occurrence of “frequent fires and explosions” associated with the production of uranium metal, no attempt was made to assess potential intakes of these episodic events.

**Finding #15:** *Technical Basis for Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities*, ORAUT-OTIB-0004, Rev. 03 (ORAUT 2006) is referenced for estimating non-operational intakes. OTIB-0004 was canceled before Rev. 03 of the Ames Site Profile (ORAUT 2012a) was issued. Moreover, the much higher intake values for inhalation and ingestion during non-operating years (i.e., 1954–1976) are inconsistent with intake values for operating years (1942–1953) as given in Table 5-8 of the Ames TBD.

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**Finding #16:** NIOSH’s approach for deriving estimates of thorium intakes from residual contamination post-1954 does not make the best use of survey data reported by Klevin (1952) and use of ORAUT-OTIB-0070, Rev. 01 (ORAUT 2012b).

**Finding #17:** Given the availability of credible data, NIOSH’s exclusion of thorium exposure in dose reconstruction is not justified.

**Finding #18:** Due to the fact that very little is known about the design features and technical specifications of the Hot Lab and the absence of worker monitoring/facility survey data, the applicability of NUREG-1400 (Hickey et al. 1993), Section 1.2, for use in dose reconstruction lacks technical merit and credibility for a facility that operated between 1943 and 1951.

**Finding #19:** Although Section 5.4.2 of the Ames TBD is titled, “Fission Product Intakes from Research Reactor Operations and Decontamination and Decommissioning,” NIOSH restricted intakes to two activation products that are arbitrarily based on a 1977 Energy Research and Development Administration (ERDA) gross beta air concentration limit.

### 2.3 OCCUPATIONAL EXTERNAL DOSE

**Finding #20:** By means of documented anecdotes/testimonials regarding potential frequencies of blowouts, technical data for a specific blowout documented at Feed Materials Production Center (FMPC), and reasonable assumptions, SC&A derived significant U and Th intakes and associated organ doses that are applicable to workers at the Ames Laboratory, but were not considered/included in ORAUT-TKBS-0055, Rev. 03 (ORAUT 2012a).

**Finding #21:** SC&A’s concerns about the use of the same surrogate data sources and questionable assumptions for deriving external dose for Ames’ workers exposed to uranium closely parallel those related to uranium intakes as cited in Findings #10 and #13.

**Findings #22:** Given the availability of highly credible and site-specific data for deriving external doses from thorium exposure, NIOSH’s decision to exclude said exposures/doses is not justified.

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### 3.0 NIOSH'S RESPONSE TO THE SC&A REVIEW OF THE AMES SITE PROFILE

In response to SC&A's review of ORAUT-TKBS-0055, Rev. 03 (ORAUT 2012a), NIOSH issued a report titled *NIOSH Response to SC&A Review of the Ames Site Profile Document Regarding Uranium Internal Exposures*, Rev. 0, dated July 29, 2015 (NIOSH 2015). This report addressed 11 of the 22 findings cited above (i.e., Findings #1, #2, #7, #9, #10, #11, #12, #13, #14, #15, and #20). A shared feature of these findings is that they pertain either exclusively or in part to **uranium** intakes. In Section 2.0 of the response, NIOSH provided the following summary statements and conclusions:

*The **current** Site Profile for Ames Laboratory (ORAUT 2012a), or Technical Basis Document (TBD), provides intake rates of uranium for different job categories from the three buildings previously used to process uranium. The TBD also provides environmental uranium intakes. The various uranium intakes in the TBD are based on surrogate air sampling data from other facilities and exposure models. [Emphasis added.]*

*. . . NIOSH has reviewed [SC&A's] comments, the TBD methods, and available references and agrees that the uranium intakes in the TBD need to be re[-]evaluated.*

*In this paper, NIOSH proposes to replace the uranium intakes in the TBD with intakes derived from bioassay data from 1944 and 1945 of workers engaged in uranium production, which includes some of the peak uranium production months at Ames during World War II. This is the bioassay data discussed in the **SC&A report**. Intakes in subsequent years are then derived from the production era intake rates. **None of the current methods** used to model intakes in the TBD, and to which SC&A had comments, are being retained in the proposed changes. Thus, this paper does not attempt to respond to each technical issue identified by SC&A, **although Section 3.2 identifies the method being proposed to resolve each finding**. [Emphasis added.]*

In brief, Section 3.2 of the NIOSH Report (NIOSH 2015) identifies each of SC&A's 11 findings listed above (i.e., Findings #1, #2, #7, #9, #10, #11, #12, #13, #14, #15, and #20) and categorizes them based on commonalities that permit their collective resolution. For example, SC&A's Findings #1, #2, #7, and #9 pertain to current dose models used to derive uranium intakes from **environmental sources**. To resolve these findings, NIOSH proposes the following:

*. . . This paper addresses those comments by proposing a new method to calculate intakes. The uranium intakes presented herein include a "Low" exposure category based on bioassay data from workers who were incidentally exposed to uranium during the production years, as discussed below. **This method should account for environmental intakes from all sources, including blowouts**. Additionally, methods are presented to estimate intakes from a gradually depleted source term after the end of uranium production. [Emphasis added.]*

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### 3.1 NIOSH'S PROPOSED REVISIONS FOR URANIUM INTAKES

Production Years/Demolition. In Section 5.0 of the report, NIOSH evaluated 67 uranium urinalysis samples representing 48 workers who were ranked by their supervisors into 4 exposure categories. NIOSH re-evaluated these data and derived uranium intake estimates during production years for High, Medium, and Low exposure categories of workers, as given in Tables 2, 3, and 4 of Section 5.4.

Residual Contamination. After 1953, Section 5.5 of the NIOSH Report modeled internal exposure potential to uranium by deriving the air concentration level that represented the 50<sup>th</sup> percentile inhalation intake rate during the operational period. By assigning a 30-day period of settling, a starting surface contamination was defined, which by means of a resuspension factor of  $1 \times 10^{-5}/m$  and a breathing rate of  $9.6 \text{ m}^3/d$  was used to define the daily inhalation rate for 1953. For subsequent years, a depletion rate of 0.00067 per day was applied, as given in Table 5.

Table 6 identifies daily intakes by ingestion by year, which are based on guidance cited in OCAS-TIB-009 (OCAS 2004), the derived starting surface contamination in 1953, and the previously identified deletion rate of 0.00067 per day.

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#### 4.0 DISCUSSION OF AND RESPONSE TO REVISED URANIUM INTAKES FOR AMES LABORATORY PROPOSED BY NIOSH

SC&A's assessment of proposed revisions reflects a multi-step process. At the core of revisions proposed by NIOSH was the use of empirical, site-specific urinalysis data reported by Ferretti, et al. 1951, which was a principal SC&A recommendation, as summarized in Section 2.1 above in Finding #10.

From this data set, NIOSH derived intake estimates (1) for operational/material processing years and (2) from exposures due to residual contamination for the years post-1953.

For **operational years**, NIOSH derived intakes for the following worker categories:

- High (95<sup>th</sup> percentile intakes): for individuals who operated process equipment and maintenance/laboratory/health physics workers
- Medium (50<sup>th</sup> percentile intakes with GSD of 3): for supervisory staff, engineers, and others who were routinely in production areas and may have episodically been in the vicinity of processing areas.
- Low: for individuals that include office workers or **non-uranium** workers whose exposure may have been highly restricted and/or limited to **onsite ambient/environmental** levels.

For subsequent years, inhalation and ingestion intakes from residual contamination were based on the air concentration (corresponding to the 50<sup>th</sup> percentile intake value during the period of uranium processing) and subsequently modeled by means of assumed parameter values of particle deposition, resuspension, and inhalation rates as previously described.

Included in our evaluation of NIOSH's revised approach for deriving uranium intakes, SC&A assessed the following elements:

- NIOSH's interpretation of the uranium urinalysis data used for deriving intake/inhalation values in terms of their technical merit and claimant favorability
- Use of established/approved guidance documents and protocols for the revised estimates of uranium intakes
- Assumptions and parameter values used for modeling exposures to residual contamination
- Verification of revised intake values cited in Tables 2, 3, 4, 5, and 6 of the NIOSH report (NIOSH 2015).

Based on our review of the proposed revisions to **uranium intakes** for the Ames Site Profile, SC&A agrees with the revised methodology used by NIOSH. SC&A further concludes that the revised estimates of uranium intakes are technically defensible, claimant favorable, and

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adequately address SC&A's concerns cited in Findings #1, #2, #7, #9, #10, #11, #12, #13, #14, #15, and #20.

Correspondingly, it is SC&A's recommendation to the Board that said findings be closed.

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