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**ADVISORY BOARD ON RADIATION AND WORKER HEALTH**

**NATIONAL INSTITUTE FOR  
OCCUPATIONAL SAFETY AND HEALTH**

**A REVIEW OF NIOSH'S PROGRAM EVALUATION REPORT  
DCAS-PER-052, "WESTINGHOUSE NUCLEAR FUELS  
DIVISION"**

**Contract No. 211-2014-58081  
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S. COHEN & ASSOCIATES: <i>Technical Support for the Advisory Board on Radiation &amp; Worker Health Review of NIOSH Dose Reconstruction Program</i>	Document No. SCA-TR-PR2014-0094
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#### Record of Revisions

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## ABBREVIATIONS AND ACRONYMS

Advisory Board or Board	Advisory Board on Radiation and Worker Health
AEC	Atomic Energy Commission
d	day
DCAS	Division of Compensation Analysis and Support
DR	dose reconstruction
DCF	dose conversion factor
dpm/m <sup>3</sup>	disintegration per minute per cubic meter
DR	dose reconstruction
EE	Energy Employee
EEOICPA	Energy Employees Occupational Illness Program Act of 2000
GM	geometric mean
GSD	geometric standard deviation
NIOSH	National Institute for Occupational Safety and Health
OCAS	Office of Compensation Analysis and Support (now DCAS)
ORAUT	Oak Ridge Associated Universities Team
PEP	Program Evaluation Plan
PER	Program Evaluation Report
POC	probability of causation
SC&A	S. Cohen and Associates (SC&A, Inc.)
SRDB	Site Research Database
TBD	technical basis document
TIB	technical information bulletin

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## 1.0 STATEMENT OF PURPOSE

To support dose reconstruction (DR), the National Institute for Occupational Safety and Health (NIOSH) and the Oak Ridge Associated Universities Team (ORAUT) have assembled a large body of guidance documents, workbooks, computer codes, and tools. In recognition of the fact that all of these supporting elements in DR may be subject to revisions, provisions exist for evaluating the effect of such programmatic revisions on the outcome of previously completed DRs. Such revisions may be prompted by document revisions due to new information, misinterpretation of guidance, changes in policy, and/or programmatic improvements.

The process for evaluating potential impacts of programmatic changes on previously completed DRs has been proceduralized in OCAS-PR-008, *Preparation of Program Evaluation Reports and Program Evaluation Plans* (OCAS 2006), Revision 2, dated December 6, 2006. This procedure describes the format and methodology to be employed in preparing a Program Evaluation Report (PER) and a Program Evaluation Plan (PEP).

A PER provides a critical evaluation of the effect(s) that a given issue/programmatic change may have on previously completed DRs. This includes a qualitative and quantitative assessment of potential impacts. Most important in this assessment is the potential impact(s) on the Probability of Causation (POC) of previously completed DRs with POCs of <50%.

During a teleconference by the Advisory Board's Procedures Review Subcommittee meeting on August 28, 2014, SC&A was tasked by the Board to conduct reviews of two PERs. Included among the PERs is DCAS-PER-052, *Westinghouse Nuclear Fuels Division* (DCAS 2014). In conducting a PER review, SC&A is committed to perform the following five subtasks, each of which is discussed in this report:

Subtask 1: Assess NIOSH's evaluation/characterization of the "issue" and its potential impact(s) on DR. Our assessment intends to ensure that the "issue" was fully understood and characterized in the PER.

Subtask 2: Assess NIOSH's specific methods for corrective action. In instances where the PER involves a technical issue that is supported by document(s) [e.g., white papers, technical information bulletins (TIBs), procedures] that have not yet been subjected to a formal SC&A review, Subtask 2 will include a review of the scientific basis and/or sources of information to ensure the credibility of the corrective action and its consistency with current/consensus science. Conversely, if such technical documentation has been formalized and previously subjected to a review by SC&A, Subtask 2 will simply provide a brief summary/conclusion of this review process.

Subtask 3: Evaluate the PER's stated **approach** for identifying the universe of potentially affected DRs, and assess the **criteria** by which a subset of potentially affected DRs was selected for re-evaluation. The second step may have important implications in instances where the universe of previously denied DRs is very large and, for reasons of practicality, NIOSH's re-evaluation is confined to a subset of DRs that, based on their scientific

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judgment, have the potential to be significantly affected by the PER. In behalf of Subtask 3, SC&A will also evaluate the timeliness for the completion of the PER.

Subtask 4: Conduct audits of DRs affected by the PER under review. The number of DRs selected for audit for a given PER will vary. (It is assumed that the selection of the DRs and the total number of DR audits per PER will be made by the Advisory Board.)

Subtask 5: Prepare a written report that contains the results of DR audits under Subtask 4, along with our review conclusions.

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## 2.0 RELEVANT BACKGROUND INFORMATION

For the years 1971 and 1972, the Westinghouse Nuclear Fuels Division received nuclear materials of enriched uranium from the Atomic Energy Commission's (AEC's) Fernald plant and a shipment of plutonium from the West Valley facility, which had originally come from the Hanford facility. Records suggest that the plutonium also included thorium, and both radionuclides were used at the Westinghouse facility for experimentation and in the manufacture of mixed oxide fuels.

Although the Westinghouse facility was actively engaged in work with other radioactive materials in other years that post-date 1972, these activities were not related to nuclear weapons production and are, therefore, not covered under the Energy Employees Occupational Illness Program Act of 2000 (EEOICPA).

For DR, facility operations at Westinghouse are confined to the years 1971 and 1972, along with the residual period for years 1973 through 1979.

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### **3.0 SUBTASK 1: IDENTIFY THE CIRCUMSTANCES THAT NECESSITATED THE NEED FOR DCAS-PER-052**

Perhaps for the reason that the Westinghouse facility's AEC operations were limited to two years, no Technical Basis Document (TBD) was developed for this site. In lieu of a Site Profile for guidance in DR, NIOSH had developed a "template" that provided a limited overview of facility operations, radiological source terms, and personnel monitoring practices.

The original template also referenced a total of **3,093 air samples** taken routinely around facility process areas and the stack. These air samples were regarded as **general area air samples** and reported as **gross total alpha activity** in dpm/m<sup>3</sup> of air; a lognormal distribution was developed, which identified the 95% value, the geometric mean (GM) value, and the geometric standard deviation (GSD) for use in assigning intakes to unmonitored workers.

Subsequently, a substantial number of air samples were discovered that raised the total number to **12,694**. When analyzed, the expanded air sample data significantly raised calculated intakes over previous estimates.

The **original template** for the Westinghouse Nuclear Fuels Division site was updated with higher estimates of inhalation and ingestion uptakes on June 8, 2012; and on March 25, 2014, NIOSH issued DCAS-PER-052 in order to address potential impacts of the revised template on previously completed DRs.

#### SC&A's Comments

Among programmatic revision that may impact the outcome of previously completed DRs and the need for a Programmatic Evaluation Report (PER), none is more justifiable than the discovery of new information/data that significantly raises estimates of radiation exposure/dose.

Based on the acquisition of new data, SC&A concurs with the issuance of DCAS-PER-052, and there are no findings.

## 4.0 SUBTASK 2: ASSESS NIOSH’S SPECIFIC METHODS FOR CORRECTIVE ACTION

In instances where the PER involves a technical issue that is supported by a document that has been formalized, Subtask 2 will provide a brief summary.

### 4.1 AN OVERVIEW OF THE WESTINGHOUSE FACILITY’S “OLD TEMPLATE”

Prior to June 8, 2012, the air monitoring results of 3,093 general air samples of gross alpha activity were used to define a lognormal distribution of daily inhalation and ingestion values that were based on a breathing rate of 9.6 m<sup>3</sup> per day and for 250 working-days per year during the operational years 1971 and 1972. Airborne activities (and estimates of intakes) during the residual period were reduced in accordance with ORAUT-OTIB-0070 (ORAUT 2012). Table 1 identifies daily intakes of alpha-emitting radionuclides through inhalation and ingestion.

**Table 1. Recommended Intakes Defined Under “Old Template”**

Year	OTIB-0070 Adjustment Factor	Inhalation Intake (dpm/d)			Ingestion Intake (dpm/d)	
		Geometric Mean	GSD*	95 <sup>th</sup> Percentile	Geometric Mean	95 <sup>th</sup> Percentile
1971–1973	1	9.122	4.638	40.938	1.824	8.188
1974	0.03	0.274	4.638	1.228	0.055	0.246
1975–1979	0.007	0.064	4.638	0.287	0.013	0.057

In support of data provided in Table 1, the “Old Template” contained the following guidance for the assignment of either the 95<sup>th</sup> percentile values or the geometric mean:

*Partially-monitored workers (i.e., those who have bioassays for uranium and/or plutonium) should be assigned unmonitored exposure for those radionuclides (uranium, plutonium, or natural thorium) for which the workers were unmonitored, based on the 95<sup>th</sup> percentile intake rate minus any missed dose calculated from the bioassay data. Since these results are based on gross alpha results, any intakes accounted [sic] from bioassay data would also be accounted for in a gross alpha result.*

*For completely unmonitored workers, unmonitored exposures should be based on the geometric mean intake rate and assigned as uranium, plutonium, or natural thorium, based on whichever nuclide provides the most claimant-favorable result. [Emphasis added.]*

#### SC&A’s Comments

Under the “Old Template,” a distinction was made that the 95<sup>th</sup> percentile was to be used only for those workers with a documented history with some bioassay monitoring. Even a limited history of bioassay monitoring would support the assumption of potential exposure to airborne environments. Conversely, in the complete absence of documented bioassay data, potential exposures to airborne contaminants may justifiably assume lower exposure potential, along with the recommended assignment of the GM and GSD values.

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## 4.2 AN OVERVIEW OF THE WESTINGHOUSE FACILITY'S "NEW TEMPLATE"

With the discovery of 9,601 additional air samples that brought the total to 12,694 samples, a revised distribution of gross alpha air concentrations was developed. From these data, the following new inhalation and ingestion intakes were derived at the 95<sup>th</sup> percentile for Operators and General Labors; Supervisors are assumed to be 50% of the Operator/General Labors exposure; and All Other Workers are assumed to be 10% of the Supervisor's exposures. Tables 2a, 2b, and 2c identify revised intake values for the three classifications of workers.

**Tables 2a, 2b, and 2c. Recommended Intakes Based on Worker Classification under the Revised New Template**

Year	OTIB-0070 Adjustment Factor	Inhalation Intake (dpm/d)	Ingestion Intake (dpm/d)
1971-1972	1.000	965.121	19.302
1973	1.000	965.121	19.302
1974	0.783	965.121	19.302
1975	0.613	755.690	15.114
1976	0.480	591.619	11.832
1977	0.376	463.258	9.265
1978	0.294	362.886	7.258
1979	0.231	283.746	5.675

Year	OTIB-0070 Adjustment Factor	Inhalation Intake (dpm/d)	Ingestion Intake (dpm/d)
1971-1972	1.000	482.561	9.651
1973	1.000	482.561	9.651
1974	0.783	482.561	9.651
1975	0.613	377.845	7.557
1976	0.480	295.810	5.916
1977	0.376	231.629	4.633
1978	0.294	181.443	3.629
1979	0.231	141.873	2.837

Year	OTIB-0070 Adjustment Factor	Inhalation Intake (dpm/d)	Ingestion Intake (dpm/d)
1971 - 1972	1.000	48.256	0.965
1973	1.000	48.256	0.965
1974	0.783	48.256	0.965
1975	0.613	37.785	0.756
1976	0.480	29.581	0.592
1977	0.376	23.163	0.463
1978	0.294	18.144	0.363
1979	0.231	14.187	0.284

In support of Tables 2a, 2b, and 2c, the Revised Template provides the following additional guidance for assigning doses to each of the three worker classifications:

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*Intake ratios between the classifications of workers are based on the guidance found in the Technical Basis Document: Site Profiles for Atomic Weapons Employers That Worked Uranium Metals (SRDB Ref ID 101251) [Battelle 2011].*

...

*During the operational period (1971–1972), **partially-monitored workers**, those who have bioassays for uranium and/or plutonium, should be assigned unmonitored exposure in excess of any missed dose calculated from the bioassay data, i.e. subtracting missed intake activity from the **95<sup>th</sup> percentile intake activity described in the tables above**, and assigning the remainder as either uranium, plutonium, or natural thorium (excluding the ones accounted for via bioassay), based on which nuclide provides the most claimant favorable result.*

*For **completely unmonitored workers**, unmonitored exposures should be based on the **geometric mean** intake rate and assigned as either uranium, plutonium, or natural thorium, based on which nuclide provides the most claimant[-]favorable result.*

*During the residual period (1973–1979), intakes should be based on the tables above. These should be assessed as either uranium, plutonium, or natural thorium, based on which nuclide provides the most claimant[-]favorable result. These intakes should be limited by the worker’s bioassay data if they would result in higher excretions than detected. [Emphasis added.]*

### SC&A’s Comments and Findings

Under the Revised Template, exposure potential was based on **worker classification**, which reduced the intake values of the “Unmonitored Other Workers” to 48.256 dpm/d or one-twentieth of the 965.121 dpm/d assigned to the highest exposed workers (i.e., Operators and Labor). Conceptually, it would appear that a secondary adjustment that considers the “partial existence” or the “complete absence” of bioassay data is redundant.

Furthermore, the recommendation that “. . . For completely unmonitored workers, unmonitored exposures should be based on the **geometric mean intake rate** . . .” [emphasis added] is, in fact, **not** possible, since Tables 2a, 2b, and 2c do **not** provide the GM and GSD for the newly acquired air sample dataset of 12,694 air samples.

Lastly, NIOSH’s assignment of “unmonitored” **internal** dose based on “worker classification” may be of limited relevance/credibility. Perhaps a more reliable indicator of potential internal exposure is a quantitative evaluation of the worker’s external exposure records on the reasonable assumption that a quantitative relationship between internal and external exposures exists.

Finding 1. Guidance for adjusting intakes based on “partially monitored” versus “completely unmonitored” status of a worker not only appears redundant, but more importantly, this distinction cannot be made with available data provided in the revised Westinghouse template.

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The assessment of internal dose also requires that the dose reconstructor evaluate exposures to all three potential sources of alpha-emitting radionuclides representing (1) 2% enriched recycled uranium, (2) 12% 10-year-old fuel-grade plutonium, and (3) natural thorium, and select the one with the most claimant-favorable result. To do so requires the use of radionuclide ratios among those with alpha emissions. For the 12% 10-year-old fuel-grade plutonium mixture, NIOSH provided the following table:

<b>Radionuclide</b>	<b>12% 10-year-old Fuel-Grade Plutonium Ratios</b>
Pu-238:Alpha	0.117
Pu-239:Alpha	0.593
Pu-241:Alpha	14.201
Am-241:Alpha	0.289

The fractional contributors of alpha emitters include Pu-238 at 0.117, Pu-239 at 0.593, and Am-241 at 0.289, for a total of 1.0. The table identifies Pu-241 as an alpha emitter, which is incorrect. Thus, the assignment of a daily intake of alpha emitters defined in Tables 2a, 2b, and 2c must be proportionately divided among Pu-238, Pu-239, and Am-241, and separate internal exposures must be evaluated for Pu-241, which has a half-life of 13.2 years and decays to Am-241, an alpha emitter.

Finding 2. The designation of Pu-241 as an alpha emitter is incorrect.

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## 5.0 SUBTASK 3: EVALUATE THE PER'S STATED APPROACH FOR IDENTIFYING THE UNIVERSE OF POTENTIALLY AFFECTED DRs

Under Section 3.0 of DCAS-PER-052, NIOSH's plan for resolution or corrective actions included the following steps and criteria:

- (1) Given the issue date of the revised template for the Westinghouse facility on June 8, 2012, NIOSH assessed the number of claims that had been completed **after June 8, 2012**, to ensure that the revised template had been used. None were found.
- (2) NIOSH reviewed DRs that were completed prior to June 8, 2012, under the original template. A total of 68 claims were completed prior to June 8, 2012, with POC values less than 50%.
- (3) Using data and guidance contained in the revised template issued on June 8, 2012, NIOSH recalculated the doses for all 68 claims.
- (4) The re-evaluation of the 68 claims yielded (a) 17 claims with a revised POC greater than 50%, (b) one claim with a POC between 45% and 50%, which upon further evaluation, nevertheless, remained below 50%, and (c) 50 claims with revised POCs below 45%.

### SC&A's Comments

Selection criteria for the re-evaluation of DRs potentially impacted by DCAS-PER-052 were correctly based on the issue date of the revised Westinghouse facility's template on June 8, 2012, along with the standard required POC values of <50%.

Under Subtask 3, there were no findings.

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## **6.0 SUBTASK 4: CONDUCT AUDITS OF A SAMPLE SET OF DRs AFFECTED BY DCAS-PER-052**

The re-evaluation for internal exposure of DRs performed under the original template required the need to assign the energy employee (EE) to one of three **worker classifications** under the revised template; and depending on the resolution of Finding 1, workers may have further been defined as partially monitored or completely unmonitored.

Thus, depending upon the resolution of Finding 1, SC&A recommends the selection of either 3 or 6 cases from among the 51 re-evaluated DRs with POCs less than 50%:

- Three DRs, if all 51 re-evaluated DRs were assigned intakes defined for “partially monitored” workers.
- Six DRs, if re-evaluated DRs involved workers representing both partially monitored workers and completely unmonitored workers whose intakes were reduced by the use of GM and GSD values that were not cited in the new template.

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## 7.0 REFERENCES

42 CFR 82, 2002. *Methods for Radiation Dose Reconstruction under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule, Federal Register/Vol.67, No. 85/Thursday, May 2, 2002, p. 22314.

Battelle 2011. *Technical Basis Document: Site Profiles for Atomic Weapons Employers That Worked Uranium Metals*, Rev. 1, Battelle Memorial Institute. June 17, 2011, SRDB Reference ID 101251.

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