MEMORANDUM

TO: Subcommittee on Procedures Review
FROM: SC&A, Inc.
DATE: October 20, 2016
SUBJECT: Y-12 ORAUT-OTIB-0013 and ORAUT-PROC-0042 Findings and Resolutions

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Introduction and Background

NIOSH has issued the following four documents concerning coworker doses and adjustments to coworker doses for individual Y-12 workers:

- ORAUT-OTIB-0013 (hereafter "OTIB-0013"), *Individual Dose Adjustment Procedure for Y-12 Dose Reconstruction* (ORAUT 2004a)
- ORAUT-PROC-0042 (hereafter "PROC-0042"), *Accounting for Incomplete Personal Monitoring Data on Penetrating Gamma-Ray Doses to Workers in Radiation Areas at the Oak Ridge Y-12 Plant Prior to 1961* (ORAUT 2004b)
- ORAUT-OTIB-0044 (hereafter "OTIB-0044"), *Historical Evaluation of the Film Badge Dosimetry Program at the Y-12 Facility in Oak Ridge, Tennessee: Part 1 – Gamma Radiation* (ORAUT 2013a)
- ORAUT-OTIB-0064 (hereafter "OTIB-0064"), *Coworker External Dosimetry Data for the Y-12 National Security Complex* (ORAUT 2013b)

OTIB-0044 of 2013 replaced OTIB-0013 of 2004 for individual workers' dose adjustments, and OTIB-0064 of 2013 replaced PROC-0042 of 2004 for coworker dose assignments.

Procedures Review Subcommittee Meeting – May 16, 2016

During the Procedures Review Subcommittee (PRSC) Meeting of May 16, 2016, SC&A was tasked with determining if previous SC&A OTIB-0013 findings (SC&A 2007) had been addressed by the replacement document OTIB-0044, if the findings were no longer applicable, or if the findings were carried over to OTIB-0044. Additionally, SC&A was tasked with determining if previous SC&A PROC-0042 findings (SC&A 2007) had been addressed by the replacement document OTIB-0064, if the findings were no longer applicable, or if the findings were carried over to OTIB-0064.

SC&A's Evaluation of OTIB-0013 Findings and Their Resolutions

There were originally five SC&A findings for OTIB-0013 (referred to as "review objectives" in SC&A 2007). The following is a brief summary of these findings and their resolutions. (The text of the findings is taken from the Board Review System [BRS 2016a].)

Finding 1

> *There are areas where the data are not clearly defined or there are conflicts in the years stated: (1) It is not clear from the text why there are solid green dots representing measured doses in Figure 1 for the period 1956–1960. (2) It is not clear from the OTIB for what time period these dose adjustment factors are to be applied, due to conflicting statements in the document.*

Resolution: Concerns with Figure 1 in OTIB-0013 have been addressed in Section 7.5 of OTIB-0044. Other areas have been clarified by previous responses, and some areas are no longer applicable because OTIB-0013 has been canceled, and the findings did not carry over into OTIB-0044. Based on SC&A's review of OTIB-0044, we find that this issue has been adequately addressed and recommend closure.

Finding 2

> *(1) Periods when most of the recorded dosimetry data were not available or not usable for deriving a dose distribution were not specifically mentioned in this OTIB to inform the dose reconstructor what data was and was not used to obtain the coworker dose distribution data. (2) An incorrect LOD value used when the worker's dose = 0, the laboratory minimum LOD of 40 mrem should at least be used in this analysis.*

Resolution: (1) OTIB-0044 clarifies the use of data from 147 workers (page 9). (2) This item has been resolved, and the PRSC closed this finding during its May 16, 2016, meeting (BRS 2016).

Finding 3

> *The method for applying the estimated scaling factors is based on the assumption that the individual's potential for exposure during the 1950s is similar to that from 1961 to 1965, and that the individual's doses differ from the coworker population dose by a constant factor both in the later years when data are available for comparison and in the earlier unmonitored years. However, no evidence is presented to support these assumptions. Moreover, under the proposed procedure the most uncertain scaling factors, estimated for the individuals with only five quarters of data, are then applied to the largest number of unmonitored quarters, compounding the effects of uncertainty. Despite the mathematically correct use of maximum likelihood methods for estimating the scaling factors, the constancy of the scaling factors over time and the application of such factors to possibly inappropriate distributions in the early years are not adequately addressed.*

Resolution: OTIB-0013 is no longer in use, and OTIB-0044 has replaced it. SC&A's concern with the scaling factors has been addressed in OTIB-0044, Sections 7.4 and 7.5. Based on SC&A's review of OTIB-0044, we find that this issue has been adequately addressed and recommend closure.

Finding 4

> *OTIB-0013, Table 2, indicates a discontinuity in the dose assignment function at low and zero doses, i.e., in the 0–10 mrem range.*

Resolution: NIOSH responded by stating that the scaling factor is to adjust upward the standard unmonitored dose for a worker; doses in the 0–10 mrem range would not be relevant for scaling. SC&A agreed with NIOSH's response. The PRSC closed this issue on December 9, 2008.

Finding 5

> *Incorrect use of Scaling Factor terminology in Workbook, etc. There is a misuse of terminology that could result in incorrect dose assignment if the dose reconstructor is not familiar with the intent of both OTIB-0013 and PROC-0042. This stems from using the term "scaling factor" interchangeably for f and for exp(f).*

Resolution: OTIB-0013 and its workbook are no longer in use; OTIB-0044 has replaced them. The OTIB-0064 coworker model for Y-12 is based on ORAUT-OTIB-0020, *Technical Information Bulletin: Use of Coworker Dosimetry Data for External Dose Assignment,* Revision 03 (ORAUT 2011), and not on scaling factors, such as those used in OTIB-0013. Based on SC&A's review of OTIB-0044, we find that this issue has been adequately addressed and recommend closure.

SC&A's Evaluation of PROC-0042 Findings and Their Resolutions

There were originally six SC&A findings for PROC-0042 (referred to as "review objectives" in SC&A 2007). The following is a brief summary of these findings and their resolutions. (The text of the findings is taken from the Board Review System [BRS 2016b].)

Finding 1

> *Generally, the OTIB was written in a fairly clear and logical manner. However, there are several areas that could be improved to assist the dose reconstructor in understanding the different stages of development of the dose reconstruction instructions. Additionally, some wording and errors contained in the text create confusion and require several rereads, and/or assumptions to be made, to clarify the issues.*

Resolution: OTIB-0064 is a complete rewrite of the Y-12 coworker procedure compared to PROC-0042 and, therefore, does not contain the same text errors and clarification issues identified by SC&A for PROC-0042. Additionally, the purpose and scope of using coworker data are outlined in Section 2.0, page 7, of OTIB-0064.

SC&A recommends closing this issue.

Finding 2

> *The OTIB was generally written in a prescriptive manner. However, several areas could be improved. (1) In Section 5, page 4, the dose reconstructor is not provided with definite instructions on how to evaluate the monitoring data from the 1940s and 1950s. Reference*

to problems during this era and appropriate OTIBs would be helpful. (2) Section 6.3, page 9, instructs the dose reconstructor to use the "Microsoft® Excel® computer program and Crystal Ball®," and Section 6.4, page 10, instructs the dose reconstructor to perform steps to calculate the scaled annual distributions for organ doses. Both instructions are without a definite reference to the name of the programs and/or workbooks to be used. This could cause incorrect dose reconstruction results if the wrong programs and/or workbooks were used, or inconsistencies between different dose reconstructors.

Resolution: OTIB-0064 is a complete rewrite of the Y-12 coworker procedure compared to PROC-0042, does not contain the same methodologies, and does not use the scaling factors for which SC&A identified issues in PROC-0042. Therefore, this finding is not applicable to OTIB-0064.

SC&A recommends closing this issue.

Finding 3

It is not stated in this document that the dose data for the years 1947–1956 (3rd quarter) in Table 5.1, page 5, are not actually from badged workers' dose records. In fact, these values are inferred doses from regression analyses of 147 badged workers at Y-12 for the period of 1956–1965. ORAUT-RPRT-0032 [ORAUT 2005] *must be analyzed to understand the development of this data. This may be an acceptable method to use in view of the lack of actual, reliable, recorded dose data for 1947–1956, but it should be clearly stated in the procedure that this is the case and not presented as actual dose of record. The second paragraph on page 4 of the procedure only refers to "the estimated parameters for lognormal distributions derived for each calendar quarter for July 1947 to December 1965 (ORAUT-OTIB-0013)," but not to the origin of the dose data.*

Resolution: OTIB-0064 is a complete rewrite of the Y-12 coworker procedure compared to PROC-0042. Where data from the 147 badged workers at Y-12 are used, they are identified as such on pages 34 and 35 of OTIB-0064. Therefore, this finding is not applicable to OTIB-0064.

SC&A recommends closing this issue.

Finding 4

For this procedure to be considered claimant favorable in instances where claimants were not monitored, there are a number of assumptions/limitations that have to be accepted. These assumptions/limitations are not necessarily explicitly pointed out in detail in the procedure, and links/references to other documents must sometimes be followed to fully evaluate the applicability and technical soundness of this document.

Resolution: OTIB-0064 is a complete rewrite of the Y-12 coworker procedure compared to PROC-0042. Assumptions, applications, and limitations are provided in OTIB-0064, such as on pages 7, 8, 14, and 15. Therefore, this finding is not applicable to OTIB-0064.

SC&A recommends closing this issue.

Finding 5

Most of this procedure employed scientifically valid protocols for reconstructing doses. However, some technical errors were found in the text that could lead to errors in the assigned dose errors, if used as stated in the procedure. (1) The procedure appears to contain a technical error in applying the scaling factor. This error would not result in an underestimate of a worker's dose, but could result in a worker that had average, or below average, recorded doses during 1961–1965 being assigned a higher dose during 1947–1960 than another worker that has greater than average recorded doses during 1961–1965. (2) Additionally, change the title of Section 6.2, page 8, from Use of calculated scaling factors greater than unity to Use of calculated scaling factors greater than zero. This is needed because the scaling factor appears in the exponent (GM = eu+f) in calculating the scaled value of the geometric mean. Therefore, it must be zero to apply a multiplication factor of 1.0 to the dose. These paragraphs, and the associated errors, do not appear in the other related OTIBs and RPRT.*

Resolution: OTIB-0064 is a complete rewrite of the Y-12 coworker procedure compared to PROC-0042, does not contain the same methodologies, and does not use scaling factors for which SC&A identified issues in PROC-0042. Therefore, this finding is not applicable to OTIB-0064.

SC&A recommends closing this issue.

Finding 6

The procedure appears to contain a technical error in applying the scaling factor. This error would not result in an underestimate of a worker's dose, but could result in a worker that had average, or below average, recorded doses during 1961–1965 being assigned a higher dose during 1947–1960 than another worker that has greater than average recorded doses during 1961–1965. To correct this error, the last paragraph on Page 6 should be changed from "…assume a scaling factor of unity (one) and use…" to "…assume a scaling factor of zero (0) and use…." Also, change the second paragraph on page 8 from:

…assume a scaling factor of unity (one) and use the "population dose distributions for monitored workers" in Table 5.1 as a reasonable but necessary claimant favorable procedure to generate data for input to the NIOSH-IREP Program. If a scaling factor is assumed to be unity (one) or a scaling factor for a monitored worker is calculated to be equal to or less than unity (one),…

to:

…assume a scaling factor of zero (0) and use the "population dose distributions for monitored workers" in Table 5.1 as a reasonable but necessary claimant favorable procedure to generate data for input to the NIOSH-IREP Program. If a scaling factor is assumed to be zero (0) or a scaling factor for a monitored worker is calculated to be equal to or less than zero (0),…

Additionally, change the title of Section 6.2, page 8, from: "Use of calculated scaling factors greater than unity" to: "Use of calculated scaling factors greater than zero"

This is needed because the scaling factor appears in the exponent (GM = eu+f) in calculating the scaled value of the geometric mean. Therefore, it must be zero to apply a multiplication factor of 1.0 to the dose.*

Resolution: OTIB-0064 is a complete rewrite of the Y-12 coworker procedure compared to PROC-0042, does not contain the same methodologies, and does not use scaling factors for which SC&A identified issues in PROC-0042. Therefore, this finding is not applicable to OTIB-0064.

SC&A recommends closing this issue.

Summary and Conclusions

In reviewing the original findings for OTIB-0013 and PROC-0042 in light of their replacement documents, OTIB-0044 and OTIB-0064, respectively, SC&A found that most of the previous findings are not applicable to the newer documents because of changes in methodology, application, and text. The remaining areas have been resolved or are corrected in the new documents. Therefore, SC&A suggests that the findings for OTIB-0013 and PROC-0042 be closed. However, SC&A was tasked with only addressing the previous findings in OTIB-0013 and PROC-0042 to determine if they are present in the newer documents. SC&A did not perform a technical evaluation of the replacement documents OTIB-0044 and OTIB-0064 or their application and appropriateness to dose reconstruction, as that would require additional tasking by the PRSC. Because the methods of deriving the adjustment factors and coworker doses in OTIB-0044 and OTIB-0064 are substantially different from those used in OTIB-0013 and PROC-0042, SC&A recommends that a full technical review of OTIB-0044 and OTIB-0064 be performed, especially an evaluation of the statistical methodology and results obtained.

References

BRS 2016a. *Rev. 00, Finding No and SC&A Page No: OTIB-0013-02 / 101–102,* Board Review System, Subcommittee on Procedures Review. May 16, 2016.

BRS 2016b. *Rev. 00, Finding No and SC&A Page No: PROC-0042-01 / 262,* Board Review System, Subcommittee on Procedures Review. June 8, 2016.

ORAUT 2004a. *Technical Information Bulletin: Individual Dose Adjustment Procedure for Y-12 Dose Reconstruction,* ORAUT-OTIB-0013, Revision 00, Oak Ridge Associated Universities, Cincinnati, Ohio. September 9, 2004.

ORAUT 2004b. *Accounting for Incomplete Personal Monitoring Data on Penetrating Gamma-Ray Doses to Workers in Radiation Areas at the Oak Ridge Y-12 Plant Prior to 1961,* ORAUT-PROC-0042, Revision 00, Oak Ridge Associated Universities Team, Cincinnati, Ohio. September 9, 2004.

ORAUT 2005. *Technical Information Bulletin: Individual Dose Adjustment Procedure for Y-12 Dose Reconstruction,* ORAUT-RPRT-0032, Revision 00, Oak Ridge Associated Universities, Cincinnati, Ohio. September 9, 2004.

ORAUT 2011. *Technical Information Bulletin: Use of Coworker Dosimetry Data for External Dose Assignment,* ORAUT-OTIB-0020, Revision 03, Oak Ridge Associated Universities Team, Cincinnati, Ohio. November 14, 2011.

ORAUT 2013a. *Historical Evaluation of the Film Badge Dosimetry Program at the Y-12 Facility in Oak Ridge, Tennessee: Part 1 – Gamma Radiation,* ORAUT-OTIB-0044, Revision 01, Oak Ridge Associated Universities, Cincinnati, Ohio. April 29, 2013.

ORAUT 2013b. *Coworker External Dosimetry Data for the Y-12 National Security Complex,* ORAUT-OTIB-0064, Revision 02, Oak Ridge Associated Universities, Cincinnati, Ohio. April 29, 2013.

SC&A 2007. *Review of NIOSH/ORAUT Procedures and Methods Used for Dose Reconstruction, Review of the Third Set of Procedures (45 Procedure Reviews),* SC&A, Inc., Vienna, Virginia, and Saliant, Inc., Maryland. October 29, 2007.