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**Working Draft**

**ISSUES MATRIX FOR THE SAVANNAH RIVER SITE  
SEC PETITION AND PETITION EVALUATION REPORT**

**Contract Number 200-2009-28555**

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## INTRODUCTION

This is a draft issues matrix for the Savannah River Site (SRS) SEC Petition and Petition Evaluation Report (ER), prepared pursuant to the Advisory Board of Radiation and Worker Health's charge to SC&A to review the SRS SEC Petition (Petition number SEC-00103) and its associated ER, published by NIOSH on November 14, 2008, and the request of the Chair of the Working Group, Mark Griffon, that a first draft of an SEC matrix be prepared.

This matrix is based in part on issues that are unresolved from the SC&A review of the SRS Site Profile and appear to be SEC issues at the present time, SC&A's review of NIOSH's ER of the SRS SEC petition published in November 2008, and SC&A's preliminary review of the petition that was performed prior to the publication of the NIOSH ER. It also draws on interviews completed by SC&A to date as part of its SEC petition review.

NIOSH continues to work on a number of issues after the publication of the ER, including thorium up to 1960, which was reserved in the ER; neutron data; and development of coworker models. SC&A is conducting interviews and document research in parallel with NIOSH's work (logistically coordinated with NIOSH, so as to enable DOE to use its support resources as efficiently as possible). Additional issues may be added or issues may be removed from this SEC matrix as SC&A and NIOSH research proceeds and analyses are presented and discussed in Working Group meetings.

It should be noted that the latest officially issued revision of the SRS technical basis document (TBD) is dated April 5, 2005. This is Revision 03 of the SRS TBD (ORAUT-TKBS-0003). Subsequent work was done with the intention of revising the TBD, but no revision has been published. A revision number "04-E" dated November 6, 2006, is available on the O-Drive and was discussed during Working Group meetings. We have referred to this in preparing this matrix. However, this is not an official version and is not available to the petitioners, so far as SC&A is aware. The latest version referred to in the ER is the April 5, 2005, revision (though it is incorrectly identified as Rev. 02, ER, p. 84).

Reference is made to these earlier documents (including documentation connected to the TBD comment resolution process) only as necessary to establish the status of the issue in the SEC context, if such a reference is necessary beyond the discussion in the ER.

## Issues Matrix for the SRS SEC Petition and Petition ER

### Part 1 – Internal Dose Issues

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	TBD Matrix No. or Review Section No.	ER Position	Comments, History and Current Status
1	Thorium – pre-1960	7.1.1.8	NIOSH has reserved thorium dose reconstruction for the period up to December 31, 1959. The ER states that there are 224 urinalysis samples for thorium in 1956. No bioassay samples have been found after that (ER, p. 53). No data or coworker models have been provided. Issue is, in part, a carry-over from the SC&A site profile review. No data have been provided either for construction or non-construction workers.	1c.	The NIOSH ER reserves the thorium internal dose-related data prior to 1960. There are currently no data for doing internal dose reconstruction for thorium.	NIOSH has not yet provided the data or coworker model for thorium (or in the alternative, initiated an addition to the SEC class) as of August 15, 2009.
2	Thorium from Jan 1, 1960 on	7.1.1.8	Post-1960 thorium. This issue is partly a carry-over from the TBD. NIOSH has not provided thorium data for the period starting on January 1, 1960. There is no analysis showing that the production worker intakes of thorium in this period can be bounded. No analysis of the relationship of bounding dose for production workers to that of construction and maintenance workers has been provided. No job-specific analysis has been provided for differences among types of construction workers.	1c.	The ER states that in-vivo data are available post-1960. NIOSH also states “representative air monitoring data” are available for unencapsulated thorium before 1961. These would be used to bound doses for production workers “and therefore, for construction and maintenance trade workers” (ER, p. 54).	Neither the data nor the bounding dose analysis for production workers have been provided.

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3	RU	7.1.1.2	<p>This issue is in part a carry-over from the SC&amp;A TBD evaluation. While Table A-2 of the TBD contains some trace contaminant data for the FA line, it provides no references and no demonstration that they are bounding, or that data apply to all types of RU (involving both military and non-military isotope production), various enrichments of recycled uranium, and all periods. Some new trace contaminant data were published in Table 4-6 (p. 71) of Rev. 04-E of the TBD (unpublished). The data are from Crase and LaBone 2000. The issues relating to this and other cited data discussed in the SC&amp;A TBD review have not been addressed in the ER. A timeline for the RU operations has not been published. No analysis of the relationship of production worker to construction and maintenance workers has been published.</p>	1a.	ER does not contain trace contaminant data. It refers to the TBD for activity fractions (p. 46).	<p>In the September 2006 comment resolution matrix, NIOSH is noted as planning to provide a table with trace contaminant values in the next TBD revision for the six impurities with largest impact on dose, with different impurities for DU or natural uranium and enriched uranium. NIOSH also stated that a generic OTIB was about to be issued for recycled uranium. According to the July 7, 2007, comment resolution notes, “ORAUT-OTIB-0053, <i>Dose Reconstruction Considerations for Recycled Uranium Contaminants</i>, was to be completed by December 2006, but has not yet been posted.” As of mid-August 2009, this has not yet been issued.</p>

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4	Trivalent actinides Am, Cm, Cf	7.1.1.5, 7.1.1.6, 7.1.1.7	Trivalent actinides: americium, curium, and californium. There are no data for curium-244 until 1963 (ER Figure 7-1). Data analysis and co-worker models have not been provided for any period. Relevance of later data to earlier periods has not been established. Relationship between non-construction worker and construction worker intakes for trivalent radionuclides in the period before monitoring began and after monitoring began has not been established. Where NIOSH proposes to use gross alpha data (e.g. for Cf-252, method for selecting workers for assigning dose and selecting the radionuclide) have not been scientifically established. The resulting dose estimates would need to be examined for validity and reasonableness. Californium-252 assignment would also need to be reviewed in relation to spontaneous fission related organ doses (including neutrons from spontaneous fission after intake).	1d.	NIOSH proposes to use measured data or coworker models for estimating dose with sufficient accuracy (ER Sections 7.1.1.5 to 7.1.1.7). Since data were collected for all three trivalent radionuclides rather than each separately, NIOSH proposes to assign the result to Cf-252 as appropriate. (ER, p. 51)	Remains open since the time of the TBD reviews.

## Issues Matrix for the SRS SEC Petition and Petition ER

### Part 1 – Internal Dose Issues

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	TBD Matrix No. or Review Section No.	ER Position	Comments, History and Current Status
5	Np-237	7.1.1.4	Data analysis and coworker model not provided. Adequacy of data for coworker model not established. Applicability of back-extrapolation of data from 1960s and after to pre-1960 period not established. Relationship between construction worker and non-construction worker data not established.		NIOSH proposes to use data for the workers who were monitored to reconstruct their dose and a coworker model for the rest. Data available from 1960 onward in claimant database.	
6	Fission and activation products	7.1.1.9	Validity of back-extrapolation of Sr-90 data has not been established. Adequacy of fission product monitoring data for coworker model has not been established. Relationship of non-CW intake estimates to CW intake estimates for fission products has not been established. The proposed coworker model has not been published.		ER states that strontium radioisotope monitoring began in the “late 1950s.”	
7	Co-60	7.1.1.10	Validity of use of FP data prior to 1960 has not been established; relationship of non-CW data to CW data has not been established. Coworker model has not been published.	1e.	Individual bioassay data or coworker model based on claimant data will be used. Targets were encapsulated (comment in TBD matrix).	The potential similarity of the irradiation of encapsulated sources is noted in the July 7, 2007, Working Group meeting notes. The issue was kept open, but no action items were identified. ER does not address the issue of incidents.

## Issues Matrix for the SRS SEC Petition and Petition ER

### Part 1 – Internal Dose Issues

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	TBD Matrix No. or Review Section No.	ER Position	Comments, History and Current Status
8.	Po-210	7.1.1.11	The coworker model has not been published. Incidents are not addressed. Relationship of CW to non-CW intakes has not been established.	1e.	Some bioassay data are available for the few workers involved, and a coworker model will be developed for those without individual data.	
9	Tritium	7.1.1.1	NIOSH has not demonstrated that the TBD approach of applying environmental doses to unmonitored workers (no badge, no bioassay), and reporting level to workers with external monitoring only, is suitable for unmonitored construction workers. NIOSH has not demonstrated that it has a bounding dose approach for tritium for CW.	8.	Bioassay data are available and unmonitored worker tritium intakes can be estimated by using the approach in the TBD.	SC&A's preliminary analysis indicates that CW tritium intakes were larger than those of non-CW intakes for most periods. More analysis is needed by job type. Adequacy of data for CW needs examination (see below).
10	Special tritium compounds for CW		ER does not discuss exposure of CW to special tritium compounds. Relationship of CW to non-CW exposure to special tritium compounds or some other means of bounding CW exposure to them needs to be established. OTIB-0066, which discusses a method to calculate doses due to exposure to special tritium compounds, is not specific to SRS and does not discuss dose reconstruction issues	8	ER refers to OTIB-0066 for special tritium compound exposure.	SC&A's preliminary review of tritium bioassay data indicate that, for most periods, CW had higher bioassay results. It is unclear if this was the result of higher exposure or exposure to tritium compounds with higher biological half-lives, or both. SC&A TBD review also specifically refers to exposure to tritium compounds during decontamination and decommissioning operations.

## Issues Matrix for the SRS SEC Petition and Petition ER

### Part 1 – Internal Dose Issues

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			for such compounds specific to construction workers.			
11	Exotic radionuclides	7.1.1.9 in part	About 150 radionuclides were produced at SRS, and targets were fabricated there (TBD unpublished Revision 04-E, p. 25). No analysis of the production processes is provided; nor is there any description of incidents. The incident database is incomplete, which was one of SC&A’s findings in its TBD review (see below). The lack of analysis may be parallel to the situation at Y-12, where a large number of isotopes were produced, with the difference that at Y-12, they were produced in accelerators, and at SRS, they were produced in reactors. No documentation of the encapsulation processes is provided. The exceptions to the coverage of radionuclides by whole-body counting are not discussed. There is no discussion of whether any of the target materials were themselves radioactive.	1e. and 1f.	No explicit discussion of these 150 radionuclides is provided. Revision 04-E of the TBD states that “potential for intake was minimal” because targets were encapsulated and irradiated targets were shipped offsite for product recovery (p. 25). Whole-body counting would take account of “most” special radionuclides, including Tm-170 (TBD matrix, Sept. 06 version).	



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### Part 1 – Internal Dose Issues

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12	Internal dose due to incidents	5.2.3, 7.3.6	The Special Hazards Investigations list is incomplete. In its Tank Farm Fault Tree Databank, the site acknowledged that many early tank farm area incidents were not recorded (until 1965). NIOSH has not addressed the evidence provided in the SC&A TBD review that there were incidents in the 200-Area tank farms that were not recorded.	TBD review Section 5.6.2 and matrix comment 4	ER states that there are incident records, including the Special Hazards Investigation files. It states that construction workers in incidents were monitored and, hence, it can reconstruct the dose attributable to incidents (ER, p. 29). No evidence of cover up of incidents was found, and NIOSH can bound dose in any case (ER p. 71)	Construction worker interviews also indicate that there were unrecorded incidents, confirming tank farm Fault Tree Databank documentation. SC&A interviews indicate that often there was no HP coverage, even when there were incidents. An accident at the Heavy Water Components Test Reactor was also mentioned, and records relating to this accident need to be investigated; it is not discussed in the TBD or ER. The issue of exposures due to incidents was also raised in the petition. The petition also raises the issue of cover-up of incidents. While SC&A has not addressed the issue of cover-ups, the research so far indicates that there were incidents that were not entered into the Special Hazards Investigations list. There is explicit recognition in the Fault Tree Databank for the tank farms that many incidents before 1965, including high-level waste tank leaks, were not recorded unless they were “of particular interest.”

## Issues Matrix for the SRS SEC Petition and Petition ER

### Part 1 – Internal Dose Issues

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	TBD Matrix No. or Review Section No.	ER Position	Comments, History and Current Status
13	Overall CW to non-CW internal dose relation	7.1	OTIB-0052 did not contain an analysis specific to SRS for CW to non-CW radionuclide intakes. SC&A preliminary review of CW and non-CW claimant bioassay data compiled by NIOSH indicates that the assumption that non-CW intakes (as indicated by bioassay data) would be generally higher than for CW is not generally valid. The adequacy of bioassay data for constructing coworker models needs to be examined for different periods, areas, radionuclides, and types of construction workers.		ER states that OTIB-0052 found non-CW intakes “were generally higher than construction trades workers” (ER, p. 39). OTIB-0052 suggests a 1:1 ratio for CW to non-CW intakes.	SC&A interviews indicate that CW workers often did the same jobs as non-CW workers, but, being lower down in the hierarchy, were often assigned jobs with greater exposure potential. CW to non-CW bioassay average and 84 <sup>th</sup> percentile ratios greater than one in several (but not all) cases examined in a preliminary review by SC&A provide quantitative evidence for this view. DuPont had its own maintenance workers, and there was considerable overlap in the job descriptions between these DuPont workers and construction workers who were not DuPont employees, according to SC&A worker interviews. According to one interview, the H-Area tank farm has more lax radiation protection and less HP coverage. Note also that one interviewee indicated that CW put up their own tents in tank farm work areas. Different exposure patterns of CW were also raised in the petition.
14	Special Exposure Conditions	7.4.2	There are several areas of concern that can be described as “special exposure conditions,” including off-normal or unauthorized work practices, burning of spent tributyl	TBS Review Section 5.10	The ER states that NIOSH has evaluated source terms, and that NIOSH can reconstruct dose for workers in tank farms, including via use of coworker models (ER	SC&A Worker interviews done as part of the SEC investigation also indicate off-normal practices and high exposure potential during certain types of work, including in the Tank Farms.

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### Part 1 – Internal Dose Issues

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			phosphate in open pans in the early years (to ~1970), and high exposure potential during certain authorized work practices, such as opening tank risers or cleanup of high-level waste leaks.		pp. 71–72).	
15	Construction worker job types		Worker intakes and coworker models may have to be built by construction worker job type in order to ensure that the models are bounding doses (or more accurate than bounding doses).		ER assumes that non-CW internal dose data will bound CW dose.	Preliminary SC&A investigations indicate that CW intakes were often higher than non-CW intakes, and that CW intakes varied significantly by job type. The petition raises the issue of especially hazardous working conditions – see, for instance, Affidavit number 12.
16	OTIB-0075 validity for SEC use – internal dose	7.1, 7.3.4, 7.4.2	The use of OTIB-0075, which asserts representativeness of claimant data for the whole worker population for SRS construction worker SEC, is questionable.		Claimant samples are representative of the entire worker population.	This is a new TIB referred to in the SRS ER. SC&A is doing a focused review notably for internal dose at SRS.

**Issues Matrix for the SRS SEC Petition and Petition ER**  
**Part 2 – External Dose Issues**

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	SC&A TBD Comment No.	ER Position	Comments, History, and Current Status
17	Early neutron dose to about 1961	7.2.2.2	Figure 7-3 of the ER (p. 65) shows no neutron monitoring data for the 200-F Area until about 1958, and generally less than 20 badges per cycle until 1962 (except for part of 1959). This was “one of the highest neutron-exposure areas at SRS,” according to the ER (p. 64). The entire early period will have to depend almost exclusively on area neutron and photon monitoring data. The relationship of the n/p ratio data to workers and their personnel neutron exposure experience will need to be established with essentially no reference to actual monitoring data. It is unclear whether there are any early neutron monitoring data for CW at all.		n/p ratios are being developed (see also next row).	This issue was also raised by the petitioners.
18	Neutron dose	6.2 and 7.2.2	ER acknowledges unmonitored dose at SRS due to neutrons, since monitoring was required only when area neutron dose rates were in excess of 1 mrem per hour. Neutron data are very sparse in general up to the mid-1960s, and sparse even after that. Work to determine n/p ratios is ongoing. Representativeness of area	4. Also see SCA TBD Review Section 5.5	ER states that work to determine n/p ratios is ongoing, and that a coworker model would also be developed. It also states that CW workers were “generally not assigned to work” in areas expected to have the most neutron exposure.	The SRS Working Group discussion on neutron dose as presented by NIOSH was in the context of different ratios for likely compensable, likely non-compensable, and best-estimate dose reconstructions. This issue was still left as open. The ER states that considerable research still needs to be done to determine n/p ratios.

**Issues Matrix for the SRS SEC Petition and Petition ER**  
**Part 2 – External Dose Issues**

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	SC&A TBD Comment No.	ER Position	Comments, History, and Current Status
			<p>monitoring for worker exposure and representativeness of available n/p data for all workers in the class needs to be assessed.</p> <p>Additionally, back extrapolation of post-1972 data was proposed in the TBD. It is unclear whether there will be back extrapolation to demonstrate bounding dose; if there is, the validity of such back extrapolation may need to be examined.</p> <p>Validity of assumption of low neutron doses in the reactor areas needs to be examined.</p> <p>Validity of implicit assumption that CW neutron doses were lower than non-CW workers needs to be examined in view of the higher bioassay results for some periods and radionuclides, including plutonium in some periods.</p> <p>ER does not explicitly discuss how the general n/p ratios and coworker models will be applied to various types of construction workers.</p>			

**Issues Matrix for the SRS SEC Petition and Petition ER**  
**Part 2 – External Dose Issues**

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	SC&A TBD Comment No.	ER Position	Comments, History, and Current Status
19	Test reactor neutron dose		Neither the ER nor the TBD analyze the neutron dose at the Heavy Water Components Test Reactor.		ER does not discuss this issue.	SC&A interviews indicate an incident took place at this reactor (crack in the core). Incident records would need to be investigated.
20	Tank Farm exposure geometry		NIOSH to estimate the geometry of exposure in special work situations, such as those described in the F and H Area Tank Farm Fault Tree Databank, and the frequency with which these corrections may need to be applied to external dose. While correction factors can, in principle, be calculated, it is not clear that a scientifically valid set of scenarios, including time worked and radiological conditions, can be constructed. NIOSH has not addressed this issue in the ER.	5.6.3	ER does not discuss this issue.	As part of TBD comment resolution, NIOSH was to evaluate geometry of exposure in tank farm work, such as clean-up spills, work on pipes and valves, etc., where the source was at a lower level than the badge. The question of geometry of exposure is illustrated by examples from the Fault Tree Databank for the F and H Area tank farms.
21	External exposure co-worker data adequacy for CW	7.2.1.3	OTIB-0052 is claimant favorable for a large majority of construction workers. However, it is not so for some categories. A bounding dose (or better) demonstration needs to be made for all CW job types.		OTIB-0052 will suffice for coworker model.	

**Issues Matrix for the SRS SEC Petition and Petition ER**  
**Part 2 – External Dose Issues**

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	SC&A TBD Comment No.	ER Position	Comments, History, and Current Status
22	Badges not capturing dose		SC&A worker interviews suggest that workers kept their badges out of higher radiation areas in order not to exceed dose limits, or sometimes CW would be in radiological situations without knowing it (one incident is described when workers were working with radioactive tools thought initially to be clean).			
23	External dose recording accuracy and completeness	7.3	Petitioners raise the issue of working conditions with high dose rates when badge dose may have been under-recorded or not recorded (such as weekend work) and/or pencil dosimeters were off-scale, or when there are zero doses in the record. An issue connected to this would be whether the HPAREH database reflects actual work experience. Petitioners also state that in some cases, workers thought they were working in clean areas that were then determined to be contaminated.		Coworker and missed dose approaches can bound dose.	An evaluation comparing pencil and badge doses of the type that has been done before would be recommended to investigate this issue. SC&A is conducting interviews that include questions regarding working conditions. The ability of a coworker model to capture these kinds of problems raised in the petition has not been the topic of TBD comment resolution and, therefore, would need to be addressed as part of the SEC process.

**Issues Matrix for the SRS SEC Petition and Petition ER**  
**Part 3 – Early Monitoring Data**

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	SC&A TBD Comment No.	ER Position	History and Current Status
24	Early monitoring data	Various	The ER has addressed lack of early monitoring data for many workers and radionuclides by a number of devices, including building coworker models, using reporting levels, using air monitoring data, and estimating neutron to photon ratios. While each of these needs to be assessed in its own right (as described in the issues listed above), an overall assessment of early recordkeeping practices, adherence to procedures, and adequacy of data appears to be warranted.	5	Various.	Early worker monitoring is also raised as an issue in the SRS petition.



## Issues Matrix for the SRS SEC Petition and Petition ER

### Part 4 – Environmental Dose

SEC Comment No.	Issue Brief	ER Section No.	Issue Description	SC&A TBD Comment No.	ER Position	History and Current Status
25	Environmental dose	None	Using dispersion modeling of stack source terms as described in the TBD and referred to in the ER (p. 72) is not appropriate for onsite SRS workers. For instance, thousands of gallons of solvents contaminated with fission products and plutonium were burned in the Burning Ground. Use of a Gaussain plume model is not appropriate here, especially for particles greater than half a micron. Furthermore, the resuspension factor does not appear to be claimant favorable and is not entirely appropriate for this class of problem. It may not be claimant favorable by three or four orders of magnitude. Even for stack releases, one potentially significant issue is the non-conservatism of the standard Gaussian model used in the TBD, where it pertains to “non-standardized” short-term releases occurring during stable atmospheric conditions.	7	Mentions environmental dose in passing and refers to the TBD. Resuspension is not discussed.	NIOSH was to perform an evaluation of open pan burning of solvents as part of TBD comment resolution. The ER contains no discussion of this issue. NIOSH and SC&A disagree regarding the resuspension factor.