DRAFT

DCAS-PER-042, SUBTASK 4:

REVIEW OF IMPACTED CASES REWORKED FOR THE EVALUATION OF DOSES FROM REVISED TBD FOR THE LINDE CERAMICS PLANT

Contract No. 211-2014-58081

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Disclaimer

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DCAS-PER-042, SUBTASK 4: REVIEW OF IMPACTED CASES REWORKED FOR THE EVALUATION OF DOSES FROM REVISED TBD FOR THE LINDE CERAMICS PLANT	Page 2 of 20
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Project Manager: _____ Date: _____ John Stiver, MS, CHP	Reviewer: U. Hans Behling John Stiver

Record of Revisions

Revision Number	Effective Date	Description of Revision
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TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

Advisory Board	Advisory Board on Radiation and Worker Health
CADW	Chronic Annual Dose Workbook
DCAS	Division of Compensation Analysis and Support
DCF	dose conversion factor
DOL	(U.S.) Department of Labor
DR	Dose Reconstruction
EE	Energy Employee
IREP	Interactive RadioEpidemiological Program
LCP	Linde Ceramics Plant
NIOSH	National Institute for Occupational Safety and Health
NOCTS	NIOSH/OCAS Claims Tracking System
NP	non-penetrating
OCAS	Office of Compensation Analysis and Support
ORAUT	Oak Ridge Associated Universities Team
PER	Program Evaluation Report
POC	Probability of Causation
PRSC	Procedures Review Subcommittee
R	Roentgen
rem	Roentgen equivalent man
SC&A	S. Cohen and Associates (SC&A, Inc.)
SCC	squamous cell carcinoma
SEC	Special Exposure Cohort
TBD	Technical Basis Document

1.0 RELEVANT BACKGROUND INFORMATION

S. Cohen and Associates (SC&A) was tasked by the Advisory Board on Radiation and Worker Health (Advisory Board) to conduct a review of DCAS-PER-042, *Linde Ceramics Plant TBD Revision* (DCAS 2012). DCAS-PER-042 was issued to determine the number of claims impacted by Rev. 03 to the Linde Ceramics Plant (LCP) technical basis document (TBD) of July 2012 (ORAUT 2012a), as compared to previous versions of the TBD. The revised TBD contained significant changes that would potentially impact most of the previous dose reconstructions (DRs); therefore, it was necessary to re-evaluate all the previous LCP claims with a probability of causation (POC) <50%, and which had non-Special Exposure Cohort (SEC) covered cancers, to determine if any of the POC values would exceed 50% using the latest TBD (ORAUT 2012a).

On August 19, 2014, SC&A submitted to the Procedures Review Subcommittee (PRSC) our review of the National Institute for Occupational Safety and Health's (NIOSH's) program evaluation report (PER), DCAS-PER-042 (SC&A 2014). In conducting a PER review, SC&A is committed to perform five subtasks, as specified below:

Subtask 1: Assess NIOSH's evaluation/characterization of the "issue" and its potential impacts 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, 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 third 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 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, based on important elements such as (1) the number of target organs/tissues that may be impacted by a PER, (2) the method/data that were employed in the original DR, and (3) the time period, work location, and job function(s) that characterize the DR of a claim. (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 comprehensive written report that contains the results of the above-stated subtasks, along with our review conclusions.

This report fulfills the requirement defined in Subtask 4, "Conduct audits of DRs affected by the PER under review." Under Section 2.0 of DCAS-PER-042, NIOSH identified the following issues, for which some cases may require re-evaluation.

- *Several changes in these revisions have resulted in either an increase or a decrease in assigned dose. Most of the decrease in dose assignment occurred as a result of the addition of Linde Ceramics to the Special Exposure Cohort. Under the provisions of the SEC, some sources of exposure were deemed insufficiently accurate to be included in dose reconstruction and that source of exposure was removed from the TBD.*

- *Revision 3 of the TBD included the assignment of dose in the utility tunnels that was higher than any of the previous versions of the TBD. Other changes affected the distribution used for the reconstruction of internal doses. One such example is the intakes assessed for trades workers from 1955 to 1969. The estimate of those intakes went from using a distribution to assigning a constant that was higher than the geometric mean of the distribution but lower than the 95th percentile of the distribution. Other revisions both increased or decreased doses for some or all employees and for some or all years.*

SC&A queried the NIOSH/OCAS Claims Tracking System (NOCTS) database and estimates that approximate **253** cases were completed before Rev. 03 of the LCP TBD was released. Of these previous cases that had DRs, NIOSH eliminated the claims that did not need to be re-evaluated (i.e., those with POCs >50% or had only SEC-covered cancers), as outlined in Section 3.0 of DCAS-PER-042:

> *The number of changes that either increased or decreased the assigned dose affects nearly every previously completed claim. It was therefore not possible to narrow the population of claims that were potentially affected. Because three separate SEC classes were designated for the Linde Ceramics Plant, however, a number of claims have been awarded compensation without the need for a dose reconstruction. Claims in that category would not need a new dose reconstruction, so they were excluded from further evaluation. To determine this group of claims, NIOSH used a list of cancers that qualify for compensation under the SEC and the employment dates verified by the Department of Labor (DOL). Those claims with a listed cancer and at least one year of employment (250 working days) during an SEC period were excluded from further evaluation. The exception to this was made for claims that had both a listed and non-listed cancer. Those were included in the evaluated population in case a dose reconstruction was necessary for DOL to evaluate compensation for medical benefits of the non-listed cancer.*

The SEC time periods used in this evaluation included 10/1/1942 through 12/31/1969, which is the period covered by the three SEC classes that were added.

It was found that approximately **175** of the 253 claims did not need to be re-evaluated; that left **78** claims that had original POCs <50% and/or had non-SEC covered cancers. (The term "approximate" is used here because some claims may change status with time.) Of these 78 claims, **74** claims were re-evaluated and found to have POCs of <50% (of these 74 claims, 3 had both SEC covered cancers and non-SEC cancers), and **4** of the 78 re-evaluated claims had revised POCs >50%.

During the August 28, 2014, PRSC meeting, SC&A was tasked with evaluating **2** claims reworked by NIOSH [using Rev. 03 of ORAUT-TKBS-0025 (ORAUT 2012a)] to determine if NIOSH followed the correct protocol for evaluating and assigning external and internal doses for the reworked cases. SC&A's evaluation of the 2 cases consisted of a complete audit, as opposed to a focused audit, because the many changes in Rev. 03 of the LCP TBD required a completely revised DR to be performed by NIOSH. SC&A selected 2 cases from the 71 claims that had a revised POC of <50%, and were not compensated under the LCP SEC. SC&A's evaluation of these 2 cases reworked by NIOSH is provided in Sections 2 and 3 of this report.

2.0 APPLICATION OF DCAS-PER-042 TO CASE #[CLAIM A]

2.1 BACKGROUND INFORMATION FOR CASE #[CLAIM A]

Case #[Claim A] represents an energy employee (EE) who worked at the LCP from [redacted], through [redacted]. During this employment period, the EE worked as a [redacted] and [redacted] at various locations within LCP**.** The EE was diagnosed with **prostate cancer** (ICD-9 Code 185) in [redacted]. There were no records that the EE was monitored for external exposures or internal intakes during employment.

NIOSH performed the original DR for this case in June 2005, and then performed a complete re-evaluation of the claim using Rev. 03 of the TBD (ORAUT 2012a) in August 2012. Table 1 below provides a summary of organ dose estimates derived by NIOSH in the recent DR that corresponds to data contained in the entries in the Interactive RadioEpidemiological Program (IREP) Input table, and reproduced in this report as Appendix A-1. The total dose of **7.898 rem** produced a POC of **25.35%**; on this basis, the claim would not be eligible for compensation.

Table 1. Summary of NIOSH-Derived External/Internal Dose Estimates

	IREP Entry No.	Dose (rem)
External Dose (Occupational):		
▪ Recorded/Modeled Dose:		
- Electrons >15 keV	NA	–
- Photons 30–250 keV (Plant Area)	1–33	7.225
- Neutrons 0.1–2 MeV	NA	–
▪ Missed Dose:	NA	–
▪ Onsite Ambient Dose (Tunnels)	34–64	0.082
▪ Occupational Medical Dose	NA	–
Internal Dose:		
- U, Th, Po, Pa, Ac, and Ra Alpha Dose	65–110	0.591
Total		**7.898**

NA = Not applicable in this case

2.2 SC&A'S EVALUATION OF NIOSH'S REWORKED EXTERNAL DOSE ASSIGNMENT

There were no records of the EE being monitored while employed at the LCP.

2.2.1 External Photon Dose - Plant

For external dose exposure in the plant area, SC&A derived the photon doses using the exposure (as opposed to the deep dose) dose conversion factor (DCF) of 1.244 for the bladder from OCAS-IG-001 (OCAS 2007, page 46). The bladder is the surrogate organ for the prostate, as per ORAUT-OTIB-0005 (ORAUT 2012b, page 12).

1952–1953 Plant Photon Dose

For this period, the external doses were derived using the dose value (1.85 R/year) in Table 4-24, page 65, of ORAUT-TKBS-0025, Rev. 03 (for a [redacted]) multiplied by the DCF of 1.244. An example of SC&A's photon dose calculations for the prostate for 1953 is as follows:

30–250 keV photon dose = (Table 4-24 dose) × DCF × Energy fraction
30–250 keV photon dose = 1.85 rem × 1.244 × 1.0 = 2.301 rem

This matches the dose assigned in entry #2 of the IREP Input table.

1954–1984 Plant Photon Dose

For this period, the external doses were derived using the dose value (0.068 rem/year) in Section 6.2, page 70, of ORAUT-TKBS-0025, Rev. 03 (for Building 30, the most contaminated building) multiplied by the DCF of 1.244. An example of SC&A's photon dose calculations for the prostate for 1954 is as follows:

30–250 keV photon dose = (0.068 rem) × DCF × Energy fraction
30–250 keV photon dose = 0.068 rem × 1.244 × 1.0 = 0.085 rem

This matches the dose assigned in entry #3 of the IREP Input table.

SC&A derived a total plant photon dose of 7.225 rem, which matches the total dose assigned by NIOSH in entries #1–#33 of the IREP Input table, as shown in Appendix A-1.

SC&A had no findings in this section.

2.2.2 Ambient External Dose – Tunnels

The EE would be considered a [redacted]; therefore, the EE potentially spent time in the [redacted] at the LCP. For external dose exposures in the [redacted], ORAUT-TKBS-0025, Rev. 03, page 76, recommends using the ambient organ DCF, which is 0.940 for the prostate (bladder) according to OCAS-IG-001 (OCAS 2007), page 46.

1954–1956 Tunnel Photon Dose

For this period, the external doses were derived using the dose value (0.001 rem/year) in Table 6-13, page 70, of ORAUT-TKBS-0025, Rev. 03 (for a [redacted]). An example of SC&A's photon dose calculations for the prostate for 1954 is as follows:

30–250 keV photon dose = (Table 6-13 dose) × DCF × Energy fraction
30–250 keV photon dose = 0.001 rem × 0.940 × 1.0= 0.001 rem

This matches the dose assigned in entry #34 in the IREP Input table.

1957–1984 Tunnel Photon Dose

For this period, the external doses were derived using the dose value (0.003 rem/year) in Table 6-13, page 70, of ORAUT-TKBS-0025, Rev. 03 (for a [redacted]). An example of SC&A's photon dose calculations for the prostate for 1957 is as follows:

30–250 keV photon dose = (Table 6-13 dose) × DCF × Energy fraction
30–250 keV photon dose = 0.003 rem × 0.940 × 1.0 = 0.003 rem

This matches the dose assigned in entry #37 in the IREP Input table.

SC&A derived a total tunnel photon dose of 0.082 rem, which matches the total dose assigned by NIOSH in entries #34–#64 of the IREP Input table shown in Appendix A-1.

SC&A derived a total external photon dose of **7.307 rem**, which matches the total dose assigned in entries #1–#64 of the IREP Input table shown in Appendix A-1.

SC&A had no findings in this section.

2.2.3 Neutron Dose

According to ORAUT-TKBS-0025, Rev. 03, page 70, there was no significant neutron exposure during the EE's employment period at the LCP; therefore, NIOSH did not assign neutron dose for this EE.

SC&A had no findings in this section.

2.2.4 Occupational Medical Dose

According to ORAUT-TKBS-0025, Rev. 03, page 67, x-ray exams were performed off site at a non-covered facility during the EE's employment period at the LCP; therefore, NIOSH did not assign medical x-ray dose for this EE.

SC&A had no findings in this section.

2.3 SC&A'S EVALUATION OF NIOSH'S REWORKED INTERNAL DOSE ASSIGNMENT

There were no records of the EE being bioassayed while employed at the LCP.

2.3.1 Internal Dose

For internal dose assignment, the inhalation and ingestion intake values (for Ra-226, Th-230, U-238, U-235, and U-234) from Table 6-8, page 73, for [redacted] for the period 1954–1984 were used; additionally, the intake values (for U-234, Th-230, Ra-226, Po-210, Pa-231, and Ac-227) for the plant from Table 6-2 (inhalation), page 68, and Table 6-3 (ingestion), page 69, for the period 1970–1984 were used. These intake values were entered into the Chronic Annual

Dose Workbook (CADW) and the annual doses determined using the solubility that produced the maximum dose. A total internal dose of **0.591 rem** was derived, which matches the dose assigned to the prostate in entries #65–#110 of the IREP Input table shown in Appendix A-1 of this report.

SC&A had no findings in this section.

2.4 SC&A'S REVIEW OF DCAS-PER-042 ISSUES RELATED TO CASE #[CLAIM A]

This was a partial DR because complete internal dose could not be reconstructed, as per the LCP SECs. SC&A derived a total dose **7.898 rem**, which produced a POC of **25.35%.**

SC&A evaluated NIOSH's reworked DR, and SC&A derived the same doses and POC values as NIOSH did and concurs that NIOSH used the correct protocol to assign external and internal doses in this case.

3.0 APPLICATION OF DCAS-PER-042 TO CASE #[CLAIM B]

3.1 BACKGROUND INFORMATION FOR CASE #[CLAIM B]

Case #[**Claim B**] represents an energy employee (EE) who worked at the LCP from [**redacted**], through [**redacted**]. During this worker's employment, the EE worked as a [**redacted**]**,** [**redacted**]**,** [**redacted**]**, and** [**redacted**] at various locations within the LCP**.** The EE was diagnosed with squamous cell carcinoma (SCC) **skin cancer** of the [**redacted**] (ICD-9 Code 232.6) in 2001. There were no records that the EE was monitored for external exposures or internal intakes during employment.

NIOSH performed the original DR for this case in August 2006, and then performed a complete re-evaluation of the claim, using Rev. 03 of the ORAUT-TKBS-0025, in August 2012. Table 1 provides a summary of organ dose estimates derived by NIOSH in the recent DR that corresponds to data contained in the entries in the IREP Input table, and reproduced in this report as Appendix A-2. The total dose of **23.360 rem** produced a POC of **10.73%**; on this basis, the claim would not be eligible for compensation.

Table 2. Summary of NIOSH-Derived External/Internal Dose Estimates

	IREP Entry No.	Dose (rem)
External Dose (Occupational):		
▪ Recorded/Modeled Dose:		
- Electrons >15 keV (Plant Area) 1953	1	2.610
- Electrons >15 keV (Plant Area) 1954–1991	41–78	12.388
- Photons 30–250 keV (Plant Area) 1953–1991	2–40	3.955
- Neutrons 0.1–2 MeV	NA	–
▪ Missed Dose:	NA	–
▪ Onsite Ambient Dose (Tunnels)		
- Electrons >15 keV, 1953–1956	82–84	0.279
- Photons 30–250 keV, 1953–1956	79–81	0.002
- Photons and Electrons, 1957–1991	85–154	3.536
▪ Occupational Medical Dose	NA	–
Internal Dose:		
- U, Th, Po, Pa, Ac, and Ra Alpha Dose	155–202	0.590
Total		**23.360**

NA = Not applicable in this case

3.2 SC&A'S EVALUATION OF NIOSH'S REWORKED EXTERNAL DOSE ASSIGNMENT

There were no records of the EE being monitored while employed at the LCP.

3.2.1 External Photon Dose - Plant

For external exposures in the plant area, SC&A derived the photon doses using a DCF of 1.00 for the skin, as per ORAUT-OTIB-0017 (ORAUT 2005, page 6).

1953 Plant Photon Dose

For this period, the external doses were derived using the dose value (1.85 R/year) in Table 4-24, page 65, of ORAUT-TKBS-0025, Rev. 03 (for a [redacted]) multiplied by the DCF of 1.000. An example of SC&A's photon dose calculations for the skin for 1953 is as follows:

30–250 keV photon dose = (Table 4-24 dose) × DCF × Energy fraction
30–250 keV photon dose = 1.85 rem × 1.000 × 1.0 = 1.850 rem

This is compared to 1.650 rem in entry #2 of the IREP Input table; a NIOSH/SC&A value of 1.650/1.850 = 0.892.

1954–1991 Plant Photon Dose

For this period, the external doses were derived using the dose value (0.068 rem/year) in Section 6.2, page 70, of ORAUT-TKBS-0025, Rev. 03 (for [redacted]) multiplied by the skin DCF of 1.000. An example of SC&A's photon dose calculations for the skin for 1954 is as follows:

30–250 keV photon dose = (0.068 rem) × DCF × Energy fraction
30–250 keV photon dose = 0.068 rem × 1.000 × 1.0 = 0.068 rem

This is compared to 0.061 rem in entry #3 of the IREP Input table; a NIOSH/SC&A value of 0.061/0.068 = 0.892.

SC&A derived a total plant photon dose of **4.434 rem** compared to the NIOSH-assigned dose of **3.955 rem** in entries #2–#40 of the IREP Input table; a NIOSH/SC&A value of 0.892.

Finding #1: NIOSH Used an Incorrect Skin DCF for Plant Photon Dose

SC&A found that NIOSH used a skin DCF of 0.892 from OCAS-IG-001 (OCAS 2007), page 58, instead of 1.00 recommended in ORAUT-OTIB-0017 (ORAUT 2005), page 6. Although the [redacted] exposure Section 6.4 of ORAUT-TKBS-0025, Rev. 03 (ORAUT 2012a), page 76, recommends using external ambient DCFs (which for skin is 0.677) to assign organ dose, this appears to apply only to [redacted] exposures, and not to the general plant exposures, as this is not recommended in the other sections of the TBD. SC&A noted that for the other case (#[Claim A]) previously analyzed above for PER-042, for the photon doses from the plant, the DR used the correct exposure DCF of 1.244 for the prostate; however, ORAUT-OTIB-0017 (ORAUT 2005) should override OCAS-IG-001 (OCAS 2007) concerning skin DCFs for plant exposures.

This error would not significantly impact the dose assigned, or the final POC in this case.

3.2.2 External Electron Dose - Plant

For external non-penetrating (NP) exposures in the plant area, SC&A derived the electron doses using a DCF of 1.00 for the skin.

1953 Plant Electron Dose
For this period, the external NP doses were derived using the beta dose value (2.610 rem/year) in Table 4-24, page 65, of ORAUT-TKBS-0025, Rev. 03 (for a [redacted]) multiplied by the DCF of 1.000. An example of SC&A's photon dose calculations for the skin for 1953 is as follows:

30–250 keV photon dose = (Table 4-24 beta dose) × DCF × Energy fraction.
30–250 keV photon dose = 2.610 rem × 1.000 × 1.0 = 2.610 rem

This is compared to 2.610 rem in entry #12 of the IREP Input table; a NIOSH/SC&A value of 1.00.

1954–1991 Plant Electron Dose
For this period, the external doses were derived using the dose value (0.326 rem/year) in Section 6.2, page 70, of ORAUT-TKBS-0025, Rev. 03 (for [redacted]) multiplied by the DCF of 1.000. An example of SC&A's electron dose calculations for the skin for 1954 is as follows:

>15 keV electron dose = (0.326 rem) × DCF × Energy fraction
>15 keV electron dose = 0.326 rem × 1.000 × 1.0 = 0.326 rem

This is compared to 0.326 rem in entry #41 of the IREP Input table, a NIOSH/SC&A value of 1.00.

SC&A derived a total plant electron dose of **12.388 rem** compared to the NIOSH-assigned dose of **12.388 rem** in entries #41–#78 of the IREP Input table; a NIOSH/SC&A value of 1.00, which is in agreement.

SC&A had no findings in this section.

3.2.3 External Ambient Photon and Electron Doses – Tunnels

The EE would be considered a [redacted]; therefore, the EE potentially spent time in the [redacted] at the LCP. For external dose exposures in the [redacted], ORAUT-TKBS-0025, Rev. 03, page 76, recommends using the ambient organ DCF, which is 0.677 for the skin, according to OCAS-IG-001 (OCAS 2007), page 58.

1954–1956 Tunnel Dose
For this period, the external doses were derived using the dose value (0.001 rem/year) in Table 6-13, page 70, of ORAUT-TKBS-0025, Rev. 03 (for a [redacted]). An example of SC&A's photon and electron dose calculations for the skin for 1954 is as follows:

30–250 keV photon dose = (Table 6-13 gamma dose) × DCF × Energy fraction
30–250 keV photon dose = 0.001 rem × 0.677 × 1.0 = 0.001 rem

This matches the 0.001 rem assigned in entry #79 of the IREP Input table.

>15 keV electrons = (Table 6-13 beta dose) × DCF × Energy fraction
>15 keV electrons = 0.093 rem × 1.00 × 1.0 = 0.093 rem

This matches the 0.093 rem assigned in entry #82 of the IREP Input table.

1957–1991 Tunnel Dose
For this period, the external doses were derived using the dose value (0.003 rem/year) in Table 6-13, page 70, of ORAUT-TKBS-0025, Rev. 03 (for a [**redacted**]). An example of SC&A's photon dose calculations for the skin for 1957 is as follows:

30–250 keV photon dose = (Table 6-13 gamma dose) × DCF × Energy fraction.
30–250 keV photon dose = 0.003 rem × 0.677 × 1.0 = 0.002 rem

This matches the 0.002 rem assigned in entry #85 of the IREP Input table.

>15 keV electrons = (Table 6-13 beta dose) × DCF × Energy fraction.
>15 keV electrons = 0.099 rem × 1.00 × 1.0 = 0.099 rem

This matches the 0.099 rem assigned in entry #86 of the IREP Input table.

SC&A derived a total external photon plus electron tunnel dose of **3.817 rem**, which matches the total dose assigned in entries #79–#154 of the IREP Input table shown in Appendix A-2 of this report.

SC&A had no findings in this section.

3.2.4 Neutron Dose

According to ORAUT-TKBS-0025, Rev. 03, page 70, there was no significant neutron exposure during the EE's employment period at the LCP; therefore, NIOSH did not assign neutron dose for this EE.

SC&A had no findings in this section.

3.2.5 Occupational Medical Dose

According to ORAUT-TKBS-0025, Rev. 03, page 67, x-ray exams were performed off site at a non-covered facility during the EE's employment period at the LCP; therefore, NIOSH did not assign medical x-ray dose for this EE.

SC&A had no findings in this section.

3.3 SC&A'S EVALUATION OF NIOSH'S REWORKED INTERNAL DOSE ASSIGNMENT

There were no records of the EE being bioassayed while employed at the LCP.

3.3.1 Internal Dose

For internal dose assignment, the inhalation and ingestion intake values (for Ra-226, Th-230, U-238, U-235, and U-234) from Table 6-8, page 73, for [**redacted**] workers for the period 1954–1991 were used; additionally, the intake values (for U-234, Th-230, Ra-226, Po-210, Pa-231, and Ac-227) for the plant from Table 6-2 (inhalation), page 68, and Table 6-3 (ingestion), page 69, for the period 1970–1991 were used. These intake values were entered into the CADW and the annual doses determined using the solubility that produced the maximum dose. A total internal dose of **0.590 rem** was derived, which matches the dose assigned to the skin in entries #155–#202 of the IREP Input table shown in Appendix A-2 of this report.

SC&A had no findings in this section.

3.4 SC&A'S REVIEW OF DCAS-PER-042 ISSUES RELATED TO CASE #[**CLAIM B**]

This was a partial DR because complete internal dose could not be reconstructed, as per the LCP SECs. SC&A derived a total dose **23.839 rem**, which produced a POC of **11.56**% (compared to NIOSH's assigned dose of **23.360 rem** and POC of **10.73%**).

SC&A evaluated NIOSH's reworked DR and found that NIOSH used the correct protocol to assign external and internal doses in this case, except for one finding where NIOSH applied the skin ambient DCF for photon dose at the plant, when a DCF of 1.00 should have been used according to ORAUT-OTIB-0017 (ORAUT 2005).

4.0 SUMMARY CONCLUSIONS

Under SC&A's *A Protocol to Review NIOSH's Program Evaluation Reports (PERs)* (SC&A 2009), Subtask 4 requires the audit of DR case(s) as a result of the PER under review. For DCAS-PER-042 (DCAS 2012), there were 71 cases that met the applicable criteria.

During the August 28, 2014, PRSC meeting, SC&A was tasked with evaluating the appropriate cases concerning the application of DCAS-PER-042.

This report satisfies the Subtask 4 requirement. For the two cases selected from the 71 cases impacted by DCAS-PER-042, SC&A provided an overview of the case and a brief review of NIOSH's dose estimates. Because of the extensive changes in the revised TBD, SC&A then provided a complete analysis of the DR of the 2 cases using Rev. 03 of ORAUT-TKBS-0025 (ORAUT 2012a).

As discussed in Section 2, SC&A found that NIOSH did correctly apply the appropriate doses as recommended by DCAS-PER-042 (DCAS 2012) using ORAUT-TKBS-0025, Rev. 03, for Claim #[**Claim A**]. In Section 3, Claim #[**Claim B**], SC&A found that NIOSH applied the appropriate doses as recommended by DCAS-PER-042 using ORAUT-TKBS-0025, Rev. 03, except for the photon dose from the plant. It is SC&A's understanding that NIOSH should have used the skin DCF of 1.00, as per ORAUT-OTIB-0017 (ORAUT 2005), instead of the ambient DCF of 0.892 from OCAS-IG-001 (OCAS 2007); this small error, however, has a small impact on the doses assigned and the final POC in this case.

5.0 REFERENCES

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OCAS 2007. *External Dose Reconstruction Implementation Guideline*, OCAS-IG-001, Rev. 03, National Institute for Occupational Safety and Health, Office of Compensation Analysis and Support, Cincinnati, Ohio. November 21, 2007.

ORAUT 2005. *Technical Information Bulletin: Interpretation of Dosimetry Data for Assignment of Shallow Dose*, ORAUT-OTIB-0017, Rev. 01, Oak Ridge Associated Universities Team, Cincinnati, Ohio. October 11, 2005.

ORAUT 2012a. *Technical Basis Document for the Linde Ceramics Plant*, ORAUT-TKBS-0025, Rev. 03, Oak Ridge Associated Universities Team, Cincinnati, Ohio. July 26, 2012.

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APPENDIX A-1: CASE #[CLAIM A] NIOSH'S IREP INPUT TABLE

[The IREP Input Tables in this appendix have been redacted in full in accordance with the Privacy Act.]

APPENDIX A-2: CASE #[CLAIM B] NIOSH'S IREP INPUT TABLE

[The IREP Input Tables in this appendix have been redacted in full in accordance with the Privacy Act.]