SC&A's Evaluation of ORAUT-TKBS-0016-5, Revision 03, "Mound Plant – Occupational Internal Dose"

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ORAUT-TKBS-0016-5

ORAUT-TKBS-0016-5, technical basis document (TBD)-5, issued:

- September 9, 2004: Revision 00
- March 13, 2009: Revision 00 PC-1
- December 13, 2010: Revision 01
- April 18, 2013: Revision 02
- March 3, 2017: Revision 03

TBD-5 reviews

- **July 16, 2006:** SC&A issued review of TBD-5, revision 00
- **May 25, 2012:** SC&A issued matrix summarizing site profile issues in conjunction with Special Exposure Cohort (SEC) review
  - Total of 21 issues (findings)
- **February 11, 2016:** SC&A issued review of TBD-5, revision 02, and found five issues remained open:
  - Matrix Issue 5, Plutonium (Pu)-240, Pu-241
  - Matrix Issue 6, Tritides
  - Matrix Issues 11, 12, and 13, Internal dosimetry data completeness
- **April 20, 2016:** Per Board Review System, work group reviewed and closed remaining matrix issues 5, 6, 11, 12, and 13
- **April 27, 2016:** National Institute for Occupational Safety and Health (NIOSH) issued matrix summarizing their respond to previous issues
- **January 16, 2026:** SC&A issued review of TBD-5, revision 03

2026 TBD-5 review

In the 2026 review, SC&A focused on:

- Identifying changes in TBD-5, revision 03, compared to revision 00
- Tables, equations, and dose reconstruction (DR) recommendations in TBD-5, revision 03

Identifying changes in TBD-5, revision 03, section 5.1, compared to revision 00

Introduction section contained expanded information and added several subsections:

- 5.1.1: Purpose
- 5.1.2: Scope: Added information, part of which states that revision 03 does not contain guidance to reconstruct doses at Dayton Laboratory facilities or for dates earlier than February 1949
- 5.1.3: Special Exposure Cohort (SEC): Added new section concerning SEC for Mound Plant (MP) workers, along with effective dates covering period 1949–1980

Identifying changes in other sections of TBD-5, revision 03, compared to revision 00

Sections added or updated:

- 5.3.8: Added new section concerning the rare radioactive isotope program
- 5.4.4: Added new table 5-4 concerning in vivo counting systems and minimum detectable activities (MDAs)
- 5.7.2: Updated and expanded MDA information for fecal samples in table 5-8
- 5.8.2: Expanded weapons-grade plutonium information
- 5.8.2.1: Updated and expanded use of MP alternate dissolution model for Pu-238
- 5.8.2.2: Added new section concerning considerations for type SS Pu-239 (super slow absorption rate that ultimately changes the results of biometrics)
- B.6: Condensed information concerning solubility and lung clearance type compared to attachment 5A in revision 00
- B.7: Condensed information concerning radionuclide use by location compared to attachment 5B in revision 00

Summary of identifying changes

SC&A compared TBD-5, revision 03, to revision 00 and found:

- In general, both revisions contained approximately the same information
- Some information was organized differently in revision 03 compared to revision 00, with revision 03 containing additional/updated information where appropriate, for example:
  - Introduction, Purpose, Scope, SEC sections added
  - Rare radioactive isotope program section added
  - Tables with MDA values for in vivo counting and fecal samples added

SC&A's review of tables in TBD-5, revision 03

- Reviewed tables in revision 03 for technical content and compared them to corresponding tables in revision 00
- Reviewed Site Research Database (SRDB) documents referenced in TBD-5 to determine accuracy of tables in general
- Found tables correct, with exceptions discussed on slides 9–15

Observation 1: Detection limit not same as MDA

- Table 5-3 states, “blanks counted, detection limits (MDAs) quantified”
- Text indicates detection limit is same as minimum detectable activity (MDA)
  - Is not always true and subject of further discussions in other observations contained in this review

Observation 2: Term "MDA" used to replace detection limit values

- Table 5-6 uses the term "MDA" to replace the term "detection limit" but uses same numerical values as were used in table 5-4 of TBD-5, revision 00
- Several references in section 5.5.3 of TBD-5, revision 03, indicate:
  - Lower detection limit (LDL) value is not equal to MDA value
  - MDA values are greater than LDL values
  - An MP document (MJW Corporation [MJW], 2002) uses the term "lower limit of detection" (Ld) and defines MDA as shown on the next slide

Example equation for MDA

$$MDA = Ld/(2.2 \times E \times Y)$$

- When counting efficiency (E) is assumed to be 0.50 and chemical yield (Y) is 0.85:
  - Value of MDA (picocurie per liter) is equal to 1.1 times value of Ld (counts per minute)
  - In that case, the value of MDA is approximately equal to LDL or Ld
- But this would not be true for other counting efficiencies and chemical yields:
  - Meyer (1992) lists detector counting efficiency of 0.30; this would result in an MDA equal to 1.8 times the value of Ld

Observation 3: Term used to describe detection limits represents a mixture of Ld, LDL, and MDA

- Tables 5-15, 5-7, 5-17, and 5-18 use the term “detection limits” in revision 00
- Corresponding tables 5-15, 5-17, 5-18, and 5-19 use the term “MDA” in revision 03
- SC&A reviewed referenced documents for these tables and found that terms used to describe detectable limits were a mixture of Ld, LDL, and MDA

Observation 4: Reference not provided

SC&A could not locate any references in TBD-5, revision 03, for the radon-222 working level month values recommended in table 5-20

Finding 1: Apparent error in equation and/or text (table 5-21, first equation)

- Table 5-21: First equation for polonium-210 (Po-210), for 1944–1963, states:

  Daily Excretion Po-210 = Po cpm/0.5 × 0.85/0.1 × 1400 mL/Aliquot mL

  (where mL is milliliter; cpm is count per minute)

- An extraction efficiency of 0.86 is given in section 5.9.10 and in footnote d of table 5-21
- However, an extraction efficiency of 0.85 is used in both equations in table 5-21 and recommended by Meyer (1992)

Finding 1: Apparent error in equation and/or text (table 5-21, second equation)

- Table 5-21: Second equation, for 1964–1973, states:

  Daily Excretion Po-210 = Po cpm/0.5 x 0.85/0.1 x 1400 mL/Aliquot mL

- In this equation, the correction factor for chemical recovery of 0.1 should be 0.63 according to section 5.9.10 and table 5-21, footnote d

Comments concerning other tables

- SC&A reviewed tables in TBD-5, revision 03, in detail
- Besides the four observations and one finding previously stated, some general notes regarding the addition or deletion of information in tables are provided in section 4.1.6 of SC&A's 2026 report
- SC&A found these modifications to be correct and useful for DR purposes

SC&A's review of equations used in TBD-5

- Reviewed equations 5-1 through 5-14 and found them to be technically correct and same as those presented in TBD-5, revision 00
- Identified no findings or observations concerning equations in revision 03 of TBD-5

SC&A's review of dose reconstruction recommendations in TBD-5

- Found in general DR recommendations are summarized and implicit in contents of the tables, which SC&A has verified
- However, some explicit DR recommendations are provided in text of TBD-5
- Section 4.3 of SC&A's 2026 report summarizes DR recommendations, including the assignment of various radionuclides and their MDA values
- Did not identify any findings or observations concerning DR recommendations in TBD-5, revision 03

SC&A's evaluation of commitments to modify TBD-5

- Reviewed previous TBD and SEC internal dose issues that NIOSH had committed to resolve by making modifications to TBD-5
- These issues and their potential resolutions are summarized on slides 20–24

Matrix issue 5: Pu-240, Pu-241

- This was a remaining action item identified in SEC matrix
- NIOSH was to confirm a bounding intake for Pu-241 for use in DR program, and MP work group closed issue
- Resolution: SC&A finds the revised and new information in table 5-11 of TBD-5, revision 03, fulfills this commitment

Matrix issue 6: Tritides

- During MP work group discussion of this SEC issue, NIOSH acknowledged that some consideration was needed by dose reconstructors of stable metal tritides
- Resolution: NIOSH has determined that this small increment of dose does not increase probability of causation for even the most affected workers
- SC&A reviewed this explanation and finds it fulfills this commitment

Matrix issues 11, 12, and 13: Internal dosimetry data completeness, polonium bioassays

- Issue: uncertainties and low recovery for polonium bioassay procedures
- The work group reviewed and closed matrix issues 11, 12, and 13 on April 20, 2016
- April 27, 2016: NIOSH's matrix summarized their response to previous issues:
  - Issue 13: Polonium bioassay corrections are summarized in equations 5-4 and 5-5 of TBD-5, revision 03, and are to be used by dose reconstructor to reconcile polonium urinalysis data
- SC&A finds:
  - This is essentially the same information provided in TBD-5, revision 00
  - This information does provide the dose reconstructor with DR instructions

Matrix issues 11, 12, and 13: Internal dosimetry data completeness, fecal bioassays

- Issue: fecal bioassay data
- Resolution: SC&A finds the revised and new information in table 5-8 of TBD-5, revision 03:
  - Addresses alpha-emitting radionuclides at MP
  - Provides MDA values
  - Provides additional information for DR
  - Fulfills NIOSH's commitment to provide addition information

Matrix issues 11, 12, and 13: Internal dosimetry data completeness, tritium data

- Issue: tritium data comparison
- Resolution: per TBD-5, revision 03:

  For 1957 onward, the listed and zero doses may be used, with equation 5-2, to assign a dose only when dose overestimates are appropriate. If they are not appropriate, it is necessary for the dose reconstructor to review tritium logbooks for the employee's name for the years in question and to assign dose from tritium bioassay or missed dose based on these records instead.
- SC&A agrees with NIOSH's response and finds this commitment has been fulfilled

Conclusions

SC&A reviewed contents, tables, equations, and DR recommendations in MP TBD-5, revision 03, and identified four observations and one finding summarized as follows:

- Observation 1: Detection limit not same as MDA
- Observation 2: Term “MDA” used to replace detection limit values
- Observation 3: Term used to describe detection limits represents a mixture of Ld, LDL, and MDA
- Observation 4: Reference not provided
- Finding 1: Apparent error in equation and/or text

Questions?

References

Meyer, H. E. (1992). *History of Mound bioassay programs, volume 1* (MLM-MV-93-93-0003). EG&G Mound Technologies, Mound Facility, Miamisburg, Ohio. SRDB Ref. ID 1962

MJW Corporation. (2002). *Pre-1989 dose assessment project, phase I final report, volume 1*. Williamsville, New York. SRDB Ref. ID 8739