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PRELIMINARY REVIEW OF THE REVISED SITE PROFILE FOR THE HUNTINGTON PILOT PLANT

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During the meeting of the Dose Reconstruction Subcommittee held on February 4, 2013, one of the topics discussed was SC&A's focused review (SC&A 2008) of the Huntington Pilot Plant exposure matrix, as originally provided in ORAUT 2004. During that meeting, NIOSH indicated that the original SC&A findings are now addressed in a revised version of the exposure matrix; i.e., Technical Basis Document for the Huntington Pilot Plant, Huntington, West Virginia, OCAS-TKBS-0004 (OCAS 2008). SC&A was thereby directed by the DRSC to review the revised exposure matrix to evaluate the degree to which our original findings have been addressed. This report presents that evaluation.

Following Section 1.0 "Background and Introduction" of this report, Section 2.0 presents a description of each of the 12 findings originally identified by SC&A, the degree to which each finding is addressed in the revised site profile, and SC&A's recommendation regarding closing each finding. In addition, Section 3.0 of this report presents a review of the new information provided in the revised site profile.

1.0 BACKGROUND AND INTRODUCTION

SC&A's 2008 review of the Huntington Pilot Plant was initiated as a result of discussions held during the Advisory Board conference call on November 27, 2007. Those discussions explored alternative strategies for ensuring that site profiles [also referred to as Technical Basis Documents (TBDs) or exposure matrices] for Atomic Weapons Employer (AWE) facilities receive adequate review. At that time, AWE exposure matrices were not reviewed as part of the site profile review process. The only reviews AWE exposure matrices received at that time occurred as part of the individual case dose reconstruction review process, if a case relied on a particular exposure matrix. These types of reviews were often partial reviews, as often occurs when a maximizing approach to a dose reconstruction is employed. In addition, the review of AWE site profiles is often only a partial review, because the review is limited to the extent needed to perform an adequate review of the dose reconstruction and in comparison to the comprehensive site profile reviews performed for Department of Energy (DOE) facilities. Hence, the DRSC determined that an expanded, stand-alone review of selected AWE exposure matrices was needed.

The exposure matrix for the Huntington Pilot Plant was one of three exposure matrices selected by the DRSC for a special review. The other two are Bridgeport Brass and Harshaw Chemical Company. The exposure matrix for Huntington Pilot Plant that was in effect at the time, and which SC&A reviewed, was ORAUT-TKBS-0004, *Technical Basis Document Basis for Development of an Exposure Matrix for Huntington Pilot Plant* (ORAUT 2004). The results of SC&A's review of that exposure matrix, which was published as Attachment 3 to *Audit of the Eighth Set of 30 Dose Reconstruction Cases* (SC&A 2008), contained 12 findings. This report presents a review of the revised exposure matrix to determine the degree to which each of the original 12 findings have been addressed and whether any new issues emerged from the revised review.

2.0 RE-ASSESSMENT OF ORIGINAL 12 FINDINGS

2.1 Finding 1

Claims are made without adequate citation of sources. Confidence in the validity of the TBD data and assumptions would be improved with better documentation of data sources.

This finding simply indicates that a number of statements are made in the original site profile without annotation. For example, "… most reports indicate that the maximum enrichment was ~4%" (ORAUT 2004, p. 6), and, "Documents giving details of starting material shipped from ORGDP to INCO in 1950–1961 indicated that annually between 1,980,000 and 2,587,000 pounds of contaminated nickel scrap could have been melted and used to produce nickel powder" (ORAUT 2004, p. 7). The revised site profile (OCAS-TKBS-0004) provides citations to these and other statements, citing several Atomic Energy Commission (AEC) documents. SC&A recommends closing this finding.

2.2 Finding 2

The TBD does not establish whether Huntington received contaminated nickel scrap from Paducah and Portsmouth Gaseous Diffusion Plants in addition to the Oak Ridge Gaseous Diffusion Plant. Thus, it is not clear that the yearly amount of contaminated nickel scrap assumed in the TBD is an upper bound.

It appears that the revised site profile remains silent regarding whether contaminated nickel scrap was sent to Huntington from Paducah and Portsmouth. However, in their February 2013 update to the Attachment 3 issues matrix, NIOSH indicated:

> *Ref ID 18875 clearly indicates all three gaseous diffusion plants supplied scrap nickel to INCO.*

SC&A located Ref ID 18875, "Excerpts from OROO Accounting Manual (1958)" (OROO 1952), which states:

> *Under contract provisions with AEC, the International Nickel Company receives P-2 materials from the Union Carbide Nuclear Company, K-25, and Paducah plants, and the Goodyear Atomic Corporation at Portsmouth and converts the P-2 materials into RM powder.*

Thus, it appears that Huntington did receive contaminated nickel scrap from Paducah and Portsmouth. However, this might not be an essential piece of information, because the key issue for dose reconstruction is the dust loading of nickel and the amount of uranium associated with the nickel. If there are adequate air sampling data, then throughput of nickel scrap is not an essential parameter to derive internal exposures. This issue is discussed below.

2.3 Finding 3

Averaging over historic data rather than contemporary or adjusted data in TBD Table 4 increases the estimated median nickel dust loading from 0.05 mg/m^3 to 0.2 mg/m^3, a factor of 4 increase.

This finding has to do with the fact that the original site profile estimated airborne dust loadings of nickel (expressed in terms of mg Ni/m^3) that included air sampling data collected at the time period of interest and data collected 20 years later. The SC&A concern was that the airborne uranium concentrations associated with the later years were substantially lower than the data collected at the time periods of interest, but were used to estimate the average concentration of airborne uranium dust at the time period of interest. As a result, we believe that the airborne dust loading of nickel for the time period of interest is underestimated by about a factor of 4.
Page 11 of the revised site profile corrected this problem by building a cumulative distribution of the air sampling data and adopting a geometric mean of 0.046 mg Ni/m^3, with an upper 95th percentile concentration of 0.44 mg Ni/m^3 as the default airborne nickel concentration. It is our understanding that NIOSH plans to use the upper 95th percentile concentration as a bounding value. However, it is not clear that this value will be used for all workers or those believed to have had the potential for elevated exposures. In addition, we believe that this approach continues to suffer from the same concerns that were originally raised by SC&A and the issue remains unresolved. We suggest that NIOSH use the data representing the time period of interest and adopt the upper 95th percentile concentration for all workers, especially if it is not possible to assign workers to specific locations. In theory, the approach adopted by NIOSH in its revised site profile is not necessarily claimant favorable, because it would seem to be more appropriate to use the old dataset (the values designated as "c" in Table 2 of the revised site profile), because those data better represent the time period of interest. In addition, the upper 95th percentile value from that dataset should be used, especially if a claimant's job category is uncertain. For example, the 10 values in Table 2 of the site profile designated with a "c" are the dust loadings that were collected during the time period of interest. If NIOSH were to use only the 10 historical exposure values, the 95th percentile concentration would be significantly higher; i.e., 3.088 mg Ni/m^3 vs. 0.44 mg Ni/m^3. However, SC&A understands that the high 95th percentile number derived for the historical data appears to be biased high by a single outlier of 5 mg Ni/m^3 for the "Refinery" department. Nevertheless, we believe that this issue needs to be discussed further.

SC&A recommends that this finding remain open until this issue is adequately addressed.

2.4 Finding 4

A concern with the TBD methodology is that dust loading in the breathing zone of a worker is often higher than the dust loading determined using general air samplers. A discussion of this appears in ICRP Publications 35 and 75.

Page 11 of the revised site profile states that, "These exposure estimates, made by INCO for each of the various departments, were intended to represent average airborne concentrations of nickel in all forms over an 8-hour period." Hence, we concur that the reported airborne concentrations of nickel dust represent a best attempt at characterizing the breathing zone airborne nickel concentration. SC&A recommends that this finding be closed.

2.5 Finding 5

The TBD assumes that the median dust loading provided is universally applicable. However, a more claimant-favorable approach in the absence of specific worker data would be to assume that the worker was a member of the critical population groups at the plant, where the assumed median exposures were at the high end of the distribution, perhaps 90th or 95th percentile values. At the former, the dust loading is estimated to be 5.57 mg/m^3, and at the latter 7.15 mg/m^3, based on TBD Table 4 data (SC&A 2005, SC&A 2006).

This finding is virtually identical to Finding 3 and can be withdrawn.

2.6 Finding 6

The TBD does not mention possible exposures through ingestion pathways nor justify why they may not be significant compared to the inhalation pathway.

Page 13 of the revised site profile explicitly addresses ingestion using the rule of thumb of 0.2 times the airborne concentration of uranium equals the daily ingestion rate of uranium. On this basis, SC&A recommends that this issue be closed.

2.7 Finding 7 and Finding 8

These two findings are combined for convenience.

<u>Finding 7</u>

The TBD uses 1980 post-decontamination radiation survey data (Berger 1981) to estimate exposures from surface contamination during the plant operations period (Table 6). However, since the survey took place 18 years after the end of the operations period and after decontamination activities, when only the compressor building remained standing, it does not seem representative of the contamination levels that were present during the operations period and afterward, before decontamination occurred in late-1978 to mid-1979. Perhaps, in the absence of more applicable survey data, NIOSH could obtain and use data on the surface contamination of nickel dust at other nickel-melting operations.

<u>Finding 8</u>

Using MicroShield, SC&A estimated the air exposure rate 1 meter and 1 foot from a 5-by-5 double array to be 0.91 R/y and 2.38 R/y, respectively. These air exposure rates correspond to a bladder dose of 0.97 rem/y at 1 meter and 2.53 rem/y at 1 foot, respectively. The dose to the bladder (at 1 meter away) reported in the TBD is 0.138 rem/y. The difference between our derived bladder doses and those reported in the TBD are large enough to raise some questions regarding the accuracy of the values in the TBD (SC&A 2006, p. 11).

Section 6 of the site profile presents an entirely revised strategy for deriving the external penetrating and non-penetrating doses to workers during operations. Section 6.1 explains that the limiting penetrating dose to workers is from nickel scrap residue that was placed and stored in 20-gallon drums before being shipped back to the AEC. Within the context of the Huntington site profile, the term "residue" refers to the step in the processing of the contaminated scrap nickel barriers containing the highest concentration of uranium (i.e., 1% by weight). External exposures to penetrating radiation from the stored nickel residue were derived using MCNP to estimate the dose rates at 30 cm and 100 cm from the stored material. The deep dose exposure rates were estimated by NIOSH to be 3.2E-5 rad/hr at 30 cm and 1.7E-5 rad/hr at 100 cm. As explained in the revised site profile:

> *The maximally exposed worker dose was estimated by assuming that the worker was located 30 centimeters from the center of a row of drums for 2000 hours per year. This results in an annual exposure of 0.065 rad per year. This value applies to those Production personnel who may have been continually working with the drums of material, such as operators, laborers, supervisors and clerks. Other workers at the RPP are assumed to have been exposed at one half the value of the maximally exposed worker, or 0.033 rad per year. This value applies to Administrative personnel such as managers, secretaries, and other office workers.*
>
> *The annual whole body doses are to be converted to organ doses by multiplying the estimated air kerma doses discussed above by the "Kerma (K_a) to Organ Dose (H_T)" photon dose conversion factors found in Appendix B of the NIOSH External Dose Reconstruction Implementation Guideline (*[OCAS 2007]*). The exposure geometry was assumed to be anterior-posterior (AP) and the whole body dose rate is to be divided equally between photons with E=30-250 keV and photons with E>250 keV and applied as a constant distribution.*

Section 6.2 of the revised site profile also presents a completely revised strategy for estimating external beta exposure to residue. The revised site profile explains that workers could have been exposed to uncontained residue and estimated an upper bound beta exposure of 0.024 mrep/hr at contact based on UCNC 1958c and an exposure duration of 50 hours per year, resulting in a shallow dose to hands and forearms of 1.2 rem/yr for selected categories of workers. Section 6.2 of the revised site profile further explains that shallow doses to other tissues should be estimated by deriving the shallow dose rate 30 cm from the surface of the nickel residue. At this distance, NIOSH estimated that the shallow dose rate is a factor of 75 lower than the contact dose rate, or 0.00027 mrem/hr. The basis of this value is cited as NRC 2002. The assumed exposure durations range from 2,000 hr/yr for operators (i.e., 0.54 rem/yr), to 1,000 hr/yr (0.27 rem/yr) for production workers other than operators, including laborers and supervisors, to no shallow exposures for administrative personnel.

Because this approach to estimating penetrating and shallow dose from residue during operation is new, SC&A is currently performing an independent evaluation of these approaches.

2.8 Finding 9

As found in the SC&A dose reconstruction audits for Case #000205 (SC&A 2006, p. 12) and Case #005166 (SC&A 2005, p. 15), the medical exposures derived in the Huntington TBD using Scalsky 2003 is about three times greater than the corresponding exposures derived in ORAUT-OTIB-0006 (Scalsky 2005), which has been taken as the standard NIOSH methodology to determine occupational medical exposures.

Section 9 of the site profile presents the approach for reconstructing occupational medical exposures by adopting ORAUT-OTIB-0006. SC&A concurs with this approach and recommends that this finding be closed.

2.9 Finding 10

Lacking evidence to the contrary, it would be appropriate to assume that some of the occupational medical examinations had included photofluorography [PFG]*, since such examinations were common prior to about 1960.*

Subsequent to the issuance of SC&A's original review of the Huntington site profile, NIOSH clarified its guidance regarding the assignment of PFG exposures. Unlike DOE facilities, where it is appropriate to assume that PFG exposures were a matter of routine practice before a specified date, it is not appropriate to make such an assumption for AWE facilities unless there is affirmative evidence that such examinations were, in fact, performed and that they were performed on site. The reason for this clarification is that AWE facilities were under contract to the AEC, and unless such examinations were explicitly included in the AWE contract, it is inappropriate to assume that such examinations were performed. In addition, it is now NIOSH policy that, even if there is evidence that such examinations were in fact performed, a medical dose would only be assigned if the examinations were performed onsite. In light of these clarifications, SC&A recommends closing (or withdrawing) this finding.

2.10 Finding 11 and Finding 12

Findings 11 and 12 are combined for convenience.

<u>Finding 11</u>

*The TBD estimates residual surface contamination exposures in the standby period (post-operations and pre-decontamination) using 1980, post-decontamination measurement data (Table 9). This approach appears quite arbitrary, as there is no reason given to believe that the exposure rate prior to decontamination has any relation to the highest air exposure rate measured post-decontamination***.**

Finding 12

The TBD uses the 1980, post-decontamination radiological survey (Berger 1981) to estimate external exposures from surfaces during the plant operations period (Table 6), the standby period (Table 9), and the post-decontamination period (Table 10). Findings #7 and #11 comment on the unsubstantiated assumption that the post-decontamination radiation levels in the compressor building due to surface contamination are in any way related to the operations and standby period radiation levels in all of the buildings, especially in the main process building, where the nickel refining process and enriched uranium residue separation took place. Moreover, comparing Tables 6, 9, and 10, which give annual organ doses from surfaces during the operations, standby, and post-decontamination periods, respectively, reveals an apparent inconsistency; the organ doses for the operations and post-decontamination periods are identical (they resulted from the same methodology and assumptions), while the doses for the standby period are substantially greater. Why should the doses have increased after the plant was shut down, and why should the doses during the operations period be the same as those during the post-decontamination period?

Section 7.0 of the revised site profile provides guidance regarding the reconstruction of doses during the remediation period, which occurred during 1978 and 1979. It is noteworthy that the operations period ceased in 1962, and that the facility was in standby mode from 1963 up until the remediation period that began in 1978. It is also noteworthy that the revised site profile provides no guidance for reconstructing exposures during the standby period, presumably because it is assumed that there was little or no potential for exposures during this time period.

The approach recommended in the revised site profile to reconstruct doses during the remediation period is markedly different than that described in the original site profile. Specifically, the revised site profile recommends that doses for the remediation period be reconstructed in the same manner as during the operations period, as described in Sections 5 and 6 of the revised site profile.

This approach is somewhat unusual, because one would expect the exposure scenarios to be quite different. From an external exposure perspective, one would expect this strategy to be bounding, since it can be assumed that no residue was in storage on site and the only external exposures would be from residual contamination. This is also likely the case for internal exposures because, intuitively, there would have been very limited amounts of valuable nickel residue being handled during remediation, as was the case during operations. Hence, in principal, the strategy adopted by NIOSH for reconstructing doses during remediation is likely to be limiting. However, one could argue that there is no reason to believe that there is any relationship between operation and remediation, and the strategy adopted by NIOSH seems quite arbitrary.

We conclude that, though the new approach adopted by NIOSH is likely bounding and an improvement over the original strategy, there remains a need to discuss whether such a strategy is consistent with the provisions of the statute and its implementing regulations. SC&A recommends leaving this finding open until the DRSC has an opportunity to discuss this unusual strategy.

3.0 COMMENTARY ON NEW MATERIAL

This section is in preparation and will address the major new strategies and data sources NIOSH is now using to perform internal and external dose reconstructions. For example, in the earlier version of the site profile, NIOSH assumed that the level of enrichment was 36%, because this was the contractual limit on the level of enriched uranium that was permitted at Huntington. SC&A concurred with NIOSH at the time that this was a very conservative assumption, because the actual data showed that the level of enrichment in the actual uranium processed at the facility was only a few percent. Because of this extremely conservative assumption, NIOSH concluded that it was not necessary to explicitly account for the internal exposures that were associated with recycled uranium (RU), which was handled at the plant. SC&A agreed with this simplifying assumption. In the revised site profile, NIOSH no longer assumes 36% enrichment, but instead uses the more realistic enrichment of 2%, and now the site profile explicitly addresses RU by employing the RU composition used in the K-25 Gaseous Diffusion Plant TBD (ORAUT 2006). As part of this review, we did not review the models and assumptions employed in the K-25 TBD, but leave that to the Gaseous Diffusion Plant Work group.

Other aspects of the revised site profile are currently undergoing review.

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