Draft Report
For the Weldon Spring Site Work Group

SC&A'S EVALUATION OF NIOSH'S JULY 1, 2011, RESPONSE CONCERNING RECYCLED URANIUM (SEC ISSUE #5) AT WELDON SPRING

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August 2011

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S. COHEN & ASSOCIATES: ***Technical Support for the Advisory Board on Radiation & Worker Health Review of NIOSH Dose Reconstruction Program***	Document No.: SC&A Evaluation of NIOSH SEC Issue #5 Response Effective Date: Draft – August 3, 2011 Revision No. 0 (Draft)
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Task Manager: _____ Date:_____ Joseph Fitzgerald	Supersedes: N/A
Project Manager: _____ Date:_____ John Mauro, PhD, CHP	Peer Reviewer(s): Joseph Fitzgerald

Record of Revisions

Revision Number	Effective Date	Description of Revision
0 (Draft)	08/03/2011	Initial issue

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1. INTRODUCTION

NIOSH's Response of 7/01/2011

NIOSH provided a response to the Weldon Spring Site (WSS) SEC Issue #5 (SC&A 2010) and site profile Issue #4 (SC&A 2009) in an e-mail of July 1, 2011, by Mark Rolfes (NIOSH 2011) that contained an attachment titled, *NIOSH response on WSP Recycled Uranium issues 06-07-2011.docx*.

Below is a summary of the original recycled uranium (RU) issue; NIOSH's response of July 1, 2011; and SC&A's evaluation of NIOSH's response.

2. SC&A'S RU SEC ISSUE

The following is a breakdown of SC&A's original RU issue:

A. RU received in 1961 – SC&A found that the year the dose reconstructor is to start assigning all RU doses from the uranium analysis is not consistent within the different Technical Base Documents (TBD) and the SEC Evaluation Report (ER). If materials potentially containing RU started to be processed in 1961 at the WSS, then the dates should be consistently stated as "prior to 1961" and "1961 and after," not "after 1961" or "after 1962." Additionally, it has not been verified that the WSS did not receive RU before 1961.

B. Application of 100 ppb Pu/U – SC&A found that ORAUT-TKBS-0028-5 (ORAUT 2005), page 15, recommends that 100 ppb Pu-239, 3,500 ppb Np-237, and 9,000 ppb Tc-99 be added to the intake, based on the uranium intake value. SC&A deciphered the contents of Fernald ORAUT-TKBS-0017-5 (ORAUT 2005), Table 5-11, conversion factors as follows:

#pCi Pu-239 = (100 ppb-Pu/U) × (62.89 pCi-Pu/gm-U per 1 ppb-Pu/U) × (#gm-U in bioassay)

Where: 1 ppb-Pu/U = (1E-9 gm-Pu/gm-U) × (6.21E-2 Ci-Pu/gm-Pu) × (1E12 pCi/Ci)
$\simeq$ 62.89 pCi-Pu/gm-U (*6.21E-2 Ci-Pu/gm-Pu is the specific activity of Pu-239*).

This is not made very clear in ORAUT-TKBS-0028-5 (ORAUT 2005), page 15, or ORAUT-TKBS-0017-5 (ORAUT 2004), page 17, but is applicable if used correctly. The same analysis applies to Np-257 and Tc-99.

However, SC&A's review of WSS claims indicates that this method was correctly applied in only one of the full dose reconstruction (DR) best-estimate cases that SC&A analyzed. While in several of the DR cases where the probability of causation was <50% and a full DR should have been performed and the EE worked during the 1961–1966 time period, no internal intakes from RU were assigned. This is technically a DR issue and not an SEC issue, but the oversight during DR may have resulted from the lack of clarity in ORAUT-TKBS-0028-5 (ORAUT 2005).

C. Differences in TBD and ER and adequacy of 100 ppb Pu/U – Table 5-6, page 27, of the NIOSH ER (NIOSH 2010) lists values not found elsewhere in the documents quoted above; hence, there does not appear to be consistency between the ER and the TBDs. It is not obvious how the values listed in Table 5-6 of the ER were derived from DOE 2000, why they are lower than the recommended values found in the WSS TBD, and how they are to be applied in the DR process. The reference provided in the ER was DOE 2000, page 1,140; however, there is no indication in the ER how the data in Table 1 on page 1,140 and the following pages, generated the values listed in Table 5-6 of the ER. SC&A found that a 1964 WSS document (MCW 1964) provided some qualitative analyses of alpha and gamma activities and energy spectra, and comparative external exposure rates of two feed materials sampled in 1964. However, this does not provide quantitative values of Pu-239, Np-237, and Tc-99 by which to derive ppb-U values to compare to the Fernald values, or the values recommended in the ER.

D. Reliability of Documents – Even if the greater concentration values of 100 ppb Pu-239, 3,500 ppb Np-237, and 9,000 ppb Tc-99 are used, it has not been documented that these values are necessarily correct or bounding. SC&A reviewed the source of these concentration values, which is a document entitled, *DOE Ohio Field Office Recycled Uranium Project Report* (DOE 2000), as referenced in the ER. However, this document does not provide defined sources for its recommended values of the radionuclide concentrations; therefore, these concentration values appear to be estimates or assumptions, rather than measured values. Because both the WSS TBD and the ER base the RU composition and throughput at the WSS on Fernald RU data, then the Fernald issues are relevant to the WSS issues and, as SC&A has pointed out in their review of the Fernald SEC (SC&A 2007), there are contradictions within the Fernald TBDs, the DOE 2000 document, and the DOE 2003 document; hence, "it is likely that the DOE 2000, which is the basis for the data on RU, is incorrect even for the basic value relating to uranium receipts at Fernald" (SC&A 2007, page 35).

3. SC&A'S SUMMARY OF NIOSH'S JULY 1, 2011, RESPONSE

NIOSH provides a brief history of the RU contaminates at Atomic Energy Commission (AEC)/ Energy Research and Development Administration (ERDA)/Department of Energy (DOE) facilities from 1944–2000. One of the important dates is listed in the table on page 4 as *2/15/61* when the first RU was introduced in the process at Fernald (SC&A verified this information in DOE 2000 and noted that the correct reference for 1961 on page 4 of NIOSH's report (NIOSH 2011) should be 4, not *5*. Therefore, according to this document, the WSS could not have received RU before February 15, 1961, from Fernald.

NIOSH explains that the original value of 100 ppb Pu/U was the dose reconstruction default value selected for Fernald and represented the highest value listed in Appendix F-1, Table F.3-1, page 1,099, of DOE 2000 (with the exception of the tower ash and decontamination residue), which did not represent a long-term exposure pathway). Later analyses of the WSS RU issue for the ER indicated that Subgroup (SG) 6A was more representative of the WSS operations; therefore, the values associated with SG-6A were recommended in the ER. NIOSH states that the 1970s and 1980s value of 400 ppb Pu/U at Fernald would not be applicable to the WSS operations.

NIOSH goes on to provide some details concerning the industry limits and guides instituted at AEC/ERDA/DOE facilities over time, which was generally <10 ppb Pu/U, especially during the WSS operational period. NIOSH provides Table 2 on page 7 of NIOSH 2011 that summarized the SG-6A and ORAUT-TKBS-0028-5 concentration values for Pu, Np, and Tc.

In conclusion, NIOSH recommends that the original 100 ppb Pu/U, 3,500 ppb Np/U, and 9,000 ppb Tc/U be retained, because these values have already been used in previous DR cases, and these default values will assure that no worker exposure will be underestimated.

4. SC&A'S EVALUATION OF NIOSH'S JULY 1, 2011, RESPONSE

SC&A evaluated NIOSH's response in view of the four major items contained in the original SEC Issue #5, as outlined above in Section 2.

A. RU received in 1961 – SC&A recommends that TBDs, workbooks, etc., be revised to be consistent in the wording concerning when to apply RU intakes at the WSS; i.e., "1961 and after." The documentation SC&A has reviewed to date indicates that this was the earliest date RU could have been introduced in the process stream at the WSS on a dosimetric-significant basis.

B. Application of 100 ppb Pu/U – SC&A provided a list of five WSS DR cases to NIOSH on February 2, 2011, only one of which appeared to have the correct application of 100 ppb Pu/U. It is recommended that NIOSH provide an analysis of these five cases, and other WSS cases as appropriate, to determine if the 100 ppb Pu/U and Np and Tc concentrations are being correctly applied in DR cases.

C. Differences in TBD and ER and adequacy of 100 ppb Pu/U – SC&A analyzed NIOSH's Fernald and WSS TBDs, the WSS ER recommendations, and the white paper exchanges between SC&A and NIOSH concerning concentrations of plutonium, neptunium, and technetium in RU. SC&A found that, similar to the Fernald site, the recommended values of 100 ppb Pu/U, 3,500 ppb Np/U, and 9,000 ppb Tc/U **do not** provide for adequate bounding of potential RU contaminant intakes at the WSS. The recent Fernald values should also be applied to WSS because this issue is not site-specific; rather, it depends on the refining and production processes. Because the WSS and Fernald used the same refining and production processes, the higher values proposed in NIOSH's response to SC&A's second white paper on RU at Fernald also apply to the WSS. Those values are:

400 ppb for Pu (Subgroup 8; enriched MgF_2)
11 ppm Np-237 (Subgroup 11; Waste residues)
20 ppm Tc-99 [Subgroup 6B; $U0_3$, UF_4, and Residues/Intermediates from A508 $U0_3$ (Low Cross-Over Potential)]

NIOSH's makes the statement on page 6 (NIOSH 2011) that:

> *This raises the recommended Fernald defaults to 400 ppb plutonium at Fernald. These defaults have no direct application to Weldon Spring, since the values*

> *listed are derived primarily from higher levels of the 1970s and 1980s and are outside the operational time period of Weldon Spring production operations.*

However, this statement is incorrect. The 400 ppb Pu/U is based on the upper 95th percentile of a log-normal fit to the enriched MgF_2 process subgroup data in DOE 2000 and is representative of metals production operations. As discussed extensively in SC&A's second white paper on RU (SC&A 2011) and in our presentation to the Advisory Board at the meeting in St. Louis, Missouri, on May 24, 2011, MgF_2 was known to concentrate transuranics and fission products, and was reused in crucible and reduction vessel liners. Metal production workers were exposed to the highest dust loads and highest RU contaminant concentrations at WSS and at Fernald, except for the down-blending operators at the latter site. It is critically important to note that down-blending at Fernald took place upstream of all subsequent processing steps. Thus, the concentration of RU contaminants in MgF_2 for metals production was not proportional to the levels in feedstocks, and therefore is not correlated with the receipts of highly contaminated tower and furnace ashes from the gaseous diffusion plants (GDPs) in the 1970s and 1980s. Thus, because the WSS produced uranium metal from RU feedstock in a process nearly identical to that at Fernald, the higher contaminant values (particularly 400 ppb for Pu) apply **regardless of the timeframe**.

D. Reliability of Documents – DOE 2003 did provide some clarification and addressed inconsistencies in DOE 2000 and related RU reports. According to DOE 2003, page 8:

> *Nine reports were prepared in 2000 that encompassed the years 1952 to 1999 for the principal DOE sites that either processed, shipped, or received recycled uranium. … The reports that were published in 2000 contained some inconsistencies between quantities of recycled uranium shipped and the quantities received. These inconsistencies were caused by differing site accounting methods, as well as by the operational definitions of recycled uranium used by the sites to determine the quantities of recycled uranium shipped and received.*

However, SC&A believes that if the DOE 2000 and/or DOE 2003 documents are to be used as the basis for bounding values for DR purposes, there must be an accounting of the high variability in the available data and the associated uncertainties. SC&A has provided an analysis of these documents as to their applicability to DR in a recent white paper; further details can be found in that review, especially pages 38–44 (SC&A 2011). A summary quote (page 41) and Finding #4 (page 43) from that SC&A review are as follows:

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> *Nonetheless, despite the extraordinary accomplishment of preparing* [DOE 2000] *under such challenging circumstances, it cannot serve as a reliable source of information for precise or accurate data on TRU and fission product contaminant concentrations in recycled uranium that is reliably representative of the RU shipments to Fernald, Weldon Spring and other sites. It may or may not be possible to compile more complete and representative data, but the analysts who compiled* [DOE 2000] *knew at the time that to obtain and analyze the full range of data needed to*

ensure a reasonably complete and representative characterization of the contaminant concentrations would require more time than was available in late 1999–early 2000.

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Finding #4: [DOE 2000] *is questionable as the basis for the NIOSH defaults; source data should be reviewed in the context of dose reconstruction and an SEC. The* [DOE 2000] *report for RU data is neither comprehensive nor reliably representative and rigorous in its scrutiny of data validity. Clearly the subgroups listed in Tables ES-5A, 5C and 5D are not sufficiently detailed to reflect the wide range of RU sources that would result from analysis of the permutations of processing facility, process operations, time of operation and fuel/target type. It is incumbent on NIOSH to review the source data for its adequacy in bounding worker doses in an SEC context.*

It is noteworthy that NIOSH's response to SC&A 2011 acknowledges the limitations of these documents and proposes to use the upper 95th percentiles of lognormal fits to the datasets to account for variability and uncertainty.

5. REFERENCES

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