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**ADVISORY BOARD ON
RADIATION AND WORKER HEALTH**

National Institute for Occupational Safety and Health

**SC&A REVIEW OF DCAS-RPT-005, REVISION 00,
ALTERNATIVE DISSOLUTION MODELS FOR INSOLUBLE
PLUTONIUM-238**

**Contract No. 211-2014-58081
SCA-TR-2017-PR001, Revision 0**

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January 2017

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SC&A, INC.: *Technical Support for the Advisory Board on Radiation and Worker Health Review of NIOSH Dose Reconstruction Program*

DOCUMENT TITLE:	SC&A Review of DCAS-RPT-005, Revision 00, Alternative Dissolution Models for Insoluble Plutonium-238
DOCUMENT NUMBER/ DESCRIPTION:	SCA-TR-2017-PR001
REVISION NO.:	0 (Draft)
SUPERSEDES:	N/A
EFFECTIVE DATE:	January 13, 2017
TASK MANAGER:	Kathleen Behling [signature on file]
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Record of Revisions

Revision Number	Effective Date	Description of Revision
0 (Draft)	01/13/2017	Initial issue

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ABBREVIATIONS AND ACRONYMS

ABRWH	Advisory Board on Radiation and Worker Health
DCAS	Division of Compensation Analysis and Support
ICRP	International Commission on Radiological Protection
IMBA	Integrated Modules for Bioassay Analysis
LANL	Los Alamos National Laboratory
NIOSH	National Institute for Occupational Safety and Health
NUMEC	Nuclear Materials & Equipment Corporation
ORAUT	Oak Ridge Associated Universities Team
OTIB	ORAUT technical information bulletin
Pu	plutonium
SRS	Savannah River Site

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1.0 INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) presented DCAS-RPT-005, *Alternative Dissolution Models for Insoluble Pu-238* (2016, hereafter “RPT-005”) to replace ORAUT-OTIB-0083 (hereafter “OTIB-0083”), Revision 0, *Dissolution Models for Insoluble Plutonium-238* (2013), which was cancelled.

Several changes were made that address most of the 14 findings that SC&A presented in its review of OTIB-0083 (SC&A 2013). Those findings were discussed during the February 13, 2014, Subcommittee on Procedures Review meeting.

2.0 REVIEW OF DCAS-RPT-005, REVISION 00 (2016)

RPT-005 provides guidance on the evaluation of intakes for workers who were exposed to ceramic forms of plutonium-238 (Pu-238). Workers who are exposed to Pu-238 can exhibit non-monotonic urinary excretion patterns that are indicative of non-standard lung biokinetics.

RPT-005 indicates that site-specific lung dissolution models should be used in dose reconstructions for insoluble forms of Pu-238 as an additional dissolution type, in addition to the standard Types M and S. The dissolution type that results in the highest dose to the organ of interest should be used for the final dose assignment.

These additional dissolution types should be used at the Los Alamos National Laboratory (LANL), the Mound Site, the Savannah River Site (SRS), and the Nuclear Materials & Equipment Corporation (NUMEC). Incidents involving exposure to similar Pu-238 sources at other sites should be evaluated on a case-by-case basis, using the LANL model.

As described in RPT-005, the available urinary excretion patterns following intakes of Pu-238 at LANL, the Mound Site, and SRS were reviewed. Using these data, parameters for site-specific dissolution models were developed for the Mound and LANL sites.

The report is very well written, with all sections explained in a didactic way. RPT-005 discusses the reason for the special lung modeling for exposures to certain ceramic compounds of Pu-238, describes the International Commission on Radiological Protection (ICRP) Publication 66 (1994) lung dissolution model and its parameters, and provides the applicable inputs into the Integrated Modules for Bioassay Analysis (IMBA) software.

The document is scientifically well based. Attachment A, Sections A-1, A-2, and A-3, describe the development of personalized model parameters for various individuals who were exposed at LANL, Mound, and SRS. Each exposure case is described and the parameters are derived using individual bioassay data. Table A-1, Section A-5, provides the lung dissolution parameters estimated for workers exposed at LANL, Mound, and SRS. The parameters for standard Type S plutonium (S-21) and standard Type M plutonium (M-22) are also given. Figure A-7 shows the comparisons of individual curve fittings, using the dissolution parameters from Table A-1.

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Attachment A, Section A-5, summarizes the lung dissolution parameters that should be used for each site. In this section, SC&A has some concerns related to NIOSH's statement that:

The parameters for Mound-13 are considered to be representative of those observed for Mound cases and should be used as the defaults for Mound and SRS.

SC&A believes that NIOSH should explain why the parameters for Mound-13 should be used as the default for Mound.

In addition, the inclusion of SRS default parameters in the sentence quoted above, implying that the default parameters for Mound should be used for SRS, is probably a typographical error, because it contradicts the following paragraph from Section A.5.1:

*The LANL default model is considered to be the most conservative of the models and should be used for NUMEC and any other site where a ²³⁸Pu dissolution model is needed but was not explicitly defined in the report. Given that there is only one case available for evaluation at SRS, a site-specific dissolution model could not be developed. Examination of Figure A-7 indicates the clearance pattern of ²³⁸Pu falls somewhere between that of Mound and LANL. **Thus, the LANL model should also be used for SRS cases.** [emphasis added]*

SC&A finds the above paragraph to be correct and claimant favorable.

In summary, SC&A has two findings about RPT-005:

- **Finding 1:** NIOSH should provide justification for using Mound Case 13 dissolution parameters as the default for all Mound workers.
- **Finding 2:** The use of Mound Case 13 parameters as a default for SRS workers is an apparent mistake. It contradicts the more claimant-favorable statement in the same section of the report: "The LANL model should also be used for SRS cases."

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3.0 DISCUSSION OF THE STATUS OF THE 14 FINDINGS PRESENTED BY SC&A IN ITS REVIEW OF OTIB-0083, AS ADDRESSED IN RPT-005.

Summarized below are the 14 findings identified as a result of SC&A's review of OTIB-0083 (SC&A 2013), along with a brief discussion of whether SC&A believes these findings have been adequately addressed in RPT-005.

3.1 FINDING 1

The applicability and target audience of OTIB-0083 is not well defined.

SC&A recommends that this finding be closed: RPT-005 clearly defines the target audiences and the U.S. Department of Energy and atomic weapons employer sites that had the potential for exposure to this form of plutonium.

3.2 FINDINGS 2, 3, 4, AND 5

- **Finding 2:** NIOSH did not demonstrate that Type J plutonium is a material that would be rarely encountered in the workplace.
- **Finding 3:** NIOSH does not explain why Type L was chosen to evaluate the doses for certain scenarios, as exemplified in Tables 2-1 and 2-2. Type L was derived based on a singular incident that occurred at Mound in 1960.
- **Finding 4:** NIOSH did not demonstrate that Type L was commonly found in the workplace at Mound or at any other places.
- **Finding 5:** NIOSH did not demonstrate that exposures at Mound to Pu-238 that show non-monotonic absorption from the lungs may be well characterized by Type L Pu-238, at all times and at all areas.

SC&A recommends that Findings 2, 3, 4, and 5 be closed: These findings can be closed because RPT-005 refers to the application of lung model "Type L" at Mound, as well as at other sites. NIOSH now differentiates the sites (LANL, SRS, NUMEC, and Mound). For Mound, in particular, data from various incidents are used to derive the most suitable model for Pu-238 to be applied in the installation.

3.3 FINDING 6

NIOSH does not state whether the technical calculations to derive the limiting dissolution types should stand as examples of similar calculations to be performed in other facilities besides Mound.

SC&A recommends that Finding 6 be closed: NIOSH now specifies how alternative dissolution models for Pu-238 should be applied to different installations.

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3.4 FINDING 7

NIOSH does not compare organ doses from acute intakes of Type L Pu-238 with chronic intakes of Types M and S Pu-238 materials. NIOSH should discuss the limiting dissolution types for acute intakes of Type L versus chronic intakes of Type M or Type S Pu-238, as this is an important problem in dose reconstruction.

SC&A recommends that Finding 7 be closed: This finding does not apply to RPT-005.

3.5 FINDING 8

In Section 4, NIOSH defines the parameters for Type L exposures at Mound and compares the dissolution curves with Type J and Type S but does not demonstrate that Type L is typical of Mound exposures.

SC&A recommends that Finding 8 be closed: This finding does not apply to RPT-005.

3.6 FINDING 9

The purpose of Section 4 is not well defined in relation to other exposures to Pu-238 that show non-monotonic behavior at Mound and at other sites.

SC&A recommends that Finding 9 be closed: RPT-005 defines non-monotonic behavior of Pu-238 at other sites besides Mound.

3.7 FINDING 10

There is no guidance in either ORAUT-TKBS-0016-5, Revision 02, or OTIB-0083 on which areas of Mound and in which time period Tables 2-1 and 2-2 should be used. The lack of such guidance implies that the tables should be used at all areas and at all times to interpret Mound Pu-238 bioassay results. If this is not NIOSH's intent, then either ORAUT-TKBS-0016-5, Revision 02, or OTIB-0083 should be modified to specify where and when Tables 2-1 and 2-2 should be used.

SC&A recommends that Finding 10 be closed: Alternative models for dissolution of Pu-238 are defined in Attachment A, Section A-5.1.

3.8 FINDING 11

For sites other than Mound where non-monotonic behavior of Pu-238 is observed, there is no assurance that the Pu-238 behavior at that site will correspond to Mound's Type L Pu-238 behavior. There is no information in OTIB-0083 on how to deal with exposures to Pu-238 material that present dissolution parameters different from Types M, S, and L. Thus, the usefulness of OTIB-0083 to sites other than Mound is questionable.

SC&A recommends Finding 11 be closed: Alternative models for dissolution of Pu-238 are defined for different sites and summarized in Attachment A.

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3.9 FINDING 12

OTIB-0083 is difficult to follow and understand. The sections do not follow a natural order. NIOSH's Type J and NIOSH's Type L Pu-238 compounds are only introduced in Section 4, although they are used in Sections 1, 2, and 3.

SC&A recommends that Finding 12 be closed: This finding does not apply to RPT-005.

3.10 FINDING 13

OTIB-0083 is essentially the same document as the white paper, *Modeling Intakes of Pu-238 at Mound* (LaBone and Brackett 2009). OTIB-0083 is only clear for those that participated in discussions regarding Pu-238 exposures at Mound.

SC&A recommends that Finding 13 be closed: This finding does not apply to RPT-005.

3.11 FINDING 14

OTIB-0083 does not discuss the existence of other non-monotonic forms of Pu-238 at Mound, nor present any research done to prove that Type L is the only appropriate form of Pu-238 to be included in the calculation of the limiting dissolution type.

SC&A recommends that Finding 14 be closed: For Mound, data from various incidents are used to derive the most suitable model for Pu-238 to be applied in the installation.

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4.0 REFERENCES

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