Discussion of Ames Laboratory TBD Findings on External Dose

Rev 0

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1.0 Introduction

The Ames Laboratory Technical Basis Document (TBD) (ORAUT, 2012) contains external dose information used as guidance for dose reconstructions.

SC&A's review (SC&A, 2013) of the TBD resulted in several findings that question the values or sufficiency of the external dose reconstruction methods in the TBD. This document discusses those issues and proposes some changes be made to the TBD.

Each of SC&A's findings on external dose are listed below in section 2.0 with a brief response. The sections that follow discuss the issues in more detail and present an overview of the methods NIOSH proposes to be used in a revised TBD.

2.0 External Dose Findings

Finding #3: *NIOSH's selection of personnel at the Ames Laboratory Research Reactor (ALRR) Facility as the target population is inappropriate and results in dose estimates that are not claimant favorable.*

> Response: This finding concerns ambient external dose. The ambient external dose values in the TBD should be eliminated because the currently available data is limited. External coworker doses should be used when individual monitoring data is insufficient to complete a dose reconstruction. This is discussed in more detail in section 6.0.

Finding #4: *NIOSH's selection of data from the 1961 survey conducted at the Synchrotron Facility defines fenceline dose rates that are 1 to 2 orders of magnitude lower than other measurements reported in the survey when beam direction was shifted from a westerly to easterly direction.*

> Response: This comment concerns ambient external doses, which NIOSH is now proposing to eliminate from the TBD, as noted above. The much higher dose rates from the 1961 survey mentioned by SC&A are dose rates *inside* the Synchrotron fence when the Synchrotron was operating at 60 to 65 MeV. Ambient dose should not be used for dose reconstructions for any Synchrotron worker, whether inside or outside the building.

Finding #5: *SC&A concludes that the 1961 survey measurements, which were limited to gamma dose rates, were incomplete and may have substantially underestimated total exposure by excluding the contribution of particulate radiation.*

Response: This finding concerns ambient external doses, which NIOSH is now proposing to eliminate from the TBD, as noted above. Coworker data should be used when individual dosimeter data is not available.

Finding #21: *SC&A's concerns about the use of the same surrogate data sources and questionable assumptions for deriving external dose for Ames' workers exposed to uranium closely parallel those related to uranium intakes as cited in Findings #10 and #13.*

Response: NIOSH recommends changes to the surrogate dose data in the TBD, as discussed in section 5.3. As noted in related Finding #13, SC&A also questions the sufficiency of providing multiple building and multiple job category levels of exposure for external dose during the uranium production years. Based on review of available information on work locations for claimants, job categories, and the nature of work evolutions at the Ames facilities during the uranium production years of 1942 through 1945, NIOSH is proposing a simpler approach that should be favorable to claimants and that can be implemented consistently.

Finding #22: *Given the availability of highly credible and site-specific data for deriving external doses from thorium exposure, NIOSH's decision to exclude said exposure/doses is not justified.*

Response: In the designation for the SEC class added via petition SEC-00185, the Secretary of Health and Human Services determined certain external doses cannot be reconstructed with sufficient accuracy from 1942 through 1954 (Sebelius, 2011). SC&A suggested radiation surveys taken in March 1952 are sufficient for estimating doses from 1942 – 1952. NIOSH does not consider those results sufficient to characterize external radiation exposures from thorium production, as indicated in the Evaluation Report for SEC-00038 (NIOSH, 2006).

Additional review by NIOSH for this finding indicates some limited gamma dose results are available from film badges in late 1952, but these were reportedly for some Synchrotron workers. Regular dosimetry for beta-gamma exposures began at Ames Laboratory in 1953. Thorium production ended in April 1953.

NIOSH has compiled dosimeter results and considers the available beta-gamma dosimetry data sufficient to use for unmonitored doses starting in 1953. Some neutron dosimeter data are available starting in 1954, and NIOSH intends to use that data to assign unmonitored dose for workers potentially exposed to neutrons starting in 1954.

NIOSH intends to clarify the use of coworker data in updated instructions in the next revision of the TBD.

3.0 SEC Feasibility Determinations

Classes of Ames Laboratory workers have been added to the Special Exposure Cohort (SEC) for 1942 through 1970 based on insufficient data to fully reconstruct certain internal and external doses. Information on those determinations are provided in section 1.3 of the TBD.

The Designation Findings for the most recent SEC class, added via petition SEC-00185, includes a determination that certain external doses cannot be reconstructed from 1942 through 1954 (Sebelius, 2011). NIOSH previously determined it only has sufficient information to estimate beta-gamma dose from exposure to uranium in all years, beta-gamma dose from other sources starting in 1953, and neutron dose starting in 1954 (NIOSH, 2006).

4.0 General Approach to External Dose Reconstruction at Ames Laboratory

There are no dosimetry data available at Ames until 1952. The available 1952 data is not sufficient for dose reconstructions. NIOSH will consider any individual dose data that is available for a claim.

External dose from potential exposure to uranium, as specified in the TBD, will be included in dose reconstructions. Section 5 of this document discusses changes recommended to the TBD for reconstruction of external dose from uranium in response to the comments received from SC&A.

NIOSH has a database of Ames dosimetry data that can be used to estimate unmonitored beta and gamma doses starting in 1953 and unmonitored neutron doses starting in 1954. These data will be applied to unmonitored workers, as appropriate. Table 6-7 of the TBD provides the coworker data. This paper also proposes to use the coworker data to bound ambient dose.

5.0 External Dose Reconstruction from Uranium Operations

Coworker data is sufficient to reconstruct unmonitored beta gamma doses starting in 1953. In this document, surrogate data from another site has been used to estimate uranium dose from 1942 through 1952. The methods presented herein differ from those in the Ames TBD, based on more appropriate data available in the Electro Metallurgical Company TBD (NIOSH, 2015).

The current Ames TBD surrogate uranium data approach is summarized in section 5.2 and the newly proposed surrogate data is presented in section 5.3.

5.1 Ames Uranium Operations

Iowa State College produced uranium metal from 1942 through 1945. The initial early 1942 Iowa State College contract was for developmental work. It involved experimental work with

small quantities of uranium compounds to develop metal reduction methods. This experimental work led to a production operation in the latter part of 1942. The production operation involved reducing UF_4 to metal "biscuits", or ingots, then recasting them into derbies. Ames also had an operation to recover and recast scrap uranium metal turnings generated at other sites.

The buildings involved with uranium production were the Chemistry Building, Physical Chemistry Annex I (Annex I), and Physical Chemistry Annex II (Annex II). The production operations were done in Annex I and Annex II, which were temporary production facilities established at Ames while industry established more permanent production facilities. The Chemistry Building work was more limited to early development work; however, uranium metal for the Metallurgical Laboratory was produced in that building in 1942. Iowa State College's uranium production operation continued until the latter part of 1945. Additional information on the Ames uranium production work can be found in *NIOSH Response to SC&A Review of the Ames Site Profile Regarding Uranium Internal Exposures* (Ellis and Tomes, 2015).

5.2 Current Ames TBD Surrogate Uranium Dose

The current version of the Ames TBD provides prescriptive annual external doses in Tables 6-4, 6-5, and 6-6 for workers in the Chemistry Building, Annex I, and Annex II, respectively.

The annual doses provided in TBD Tables 6-4 and 6-5 for the Chemistry Building and Annex I were based on dose from refining uranium. The TBD references the Mallinckrodt site Technical Basis Document (ORAUT, 2010) and *The Industrial Hygiene of Uranium Refining* (Christofano and Harris, 1960) as the source of the data. The Table 6-6 dose values for Annex II are based on dose rates provided in Battelle-TBD-6000 (Battelle, 2011) that are applicable to working with cast uranium metal.

The doses provided in Tables 6-4 and 6-5 for the Chemistry Building and Annex I are higher than those for Annex II to allow for exposure to uranium progeny on the surface of freshly cast metal (references indicate all the casting work was done either in the Chemistry Building or in Annex I). The reduction and recasting furnace work at Ames are the processes for which dose rates could be higher than for work with cast uranium metal work or for exposure to UF_4. The potentially higher dose is attributed primarily to beta radiation from U-238 progeny on the surface of freshly cast metal (Battelle, 2011, p. 21).

The Christifano and Harris paper reported monitoring results from uranium facilities in the late 1940s and the 1950s. Airborne radioactivity results were the principle subject of the study, but some external radiation doses were provided. Most of the external doses provided were from facilities that processed ores that had significant gamma dose from radium. None of the provided external doses in that reference were from purified UF_4 or uranium metal reduction and recasting operations; therefore, that reference provides no specific doses for the type of uranium operation

at Ames. It also provides no dose rates on the specific type of uranium scrap recovery operations at Ames.

The Ames TBD also cites the Mallinckrodt TBD for dose rates from refining uranium; however, it is not clear how the doses in Tables 6-4 and 6-5 were determined. Although some of the work at Mallinckrodt was similar to the work at Ames, there were multiple production processes at Mallinckrodt that would not be applicable to Ames workers. Therefore, other sources of data is now considered for the Ames TBD. The use of Batelle-TBD-6000 is considered appropriate for exposure to uranium metal; however, more appropriate surrogate data is discussed in section 5.3.

Each of the three TBD external dose tables for the uranium facilities have somewhat different dose values and each have five levels of exposure based on job categories. SC&A questioned the sufficiency of the surrogate dose data in Finding #21; they also provided additional detail on application of the surrogate data in finding #13. Finding #13 questioned the multiple job categories and said scaling of uranium doses based on facility and job function is without technical support. NIOSH agrees there is insufficient information to support the multiple dose levels based on job descriptions. Changes are proposed below.

5.3 Proposed Surrogate Uranium Dose

NIOSH does not believe work process and job assignments were established well enough at Iowa State College in 1942 through 1945 to provide facility-specific and job-based doses. It was also reported in references that due to the urgency of the program Ames sent workers wherever they were needed regardless of their assigned job. NIOSH plans to remove the TBD's distinction of a lower dose potential for Annex II workers. The three building-specific dose models will be replaced in favor of a single facility dose model. Annual doses will be provided that will be applicable to two categories of workers: those who potentially worked with uranium or in the contaminated facilities and those who were not likely to work in the production areas or with the material. The latter, lower exposed, category of workers are assumed to have made entries in the uranium facilities and received significant incidental exposure.

NIOSH recently issued a Technical Basis Document that includes an evaluation of coworker external doses at the Electro Metallurgical Company (Electro Met). The coworker data is from dosimeters worn by workers from June 1948 to September 1949. The Electro Met data is more representative of potential exposures to uranium production workers at Ames than what is currently provided in the Ames TBD. The Electro Met coworker data is also somewhat higher than the doses in Battelle-TBD-6000, which the TBD currently uses for Annex II workers exposed to uranium metal. NIOSH considers the Electro Met data the best currently available data to estimate dose for Ames uranium workers who are not compensated via the SEC class.

Electro Met's uranium production facility used the "Ames process" to reduce UF_4 to uranium metal ingots, which were then recast into derbies and shipped to other sites. The Ames process was developed during the uranium production period at Ames. Some of the early development work at Ames involved other experimental methods, but by August 1942, the basic Ames method was established. That method was improved and evolved into the methods used for the bulk of the production work at Ames, and it was the method used by Electro Met. The Ames process development work was largely concerned with how to construct the reduction "bomb" and how to obtain larger and more pure ingots. Although some minor process differences are noted during the development work at Ames, the Electro Met data likely overestimates average exposures at Ames during the early development period when smaller quantities were processed. Additional evaluation on the surrogate data use criteria is included as Attachment A of this document.

The Electro Met TBD Table 7 provides an annual photon dose of 4.403 rem based on the 95th percentile of the weekly dosimeter results. The 95th percentile will be assigned to "Operators"; Operator dose will be applicable to anyone involved with research, production, labor, maintenance, or any non-administrative type of work. Some workers had little potential for exposure. A lower exposure category for "Administrative Workers" will be used and assigned the Electro Met median annual dose of 1.356 rem; that level of dose will allow for intermittent exposure in the production areas under the presumption that they could have intermittent exposure for a significant amount of time. The Administrative Worker category should be applied to secretaries, security personnel, managers, or other office personnel. Attachment B has information on the job descriptions from NOCTS for claimants with employment in the 1942 through 1952 period.

Beta doses will be assigned similar to the Electro Met model at ten times the gamma dose to allow for higher potential beta dose from reduction and remelting. Extremity dose in the Electro Met TBD is based on TBD-6000 values, as that is the best available data. Hand and forearm dose is provided only for the Operator category.

The proposed new doses for Ames for 1942 through 1945 are summarized in Table 2.

Table 2: Uranium Production Period Annual Doses, 1942 - 1945

Operators	
Whole body, photons:	4.403 rem
Non-penetrating, skin of whole body:	44.03 rad
Non-penetrating, hand and forearms:	276 rad
Administrative Workers	
Whole body, photons:	1.356 rem
Non-penetrating, skin of whole body:	13.56 rem

1. The annual dose should be prorated for partial years, as applicable, and applied in IREP as the median value of a lognormal distribution with a geometric standard deviation of 3.

Although Ames' uranium production operations ended by the end of 1945, other operations continued in Annex I and Annex II, notably thorium production before construction of Wilhelm Hall was completed. Prior to 1953 it is not feasible for NIOSH to reconstruct dose from radioisotopes other than uranium; however, NIOSH can provide a bounding estimate of potential dose from uranium in the post production years.

Although uranium production was turned over to industry, some uranium research and developmental work may have continued at Ames after 1945. That work may have involved some metal casting work, or at least there was some limited potential exposure to uranium metal. This is suggested by records of shipments of relatively small quantities of uranium metal from Ames in the years after the war (a few hundred pounds compared to many tons produced during the war). The median dose from the production years should bound the external dose to workers potentially exposed to uranium during 1946 through 1952 (Ames coworker data is available starting in 1953). Uranium exposures are presumed to have occurred in the Chemistry Building, Annex I, or Annex II, the three facilities associated with earlier uranium developmental and production work.

Records for claimants indicate that not all Ames workers worked in any of the three uranium facilities, or had jobs that involved working with radioactive material. For those workers an estimate of whole body dose from contamination is made to allow for any occasional entrance into the uranium contaminated facilities.

External dose from uranium contamination is derived from the median Type S uranium intake of 6,932 pCi/day (Ellis and Tomes, 2015). This production era calendar day intake rate was derived from Ames bioassay data during uranium operations. An air concentration correlating to that intake rate was estimated by assuming an annual inhalation volume of 2,400 m^3. This results in an air concentration of 2,340 dpm/m^3. An estimate of surface contamination was made using the methods specified in Battelle-TBD-6000 section 3.4.2. These assumptions provide a contamination level of 4.55×10^6 dpm/m^2. The dose rate factors from Battelle-TBD-6000,

Table 3.10, were then used to estimate a photon dose of 0.004 rem per year and a beta dose of 0.042 rem per year based on a 48 hour work-week.

Doses for the Ames post uranium production period are provided in Table 3.

Table 3 Uranium Post Production Period Annual Doses, 1946-1952

Uranium Facility Workers	
Whole body, photons:	1.356 rem
Non-penetrating, skin of whole body:	13.56 rem
Other Workers	
Whole body, photons:	0.004 rem
Non-penetrating, skin of whole body	0.042 rem

1. "Uranium Facility Workers" dose is to be applied dose to any worker in the Chemistry Building, Annex I, or Annex II, or to workers whose work locations are unknown. "Other Workers" dose is for all other workers, or for workers who had only occasional entries in those three facilities.
2. The annual dose should be prorated for partial years, as applicable, and applied in IREP as a constant.

6.0 Ambient External Dose

The Ames TBD provides annual ambient external doses for the years 1949 through 1977 in Table 4-6. Those years span the operational years of the Synchrotron facility and the Ames Laboratory Research Reactor (ALRR). NIOSH reviewed comments from SC&A and available data and references. The issues and proposed resolutions are discussed below.

Two sources of ambient dose were considered in the TBD: dose from the Synchrotron and dose from the Ames Laboratory Research Reactor (ALRR). TBD Table 4-6 provides 0.025 rem per year ambient dose from the Synchrotron for 1949 through 1977 (derived from 1961 radiation surveys), and it provides 0.001 rem per year ambient dose from the ALRR for 1965 through 1977 (derived from modeled release of Ar-41).

SC&A commented on ambient external dose in Findings 3, 4, and 5. Those findings concern the target population for the ambient dose calculation in the TBD, interpretation of radiation dose rate measurements taken around the Synchrotron Building in 1961, and potential ambient exposures from particulate radiation around the Synchrotron.

In the discussion related to Finding #3, SC&A provided specific comments based on workers meeting the definition of ambient dose provided in section 4.0 of the TBD, which defines ambient dose as dose received "outside facilities (e.g., buildings)". Ambient dose, as applied to dose reconstruction for Ames Laboratory, needs further clarification. Instructions with Table 4-6 specify ambient external doses are to be assigned only to unmonitored workers and makes no

distinction of whether a worker was potentially exposed inside a building or outdoors. Although some language in the TBD is not clear on the use of ambient dose, the TBD does not limit the application of ambient does to people working outside.

Conversely, the application of coworker dose in lieu of ambient dose is not limited to indoor work. TBD section 6.3.1.2 prescribes coworker dose for unmonitored workers who could have been intermittently exposed, and makes no distinction whether it was indoor or outdoor locations. For example, SC&A's comment included a scenario of an outdoor maintenance worker within the Synchrotron fence. Per the definition in TBD section 4.0 he could have ambient exposures, but the TBD did not consider dose rates inside the Synchrotron fence in the ambient dose estimates. In that scenario, if NIOSH does not have monitoring records coworker dose should be applied whether their tasks were indoors or outdoors.

For Ames, the ambient external dose should be considered the minimum dose to be assigned to an unmonitored worker from exposure to any source on site. The definition in TBD section 4.0 should be clarified and be consistent with instructions in section 6.3.1.2. That change should resolve some of the issues raised by SC&A. However, SC&A also had comments on the TBD's estimate of dose rates at the Synchrotron facility perimeter fence.

The ambient dose from the Synchrotron in TBD Table 4-6 was derived from a subset of the 1961 radiation measurements at the Synchrotron fence when the beam was on, with the values chosen to be applicable to use to derive a dose rate in an eastern direction within the ALRR area and adjusted for distance as described in TBD section 4.2. This was chosen as the location of a target population because it was the closest routinely occupied area. The selected data and method used in the TBD to estimate ambient doses at the Synchrotron boundary are arguable, and there does not appear to be a clear resolution to SC&A's Findings 4 and 5 using the 1961 data.

The Synchrotron and ALRR were located a couple miles from the main campus. The TBD provides no ambient external dose values from radiation that emanated from operations on the main campus. Uranium production ended in 1945, and surrogate dose for uranium exposures (through 1952) is considered in section 5.3 of this paper, while Ames coworker beta/gamma data is available starting in 1953 and neutron data starting in 1954. Thorium production in Wilhelm Hall ended in April 1953 (AEC, 1960). Research activities with radioactive materials continued. NIOSH currently has insufficient data to estimate ambient or incidental unmonitored dose.

In lieu of sufficient ambient dose data, 50th percentile coworker dose should be assigned to bound ambient dose for unmonitored workers for all years. Thus, all unmonitored workers should be assigned either the 50th percentile dose or the 95th percentile coworker dose, as specified in TBD section 6.3.1.2. These changes will be included in a TBD revision.

References

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Attachment A

Evaluation of Surrogate Data Criteria, Ames Laboratory and Electro Metallurgical Company

NIOSH evaluated information on the Ames Laboratory and Electro Metallurgical Company facilities and operations to see if the Electro Metallurgical data from 1948 through 1949 would be representative of doses at Ames during the uranium production work from 1942 through 1945. The available information was evaluated using the five criteria listed in sections 3.2 through 3.6 of *The Use of Data from Other Facilities in the Completion of Dose Reconstructions Under the Energy Employees Illness Compensation Program Act* (OCAS-IG-004) (NIOSH, 2008).

Source Term

Ames produced 700 tons of virgin uranium metal from thermite reduction of UF_4. Ames also produced 300 tons of metal that was recovered from uranium turnings (shipped from other sites). Electro Metallurgical also received UF_4 and did thermite reduction to produce uranium metal ingots, recast the ingots into derbies, and then shipped the metal to other sites. This was the same source compounds and production sequence used for most of the mass production at Ames, although the earliest work at Ames involved experimental methods and different source compounds, but in very small quantities compared to the production work. The dose from scrap recovery at Ames is bounded by the dose estimates for virgin metal production, thus the scrap recovery work is not considered in this surrogate data review.

The initial experimental and developmental work at Ames also involved uranium oxides, but by August 1942 Ames had developed the basic process using UF_4, initially on a relatively small scale, but further development resulted in a continual increase in production rate up to July 1943, after which there was a gradual reduction in Ames' virgin metal production work. This gradual reduction in Ames production coincided with the start of operations at Electro Met. Process improvements at Ames were made rather quickly with increasingly larger pieces of metal produced. These process improvements were incorporated into the Electro Met operation (Wilhelm, 1960).

The coworker dosimetry data at Electro Met was collected from June 1948 to September 1949. The average monthly uranium production rate during that time was about 35 ton/month (or 1.2 ton/day). The peak uranium metal production rate at Ames (2.2 ton/day) was higher than the average rate reported for Electro Met (1.2 tons/day), although Ames operated at that peak only very briefly. The peak production rate at Electro Metallurgical is not known, so the average is the best statistic to compare. The average production rate for Ames is not provided in available references, but can be estimated from various reports. Ames produced about 700 tons of virgin uranium metal from 1942 through the end of the war. They had produced only about 2 tons

through November 1942. Production increased rapidly during process improvements in early 1943 until its peak on July 1, 1943, then gradually declined. Regular production ended in November 1944, but they still received about 4 tons of UF_4 per month for metal production development work until the war ended. To provide an upper bound of the average monthly production at Ames it is assumed all 700 tons of virgin metal was produced in the 22 months from January 1943 through October 1944. That results in an average production rate at Ames of about 32 ton/month, compared to the 35 ton/month for Electro Met (during the time of the dosimeter coworker study).

Both sites received purified UF_4. Exposure would have been to U-238, U-234, and U-235 in normal uranium ratios. The UF_4 had been processed at other sites, so the short-lived Th-234 and Pa-234m progeny would have grown in to some degree since separation. The age since purification would affect dose rates from the progeny, with the progeny approaching equilibrium with U-238 in about 100 days after purification. The production of UF_4 and reduction to metal during the war was an urgent matter, and UF_4 production did not always keep up with metal reduction. It is not likely the UF_4 processed at Ames had aged more than the material processed at Electro Met in 1948.

Considering the above conditions, and based solely on source term, the average dose rates in the Electro Met TBD should overestimate the dose received by Ames workers.

Facility and Process Similarities

Electro Metallurgical received UF_4 and did thermite reduction to produce uranium metal ingots, recast the ingots into derbies, and then shipped the metal to other sites. This was the same source compounds and production sequence as Ames. Electro Met used the "Ames Process" that was developed at Ames before and during production work. However, there were some differences, particularly in the early development period at Ames; these differences concerned perfecting materials and reduction bomb preparation methods to produce ingots of ever increasing size.

Initially Ames processed very small amounts. In August 1942 they were processing batches of UF_4 only up to 200 gm. By September they had perfected the process enough to process 2-3 kg UF_4. In late September they had several of the "biscuits" and remelted them into an 11 pound ingot.

The actual process used for the reduction "bomb" was not fully developed until March 1943, when process improvements were made and Ames switched from calcium to magnesium as the reducing agent. After the method was perfected the reduction bombs produced at Ames varied but most were made with 6 inch diameter pipes about 3 feet long, which produced a 42 pound "biscuit", although Ames experimented with 10 inch diameter pipes that produced a 125 lb biscuit (Wilhelm, 1960). Electro Met produced ingots weighing 110-135 kg (50 – 61 lb) (NIOSH, 2015).

The Electro Metallurgical plant was built to mirror the Ames process and Electro Met engineers made trips to Ames in 1942 and 1943 to build their facility to mimic the process. Wilhelm reported the process was the same other than a difference in the metal casting equipment, which he described in some detail; he also discussed the evolution of changes in the process at AEC facilities from 1942 into the 1950s (Wilhelm, 1960).

Temporal Considerations

The facility utilized for most of the metal reduction and recasting at Ames (Physical Chemistry Annex I) was not designed to be an industrial plant. It was a converted single story frame building with additions to accommodate uranium production until industry constructed production facilities. Airborne radioactivity and worker internal doses could have been much different; however, these differences have more limited effect on external dose.

The Electro Metallurgical production facility was constructed from 1942 to 1943. Some limited operations began in March 1943 during construction, and minor changes to the facility continued to be made to incorporate processes and information learned at other facilities (MED, c1944; NIOSH, 2015). Based on descriptions and floor plans of the Electro Metallurgical plant, there does not appear to be any particular design to limit external doses, and none would be expected at that time for the given process and source material. Additionally, NIOSH has found no indication of any significant design change at Electro Met from construction in 1943 to the time of the dosimeter study in 1949. It is thought the principle difference in external dose potential would be the work practices at each facility that may result in some workers being exposed for longer periods of time in close proximity to uranium metal and compounds. These uncertainties are accounted for by a favorable application of coworker dose.

Data Evaluation

Section 5 of The Electo Met TBD provides a detailed description of the data and how it was evaluated. It addresses detection limits and uncertainty. NIOSH considers it the best available data that can be used for Ames Laboratory unmonitored dose from uranium production.

Review of Bounding Exposure Models

The Electro Metallurgical TBD annual doses are based on the 95th percentile of all monitored workers. Doses are applied as a lognormal distribution. The dose distributions of the various job categories were compared to the 95th percentile of the all monitored workers. The median values of the higher exposed job categories are reasonably bounded by the 95th percentile, with the applied lognormal distribution accounting for the spread of the data.

Attachment B

Job Titles and Scaling of External Dose from Uranium

As indicated above NIOSH plans to remove the three building-specific dose models for Annex 1, Annex 2 and the Chemistry Building and replace them with a single dose model that will be applicable to all three uranium facilities. In response to SC&A comments, the five categories of worker exposure in the current TBD were reviewed and compared to claimant records to determine if a location and task/job based exposure model is practical or can be implemented consistently.

The five uranium job categories in the current Ames TBD are the four categories from Battelle-TBD-6000 (Operator, Laborer, Supervisor, and Clerical), plus a fifth category of Researcher. The Ames TBD assumed the Researcher received 10% of the operator dose. Based on a review of job titles, a large percentage of the claims could be in the Researcher category. Table B1 shows all job position/titles for Ames claims in NOCTS with employment from 1942 through 1945. NOCTS contained fifteen claims with employment during the uranium production period.

Thirteen of the fifteen claims had a job description in NOCTS. There are two claims with no job title listed in NOCTS. Additional information in the claims files indicate the two workers were [REDACTED].

This review of claimant records and Ames process references indicates there is not sufficient supporting information to estimate scaled doses to various types of production workers or research personnel.

Table B1

Job Titles for Claims with Employment Starting in 1945 or Earlier*

[REDACTED]

Table B2 shows all job positions/titles for Ames claims in NOCTS with employment in 1942 through 1952.

Table B2

Job Titles for Claims with Employment Starting in 1952 or Earlier

[REDACTED]