



DCAS-PER-092, Subtask 4: Review of Two Reworked Cases for the Evaluation of DCAS-PER-092

Ron Buchanan, PhD, CHP

Advisory Board on Radiation and Worker Health,
Subcommittee for Procedure Reviews

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Weldon Spring facilities

- ◆ Weldon Spring Plant (WSP), Weldon Spring Quarry (WSQ), and the Weldon Spring Raffinate Pits (WSRP)
- ◆ Referred to as the Weldon Spring Plant in general
- ◆ Operated by the U.S. Atomic Energy Commission as a feed materials plant to process uranium and thorium ore by the Uranium Division of Mallinckrodt Chemical Works

Four periods of operation

1. Site acquisition and development, 1954–1957
2. Operational, 1957–1966
3. Post-operational, 1967–1985 – U.S. Department of Defense (DoD), not the U.S. Department of Energy (DOE), controlled:
 - WSP during the post-operational period 1967–1985
 - WSRP and WSQ during 1967–1974
4. Remediation, 1985–2002

EEOICPA coverage

- ◆ WSP employment is covered:
 - Operational period (1957–1966)
 - Remediation period (1985–2002)
- ◆ WSQ and WSRP employment is covered:
 - Operational period (1957–1966)
 - Post-operational period (1975–1984)
 - Remediation period (1985–2002)

Radionuclides of dose significance

- ◆ Natural uranium processed 1957–1962
- ◆ After 1962, all uranium is assumed to be enriched to 1%
- ◆ Natural thorium
- ◆ Recycled uranium processed beginning in 1961
- ◆ Rn-222 and Ra-228 considered to be potentially significant for dose reconstruction (DR)

Weldon Spring environmental dose site profile

- ◆ ORAUT-TKBS-0028-4, rev. 00, issued June 28, 2005
- ◆ ORAUT-TKBS-0028-4, rev. 01, issued May 17, 2013
- ◆ ORAUT-TKBS-0028-4, rev. 02, issued March 29, 2017
- ◆ ORAUT-TKBS-0028-4, rev. 03, issued September 8, 2017
- ◆ ORAUT-TKBS-0028-4, rev. 04, issued March 27, 2020

Weldon Spring environmental dose program evaluation reports (PERs)

- ◆ DCAS-PER-051, issued March 4, 2015, to address changes in DR procedures using ORAUT-TKBS-0028-4, rev. 01
- ◆ DCAS-PER-083, issued January 7, 2019, to address changes in DR procedures using ORAUT-TKBS-0028-4, rev. 03
- ◆ DCAS-PER-092, issued March 29, 2021, to address changes in DR procedures using ORAUT-TKBS-0028-4, rev. 04

TKBS-0028-4, rev. 04 changes that could increase assigned doses

- ◆ Environmental intakes of Rn-222 and Ra-228 were added for 1963 through 1966
- ◆ U-234 intakes were added for the Weldon Spring Quarry for the years 1990, 1991, 1993–1996, and 1998–2001
- ◆ Onsite ambient gamma doses from 1957 to 1966 were previously applied as a constant value, but rev. 04 included geometric standard deviation (GSD) values that are to be applied to the lognormal distribution

SC&A's review of PER-092, tasks 1–3

- ◆ February 15, 2022 – Advisory Board on Radiation and Worker Health Subcommittee for Procedure Reviews (SPR) tasked SC&A to review DCAS-PER-092, “Weldon Spring Plant”
- ◆ June 9, 2022 – SC&A issued “A Review of NIOSH’s Program Evaluation Report DCAS-PER-092, ‘Weldon Spring Plant’” to fulfill tasks 1 through 3

Subtask 4: Conduct audits of a sample set of reevaluated DRs impacted by PER-092

- ◆ SPR tasked SC&A with a review of representative cases
- ◆ November 2, 2022 – NIOSH provided SC&A with two cases
- ◆ December 28, 2022 – SC&A provided a written report of the results of DR audit under subtask 4 to the SPR

Subtask 4: Selection of cases

- ◆ Criterion for selection of cases:
 - Criterion 1: environmental intakes of Rn-222 and Ra-228 during all or part of 1963–1966
 - Criterion 2: environmental intake of U-234 at the WSQ during all or part of 1990, 1991, 1993–1996, and/or 1998–2001
 - Criterion 3: onsite external ambient gamma dose during all or part of 1957–1966

Subtask 4 – Two cases from NIOSH

- ◆ Case A met criterion 1 and criterion 3
- ◆ Case B did not meet:
 - Criterion 1 or criterion 3 because the energy employee (EE) was not employed at WSP during 1957–1966, and
 - Criterion 2 was not applicable because the maximum U-234 intake for the EE's employment period was greater for WSP compared to WSQ
- ◆ NIOSH stated that there were no claims with environmental U-234 intakes assigned from the WSQ

Case A dose reconstruction

- ◆ EE worked throughout the site during one covered year
- ◆ Initial DR performed in 2006 for several cancers
- ◆ DR revised in 2018 because the EE was diagnosed with additional cancers
- ◆ DR was again revised in November 2020 as a result of the issuance of ORAUT-TKBS-0028, rev 04.

Case A: Assessment of external ambient dose

2018 DR:

- ◆ Calculated external ambient dose using the median gamma dose value 0.123 rem per year from table 4-4 of ORAUT-TKBS-0028-4, rev. 03, for the year of covered employment
- ◆ Dose assigned using a constant distribution with no uncertainty in the IREP input tables

2020 reworked DR:

- ◆ Calculated external ambient dose using the median gamma dose value 0.123 rem per year from table 4-5 of ORAUT-TKBS-0028-4, rev. 04, for the year of covered employment
- ◆ dose assigned using a lognormal distribution with a GSD of 3.160 in the IREP input tables

SC&A's evaluation of case A external ambient dose assignment

- ◆ SC&A concurs with NIOSH dose assignments for most of the cancers
- ◆ However, SC&A had an observation

SC&A's evaluation of case A external ambient dose assignment – observation 1

- ◆ **Observation 1: NIOSH did not use environmental dose conversion factor (DCF) for the non-skin cancer**
 - 2020 DR assigned the external ambient dose using a DCF of 1.0 for the non-skin cancer
 - According to TKBS-0028-4, rev. 04, section 4.3.3, the isotropic exposure geometry is to be used for external ambient dose and the exposure (R)-to-organ DCF is to be used for the operational period (1957–1966)
 - An overestimate of 0.057 rem was assigned

Case A: Assessment of internal environmental dose

2018 DR:

- ◆ Calculated internal doses using environmental intake values given in table 4-3 of ORAUT-TKBS-0028-4, rev. 03, for U-234, Th-228, Th-230, Th-232, Pu-239, Pu-241, Am-241, Np-237, Tc-99, Ru-106, Zr-95, Nb-95, Sr-90, and Ra-222
- ◆ Assigned total internal doses using a lognormal distribution with a GSD of 3.0 in the IREP input tables

2020 reworked DR:

- ◆ Calculated internal doses using environmental intake values given in table 4-4 of ORAUT-TKBS-0028-4, rev. 04, for the same radionuclides as used in 2018 DR
- ◆ Assigned larger total internal doses using a lognormal distribution with a GSD of 3.0 in the IREP input tables

SC&A's evaluation of case A internal environment dose assignment

- ◆ Compared the data and parameters used in NIOSH's Chronic Annual Dose tools (CADs) to the values recommended in table 4-4 of TKBS-0028-4, rev. 04, and found them to be correct
- ◆ Found the annual dose values correctly entered in the IREP input tables, using a lognormal distribution with a GSD of 3.0
- ◆ SC&A did have an observation about several of the cancers' dose assignments.

SC&A's evaluation of case A internal environment dose assignment – observation 2

- ◆ **Observation 2: NIOSH did not always incorporate the date of cancer diagnosis**
 - For earlier cancers, the DR calculated doses using the CAD dose information from the last cancer
 - The DR included the entire year of internal dose for the year the cancer was diagnosed, rather than prorating the annual dose to the appropriate date of the earlier cancer diagnoses
 - This resulted in assigning approximately an extra 0.001 rem to each of the cancer sites other than the last cancer

Case B dose reconstruction

- ◆ EE worked throughout the site for several years
- ◆ Initial DR performed in October 2010
- ◆ DR revised in December 2010 because the EE was diagnosed with additional cancers
- ◆ DR was again revised in November 2020 as a result of the issuance of ORAUT-TKBS-0028, rev 04

Case B: Assessment of external ambient dose

2010 December DR:

- ◆ Calculated overestimate of external ambient doses using the median gamma dose values of 0.123 rem per year from table 4-12 of ORAUT-TKBS-0028-4, rev. 00, adjusted for an exposure time of 80 hours per week, prorated for the employment years
- ◆ Dose assigned using a constant distribution with no uncertainty in the IREP input tables

2020 reworked DR:

- ◆ Calculated external ambient doses using the maximum average gamma dose values from table 4-7 of ORAUT-TKBS-0028-4, rev. 04, assuming a more reasonable 2,500 hours of exposure per year (per CATI information), prorated for the employment years
- ◆ Dose was assigned using a constant distribution with no uncertainty in the IREP input tables

SC&A's evaluation of case B external ambient dose assignment

- ◆ SC&A concurs with the numerical dose values NIOSH assigned
- ◆ However, SC&A had one observation and one finding about the dose assignments

SC&A's evaluation of case B external ambient dose assignment – observation 3

- ◆ **Observation 3: NIOSH did not incorporate the diagnosis date for one of the cancers for external ambient dose**
 - It appears that NIOSH assigned the external ambient dose for the entire year to one of the cancers
 - However, one of the cancers was diagnosed in the middle of the year
 - This resulted in an additional 0.018 rem being assigned

SC&A's evaluation of case B external ambient dose assignment – finding 1

- ◆ **Finding 1: NIOSH assigned ambient external dose with a constant distribution**
 - NIOSH assigned the ambient external doses for all cancers with a constant distribution and no uncertainty in the IREP input tables
 - Section 4.4 of TKBS-0028-4, rev. 04, recommends for the post-operational external doses, the onsite ambient dose be represented as a normal distribution with a GSD of 30%
 - Annual dose values in table 4-7 of TKBS-0028-4, rev. 04, are the maximum of the average dose values for the different facilities at the site (not the 95th percentile)
 - SC&A believes that the environmental external doses should have been assigned with a normal distribution
 - SC&A reworked the DR assigning external ambient dose using a normal distribution with a GSD of 30% and derived a slightly greater combined POC value

Case B: Assessment of internal environmental dose

2010 December DR:

- ◆ Calculated internal doses using environmental intake values in table 4-7 of ORAUT-TKBS-0028-4, rev. 00, for uranium, assigned as U-234, and recycled uranium components
- ◆ Assigned total internal doses using a lognormal distribution with a GSD of 3.0 in the IREP input tables

2020 reworked DR:

- ◆ Calculated internal doses using environmental intake values in table 4-4 of ORAUT-TKBS-0028-4, rev. 04, for U-234, Th-228, Th-230, Th-232, Pu-239, Pu-241, Am-241, Np-237, Tc-99, Ru-106, Zr-95, Nb-95, Sr-90, and Ra-222
- ◆ Assigned greater total internal doses to each of the cancer sites using a lognormal distribution with a GSD of 3.0 in the IREP input tables

SC&A's evaluation of case B internal environmental dose assignment

- ◆ Compared the data and parameters used in NIOSH's CADs to the values recommended in table 4-4 of TKBS-0028-4, rev. 04, and found them to be correct
- ◆ Found annual dose values were correctly entered in the IREP input tables, using a lognormal distribution with a GSD of 3.0
- ◆ SC&A did have one observation about one of the cancers

SC&A's evaluation of case B internal environmental dose assignment – observation 4

- ◆ **Observation 4: NIOSH did not incorporate the date of diagnosis for one of the cancers for environmental internal dose**
 - For one of the cancers, the date of diagnosis was incorrectly entered in the CAD as 12/31/2001 instead of the correct diagnosis date
 - This resulted in an over-assignment of dose of ~0.001 rem

Summary of SC&A's evaluation of rework of two cases

- ◆ SC&A concludes that the doses for case A and case B were reevaluated in accordance with the requirements of DCAS-PER-092, which addresses changes in ORAUT-TKBS-0028-4, rev. 04
- ◆ SC&A identified one finding in which the DR appeared to derive a slight underestimate of POC values
- ◆ SC&A identified four observations that indicated slight overestimates of dose
- ◆ Since the combined POC value was very low for each case, none of these observations would impact the outcomes of the cases



Questions?

References

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