Review of ORAUT-RPRT-0097 for Breathing Zone to General Area Air Concentration Ratios in Small Workrooms

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ORAUT-RPRT-0097 purpose

- NIOSH evaluated the relationship between breathing zone (BZ) to general area (GA) air concentration ratios for the purpose of determining inhalation intakes of workers when their respective bioassay data are not available
- BZ:GA ratios are used to determine if adjustments to the GA air concentrations are needed to make them equivalent to BZ air concentrations in a radiological workspace

RPRT-0097 overview

- BZ air concentrations represented air breathed by workers and GA air concentrations represented air in a radiological workspace
- Respirable airborne radioactive material
  - In an ideal situation, the air concentration measured at any location within a room would be the same as having the BZ:GA ratio = 1
  - Complete air mixing rarely occurs, resulting in nonhomogeneous air concentrations measured at various locations within the room resulting in the BZ:GA ratios distribution shifting away from 1
- BZ:GA air concentration ratio information should be justified on a case-by-case basis due to the large number of potential parameters and scenarios influencing BZ and GA air concentrations within a workroom

RPRT-0097 parameters with the scope of this report that affect BZ:GA

Parameters affecting the level of mixing of an aerosol

- Room size (in terms of room area)
- Aerosol particle distribution
- Room ventilation ratio
- Room complexity

Parameters affecting the BZ:GA ratio distribution

- Sampler location and radioactive aerosol release point locations
- Low-number concentrations of dominant aerosol particles in a workroom. NIOSH does not recommend using this parameter for developing BZ:GA ratios

RPRT-0097 methodology

- Air sample data were evaluated from 5 air sampling studies for workrooms areas ranged from 190 ft^2 to 1,130 ft^2
- Aerosol size particles up to 10.5 µm were evaluated because only respirable size particles <20 µm contribute to worker inhalation intakes
- Two worker location scenarios were assumed to determine the distribution of BZ:GA ratios
- BZ:GA ratios for these scenarios were determined by fitting BZ:GA ratio distribution datasets with lognormal models using regression on order statistics (ROS), generating a geometric mean (GM) and geometric standard deviation (GSD) for each model

NIOSH's RPRT-0097 worker location scenarios

Scenario 1

- The worker and the aerosol release point are always located at the same X, Y coordinates in a room.
- This scenario generally applies to acute exposure and represents the worst-case scenario that yield the highest BZ:GA ratios.

Scenario 2

- The worker and the aerosol release point are not necessarily located at the same X, Y coordinates in a room.
- The potential BZ locations have the same probability of being located anywhere in the room.
- This scenario represents most radiological processing areas that have multiple workstations and workers moving around in a room. BZ:GA ratio distributions resulting from scenario 2 would usually be more appropriate for assessing chronic exposure scenarios.

RPRT-0097 statistical analysis

- NIOSH performed Monte Carlo simulations to combine datasets from each study to create a single dataset for BZ location scenarios 1 and 2
- The scenario 1 dataset was further subdivided into open and obstructed workspaces in the middle of the room to understand their impact on BZ:GA ratios

Combined BZ:GA ratio distributions evaluated by NIOSH

Scenario for aerosols	BZ:GA ratio GM	BZ:GA ratio GSD
Scenario 1 – open workspaces	1.39	3.27
Scenario 1 – obstructed workspaces	12.0	4.11
Scenario 1 – open and obstructed workspaces	2.95	5.03
Scenario 2 – open and obstructed workspaces	1.08	4.02

RPRT-0097 BZ:GA ratio application

- If the use of the BZ:GA ratio distribution can be justified, NIOSH provides guidance to select the most appropriate ratio from the evaluated BZ:GA ratio distributions table based on whether the exposure scenario is best represented by scenario 1 or scenario 2
- The GA air sample result for a workroom is then multiplied by the appropriate BZ:GA ratio distribution to make the measured air concentrations equivalent to BZ air concentrations in a radiological workroom

RPRT-0097 conclusions about scenario 1

- **Scenario 1 – open workspaces:** BZ:GA ratios did not indicate a significant difference between the BZ:GA ratios when the room is generally open in the middle.
- **Scenario 1 – obstructed workspaces:** BZ:GA ratios can be significantly higher when the room has a lot of obstructions in the middle.
- **Scenario 1 – open and obstructed workspaces:** BZ:GA ratios indicated a significant difference between the BZ:GA ratios when the room is generally open in the middle rather than when the room has significant obstructions in the middle. Therefore, it might be more appropriate to use a BZ:GA ratio based only on the data from rooms with obstructions in the middle.

RPRT-0097 conclusions about scenario 2

Scenario 2 – open and obstructed workspaces:

- BZ:GA ratios did not indicate a significant difference between the BZ:GA ratios when the room is generally open in the middle versus when the room has a lot of obstructions in the middle.
- No special consideration is warranted for this scenario.

RPRT-0097 conclusions about ventilation rates

Individual and combined BZ:GA ratio distributions for scenarios 1 and 2 indicate that ventilation rates for six different air change (AC) rates per hour (6, 9, 10, 12, 15, and 90 AC/hr) have no significant effect on the BZ:GA ratio distribution.

SC&A's review of RPRT-0097

- SC&A found the approach used in RPRT-0097 to develop a sampling plan to be reasonable and technically correct.
- SC&A agreed with the two worker location scenarios to adjust the site-specific GA air concentrations to make them equivalent to BZ air concentrations.
- SC&A found the statistical methods used in the sampling plan to be acceptable. SC&A additionally provided an expanded discussion of the effects that changes in variable parameters could have on the results.
- SC&A did not identify any documentation issues that would affect the readability or application of the sampling plan.

SC&A's review of RPRT-0097 approach to BZ:GA concentration ratios

- SC&A is satisfied that the NIOSH's selection of 5 studies is adequate and representative of the population of available data
- SC&A did not identify any issues with the general approach used by NIOSH in RPRT-0097 to determine BZ:GA concentration ratios in small workrooms

SC&A's review of RPRT-0097 statistical methods

- SC&A evaluated statistical methods that generated BZ:GA ratios for radiological exposure scenarios. BZ:GA ratios are generated by fitting BZ:GA ratio distributions for each of the evaluated exposure scenario datasets with lognormal models using ROS.
- SC&A concluded that statistical methods for developing the BZ:GA ratio distributions to generate GM and GSD values are appropriate.

SC&A's observation 1

Observation 1: Needs guidance for when data are insufficient to select a scenario

- If sufficient data are not available to the dose reconstructor, NIOSH should instruct the user to select the most claimant-favorable values
- SC&A questions whether the dose reconstructor will have access to the data required to make a reasonable decision about the appropriate scenario to use on a case-by-case basis

SC&A's observation 2

Observation 2: Needs guidance to document professional judgements

- NIOSH specified that it is the responsibility of the dose reconstructor to justify their decisions
- The guidance in RPRT-0097 should explicitly state that these professional decisions be included in the dose reconstruction documentation

Summary of SC&A's review of RPRT-0097

- SC&A found the technical approach, statistical analysis, application, and documentation used to develop RPRT-0097 to be valid
- SC&A identified 2 observations about the application of RPRT-0097:
  - **Observation 1:** SC&A questions whether the dose reconstructor will have access to the data required to make a reasonable decision about the appropriate scenario to use on a case-by-case basis
  - **Observation 2:** The guidance in RPRT-0097 should explicitly state that these professional decisions be included in the dose reconstruction documentation

Questions?