NIOSH Comments on the SC&A Review of the Bethlehem Steel Site Profile
Specific Responses to Findings, Observations and Procedural Non-conformances

January 25, 2005

FINDINGS

1. **In the absence of personnel monitoring data, workplace air monitoring data were the principal basis for dose estimates. The applicability of such data to individual workers, and the quality and reliability of the data were not addressed in the TBD.**

   To document more fully the applicability of the air monitoring data used in the site profile, NIOSH will add a section to the profile to address the quality, reliability and applicability of the early Atomic Energy Commission (AEC) air sampling program to the estimation of worker doses. Further, NIOSH will discuss how these measurements were consistent with the recommendations provided in ICRP 75, *General Principles for the Radiation Protection of Workers*. NIOSH recognizes that to appropriately determine exposure one must first critically evaluate the quality of the data. It is further recognized that air sample data may be collected for a variety of purposes and that any subsequent statistical analysis of such data must be viewed in the context of its original purpose. From the early days of operation, the Health and Safety Laboratory (HASL) of the Atomic Energy Commission (AEC) relied on time weighted average exposure measurements to assess inhalation hazards in the workplace. A brief description of the HASL methodology, and its relation to ICRP 75, is provided below.

   Evaluation of the HASL methodology with respect to ICRP 75 recommendations clearly shows that the HASL breathing zone (BZ) samples are representative of the worker's exposure. As indicated in the excerpts below from the HASL procedures manual, the BZ samples collected by HASL were held in a position to represent the breathing zone and are not associated with a fixed sampler. Because of this, the ICRP 75 recommendation that samples collected from area samplers be corrected to breathing zone would not be appropriate for these samples. General area (GA) samples were taken with the expressed purpose of evaluating non-localized releases to which an employee could be exposed during the course of the day. Finally, process samples (P) that were obtained during the measurement period were to assess source terms and are not indicative of concentrations to which workers may have been exposed. Further evidence of the breathing zone sampling location comes from typical operations at National Lead which states, "BZ (breathing zone) samples were collected by holding the sampling device in the immediate vicinity of the worker's head, in front of the shoulder area."

   A detailed description of the HASL methods and background on air monitoring and exposure assessment was provided in a 1973 write-up in the HASL manual (chapter B-04, The Application of Air Sampling in the Evaluation and Control of the Occupational Environment). The detailed description of the concept of representative workplace monitoring was written by A.J. Breslin, Director, Health Protection Engineering Division, HASL. It should be noted that Mr. Breslin was one of the sample collection scientists for the

Bethlehem Steel Corp uranium dust monitoring data. Breslin's write-up provides a detailed discussion of the type of samples taken, how they were taken, how they were analyzed, and how the results should be interpreted. The discussion of sampling locations, designation of sampling sites and the job task analysis sheets contained in this document are consistent with the sampling strategy employed at both Simonds Saw and Steel (SSS) and Bethlehem Steel Corporation (BSC). Early HASL procedure manuals were primarily focused on the chemistry, so earlier versions of the text may not exist (personal communication, Dr. Isabelle Fisenne). The following text, excerpted from the HASL manual, provides a description of the various sample types that were used by HASL to evaluate representative exposure.

> ***Breathing Zone Samples****- Typically, a worker performs a few operations in which he may come into close or direct contact with the hazardous material. Examples of these operations are operating a machine tool, charging a furnace, working at a chemical hood, changing the glove on a dry box, or any one of a hundred maintenance tasks that involve the dismantling of or entrance to equipment. At jobs such as these, dust concentrations are apt to be much greater than in the general area. Therefore, these activities may influence the average exposure far out of proportion to their duration.*
>
> *To measure accurately the concentration to which a worker is exposed while performing such a task, a breathing zone (BZ) sample must be collected. The sampling instrument is held in the vicinity of the worker's breathing area for the duration of the task. It should be held as close to his nose as possible short of interfering with his freedom of movement, because in situations where dust is escaping from a small aperture, concentration gradients around a source can be sharp. In one uranium plant, samples collected one foot apart at certain operations have shown concentration differences of twenty-fold. On the other hand, a sample collected so close as to interfere with the worker's movements is invalid because the job cannot be performed in the normal fashion. A small deviation in work habit may alter the dust concentration markedly.*
>
> ***General Air Samples****- Usually, the total time spent by a worker on operations requiring BZ samples constitutes a small fraction of the day. There are, of course, exceptions… Worker exposure during the balance of the work day may be characterized by samples collected of the general air (GA) in the area that he occupies.*
>
> *A GA samples is one that is collected at a fixed location during a sustained sampling period. To be meaningful, the sample must be collected within an occupied area but also it must be away from dust sources except those that may dominate the area. Customarily, the sampling instrument is placed at a height from four to six feet from the floor although in a heavily trafficked area, the instrument must be placed over the heads of the workers to avoid interference with the normal work routine….*
>
> ***Process Samples****- There is yet another kind of air sample that is often useful, the process sample. It is used to identify sources of air contamination or to determine the relative strengths of two or more sources. Process samples are distinguished from BZ and GA samples by the fact that they are taken in and around process equipment at locations*

where employees normally are not exposed. For this reason they should never be used in the evaluation of occupational exposure.

As an example, a process sample might be collected directly over a furnace to determine the amount of radioactivity that is carried by convection from the furnace to the room. The concentration at that point is not representative of an employee's exposure.

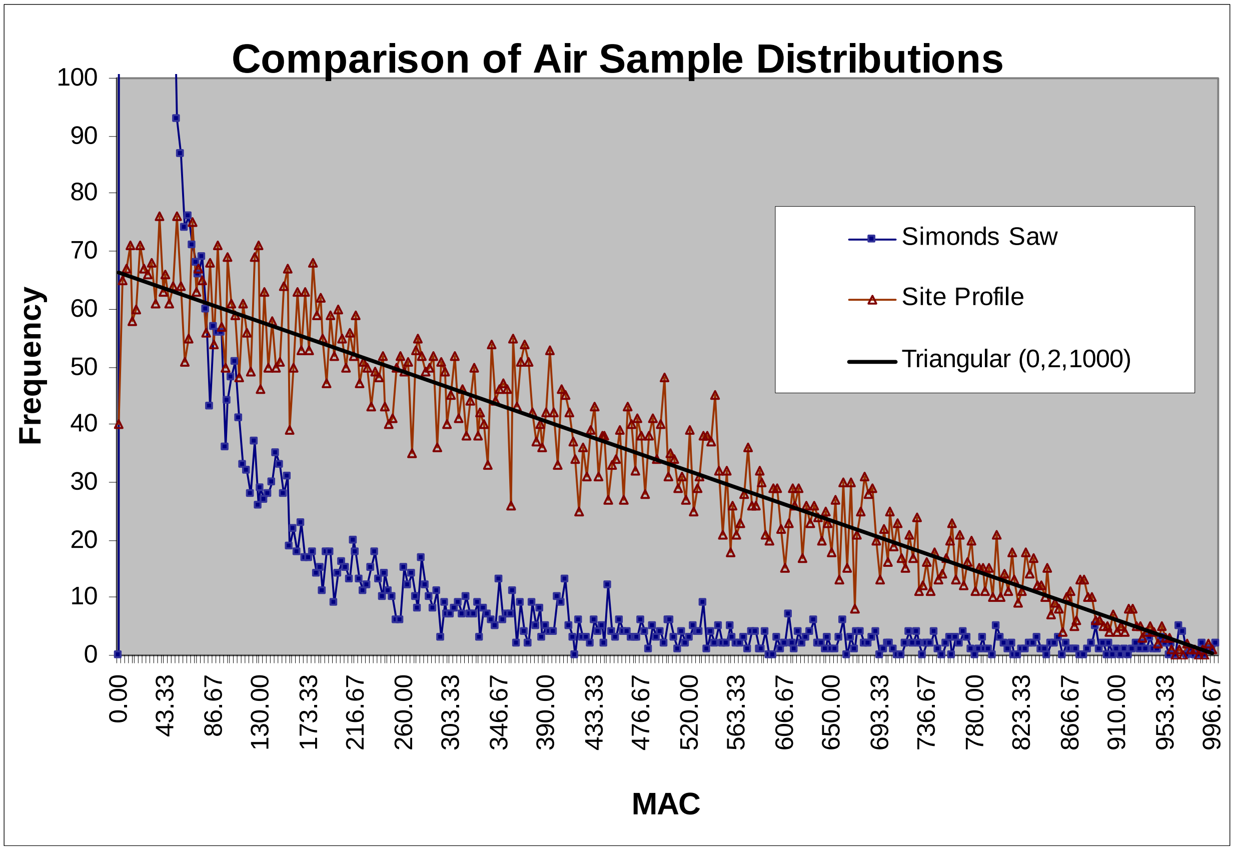
Filter Media- *…For routine air sampling, Whatman #41 filter paper is a good compromise with respect to performance characteristics. It is a cellulose fiber paper with very low ash content and nominal resistance to air flow. Its collection efficiency is satisfactory (>90%) for particles greater than a few tenths per micron in diameter at the normal sampling velocities of 100-200 linear feet per minute…*

2. The triangular distribution in Table 3 is not a statistically sound representation of the October 27, 1948 Simonds dataset. The upper bound of Table 3 is not claimant-favorable.

NIOSH acknowledges that the triangular distribution used in the site profile does not provide the best statistical fit to the Simonds Saw and Steel dataset. For purposes of making compensation decisions, the triangular distribution was viewed by NIOSH, not as a statistically precise model of the data, but as a claimant favorable characterization of the available log-normal distributions of air sample data at BSC and SSS. The triangular air sample distribution in the site profile was used to construct an internal exposure matrix that could be applied to all four years of covered uranium rolling activities at Bethlehem Steel and Simonds Saw. In doing so, NIOSH attempted to address the uncertainty associated with generating a single distribution based on data from two distinct time periods.

The triangular distribution is more claimant favorable than the underlying log-normal distributions because it results in more frequent selection of values in the extremes of the air sample distribution. Figure 1 provides a comparison of the sampling frequency distribution for the triangular distribution used in the Site profile and the best fit log-normal distribution suggested by SC&A for the Simonds Saw and Steel Data.

Figure 1



As can be seen in Figure 1, the triangular distribution selects a greater number of samples in the upper values of the distribution than the SSS log-normal distribution. NIOSH has rerun a number of cases using the SC&A proposed triangular distribution and found that in all cases the probability of causation was substantially lower (i.e., more than 30%) using SC&A's best fit than that obtained using NIOSH's triangular distribution. This is true, even though the triangular distribution truncates sampling at 1,000 MAC and the 99th percentile of the log-normal distribution was almost 2,500 MAC. This is because the mean value of the probability distribution tends to drive the probability of causation at the 99th percentile. In this case, the mean value of the log-normal distribution proposed by SC&A (168 MAC) is approximately one-half that of the triangular distribution (334).

The SC&A report does, however, raise an interesting concern regarding the application of a single facility distribution of air sample data to represent exposures for all workers. SC&A maintains that the use of a single facility distribution could underestimate exposures for those employees who worked in the areas where the highest air concentrations were measured. NIOSH has examined this concern and will modify the exposure model so that BSC workers will be assigned a continuous air exposure equal to the 95th percentile of the log-normal distribution of air samples in the facility.

To accommodate this change, NIOSH will establish two separate log-normal frequency distributions for the Bethlehem Steel data. These two distributions will represent exposures in the 1949-1950 and 1951-1952 time periods, respectively. It is necessary to divide the analysis into these two periods because the geometric means and standard deviations for the several hundred air samples collected at BSC are very different than those measured at Simonds Saw. Preliminary analyses by NIOSH indicated that the air samples collected at BSC and Simonds Saw are well represented by a log-normal distribution.

The SC&A report further makes the case that the small number of useful air samples (~36) at Simonds Saw do not provide a large degree of statistical confidence in upper tail of a fitted log-normal distribution. In their report, SC&A suggests various statistical techniques that can be used to estimate the upper limit (95th percentile) of the highest measured air samples. In addition to the small number of samples, SC&A's lack of confidence in the representative nature of these samples is further reinforced by NIOSH's inadequate discussion of the conduct of early AEC air sampling activities. As discussed in our response to finding 1, NIOSH believes that the highest air samples take at both BSC and Simonds were representative of the breathing zone of the worker and will include expanded documentation on this issue in the revision to the site profile.

There is additional evidence, however, to indicate that not only are these samples representative of the highest exposure location, they are overestimates of the actual cumulative exposure experienced by the workers. During the rolling on October 27, 1948 at SSS, the Atomic Energy Commission (AEC) staff conducted a detailed analysis of the operational time relationship (task-based analysis) for each employee working on the rolling operation. This consisted of a breakdown of the total time spent on a particular job with an additional breakdown as to the number of minutes and number of times each task was performed for each shift. Using the air samples taken during the rolling, which consisted of a combination of breathing zone and general area samples, and the detailed job task analysis, the time weighted average exposure for each worker was calculated. The result of this analysis indicated that the TWA air concentration for the highest exposed worker on October 27, 1948 was 190 MAC.

Although it is well-established that time weighted averages (TWA) exposures are more appropriate in estimating worker intakes than are single point estimates, NIOSH used the individual air sample value at SSS to establish worker intakes. In the modified profile, it will be assumed that all workers breathed the 95th percentile air concentration for every minute of each of the 480 hours that rollings were assumed to have occurred. These assumptions result in workers continuously breathing an air concentration of almost 600 MAC (30 mg U/m^3) for 10 hours per day for each rolling for all claimants, regardless of whether they actually worked with uranium.

There is also evidence that the processes at Simonds Saw in 1948 were more likely to generate higher levels of airborne activity than those at BSC in 1949 and 1950. According to workers, only finishing rolling operations were conducted at BSC while Simonds was principally involved in roughing operations. The earliest Simonds rolling in October of 1948 involved the reduction of approximately 5"diameter uranium billets to approximately 1" in diameter. These billets were heated in a gas fired furnace and transferred directly to the 16" roughing mill. This is the point at which the highest air samples were measured. It was eventually recognized that direct heating of billets produced excessive levels of airborne uranium, which resulted in the cessation of this practice in January of 1950. There is no evidence that finishing work at BSC involved direct heating of billets. It is known that some billets at BSC were pre-heated in a muffle furnace prior to being placed in a salt bath, but this furnace prevented direct contact of the uranium with the flame.

Based on the discussion above, NIOSH believes that the use of the 95th percentile of the distribution of air samples at Bethlehem Steel adequately reflects the upper limit of exposures for workers at BSC. NIOSH is interested in hearing the Board's thoughts on this issue and is willing to reconsider our position based on the Board's recommendation.

3. The selection of the minimum, mode, and maximum values in the Lower Bound Internal Exposure Matrix (Table 2) are not technically sound.

As noted by SC&A, Table 2 of the BSC Site profile is not used to evaluate any case where the probability of causation is less than 50%. It was merely inserted into the document to demonstrate that, for certain cancers such as those of the lung, it was possible to attain a probability of causation of more than 50% at substantially lower exposure levels than those provided in Table 3. The basis for this lower bound estimate was the actual air sample data collected at Bethlehem Steel in1951 and 1952. To avoid confusion, NIOSH will delete Table 2 from the profile. The deletion of this table will have no impact on any past or future analyses nor affect the compensability of any claims.

4. The assumption of nasal rather than oro-nasal breathing is not claimant-favorable and defensible given the conditions of steel mill work.

The ICRP default assumption for workers performing light exercise is that they breathe through their noses. Once the workers are engaged in heavy exercise the model assumes that 50% of the inspired air passes though the mouth. Thus, the ICRP model allows for a change in breathing patterns based on the type of work or exercise being performed. As indicated in the site profile, the maximally exposed worker was assumed to breathe at the weighted average rate of 1.7 m^3/hour, which is the ICRP default value for a heavy worker. This rate is based on a work activity composed of seven–eighths light exercise (1.2 m^3/hour) and one-eighth heavy exercise (3.0 m^3/hour). NIOSH will revise the site profile to assume that all workers at BSC were engaged in heavy work at all times during their shift. As indicated above, this will by default assume that workers were engaged in oral breathing 12.5% of the time.

The argument is made by SC&A that *due to the atmospheric conditions in the steel mill and level of work, it is likely that they were oro-nasal breathing rather than nasal breathing.* As discussed, the ICRP defaults allow for an increase in oral breathing as the work activity increases. The data provided in Table 1 of the finding, along with its associated explanatory text, seem to indicate that NIOSH should modify its profile to account for those who are habitual mouth breathers. Although NIOSH believes that the default ICRP values are suitable for workers at BSC, NIOSH is interested in hearing the opinion of the Board on this issue. If the Board believes that the default inhalation mode for workers at BSC should be habitual mouth breathing, rather than the default values recommended by the ICRP, NIOSH will reconsider this position.

5. **The ingestion dose estimates in Table 4 of the TBD represent only a fraction of potential dose from ingestion of radioactive material.**

The site profile estimates that a worker could conceivably ingest 1 gram of pure uranium over the course of 48 rollings. Using an NCRP 129 assumption of 100 mg per day for the ingestion of soil by construction workers, the SC&A review estimates that almost 5 grams of material could be ingested per 48 rollings. Since this estimate does not assume that all the ingested particulate is pure uranium, the total intake to a worker would be substantially less than this. Since rollings occurred on average 10 hours per month, there likely would be much more dust generated from the processing of steel than from the uranium. If one assumes a four week month with six 10 hour production days per week, the uranium operations would only have contributed approximately 4% to the dust loading in the facility. The site profile estimates a total ingestion of pure uranium equal to about 1 gram over 48 rollings, which equates to about 20 milligrams of uranium ingestion per rolling. Given that the percentage of ingested dust that is pure uranium is most likely less than 20%, the profile appears to be in substantial agreement with SC&A's estimate. Based on this, NIOSH believes the site profile adequately and appropriately addresses the magnitude of ingestion exposure during the days where rolling operations were conducted.

It should also be pointed out that the site profile used the claimant favorable gastro-intestinal absorption value of 2 percent. This assumes that the workers are ingesting moderately soluble forms of uranium. Given that the workers are exposed to oxides of uranium, it is quite possible and reasonable that the gastro-intestinal absorption value for insoluble forms of uranium of 0.2 percent should be used. If this were the case, the dose from the ingestion pathway, which is already a very small percentage of the dose from inhalation, would be reduced by an order of magnitude.

This finding also expressed concern that the site profile did not address exposure due to ingestion and inhalation of residual contamination between rollings. NIOSH has addressed this issue in our response to finding 7, since this same issue is raised there.

6. **The use of ICRP default particle deposition parameters is not claimant-favorable for all organs.**

The SC&A report suggests that, if the workers were exposed to 0.010 micron particles, certain organ doses could be larger than reported. NIOSH is unaware of any published studies that indicate a particle distribution centered at 0.010 microns has been observed in any facility that forged, rolled or extruded uranium metal. In fact, a report in our site research database indicates that AEC personnel in 1949 or 1950 measured particle sizes at the Simonds Saw and Steel facility using a modified cascade impactor. The sampler, which was located 4 feet from a uranium billet during roughing and finishing, was used to generate four mass median diameter distributions. The geometric means for these distributions ranged from 1.22 to 1.8 microns with a geometric standard deviation of about 2.5. To compare these values to the ICRP default 5 micron activity median aerodynamic diameter (AMAD) value, it is necessary to adjust for the density of the compound. Applying this adjustment provides a particle size distribution that is fairly close to the default 5 micron value as used in the site profile.

NIOSH has surveyed the literature and established that this value measured at Simonds Saw and Steel is consistent with the distributions observed at other uranium machining and metallurgy operations. It should be pointed out that the default particle size of 5 microns used in the ICRP 66 lung model does not assume a monodisperse aerosol, but is assumed to have a geometric standard deviation of 2.5. In addition, the default particle density in the model is 3 grams per cm^3. Although the density of uranium oxides is in the 8 -9 grams per cm^3 range, NIOSH used the claimant favorable ICRP 66 default value of 3 grams per cm^3. NIOSH believes the site profile adequately and appropriately addresses the particle size and deposition properties of uranium aerosols at BSC. NIOSH is interested in hearing the Board's thoughts on this issue and is willing to reconsider our position based on the Board's recommendation.

7. **The rationale for exclusion of external and internal dose from exposure to residual contamination is questionable.**

The SC&A review questions why exposure to residual contamination between rollings was not considered at BSC. The site profile did not include this exposure because of three facts: 1) there were reports that material accountability procedures required that all material, including the vacuuming of fine debris be collected and returned to AEC; 2) the existence of a 1952 decontamination survey of the workplace after a rolling; and 3) radiological surveys of the original equipment in 1976 and 1980 that revealed no contamination. The decontamination survey, which found no significant removable contamination, was taken on September 15, 1952 at the 10" rolling mill. In the survey, there were 14 smear samples taken that all indicate contamination levels less than 1,000 dpm U at each location. The smear locations appeared to be representative of various areas in and near the rolling operation and included smears of 6 stands, the shear, the salt bath, the cooling table and the floor. In particular it should be pointed out that the three floor samples averaged 13 dpm, which is indicative of almost no contamination.

It is stated in the SC&A review that the details of the smear analysis are not available. The counting sheet for this sample contains most of the data necessary to reconstruct the calculation. This includes: 1) the actual counts measured on the sample; 2) the counting efficiency of detection system; 3) the counter background; and, 4) the count time. The only piece of data missing to verify the calculations is the alpha self-absorption factor of 0.7 which was applied to all smear counts.

The SC&A review suggests that it was not possible for all uranium to be completely removed after rolling and that there must have been some residual contamination present in the workplace between rollings. This is supported by SC&A's interviews with workers who maintain that, because of the severe dusty conditions created during rollings, it is virtually impossible to clean uranium and/or steel dust from all surfaces. Although NIOSH has written documentation that suggests that uranium was cleaned up after each rolling, NIOSH only has one radiation survey that documents that this actually occurred. After careful review and consideration of SC&A's position, NIOSH agrees with their comment and will revise the profile to account for the dose from this potential exposure pathway. NIOSH will add dose from residual contamination due to both ingestion and inhalation. While the exact details of this modification have not been finalized, the basis of the ingestion calculation will rely on the published daily intakes for workers in dusty environments. The inhalation dose due to resuspension will be based on published values of dust loading observed in steel mills or other similar facilities. Both of these values will be corrected for the percentage of the actual intake due to uranium. Adjustments will also be made to account for the dilution of this percentage due to the introduction of new dust from the rolling of steel.

8. **The external dose (beta and gamma) due to various modes of contact with uranium including handling, inspections, finishing of the material, and heavy dust loading on clothing and skin has not been evaluated in the TBD.**

NIOSH agrees that the claimant favorable nature of the external dose distributions in the site profile has not been effectively addressed. The external dose section of the profile will be revised to explain in more detail the claimant favorable assumptions that were used in the estimation of external dose.

Rather than develop a detailed model that was tailored to specific occupations and tasks, NIOSH developed a general model which applied sufficient safety margins to account for the occupations and tasks which involved the highest exposures. The site profile specifies that no personal protective equipment was used at BSC and thus exposure potentials were not decreased in dose reconstruction. The profile further assumed that 48 rollings took place, when only 13 can be documented. During each of these rollings, the profile assumes a mode exposure of 15 mrem per hour, which is the highest shallow dose measured during surveys at Simonds Saw and Steel. Given that it was assumed there were 12 rollings each year that lasted 10 hours, the profile assigned 1.8 rem of shallow dose per year of operation as the mode of the triangular distribution. If one scales this to a 2,000 hour work year, this equates to an annual exposure of 30 rem of shallow dose per year. The maximum value of the distribution was set at 15 rem for 120 hours of operation, which equates to an annualized dose of approximately 250 rem.

As discussed previously, if the uncertainty in the exposure model is small compared to the uncertainty in the risk model, the net result is that IREP, the probability of causation program, effectively uses the mean of the distribution in the final probability of causation calculation. This means that the IREP program effectively uses 8 rem of exposure (which equates to an annualized exposure of about 133 rem) for each year of rollings operations in its calculation. NIOSH is unaware of any uranium operation in the DOE complex where uranium workers were exposed on an annual basis to shallow doses exceeding 133 rem. A review of the monitoring records for the Fernald facility between 1952 and 1955 indicates that the highest recorded annual shallow dose for workers was 10 rem. During the year with the highest recorded dose, the Fernald site produced approximately 20 million pounds of uranium metal and machined approximately 15 millions pounds of material. This far exceeds the amount of uranium handled at BSC, which by NIOSH's estimate handled at most approximately 700,000 pounds of uranium annually.

The profile suggests that there was direct handling of uranium metal by many workers which is not addressed in the site profile. Although the profile does not specifically address the direct handling of uranium metal, the 8 rem mean annual exposure in the model would allow for a worker to be in direct contact with uranium metal (either sitting, holding or carrying it next to the body) for approximately 3.3 hours per shift. Since much of the time during processing, the uranium is heated to extreme temperatures (~1200 degrees Fahrenheit), it is unlikely that any worker experienced direct contact with metal for this length of time. Further, uranium fabrication operations at Fernald, where more than 30 times the amount of uranium was directly handled, did not result in doses approaching the values provided in the profile.

Based on the above discussion, NIOSH does not believe that it is necessary to adjust the external exposure values in the site profile. NIOSH is interested in hearing the opinion of the Board on this issue. If the Board believes that the external exposures in the site profile are not adequately addressed, NIOSH will reconsider this position.

OBSERVATIONS

1. **The input of the site experts was not adequately evaluated to determine the impact of dose reconstruction efforts.**

   NIOSH has considered the input of site experts and has revised the site profile (revised June 2004) to include the ingestion pathway as an exposure mode. In other instances, NIOSH has evaluated the comments provided by workers and believes that the site profile is sufficiently claimant favorable in the areas of internal and external dose so that an upward revision is not warranted.

   As discussed above, the worker's statement that uranium metal was directly handled in contact with the body was evaluated in light of the assumptions contained in the profile. Although the profile does not specifically address the direct handling of uranium metal, the 8 rem annual exposure in the model would allow for a worker to be in direct contact with uranium metal (either sitting on or holding) for approximately 3.3 hours per shift. Since much of the time during processing, the uranium is heated to extreme temperatures (~1200 degrees Fahrenheit), it is unlikely that any worker experienced direct contact with metal for this length of time. Further, uranium fabrication operations at Fernald, where much more than 30 times the amount of uranium was directly handled, did not result in doses approaching the values provided in the profile.

2. **A comprehensive records search of relevant rolling operations documents was not performed to investigate worker testimony regarding additional rollings after 1952.**

   NIOSH requested DOE to locate and produce a copy of the contract language tasking BSC to perform rollings. To date, DOE has not been able to locate any contracts. During records searches, NIOSH is constantly on the watch for records that might help define the covered exposure period. When such records are found, the information is relayed to the Department of Energy (DOE) and the Department of Labor (DOL), so that they may evaluate them for potential modification of the covered exposure period. There are several examples where NIOSH records searches resulted in the discovery of new information that was used to extend coverage to previously uncovered workers. For example, the original Bethlehem Steel covered time period was extended by DOE to cover 1952 based on the discovery of air sample data by NIOSH. It must be stressed, however, that DOL is responsible for administering the EEOICPA, which includes establishing the time period for which a "covered facility" is deemed to be "covered." DOL has adjudicated this issue and found no documentation or basis to support additional rollings after 1952.

3. **The assumption of 10 hours of work per day may not be claimant-favorable based on available documentation and statements provided by site experts.**

   The revised model will assume continuous internal exposure to uranium at the 95th percentile of the facility distribution. This level of air concentration can only be maintained if the rolling mills are continuously operating. Based on worker input and from reviews of AEC reports, off-normal occurrences, such as cobbles or salt bath leaks, resulted in the shut down of the rolling mill process. During these shutdown periods, the generation of airborne activity would cease. As pointed out in the response to Finding 8, the external dosimetry model is sufficiently claimant favorable to account for any additional exposure above and beyond 10 hours per day.

4. **The TBD has not considered several pathways of internal exposure resulting from incidents such as cobbles, repairs of furnaces, salt bath leaks, and uptake via injuries (i.e., burns, cuts, scrapes).**

   As discussed in our responses to findings 1 and 2, NIOSH believes that the exposure matrix employed in the site profile adequately and appropriately accounts for any short-term episodic exposure incidents. The site profile, as modified, will use the 95th percentile of the air concentration data to estimate exposure. For the years 1949 and 1950, this equates to a worker being continuously submerged in a cloud of uranium dust of approximately 30 mg/m^3, which is sufficient to impair visibility in the work environment. Internal exposure to these episodic incidents tends to be brief and is overshadowed by the magnitude of the exposure assigned in the profile. Inhalation of the 95th percentile air concentration results in an annual assumed intake of more than 6 grams of uranium.

5. **The TBD makes no distinction between routine dose assignment conditions and unique exposure conditions such as high-risk work (e.g., loading and unloading of uranium, routine maintenance of equipment, clean out of pits).**

   NIOSH is revising the profile to use the 95th percentile inhalation dose for all workers. NIOSH believes that this is sufficiently adequate and appropriately accounts for the variety of exposure conditions encountered in the rolling of uranium. By using the general exposure model with sufficient safety margins, NIOSH is not requiring the claimants or survivors to clearly recall events in the distant past. When claimants bring forth unique exposure issues during the Computer Assisted Telephone Interview (CATI), the dose reconstructor is required to compare the incident or exposure conditions against those in the site profile and determine if any adjustment to the estimated dose is necessary.

6. **There is no mention of estimates of dose from environmental releases in the Bethlehem Steel TBD as there are in subsequent site profiles, such as those completed for Mallinckrodt Chemical Works, Savannah River Site, and Hanford.**

   The estimation of environmental releases is used primarily in the DOE site profiles to assign doses to unmonitored workers, who were not believed to have been exposed to radioactivity/radiation in the operational areas. For the case of BSC, it was assumed that all workers were directly exposed to the rolling mill area during the generation of radioactive material. Because of this, the addition of environmental dose is not relevant. The site profile will be revised to clarify this position.

7. **The Bethlehem Steel TBD assumes workers were given chest x-rays in a period of time when photofluorography was a prevalent technique.**

   Although NIOSH is not aware of any usage of photofluorography at BSC, and there are internal AEC communications at SSS that suggest the usage of standard x-ray cassettes, NIOSH will research this issue and amend the site profile if necessary. We anticipate completing this research within 2 months.

<u>PROCEDURAL CONFORMANCE ISSUES</u>

1. **The TBD did not take into account ICRP 75 in assessing the validity of air concentration data for estimating individual worker doses.**

   As stated in the response to finding 1, NIOSH believes that the site profile should be revised to discuss the representative nature of the air samples collected at SSS and how these can be used to reconstruct doses at BSC. This will be addressed in a new section that will be added to the site profile.

2. **The TBD did not take into account the procedure set forth for metal working AWEs in ORAUT-OTIB-0004, Technical Basis for Estimating the Maximum Plausible Dose to Workers at Atomic Weapons Employer Facilities, Rev. 2 (Anderson 2003). As a result, the maximum dose estimates for Bethlehem Steel as estimated in the TBD are far below those that would have been derived had ORAUT-OTIB-0004 (abbreviated hereafter as ORAUT-OTIB-0004) been used.**

   NIOSH's response to this issue is combined with the response to procedural conformance issue 3.

3. **42 CFR 82 requires that efficient approaches to estimating doses when compensation is denied should be worst-case estimates. The maximum dose estimation procedure in the Bethlehem Steel TBD is not defensible as a worst-case estimate.**

   After careful consideration of SC&A's comments, NIOSH does not believe there to be any procedural conformance issues related to the implementation of the requirements of 42 CFR Part 82 or the application of NIOSH's internal efficiency procedures.

   SC&A has misinterpreted 42 C.F.R. pt. 82 to require the use of worst case assumptions when applying the efficiency process to cases that are likely to be non-compensable The dose reconstruction regulation permits, but does not require, NIOSH to substitute worst case assumptions for research and analysis. 42 C.F.R. § 82.10 provides an overview of the dose reconstruction process, including a description of certain research and analysis techniques that NIOSH may use to arrive at dose estimates. Under the regulation, research and analysis will be determined sufficient to complete a dose reconstruction that does not produce a compensable level of radiation dose if one of two conditions is met: (1) dose is determined using worst-case assumptions to substitute for further research and analysis; or (2) research and analysis as described in this section has been completed. Individual dose reconstructions that produce a non-compensable radiation dose could theoretically meet both conditions, as, for example, when worst-case assumptions are used for internal dose and research and analysis is used to estimate external dose.

   The Bethlehem Steel TBD describes the research and analysis that was completed to develop an exposure matrix that includes claimant favorable assumptions where appropriate; it is not a compilation of worst-case assumptions in lieu of research and analysis. A fundamental misunderstanding of this fact appears to be the basis for this procedural conformance issue.

   Additional evidence of SC&A's misinterpretation can be found in section 5.2, *Procedural Conformance Issue 2*. In this section, the draft report questions why the more general approach of ORAU-OTIB-004 was not used in lieu of the more detailed research performed for the Bethlehem Steel TBD. The report indicates that this is a procedural conformance issue; however, the application of the approach outlined in OTIB-004 to non-compensable cases at AWE facilities is an example of the application of § 82.10(k)(2) of the dose reconstruction regulation. As such, ORAU-OTIB-004 was developed to efficiently process cases that are likely to be non-compensable, while the Bethlehem Steel site profile is an example of a situation where NIOSH completed additional research which did not rely solely on worst case assumptions to process cases.