Review of NIOSH Response to SC&A Comments on ORAUT-RPRT-0090

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To the Advisory Board on Radiation and Worker Health ORNL (X-10) Work Group

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Introduction

- **1955 to 1988:** 213 “exotic radionuclides” were produced by the Isotopes Division and its predecessors at ORNL.
- **March 2018:** NIOSH issued ORAUT-RPRT-0090, rev. 00, “Monitoring Feasibility Evaluation for Exotic Radionuclides Produced by the Oak Ridge National Laboratory Isotopes Division.”

Summary of RPRT-0090

- States that ORNL had adequate monitoring capabilities for 179 of the 213 radionuclides.
- RPRT-0090, table 7-4, summarized the 34 remaining radionuclides that needed additional evaluation:
  - 28 different radionuclides
  - 5 iodine radionuclides
  - 1 plutonium radionuclide (only at Y-12, not ORNL)

Evaluation of RPRT-0090

- **October 2018:** SC&A's review of RPRT-0090 identified seven findings and six observations.
- **June 2020:** NIOSH responded to SC&A's evaluation report in a response paper.

Finding 1

The scope of RPRT-0090 needs to be clearly defined

Finding 1: SC&A summary of NIOSH response

- The scope of RPRT-0090 was purposely limited to the production of radioisotopes by the Isotopes Division on both the ORNL and Y-12 footprints.
- RPRT-0090 was not intended to be an evaluation of whether a co-exposure model type approach could be developed for every single radionuclide.

Finding 1: SC&A response

- SC&A accepts NIOSH's clarification regarding the limited scope of RPRT-0090, which would exclude treatment of decontamination and decommissioning (D&D), construction, and maintenance activities that may encompass the facilities in question.
- SC&A recommends closure.

Finding 2

Incomplete radionuclide and radioisotope facility inventory

Finding 2: SC&A summary of NIOSH response

- The discrepancies indicated by SC&A are generally related to the scope of the document: the isotopes produced by the isotopes group versus a more general analysis of the overall radionuclide inventory at ORNL.
- The inventory listing was developed independently of the facility list and was related to isotope group activities across the site.

Finding 2: SC&A response

- SC&A accepts the clarifications provided by NIOSH in table 1 of its response and notes that an explanation will be added to the next revision of RPRT-0090 regarding the scope of the radionuclide inventory included.
- SC&A recommends closure.

Finding 3

Attachment A in vitro bioassay methods lack information about actual implementation

Finding 3: SC&A summary of NIOSH response

- NIOSH intends RPRT-0090 to be a review of the isotopes handled by the isotopes production group in comparison to the available bioassay capability.
- Although not all available data on sporadically produced radionuclides will be of sufficient quantity to allow for their use in a co-exposure model, this alone is not indicative that a potential exposure could not be bound with sufficient accuracy.

Finding 3: SC&A response

- Review of dosimetry capability, while necessary to validate that measurement techniques were technically acceptable and available, is not sufficient to address the feasibility of dose reconstruction.
- Identifying the number of samples devoid of exposure potential considerations over 30+ years of Isotope Division production arguably would not satisfy DCAS-IG-006.

Finding 3: SC&A recommendation

- At the very least, RPRT-0090 needs a weight-of-evidence approach to validate that monitoring took place (or was not necessary) for operational time periods that lacked recorded sampling or where sampling was sparse (e.g., 1 or 2 samples).
- SC&A recommends that this finding remain open.

Finding 4

Feasibility of monitoring 28 radionuclides not adequately addressed

Finding 4: RPRT-0090 evaluation of 28 radionuclides

- The “red”-shaded blocks in tables 7-2 and 7-3 mean:

  A specific radionuclide was present in inventory in the specified year, but an additional analysis was necessary to determine if the nuclide represented an infeasibility from a monitoring perspective.

- Table 7-6 uses derived air concentration (table 7-5) to illustrate the maximum organ dose for a hypothetical intake.

Finding 4: SC&A summary of NIOSH response to bioassay data

- The implementation of the monitoring program is indicated by the availability of the bioassay cards showing results for the respective methods.
- Any available bioassay data could be used to assign doses to a claimant.
- Additional review of available records and monitoring procedures will be ongoing using the data available in the SRDB.

Finding 4: SC&A summary of NIOSH response to gaps

- NIOSH's 2020 response paper presents some supplemental information to address some of the gaps in the data in table 7-6 of RRPT-0090.

Finding 4: SC&A response

- Although the resulting organ doses in table 7-6 from a hypothetical intake are not alarming, they do not appear insignificant for a potential unmonitored exposure.
- The derived doses do not directly address the monitoring feasibility question.
- The additional data in NIOSH's response do not address the monitoring feasibility question.

Finding 4: SC&A conclusion

- SC&A finds that the question of “if the nuclide represented an infeasibility from a monitoring perspective” remains relevant and that it was not specifically and completely addressed in sections 7.2 or 8.0 of RPRT-0090, or NIOSH’s 2020 response.
- SC&A recommends that this finding remain open.

Finding 5

1955 and 1956 intakes may not be bound by earlier coworker data

Finding 5: SC&A summary of NIOSH response

- 1956 releases (66,700 Ci) compared to 1947 releases (64,200 Ci) are within the measurement uncertainty in the data (i.e., estimates in releases differ by less than 4%).
- NIOSH responded to various SC&A concerns for finding 5 by clarifying the three primary justifications for co-exposure estimates:
  - Bioassay comparison
  - In vivo comparison
  - Air concentration guideline comparison

Finding 5: Original concerns re bioassay comparison

- Original SC&A concern:
  - Urinalysis samples primarily after period of interest
  - Unclear when highest samples were taken or under what circumstances
- NIOSH response:
  - Co-exposure estimates are done using thyroid monitoring, bioassay included for comparison
  - Dates and circumstances provided for highest measurements

Finding 5: SC&A position re bioassay comparison

- SC&A position:
  - Notes that comparison of data from one period to another requires the establishment of similar working conditions/exposure potential
  - Agrees there is no indication to date that conditions would result in theoretical bioassay an order of magnitude higher than those measured in later periods

Finding 5: Concerns re in vivo comparison

- Original SC&A concern:
  - In vivo comparison was a measurement taken at the end of the period of interest (1962)
  - Is it appropriate to back extrapolate that result for comparison?
- NIOSH response: Co-exposure estimates are done using thyroid monitoring; in vivo result provided for comparison to demonstrate a bounding co-exposure approach
- SC&A position:
  - Concurs in the context of comparison purposes
  - Notes (in general) caution must be used when back extrapolating data from one period to another even for comparison

Finding 5: Original concerns re air concentration limit comparison

- Original SC&A concern:
  - Air concentration data only in summary form (individual measurements and locations are unknown)
  - Are there specific locations where air concentrations may have exceeded the operating level and how often?
  - Site profile indicates maximum operating level was ~50% higher than projected air concentration from co-exposure estimate
- NIOSH response:
  - Air concentration comparison is to the allowable operating levels, not the actual measurements
  - Site profile contains an error in maximum allowable air concentration levels and will be corrected

Finding 5: SC&A position re air concentration limit comparison

- Maintains it is important to obtain and evaluate the actual air concentration measurements to determine if limits were exceeded (and if so, when and where)
- Believes the original site profile may not be in error
- Original historical records of maximum allowable air concentrations are unclear and require further discussion

Finding 5: Maximum allowable air concentrations

II. Maximum Permissible Values for Beta, Gamma and Alpha Contamination

Type of Contamination	Permissible Levels	Indication of Magnitude Smear, c/m[a] β γ	α
Air concentration	3×10^{-11} α μc/cc[b]		
Without masks	10^{-8} β,γ μc/cc[c]		
With filter type masks (gray cannister)	10^{-8} α μc/cc[b]		
	10^{-5} β,γ μc/cc[c]		
With positive air supply masks	10^{-8} α μc/cc[b]		
	10^{-5} β,γ μc/cc[c,d]		

Source: Sadowski, G. S. (1953, March 9). *Control of radiation exposure in the ORNL pilot plant* (ORNL 53-3-47). SRDB Ref. ID 103344

Finding 5: SC&A summary position

- SC&A agrees that differences in stack emissions from RaLa production were small when comparing the highest years (1947 and 1956).
- SC&A believes uncertainty still exists and that care must be exercised to assure extrapolation of co-exposure estimates are bounding.
  - Past precedent in EEOICPA suggests that when uncertainty exists, modification factors are used to assure bounding exposure estimates.
  - Example: Somewhat arbitrary factor of 10 applied in section 7.2 of RPRT-0090 to “ensure a conservative evaluation.”

Finding 6

Adequacy and implementation of in vivo bioassay program not addressed

Finding 6: SC&A summary of NIOSH response

- NIOSH believes that the volume of available monitoring data, including analysis for nonroutine radionuclides, as shown in RPRT-0090, table 4.3 (Bioassay code 000 with monitored nuclide, 1955–1988), demonstrates the capability to monitor exposure to the wide range of materials present. However, NIOSH did not intend to include a review of program implementation in RPRT-0090.

Finding 6: SC&A response

- SC&A considers this finding subsumed under finding 3 and recommends closure of this issue.

Finding 7

Unclear treatment of post-1988 monitoring capability during abandonment, deactivation, and decontamination and decommissioning phases

Finding 7: SC&A summary of NIOSH response

- The point of RPRT-0090 was to assess the feasibility of monitoring nuclides produced by the isotopes group during production operations.
- While such analysis is outside the scope of the document, it would seem credible that it would be feasible to bound exposures to the same set of radionuclides during D&D periods after 1988 with modern dosimetry methods.

Finding 7: SC&A response

- SC&A accepts this clarification, as noted in the response to finding 1.
- SC&A recommends closure of this finding.

Observation 1

Inventory discrepancy

Observation 1: SC&A summary of NIOSH response

- Inventory of radionuclides processed by the isotopes group was developed through a review of published sales records.
- The spreadsheet that SC&A refers to represents the compilation of that document review.
- NIOSH updated the radionuclide inventory based on a review of logbooks. This review resulted in the addition of radionuclides and years.

Observation 1: SC&A response

- Discrepancies that SC&A identified were additional radionuclides or years appearing in table 7-2.
- SC&A concurs that additional radionuclides or years from logbooks added to the X-10 inventory spreadsheet would explain the discrepancies in inventory between table 7-2 in RPRT-0090 and NIOSH's X-10 inventory spreadsheet.

Observation 1: SC&A conclusion

- SC&A finds this observation clarified and recommends closure.

Observation 2

Specific alpha-emitting radionuclide needs to be identified for dose reconstruction (DR)

Observation 2: SC&A summary of NIOSH response

- The original X-10 bioassay cards are provided by ORNL for individual claimants and are the basis for DR.
- The X-10 database is not used for dose reconstruction purposes.

Observation 2: SC&A response

- Considering NIOSH's clarification that the X-10 database will not be used for individual DR, SC&A concurs with NIOSH's response.
- If the X-10 database will not be used in coworker intake modeling without further consideration of specific alpha-emitting radionuclides, then SC&A finds this observation has been clarified and recommends closure.

Observation 3

Trans-plutonium radionuclides may need further analyses

Observation 3: SC&A summary of NIOSH response

- ORAUT-TKBS-0012-5 identifies americium-241 (Am-241) as the default assumption for trans-plutonium (TPO) bioassay results.
- Of the 20 radionuclides detectable by the TPO method, only two have a higher organ dose conversion factor (DCF) (curium-248 and californium-249) than Am-241.
- Am-241 inventory is much greater than the inventory for either of these two radionuclides.

Observation 3: SC&A response

- Considering the DCFs and inventory amounts of TPOs, SC&A finds that using Am-241 as the default radionuclide (if other information is not available) would be a reasonable assumption.
- SC&A finds this observation clarified and recommends closure.

Observation 4

Use of gross beta or gamma count data could result in underestimate of assigned dose

Observation 4: SC&A summary of NIOSH response to the Ru-106 issue

- The “green” shading for ruthenium-106 (Ru-106) in table 7-3 (p. 34) is indicating the presence of bioassay data, but no results for these methods were present in 1975, 1978, and 1986–1988.
- This was an editing error. In the revised RPRT-0090, table 7-3 will shade “yellow” the indicated years for Ru-106.

Observation 4: SC&A response to the Ru-106 issue

- SC&A concurs with NIOSH's response to the ruthenium-106 issue and agrees that the issue can be resolved by NIOSH making changes in the next revision of RPRT-0090.

Observation 4: SC&A summary of NIOSH reply to beta/gamma data

- X-10 bioassay cards are provided for claimants and are the basis for DR.
- Claimant's records for specific radionuclides that were monitored are available for use in claimant-specific DR.
- Specific adjustments based on individual radionuclides would be outside the scope of RPRT-0090.

Observation 4: SC&A response to the beta/gamma data issue

- NIOSH does not appear to have addressed the following issues:
  - the appropriate radionuclide and counting efficiency to be used in a given DR when the bioassay card lists gross beta or gamma counts (if this occurs)
  - the appropriate radionuclide to assign when the bioassay card lists results in dpm or microcurie without a specific radionuclide

Observation 4: SC&A conclusion

- Although RPRT-0090 is not intended to be a guide for DR, addressing the information that will be needed for DR for radionuclides from Isotope Production is appropriate when evaluating RPRT-0090.
- SC&A recommends that this observation remain open.

Observation 5

The results in table 7-6 depend on inventory used

Observation 5: SC&A summary of NIOSH response

- As indicated in observation 1, the spreadsheet SC&A referred to contained only the results of the review of Isotope Group sales/inventory data.
- Additional research was conducted for radionuclides in table 7-6 when information was incomplete. Information on the inventory discrepancies is provided in table 3, p. 12, of NIOSH's 2020 response.

Observation 5: SC&A response

- SC&A evaluated NIOSH's 2020 response and the additional information in table 3 (p. 12).
- SC&A analyzed the additional data and references and concurs with NIOSH's response that addresses the issues summarized in table 3 of SC&A's 2018 review concerning table 7-6 of RPRT-0090.

Observation 5: SC&A conclusion

- SC&A finds that this observation has been addressed and recommends closure.

Observation 6

Additional information comparing RaLa production information to commercial operations should be provided

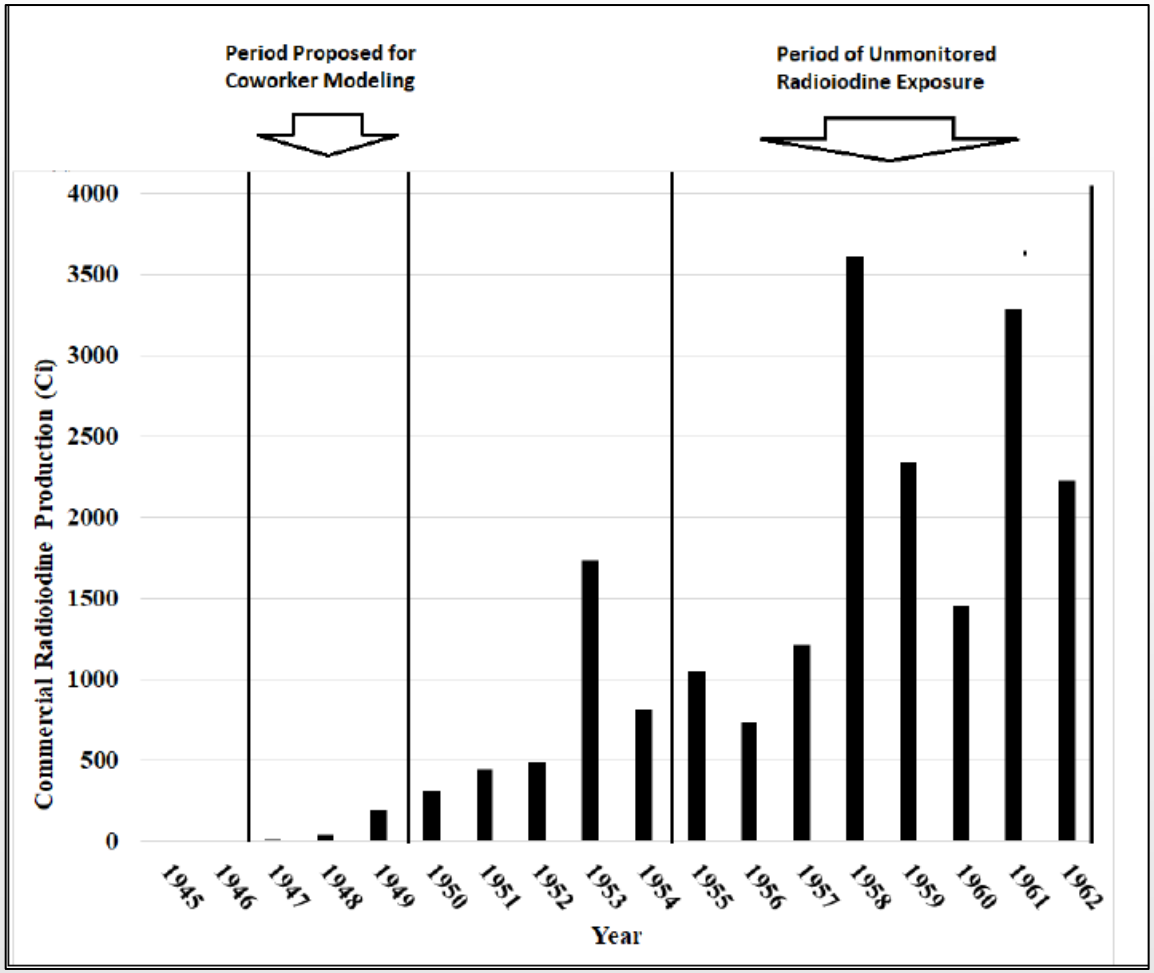
Observation 6: SC&A summary of NIOSH response

- NIOSH agrees that RaLa radioiodine production and commercial radioiodine production are different.
- Both activities were done in the same areas with the same radiological controls.
- Unlikely workers (1955–1962) were exposed to levels that would have triggered the monitoring program.

Observation 6: SC&A response

- Extrapolating exposure estimates from one period to another requires careful comparison of operations.
  - Implementation criteria (IG-006) require comparison of operations even when combining multiple years for co-exposure analysis
  - Production output for commercial operations 1956–1962 (limited monitoring data) was significantly higher than commercial output 1947–1949 (proposed co-exposure period)
- Contention that workers (1956–1962) were not exposed to levels that would have triggered monitoring cannot be evaluated.
  - Limited monitoring data 1956–1962
  - Reason for applying co-exposure estimates for 1947–1949

Observation 6: Comparison of radioiodine production



SC&A

Observation 6: Additional consideration

- Unclear if commercial operations are relevant to EEOICPA.
- Does not appear the operations (commercial versus DOE) can be separated.
- Dose reconstruction requirements when commercial operations are present may need clarification.

Questions?