



MEMO

DATE: March 24, 2015
TO: Subcommittee on Procedures Review, NIOSH, Ted Katz, DFO
FROM: U. Hans Behling
SUBJECT: Review of NIOSH's Response to DCAS-PER-045 Findings

Relevant Background Information

On April 16, 2014, SC&A was tasked by the Advisory Board's Subcommittee on Procedures Review to conduct reviews of three PERs, which included DCAS-PER-045, *Aliquippa Forge TBD Revision* (DCAS 2013).

In August 2014, SC&A submitted its draft report, *A Review of NIOSH's Program Evaluation Report DCAS-PER-045, "Aliquippa Forge TBD Revision"* (SC&A 2014). In the draft report, SC&A identified two observations and eight findings.

In response to SC&A's observations and findings, NIOSH prepared a document dated January 23, 2015, which is enclosed herein as Attachment #1.

During a teleconference meeting of the Procedures Subcommittee on February 18, 2015, SC&A was tasked to review and comment on NIOSH's responses enclosed herein as Attachment #1.

SC&A's Response and Resolution to Findings

A review of the eight (8) findings cited by SC&A identifies the fact that all findings relate to assumed model parameters/methodology used by NIOSH to derive annual **internal** exposures (from inhalation and ingestion) and **external** exposures (from penetrating and non-penetrating) exposures to **residual radioactivity** from 1950–1995, as defined in Table 5-1 of ORAUT-TKBS-0021, Rev. 01 (ORAUT 2012) and reproduced in Table 3 of SC&A 2014.

Relative to all of SC&A's findings, with the exception of Finding #4, are the following two issues: (1) NIOSH's derivation of the starting air concentration of 0.211 dpm/m^3 in 1950, and (2) the use of this value for deriving a source term depletion rate of $1.15 \times 10^{-4} \text{ d}^{-1}$, as given by the following explanation cited in Section 5.0 of ORAUT-TKBS-0021, Rev. 01 (ORAUT 2012) and reproduced in Section 4.2.2. of SC&A 2014:

*After the end of AEC rolling operations, a July 1949 survey was performed. The survey indicated that the **maximum** air dust concentration, **taken during normal operations in the Furnace area, was 5.9 $\mu\text{g}/\text{m}^3$ or 8.94 dpm/m³** (assuming a specific activity of 1.516 dpm/ μg for natural uranium) (Belmore 1949b).*

*To calculate internal exposure from residual activity the analysis assumed that **all buildings had an air concentration of 8.94 dpm/m³ in 1950**. This operational air concentration was assumed to have occurred for 1 year with no cleanup. An indoor **deposition velocity of 0.00075 m/s** was applied to calculate a 2.11×10^5 dpm/m² surface contamination level at the end of operations/start of the residual period. A **resuspension factor of $1 \times 10^{-6} \text{ m}^{-1}$** was applied to the surface contamination level, resulting in an air concentration of **0.211 dpm/m³**. A **source term depletion rate was calculated based on a starting air concentration in 1950 and the air concentration calculated based on the 1992 survey data (ORAUT 2012b)**. The 1992 calculated air concentration of **0.035 dpm/m³** was based on applying a resuspension factor of $1 \times 10^{-6} \text{ m}^{-1}$ (Abu-Eid et al. 2002) to the maximum removable surface contamination of **350 dpm alpha/100 cm²**. Using these two air concentrations, a source term depletion rate of **$1.15 \times 10^{-4} \text{ d}^{-1}$** was calculated. The ingestion intake rates were calculated using the method described in Section 3.0. The estimated daily inhalation and ingestion intake rates to residual radioactivity from AEC operations at the site (**Table 5-1**), were calculated by assuming that workers were exposed for 2,000 hr/yr. [Emphasis added.]*

SC&A's Finding #5 (see Attachment #1) questioned NIOSH's conversion of an **empirical air concentration of 8.94 dpm/m³ for 1950** to a revised "modeled" dose that at 0.211 dpm/m³ is 42-fold lower. Upon review of SC&A's Finding #5, NIOSH has agreed that "... the 1949 air sample itself [is] representative of the start of the residual period and will revise the site profile to **use 8.94 dpm/m³ as the starting point**." [Emphasis added.]

NIOSH's acceptance of 8.94 dpm/m³ as the starting air concentration for 1950 would, therefore, also change the derivation of the source term depletion rate from $1.15 \times 10^{-4} \text{ d}^{-1}$ to $3.58 \times 10^{-4} \text{ d}^{-1}$. In combination, acceptance of the empirical air concentration of 8.94 dpm/m³ and its use for deriving the source term depletion factor would not only impact all internal exposure estimates cited in Table 5-1 of the Aliquippa TBD, but also all external exposure estimates. To reconstruct penetrating external exposures from residual radioactivity, NIOSH employed the maximum reported exposure rate of 0.014 mR/hr for 1992 (Adams and Payne 1992) and back-extrapolated dose rates by the $1.15 \times 10^{-4} \text{ d}^{-1}$ source term depletion factor that had been derived inappropriately by means of the "modeled" 1949 air concentration value. Non-penetrating exposure estimates were determined by assuming a 5-to-1 ratio of non-penetrating to penetrating exposure rates during the residual exposure period.

In summary, it is SC&A's opinion that the use of the empirical air concentration of 8.94 dpm/m³ as the starting value for the residual period and its use for deriving the source term depletion rate will claimant-favorably address SC&A's concerns for Findings #1, #2, #3, #5, #6, #7, and #8.

With regard to Finding #4, SC&A still maintains that the reported air sample of 180 dpm/m³ for floor sweeping (enclosed herein as Exhibit #1) represents the highest empirically observed air concentration that is likely a bounding value. However, while "floor-sweeping" should not be considered an "unusual" activity, SC&A does agree that floor sweeping is likely a localized and episodic activity in day-to-day activities and may, therefore, not be representative of long-term steady-state conditions.

EXHIBIT #1: 1949 Belmore Memo (SRDB 9939)

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F. M. Belmore

July 28, 1949

H. Wisenbud

DECONTAMINATION OF VULCAN CRUCIBLE STEEL CO. AT WEST ALIQUIPPA PENNA.

Location	Alpha d/m (Zento)	Beta Counts mcp/hr
Winter Rest Area (Brick Floor)	3,000-4,500	5
Hearth Protection Plates	15,000-25,000	5-7
Guide Plates (2)	20,000	more than 20
Wooden Tool Cabinet	4,200	0.4
Small Wooden Bench	2,000-3,000	3-5
Vent Hoods	900-5,000	6-10
Dunps (Sheet Metal)		
Wipe Test - 12 sq. in.	nil	
Inside Vacuum System Pipe		0.8-1.0

Dust samples were taken during normal operations with the following results:

Rolling Area (south end)	4.7 micrograms per m ³
Near Mill	4.7 " " "
Furnace Area	5.9 " " "

During floor sweeping of the mill area the sample showed 119 micrograms per m³, this being the only sample in excess of the preferred level.

The sample from the mill cooling water sump measured 219 micrograms per liter which is of the order of a small multiple of background.

The above readings indicated that in general the decontamination procedures had been quite effective. Certain further steps should be taken and Mr. Flower agreed to have these taken care of right away, as follows:

1. Vacuum clean the tops of the furnaces used for the uranium work.
2. Remove dirt from top and vacuum clean the small brick floor area south of the rolling mills adjacent to the vacuum cleaning collector.

References

Abu-Eid, R.M., R.B. Codell, N.A. Eisenberg, T.E. Harris, and S. McGuire, 2002. *Re-Evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule*, NUREG-1720, Draft Report for Comment, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, DC, June. [SRDB Ref ID: 22400]

Adams, W. C., and Payne, J. L., 1992. *Characterization Survey of Portions of Aliquippa Forge Site West Aliquippa, Pennsylvania*, ORISE 93/A-6, Final Report, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee, December. [SRDB Ref ID: 6288]

Belmore, F.M., 1949b. "Decontamination of Vulcan Crucible Steel Co at West Aliquippa, Penna.," memorandum to M. Eisenbud, U.S. Atomic Energy Commission, July 28. [SRDB Ref ID: 9939]

DCAS 2013. *Aliquippa Forge TBD Revision 01*, DCAS-PER-045, NIOSH's Division of Compensation Analysis and Support, Cincinnati, Ohio. May 13, 2013.

ORAUT 2012. *Basis for the Development of an Exposure Matrix for Aliquippa Forge, Pennsylvania, Period of Operation: January 1, 1947 through February 28*, Rev. 01, ORAUT-TKBS-0021. Oak Ridge Associated Universities Team, Cincinnati, Ohio. April 26, 2012.

SC&A 2014. *A Review of NIOSH's Program Evaluation Report DCAS-PER-045 "Aliquippa Forge TBD Revision,"* SCA-TR-PR2014-0092, Rev. 0, SC&A, Inc., Vienna, Virginia. August 20, 2014.

ATTACHMENT #1: NIOSH's Responses to SC&A's Review of DCAS-PER-045

NOTICE: This report has been reviewed for Privacy Act information and has been cleared for distribution. However, this report is pre-decisional and has not been reviewed by the Advisory Board on Radiation and Worker Health for factual accuracy or applicability within the requirements of 42 CFR 82.

Responses to SC&A Review of DCAS-PER-045, *Aliquippa Forge TBD Revision*

**Response Paper
Rev. 0**

**National Institute for Occupational
Safety and Health**

January 23, 2015

Mutty Sharfi
Oak Ridge Associated Universities Team

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Reviewed by James W. Neton, Ph.D., CHP
Division of Compensation Analysis and Support

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OBSERVATION #1. NIOSH SHOULD REPHRASE THE ROLE OF ORAUT-OTIB-0070 IN SECTION 2.0 OF DCAS-PER-045.

NIOSH Response: NIOSH agrees that the revision to ORAUT-OTIB-0070 itself did not play a role in driving the PER; rather, it was the changes resulting from the incorporation of ORAUT-OTIB-0070 into the residual period methodology. The previous version of ORAUT-TKBS-0021 did not use ORAUT-OTIB-0070 in its assessment of the residual period for Aliquippa Forge because ORAUT-TKBS-0021 Rev 00 PC-1 was issued prior to the development of ORAUT-OTIB-0070. However, the inclusion of ORAUT-OTIB-0070 into the residual period methodology did result in an increase in dose for the residual period, and therefore, is a factor in the PER.

OBSERVATION #2. REVIEW OF RECORDS INDICATES THAT NEITHER REV. 00 NOR REV. 01 OF THE ALIQUIPPA FORGE TBD (ORAUT-TKBS-0021) WAS EVER REVIEWED/AUDITED BY SC&A.

NIOSH Response: No response needed.

FINDING #1. FAILURE TO ACCOUNT FOR A PREVIOUS D&D EFFORT.

NIOSH Response: The 1978 FUSRAP survey (SRDB 6325) reported all beta-gamma exposure levels at 1 meter as less than background (0.03 to 0.05 mR/hour). As this survey was performed prior to the 1988 interim remedial activities, it can be compared to the calculated 1978 residual annual external doses in ORAUT-TKBS-0021 Rev 01 to verify the impact of back-extrapolating a post-remediation result to prior years. For penetrating dose (gamma), the annual dose was 50 mrem; for non-penetrating dose (beta), the annual dose was 252 mrem. This results in a total beta-gamma exposure rate of 302 mrem per 2000 hours or 0.151 mrem/hour. Therefore, NIOSH considers the approach of back-extrapolating the maximum 1992 dose rate to be bounding and favorable and not impacted by the 1988 interim remedial activities.

FINDING #2. BACKWARD EXTRAPOLATION BY MEANS OF THE NIOSH-DERIVED SOURCE TERM DEPLETION FACTOR IS INAPPROPRIATE DUE TO IMPACTS ASSOCIATED WITH THE “INTERIM REMEDIAL ACTIVITIES” OF 1988.

NIOSH Response: As shown in the response to Finding #1, NIOSH feels that the use of the source-term depletion factor (based on the internal data) applied to the external data results in a bounding and favorable estimate of external doses. In addition, the fact that the maximum dose rate from the 1992 survey was used (rather than the 95th percentile or mean dose rate) also adds to the favorability of the assessment. Because the internal source-term depletion factor results in a more favorable, but not unrealistic, estimate of external dose, NIOSH feels this is an acceptable approach.

FINDING #3. USING NIOSH’S APPROACH FOR DERIVING INHALATION AND INGESTION RATES DURING THE RESIDUAL PERIOD, SC&A WAS UNABLE TO MATCH VALUES CITED IN TABLE 3 ABOVE (TABLE 5-1 OF ORAUT-TKBS-0021).

NIOSH Response: SC&A was able to match the starting point of the residual period. As stated in the TBD, the actual starting point of the residual period for the calculations was 1951, not 1950, because 1950 was a partial year, and therefore, just assumed to be equal to 1951. While SC&A used the 1992 data to calculate the inhalation intake rate for that year, the TBD only used the 1992 data to calculate the source-term depletion factor, then the 1992 source term depletion factor (0.179) was applied to the 1951 intake rate (0.627 pCi/d) to get the 1992 intake rate (0.112 pCi/d). Therefore, the slight discrepancy is a rounding difference in the application of the source-term depletion factor.

The difference in the ingestion intake rate is due to an error: the air concentration was not converted from dpm/m³ to pCi/m³. Therefore, NIOSH agrees that the ingestion intake rates in ORAUT-TKBS-0021 Rev 01 Table 5-1 are overestimated by a factor of 2.22 pCi/dpm. The TBD will be revised to correct this error.

FINDING #4. FAILURE TO ACKNOWLEDGE AND USE A REPORTED AIR SAMPLE THAT AT 180 DPM/M³ WAS ~20-FOLD HIGHER THAN THE CITED VALUE OF 8.94 DPM/M³, WHICH NIOSH DESCRIBED AS “THE MAXIMUM AIR DUST CONCENTRATION TAKEN DURING NORMAL OPERATIONS.”

NIOSH Response: NIOSH does not feel that the air samples associated with a short-term operation of sweeping is representative of the steady-state air concentration that would be applicable in estimating the routine conditions. This is further indicated in the cited report because the air sample associated with sweeping was the only sample in excess of the preferred level. Therefore, NIOSH does not believe that this sample should be considered when characterizing the general steady-state air concentration.

FINDING #5. NIOSH’S “CONVERSION” OF THE EMPIRICALLY MEASURED AIR CONCENTRATION OF 8.94 DPM/M³ THAT WAS REDUCED MORE THAN 42-FOLD TO A “MODELED AIR CONCENTRATION” REPRESENTS A MAJOR ERROR AS THE STARTING POINT FOR DERIVING INTERNAL DOSE FOR THE INHALATION AND INGESTION AND FOR ALL YEARS FROM 1950 TO 1995.

NIOSH Response: NIOSH agrees that the air samples taken in July of 1949 were collected after uranium rolling operations ceased and not during actual operations (even though the report states that it was taken during operations). The purpose of the visit was to evaluate the adequacy of the decontamination efforts that had already taken place. Therefore there is no need to settle an operational air concentration to calculate a residual surface contamination level and then resuspend that residual surface contamination level to estimate the starting residual air contamination levels. NIOSH considers the 1949 air samples itself representative of the start of the residual period and will revise the site profile to use 8.49 dpm/m³ as the starting point for the residual period.

FINDING #6. INAPPROPRIATE USE OF THE RESUSPENSION FACTOR $1 \times 10^{-6} \text{ M}^{-1}$ FOR POST-AEC WORK, BUT NEVERTHELESS ACTIVE OPERATIONS AT THE ALIQUIPPA FORGE FACILITY AS SPECIFIED IN THE FOOTNOTE OF TABLE 5-1 IN ORAUT-OTIB-0070.

NIOSH Response: As noted in FUSRAP report (SRDB 6325), a major decontamination effort was performed and was completed in 1950. In addition, as SC&A noted in its discussion of Finding #2, the contamination identified was overwhelmingly fixed contamination, not removable. Therefore, NIOSH feels that the re-suspension factor of $1 \times 10^{-6} \text{ m}^{-1}$ for post-AEC work is consistent with the stated guidance and ORAUT-OTIB-0070.

FINDING #7. NIOSH'S CHOICE OF THE 1992 SURVEY MEASUREMENT OF 350 DPM/100 CM² REMOVABLE ALPHA CONTAMINATION IS COMPROMISED BY THE FACT THAT IT POST-DATES THE "INTERIM DECONTAMINATION EFFORTS" CONDUCTED FROM OCTOBER TO DECEMBER 1988.

NIOSH Response: The 1978 FUSRAP survey (SRDB 6325) reported the maximum smear result as 80 dpm/100cm². Because this was performed prior to the 1988 interim remedial activities, it can be compared to the calculated 1978 residual annual internal intakes in ORAUT-TKBS-0021 Rev 01 to verify the impact of back-extrapolating a post-remediation result to prior years. The 1978 intake rate was 0.202 pCi/day. This would correspond to an air concentration of 0.0681 dpm/m³. Applying the re-suspension factor of $1 \times 10^{-6} \text{ m}^{-1}$ to calculate the associated surface contamination levels, this results in a surface contamination level of 681 dpm/100cm². Because this value exceeds the actual contamination levels prior to the 1988 interim remedial activities, NIOSH feels that the approach of back-extrapolating the maximum 1992 survey measurement to be bounding and favorable and not impacted by the 1988 interim remedial activities.

FINDING #8. NIOSH'S METHODOLOGY FOR DERIVING INTERNAL INHALATION AND INGESTION DOSE DOES NOT COMPLY WITH THE USE OF AVAILABLE DATA AND THE PRIORITIZATION OF RECOMMENDED METHODS DEFINED IN ORAUT-OTIB-0070, REV. 01.

NIOSH Response: NIOSH believes that there are two errors in the methodology. The first error is the incorrect conversion of dpm to pCi for the ingestion intakes, as indicated in the response to Finding #3. Secondly, the misinterpretation of the 1949 air samples as an operational air sample, not a post clean up air sample, as indicated in the response to Finding #5.

In addition, SC&A's recommendation that a source-term depletion factor of 0.00067 d^{-1} should be used over the calculated source-term depletion factor of 0.00012 d^{-1} in ORAUT-TKBS-0021 Rev 01 would only result in less-favorable exposure estimates. Therefore, NIOSH believes that the methodology in ORAUT-TKBS-0021 Rev 01 does comply with the use of available data and the prioritization of recommended methods defined in ORAUT-OTIB-0070 Rev. 01 and results in favorable exposure estimates, as indicated by the responses to the previous seven findings.