Draft White Paper

SC&A'S EVALUATION OF THE WELDON SPRING SITE PROFILE CHANGES COMPARED TO THE ORIGINAL FINDINGS

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Record of Revisions

Revision Number	Effective Date	Description of Revision
0 (Draft)	01/09/2015	Initial issue

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ABBREVIATIONS AND ACRONYMS

Advisory Board or ABRWH	Advisory Board on Radiation and Worker Health
CER	pg. 16
CW	coworker
DR	dose reconstruction
DWE	Daily Weighted Exposure
EU	enriched uranium
gU	gram uranium
NIOSH	National Institute for Occupational Safety and Health
ORAUT	Oak Ridge Associated Universities Team
ppb	parts per billion
RU	Recycled Uranium
SC&A	S. Cohen and Associates (SC&A, Inc.)
SEC	Special Exposure Cohort
TBD	Technical Basis Document
TIB	Technical Information Bulletin
U	uranium
V/V	verified and validated
WG	Work Group
WS	Weldon Spring

1.0 INTRODUCTION

SC&A originally identified a number of site profile findings [and sequent Special Exposure Cohort (SEC)-related findings] in the Weldon Spring (WS) site profile Technical Basis Documents (TBDs). The purpose of this report is to summarize SC&A's evaluation of the recently revised WS TBDs (2013) to determine if they sufficiently reflect the resolutions to the findings, as discussed during the numerous WS Work Group (WG) meetings, and analyzed in the various white papers issued by NIOSH and SC&A. The most relevant documents to this evaluation are:

- WS site profile TBDs (ORAUT-TKBS-0028-3 through ORAUT-TKBS-0028-6) (ORAUT 2005a–d)
- SC&A's Site Profile Review (SC&A 2009)
- NIOSH's Response to SC&A Comments on Weldon Spring Profile (NIOSH 2010b)
- NIOSH's responses contained in the April 21, 2011, e-mail, with six attachments (NIOSH 2011a)
- NIOSH's responses to the recycled uranium (RU) issue (NIOSH 2011b)
- NIOSH's responses to the Blunders[1] in Daily Weighted Exposure (DWE) data (NIOSH 2011c)
- SC&A's updated matrix, reply to RU issue, and reply to NIOSH's 4/21/2011 report (SC&A 2011a)
- SC&A's Weldon Spring Work Group submission - Data Completeness Issue (SC&A 2011b).
- SC&A's response to Weldon Spring SEC Issue #6 - neutron n/p value (SC&A 2011c).
- SC&A's evaluation of NIOSH's response of September 7, 2011, to DWE Blunders[1] in Weldon Spring data (SC&A 2011d).
- The results of WS WG meetings, held October 19, 2010; January 25, 2011; May 9, 2011; September 13, 2011; November 29, 2011; February 14, 2012, and September 10, 2012.

[1] "Blunder" is a technical term used in the International Organization for Standardization's *Guide to the Expression of Uncertainty in Measurement* (ISO 1995). It refers to mistakes that are not addressed in the statistical expression of uncertainty.

2.0 RELEVANT FINDINGS

The following table summarizes the relevant findings that were addressed by the WS WG and required changes in the WS TBDs:

Table 1. Summary of Relevant Findings Requiring Changes in WS Site TBDs

Site Profile Finding	Related SEC Finding	Relevant TBDs	Item
#4	#5	4 & 5	RU
#6, 7, 8, 9	None	3	X-Ray Exams
#14	None	4	U Ratios
#15	None	4	Natural Thorium
#18	None	5	U Decay Products
#20	None	5	Solubility Types
#21	#1d	5	CW Internal Data
#25	#9	6	Exposure Geometry
#27	1d	6	CW External Data

3.0 SC&A EVALUATION OF REVISED TBDS

During the numerous WS WG meetings and exchange of white papers, many of the site profile (and SEC) findings were resolved. Some of the resolutions required changes, or clarifications, to be made in the WS site TBDs. SC&A evaluated sections of the revised (2013) TBDs to determine if they adequately reflect the changes necessary to resolve the appropriate findings. A condensed summary of the site profile findings (provided in Appendix A) and SEC findings (provided in Appendix B) as they stood for the May 9, 2011, WS WG meeting was used as a guide to determine which findings required a change, or clarification, in the WS site TBDs. This current evaluation was only a focused effort to assess if the intended revisions had been made in the TBDs; it did not include a complete re-evaluation of the WS TBDs to determine their technical accuracy or applicability to WS. The following is SC&A's evaluation of the adequacy of the revised TBDs in reflecting the required changes.

3.1 FINDING 4: RECYCLED URANIUM NOT ADEQUATELY RECOGNIZED IN THE TBDS [RELATED SEC FINDING #5]

Original Finding
This finding originated out of the fact that ORAUT-TKBS-0028-4 (ORAUT 2005b) stated on page 12 that the environmental dose from RU at WS was not considered significant; and ORAUT-TKBS-0028-5 (ORAUT 2005c) contained minimal internal dose reconstruction information concerning RU.

SC&A's Evaluation of Revisions
SC&A evaluated the changes in the WS TBDs and found that page 11 of ORAUT-TKBS-0028-4 (ORAUT 2013b) and page 16 of ORAUT-TKBS-0028-5 (ORAUT 2013c) recommend the appropriate intakes (i.e., 100 ppb/gU Pu-239, etc.), along with an example for the dose reconstructor.

Current Status
SC&A concurs that the necessary revisions have been implemented. However, there remains one issue, in that TKBS-0028-4 (ORAUT 2013b) pages 11 and 27, and TKBS-0028-5 (ORAUT 2013c) page 16 state the year to apply RU is "*after 1961*," whereas pages 38 and 44 of TKBS-0028-5 (ORAUT 2013c) state to apply RU from "*1961–1966*." These dates need to match; it appears that the term "*after 1961*" needs to be changed to "*after 1960*" in the TBDs when referring to when to begin to apply RU intakes (otherwise 1 year of RU intakes could be mistakenly omitted).

3.2 FINDINGS 6, 7, 8, & 9: OCCUPATIONAL MEDICAL X-RAY EXAM DOSE [NO RELATED SEC FINDING]

Original Findings
These findings were related to occupational medical x-ray exam issues from the original TKBS-0028-3 (ORAUT 2005a) in which NIOSH had recommended methods for determining doses from x-ray exams using some of the WS-related data, documents, and procedures. After the release of original TBD (ORAUT 2005a), NIOSH had decided that the x-ray exams may have

been taken off site and were not to be included in the dose reconstructions; therefore, SC&A's findings were no longer applicable (as indicated in the May 6, 2011, summary of findings provided in Appendix A).

SC&A's Evaluation of Revisions
With the release of ORAUT-OTIB-0079 in 2011 (ORAUT 2011a), which states on page 5, "*If there is doubt about where the X-ray exposure was received, dose reconstructors should assume that the dose was received at a covered facility*" and the fact that WS is listed in Table 2 as a "*Covered facilities that administered occupational X-rays on site, or for which no evidence exists that X-rays were taken off site*," NIOSH has now included assigning occupational medical x-ray exam doses as per TKBS-0028-3, Rev. 01 (ORAUT 2013a). Because this revised TBD uses approved occupational medical dose reconstruction methods as recommended in ORAUT-OTIB-0006 (ORAUT 2011b) (as opposed to limited WS data), SC&A's original findings for TBD (ORAUT 2005a) are no longer applicable.

Current Status
The findings can be closed, because the revised TBD makes the original findings no longer applicable.

3.3 FINDING #14: STATED URANIUM/THORIUM/RADIUM/LEAD RATIOS SHOULD BE USED WITH CAUTION [NO RELATED SEC FINDING]

Original Finding
SC&A found that the original TBD (ORAUT 2005b, page 9) assumed that during the operations period, Th-230 was 5% of the U-238 activity, Ra-226 was 1% of the U-238 activity, and Pb-210 was 1% of the U-238 activity. These values may have been applicable for some locations and time periods at the WS site; however, this may not have been true for all locations during all time periods.

SC&A's Evaluation of Revision
The revised TBD (ORAUT 2013b) recognizes on page 10 that the uranium mill processes that produced the yellowcake concentrates that were used at both Fernald and WS effectively removed the radium, but were not effective in removing thorium; specifically Th-230. Therefore, the revised TBD recommends activity ratios for Th-230, Ra-226, and Pb-210 in uranium ore concentrate of 80%, 1%, and 1%, respectively, of that of U-238.

Current Status
SC&A found that the revised TBD provided the necessary information and recommends that this finding be closed.

3.4 FINDING #15: NATURAL THORIUM-232 NOT ALWAYS NEGLIGIBLE [NO RELATED SEC FINDING]

Original Finding
ORAUT-TKBS-0028-4 (ORAUT 2005b, page 9) assumes that because the amounts of natural thorium handled/processed at the WS site were a small fraction of the total uranium material

handled and processed, natural thorium is probably not a significant contributor to environmental inhalation doses during the operational period. This may be true on average, but this assumption does not consider the fact that some workers, or certain groups of workers, may have received a substantial portion of their inhalation dose from thorium and its decay products for a significant amount of time near a thorium handling process, or from operations that concentrated thorium, such as the raffinate pits.

SC&A's Evaluation of Revision
The revised TKBS-0028-4 (ORAUT 2013b) provides for intakes of natural thorium in Tables 4-1 and 4-2 on pages 20–22. Additionally, the revised TKBS-0028-5 (ORAUT 2013c) has an expanded Section 5.2.3 concerning natural thorium at WS.

Current Status
SC&A found that the revised TBDs provided the necessary information and recommends that this finding be closed.

3.5 FINDING #18: INCOMPLETE ASSESSMENT OF URANIUM DECAY PRODUCTS [NO RELATED SEC FINDING]

Original Finding
The original discussion in Section 5.5.2 of TKBS-0028-5 (ORAUT 2005c), pages 13–14, concerning dose estimates from the decay products of U-238 left some aspects of the process incomplete or unclear [e.g., two values (5% and 0.5%) were listed for Th-230, and it was not clear which components were included in the doses from Th-234 and Pa-234m].

Current Status
These issues were discussed at the various WS WG meetings and clarification provided. SC&A found that the revised TKBS-0028-5 (ORAUT 2013c) Section 5.2.2, page 13, removed the reference to the lower values of intakes (i.e., 0.5% Th-230 and 0.1% Ra-226) that appeared in the original TBD. In addition, the revised TBD eliminated some of the wording and/or paragraphs in Section 5.2.2 that were not needed. The various components of the Th-234 and Pa-234m radionuclides are appropriately accounted for during the internal dose analyses.

Current Status
SC&A found that the revised TBD provided the necessary information and recommends that this finding be closed.

3.6 FINDING #20: DIFFERENT SOLUBILITY CLASSES LISTED FOR SAME ELEMENT [NO RELATED SEC FINDING]

Original Finding
SC&A found that the original TKBS-0028-5 (ORAUT 2005c) lacked clarification concerning the application of the numerous solubility types provided in Section 5.2.5, pages 15 and 16.

SC&A's Evaluation of Revision
The revised TKBS-0028-5 (ORAUT 2013c), page 16, provides wording to clarify the application of the numerous solubility types provided.

Current Status
SC&A found that the revised TBD provided the necessary information and recommends that this finding be closed.

3.7 FINDING #21: COWORKER DATA NOT ADEQUATELY ADDRESSED [SEC-RELATED FINDING #1D]

Original Finding
SC&A found that the original TKBS-0028-5 (ORAUT 2005c) lacked sufficient instructions for the use of coworker doses in Tables 5-8 through Table 5-17 in some cases.

SC&A's Evaluation of Revision
The revised TKBS-0028-5 (ORAUT 2013c), page 44, provides for a summary of instruction to the dose reconstructor to assist in clarifying the assignment of internal doses.

Current Status
SC&A found that the revised TBD provided the necessary information and recommends that this finding be closed.

3.8 FINDING #25: SHALLOW AND EXTREMITY DOSES NOT SUFFICIENTLY CHARACTERIZED [RELATED SEC FINDING #9]

Original Finding
SC&A found that the original TKBS-0028-6 (ORAUT 2005d) did not adequately account for geometry factors concerning the placement of the personnel monitoring badges in relationship to the origin of the radiation, especially for uranium handlers and glovebox workers.

SC&A's Evaluation of Revision
The revised TKBS-0028-6 (ORAUT 2013d), page 30, recommends geometry correction factors in accordance with DCAS-TIB-013, page 15, (DCAS 2010) for uranium workers, and DCAS-TIB-010 (DCAS 2011), Table 1, page 11, for glovebox workers.

Current Status
While SC&A found that the revised TBD provided recommendations concerning geometry correction factors for uranium workers (DCAS-TIB-013) and glovebox workers (DCAS-TIB-010), DCAS-TIB-013 is still in progress and has not yet been fully approved by the Advisory Board on Radiation Workers Health (ABRWH) Subcommittee on Procedures Review. Therefore, the recommendation for geometry correction factors for uranium workers (using DCAS-TIB-013) still remains open until the document is fully approved.

3.9 FINDING #27: LACK OF SUFFICIENT COWORKER DATA DEVELOPMENT FOR EXTERNAL DOSE [RELATED SEC FINDING #1D]

Original Finding
SC&A found that there was some lack of clarity for assigning coworker external doses in the original TKBS-0028-6 (ORAUT 2005d).

SC&A's Evaluation of Revision
The revised TKBS-0028-6 (ORAUT 2013d) provides a revised Table 6-7 (page 19) for the average annual external gamma and beta doses by job description, and added Table 6-8 (page 20) for the median value of external gamma and beta doses by year; this provides the required information.

Current Status
SC&A found that the revised TBD provided the necessary information and recommends that this finding be closed.

4.0 SUMMARY AND CONCLUSIONS

SC&A evaluated the revised WS TBDs to determine if the resolutions reached by the WS WG concerning previously identified findings that required TBDs changes were adequately implemented in the recently released WS TBDs of 2013. SC&A found that the revised TBDs contained the necessary changes to reflect the resolutions to the findings, except for the two following items:

- Finding #4 – Wording concerning the year that RU work began at the WS site (it appears that the term "*after 1961*" needs to be changed to "*after 1960*" in the TBDs when referring to when to begin to apply RU intakes).

- Finding #25 – The recommendation for geometry correction factors for uranium workers (using DCAS-TIB-013) still remains open until DCAS-TIB-013 is approved by the ABRWH Subcommittee on Procedures Review.

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ORAUT 2011b. *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures*, ORAUT-OTIB-0006, Rev. 04, Oak Ridge Associated Universities Team, Cincinnati, Ohio. June 20, 2011.

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SC&A 2011a. *(1) Issue Matrix, (2) Evaluation of SEC Issue #5* [RU]*, and (3) Evaluation of NIOSH Response and WG Mtg. – Not PA cleared.* SCA-TR-TASK5-0015, August 3, 2011.

SC&A 2011b. *Weldon Spring Work Group submission - Data Completeness Issue - Not PA* Cleared. SCA-TR-TASK5-0015, August 15, 2011.

SC&A 2011c. *Weldon Spring SEC Issue #6-neutron n/p value*, e-mail from Ron Buchanan. SCA-TR-TASK5-0015, September 20, 2011.

SC&A 2011d. *SC&A's Evaluation of NIOSH's Response of September 7, 2011, to Daily Weighted Exposure Blunders in Weldon Spring Data.* SCA-TR-TASK5-0015, September 27, 2011.

APPENDIX A: WELDON SPRING SITE PROFILE FINDINGS THAT REQUIRE TBD CHANGES AS OF MAY 2011

TKBS Finding #	SEC Issue #	SC&A 's Original Concerns	Status
P-1	2	Lack of egress monitoring	
P-2	3	Lack of data for 1967–1984	
P-3	1	Individual vs. average exposures	
S-4	5	RU dates and assignment of Pu intakes need to be addressed	
S-5	8	Accidents/incidents	
S-6, 7, 8, 9	NA	X-ray exams records/issues	Exams conducted ***off site*** - Closed
P-10	4	Lack of atmospheric monitoring for operational period	
P-11	4	Insufficient environmental internal data for unmonitored workers	
P-12	4	Lack of maximum environmental doses	
S-13	4	Lack of sufficient effluent data prior to 1967	
S-14	NA	Stated U/Th/Ra ratios should be used with caution	As of 1/25/2011, NIOSH to issue white paper & ***TBD*** revision.
S-15	NA	Natural Th-232 not always negligible	As of 1/25/2011, NIOSH to issue white paper & ***TBD*** revision.
S-16	4	Use of environmental external doses from Fernald data	
S-17	4	Episodic releases	
P-18	NA	Incomplete assessment of uranium decay products	As of 1/25/2011, NIOSH to issue white paper & ***TBD*** revision.
P-19	4	Radon exposures	
P-20	NA	Many different solubility types listed	As of 1/25/2011, NIOSH to clarify in ***TBD*** revision.
P-21	1a & 1d	MDA and coworker data not adequately addressed	Coworker in ***SEC #1d.***
S-22	NA	Using cost center codes	
S-23	NA	Thorium in-vivo counts not reliable	
S-24	NA	Verification that EU $\leq$1%	
P-25	9	Shallow, geometry, and extremity doses not addressed	
P-26	1	Badging not consistent	
P-27	1d	External dose coworker data development	
S-28	6	Neutron exposures	

APPENDIX B: WELDON SPRING SEC FINDINGS THAT REQUIRE TBD CHANGES AS OF MAY 2011

SEC Issue #	TKBS Finding #	*Item*	SC&A 's Original Concerns	NIOSH's April 2011 Reply	SCA's Status
1 a & c	P-21, 26	*V/V of Int/Ext data*	Accuracy of the data used in DR? CER used?		
1 b	NA	*DWE*	Use of air monitoring data.	NA	
1 d	P-3, 21, 27	*Coworker data*	Sufficient data for CW? Model?	Not needed, or will be in revised ***TBD***, or 50%.	
2	P-1	*Egress monitoring*	No egress monitors. Cohort bioassays miss intakes.		
3	P-2, S-13	*1967*	No external or bioassay data for 1967. Diff situation.		
4	P-10, 11, 12, 19	*Radon*	Equal out/in radon conc & envir model not justified.		
	S-13, 16, & 17	*& thoron*	Thoron model is vague & not substituted.		
5	S-4	*RU*	Start 1961, 1962, 1963? 1 out of 5 DRs got 100ppb		***TBD***
6	S-28	*Neutrons*	1995 canister neutrons, 2001 drums gammas.		
7	NA	*Quarry & pits*	Measured only later & different conditions than oper.		
8	S-5	*Accidents/Incid.*	Potential rad accid/incid not always recorded.		
9	P-25	*Geo/Extremities*	Beta shielded? Geo & extremities factors?		***TBD***