Justification for the use of Surrogate data at Joslyn Manufacturing and Supply Co.

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In response to a request by the Advisory Board on Radiation and Worker Health (ABRWH), NIOSH has evaluated the use of surrogate data at Joslyn Manufacturing and Supply Co., (Joslyn) for the time period of August 1, 1948 through December 31, 1952. Specifically, the use of inhalation exposure distributions during this period that are provided in TBD-6000 (Battelle 2011) were evaluated against the elements contained in the Advisory Board's *Criteria for the Use of Surrogate Data*[1] (ABRWH 2010). This justification of use of surrogate data at Joslyn supports NIOSH's position that dose reconstructions during this time period can be performed with sufficient accuracy (NIOSH 2012, NIOSH 2014).

Introduction

Joslyn, located in Fort Wayne Indiana, was an important facility for the early production of uranium for the Manhattan Engineer District (MED) and later the Atomic Energy Commission (AEC). During the course of their operations well over a million pounds of uranium were handled at the facility. Early operations were in support of the effort to load the Hanford reactor with its initial charge of uranium and also consisted of applied research in how to roll and machine uranium metal for production of plutonium. Joslyn's highest production rates actually occurred during the first 7 months of 1948 as they rolled uranium as part of the Dimensional Stability Program that sought to reduce the down time of the Hanford reactors during the increased power upgrades. These reactor outages were attributed to the specific characteristics of uranium that was produced by extrusion. The AEC hoped that rolling uranium would improve the reliability and loss of reactor time caused by fuel failures that plagued them in 1947 and 1948.

Joslyn continued as one of the principal uranium production facilities until July 31, 1948, at which point Simonds Saw and Steel Co., became the uranium production facility for the AEC. From August 1948 through the end of 1952, Joslyn continued to support the AEC by rolling and machining smaller quantities of uranium, principally for research purposes.

NIOSH and its support contractor Oak Ridge Associated University Team (ORAUT) have collected a substantial amount of information on the quantity, operation details, and facility monitoring data regarding the MED and AEC activities at Joslyn from 1943 through 1952. While the operations varied over time, they typically included various machining and rolling operations of uranium in support of the MED and the AEC. Over the course of its operations this included hot rolling, quenching, Medart straightening, cooling, grinding, waste burning, and abrasive cutting of natural uranium billets into metal rods.

Monitoring data for the Joslyn facility is limited. While there were a handful of air monitoring samples taken in 1943 and 1944 by the MED using electrostatic precipitation methods, these were deemed unsuitable for use in dose reconstruction because of uncertainties in the methods. During the 1948-1952 time period evaluated in this document, NIOSH is aware of only three set of air monitoring data. This

[1]Although NIOSH also has criteria for evaluation of the use of surrogate data that are discussed in IG-004 (NIOSH 2008), the ABRWH's criteria were used in this evaluation. A review of the NIOSH criteria against those of the ABRWH indicated that the Board's criteria were inclusive of all the evaluation points contained in NIOSH's IG-004.

includes a small data set collected by the AEC's Health and Safety Laboratory (HASL) in 1951 that focused on machining operations, including samples taken at the cutoff machine and the centerless grinder (SRDB 11036 pdf pages 23-24). In 1952 HASL (Klevin 1952) collected samples that evaluated a much broader set of rolling and machining operations, which included a determination of the Time Weighted Average (TWA) daily intakes for various groups at Joslyn. The third data set was from a pre-cleanup survey that measured the contamination at Joslyn in August of 1949; nearly a year after the highest production had ended at Joslyn (Picot 1949).

Evaluation against the Criteria for Usage of Surrogate Data

In light of the operations and the available monitoring data described above, this document provides an evaluation for applying the surrogate data contained in TBD-6000 to reconstruct routine inhalation intakes of uranium at Joslyn Manufacturing and Supply Company. This usage is evaluated in accordance with the criteria established by the ABRWH specifically for the period August 1, 1948 through December 31, 1952.

1) *Hierarchy of Data – It should be assumed that the usual hierarchy of data would apply to dose reconstructions for that site (Individual worker monitoring data followed by co-worker data followed by workplace monitoring data such as area sampling followed by process and source term data.) This hierarchy should be considered when evaluating the potential use of surrogate data. Surrogate data should only be used to replace data if the surrogate data have some distinct advantages over the available data and then only after the appropriate adjustments have been made to reflect the uncertainty inherent in this substitution.*

A detailed review of records and worker interviews at Joslyn indicate that no individual monitoring data for uranium were ever collected. Facility monitoring data in the form of air samples was collected on a limited set of machining operations in 1951 by the AEC's Health and Safety Laboratory (HASL) and a more comprehensive collection with the development of Time Weighted Average daily intakes was performed by HASL in January 1952.

NIOSH has determined that the data contained in the 1951 and 1952 studies meet the analytical and methodological requirements necessary to perform dose reconstruction as they were conducted using the well understood methods employed by the AEC's Health and Safety Laboratory. These data, however, only represent two "snapshots" of the levels of airborne uranium over more than a three year exposure period. Therefore, NIOSH has used the measured data from the rolling operator and machining operator from TBD-6000 to augment the limited air samples at Joslyn.

2) *Exclusivity Constraints – In many cases, surrogate data are used to supplement the available monitoring data from a site. In those cases, the surrogate data is usually used to justify certain assumptions about the distribution or range of possible exposures or assumptions about the source terms. In those cases, no special justification is necessary beyond the usual scientific evaluation. This is akin to the Type II use described above. However, in other situations, there are no or very little monitoring data available. In those cases, the use of the surrogate data as the basis for individual*

dose reconstruction would need to be stringently justified. This judgment needs to take into account not only the amount of surrogate data being relied on relative to data from the site but also the quality and completeness of that surrogate data.

As discussed above, data collected by HASL in 1951 and in particular 1952 are available for evaluating internal dose from uranium rolling and machining operations at Joslyn. NIOSH, however, utilized the surrogate data from TBD-6000 to describe the full range of conditions and assumptions of the exposures that may have been observed beyond the single 1952 TWA study conducted by HASL. While the data from the site indicated that the bounding operation was from exposure at the rolling mills, NIOSH has also included data from rolling and machining operations in TBD-6000 to estimate exposures at Joslyn. The surrogate data utilized for the rolling and machining operations came from a study by Christofano and Harris (1960), which was a comprehensive peer-reviewed publication that analyzed 60 complete surveys from 7 different AEC uranium facilities. The data set included more than 20,000 dust samples taken in operator breathing zones as well as general areas beginning in 1948. This publication therefore represents a robust data set useful in representing exposures.

NIOSH compared the data from the 1952 air monitoring results in Table 6-1 of the Addendum of the Joslyn Evaluation Report to the daily weighted average values contained in Tables 7.3 and 7.5 of TBD-6000. Comparison of these datasets show that the TBD-6000 Machining Operator (GM=2,491 pCi/m^3, 95th percentile 35,171 pCi/m^3) and the Rolling Operator (GM=1,606 pCi/m3, 95th percentile 22,675 pCi/m^3)[2] provide conservative surrogate data substitutions for both categories. While NIOSH acknowledges there was burning of uranium waste outside of the facility, the ABRWH working group has previously agreed that those conditions are bounded by the rolling and machining operations represented in TBD-6000.

Further comparison of the data shows that this claimant favorable approach is clearly conservative as compared to the TWA rolling mill and machining operator values determined by HASL in 1952, with one exception (see Attachment 1). In TBD-6000, the geometric mean of the rolling mill operator is less than the HASL measured values at the east and west side of the 9" finishing rollers. While the TWA determined by HASL for those operators was 7451 (with a maximum value 17,672 pCi/m^3), the exposure is contained within the bounds of the distribution provided by the Rolling Operator (95th percentile 22,675 pCi/m^3). Furthermore, after July 1948, the contracts under which Joslyn operated for the Joint Rolling Program on Dimensional Stability (AEC and Atomic Energy Commission Canada) specifically called for rolling on the 18 inch mill (summary of rollings are contained in part in SRDB 118159, SRDB 120484, SRDB 04048, and SRDB 112574). This program represented smaller efforts (approximately 30 tons in each 1949 and 1950) compared to the production rates Joslyn experienced in early 1948. The 18-inch rolling mill was also shown in the 1952 study to have substantially lower air concentrations compared to the 9-inch finishing mill. The use of the 18-inch mill removed the highest source of exposure at Joslyn from many of days of operations and further substantiates that multiple mills were not used

[2] The air concentration values for the machining operator and rolling operator were derived from the stated pCi/d intakes in TBD-6000. The 95th percentile values were computed using the TBD-6000 assumption of a GSD of 5.

simultaneously during this time period because of the careful temperature control called for in the program. NIOSH knows of only one rolling event beginning in August 1948 where the 9-inch mill was used (January 1952, when HASL conducted the TWA study). Worker testimony in the 2012 outreach meeting by a worker who was in the mill area beginning in 1948 only remembered using the 18-inch mill for uranium work (SRDB 118494).

3) *Site or Process Similarities – One of the key criteria for judging the appropriateness of the use of surrogate data would be the similarities between the site (or sites) where the data were generated and the site where the surrogate data are being utilized. The application of any surrogate data to an individual dose reconstruction at a site should include a careful review of the rationale for utilizing that source of data. Factors that could be considered include, but are not limited to, similarity of the production processes, presence or absence of conditions that might affect exposure, and monitoring methods employed at the site(s). The potential availability of other sources of surrogate data needs to be considered and the selection of the surrogate data used for dose reconstruction justified. Some of the questions to be considered where appropriate are:*

    i) *Are there other sources of surrogate data that were not used?*
    ii) *Do these other potential sources contradict or undermine the application of the data from the selected site?*
    iii) *Are there adequate data characterizing the site being used that would help support its application to other sites?*
    iv) *Do the surrogate data reflect the type of operations and work practices in use at the facilities in question?*
    v) *Surrogate data should not be used if the equivalence of working conditions, source terms, and processes of the surrogate facility to the one for which dose reconstructions are being done cannot be established with reasonable scientific or technical certainty as outlined here.*

TBD-6000 provides a comparison of data across a number of facilities that conducted exactly the same types of rolling and machining operations that Joslyn performed. Review of the site data available from 1951 and 1952 shows that the rolling operations provided the highest measured exposures at the site and all operations measured on those days were found to compare very well with the distribution of data provided in TBD-6000 (see Attachment 1). NIOSH believes that these comparisons provide convincing evidence that the TBD-6000 data provide a realistic exposure assessment for operations at Joslyn. As previously discussed, the HASL laboratory utilized well described methods of collection, analysis and evaluation that reflect state of the art at the time.

NIOSH made the determination that conditions at Joslyn met with the process similarities of the facilities at which HASL made the measurements upon which TBD-6000 is based beginning with August 1, 1948. NIOSH carefully considered the following items:

- Beginning with August 1948, Joslyn was operated with AEC oversight which provided increased certainty that the air monitoring data from other facilities is appropriate for comparison.

Documented AEC oversight and presence for the operations conducted after the completion of the production campaigns that were completed in July 1948, coupled with well-defined and specific operations, allowed NIOSH to conclude the data obtained by HASL in 1951 and 1952 could be represented by the exposure conditions in TBD-6000 as early as August 1, 1948.

- Beginning in August 1948, the reduction in production levels to smaller rolling operations in support of specific research projects were less likely to have required simultaneous rollings on the three closely-located rolling mills.
- Beginning in August 1948, the contracts under which Joslyn operated for the Joint Rolling Program on Dimensional Stability (AEC and Atomic Energy Commission Canada) specifically called for rolling on the 18 inch mill. This removed the highest source of exposure (the 9" rolling mill) at Joslyn during many of the days of operation and provides additional evidence that multiple mills were not used simultaneously during this time period.

4) *Temporal Considerations: Consideration also needs to be given to the period in question, since working conditions and processes varied in different periods. Surrogate data should belong in the same general period as the period for which doses are sought to be reconstructed unless it can be demonstrated that the working conditions, procedures, monitoring methods, and (perhaps) legal requirements were comparable to the period in question.*

Temporal considerations for Joslyn were given extensive weight when determining the feasibility of dose reconstruction and the comparability of surrogate data that could be used for dose reconstruction and these have been discussed in the previous sections. It is particularly important, however, to note that Joslyn only used electrically heated furnaces to pre-heat the billets, unlike other later-constructed facilities that may have used lead or salt bath coatings. NIOSH confirmed that the TBD-6000 data set extended to cover the Simonds Saw and Steel initial studies with rolling furnace heated uranium and thus extend the applicability of TBD-6000 back to 1948.

5) *Plausibility: The manner in which the surrogate data are to be used must be "plausible" with regard to the reasonableness of the assumptions made. The plausibility determination should address issues of:*

   a) *Scientific plausibility. Are the assumed models (e.g., bioassay, concentration gradients) scientifically appropriate? Have the models been validated (where feasible) using actual monitoring data collected in a similar situation?*
   b) *Workplace plausibility. Are the assumed processes and procedures (including monitoring) plausible for the facility in question? Have all of the factors that could significantly impact exposure been taken into account? Is adequate information available about the facility in order to be able to make a fair assessment?*

While the data from the site indicated that the bounding operation was exposure at the rolling mills, NIOSH has used data from both the rolling mill and machining operator category from TBD-6000 to provide a reasonable estimate of exposure at Joslyn beginning August 1, 1948. The surrogate data utilized

for the rolling and machining operations came from a study by Christofano and Harris, which was a comprehensive peer-reviewed publication that analyzed 60 complete surveys from 7 different AEC uranium facilities. The data set included more than 20,000 dust samples taken in operator breathing zones as well as general areas beginning in 1948. This publication therefore represents a robust data set useful in representing exposures that have been shown for this site and others to represent a fair, scientifically plausible, and complete method to describe dose reconstruction methods at Joslyn after July 31, 1948. NIOSH used site data to verify that the TBD-6000 approach produced reasonable, claimant favorable estimates for the many different machining and rolling operations at Joslyn. NIOSH further reviewed carefully the operational characteristics and temporal changes at Joslyn to come the conclusion that this was an appropriate method for dose reconstruction. The changes to the rolling schedules and significantly reduced use of the highest exposure rolling mill (the 9-inch finishing mill) after July 31, 1948 further lends itself to the conclusion that TBD-6000 provides conservative and reasonable uranium intakes at Joslyn.

Attachment 1:

Comparison on Time Weighted Average Study with TBD-6000 (from Table 7-1 of the Evaluation Report Addendum)

Table 7-1: Comparison of 1952 Time-weighted Average (TWA) Study with Battelle-TBD-6000					
Joslyn Work Area/Job Description	**TWA (pCi/m^3)**	**Battelle-TBD-6000 Equivalent Description**	**GM (pCi/m^3)**	**95% (pCi/m^3)**	**AM (pCi/m^3)**
18" rough roll east	1496	Rolling Operator	1606	22675	5864
18" rough roll west	169	Rolling Operator	1606	22675	5864
Roller Forman	327	Rolling Supervisor	148	2090	540
Asst Roller (Ass't Foreman)	327	Rolling Supervisor	148	2090	540
Furnace Heaters	7	Rolling General Labor	296	4179	1081
Recorder	7	Rolling General Labor	296	4179	1081
12" rough Roll East	273	Rolling Operator	1606	22675	5864
12" rough Roll West	257	Rolling Operator	1606	22675	5864
Drag Down (Billet)	140	Rolling General Labor	296	4179	1081
9" finishing roll east	7451	Rolling Operator	1606	22675	5864
9" finishing roll west	2609	Rolling Operator	1606	22675	5864
Quench Tank	70	Rolling General Labor	296	4179	1081
Draggers	374	Rolling General Labor	296	4179	1081
Rod Stamper	109	Rolling General Labor	296	4179	1081
Rod Bundler	58	Rolling General Labor	296	4179	1081
Lathe Operation	5	Machining Operator	2491	35171	9096

The 1952 study presented in Attachment 1 is the only time-weighted-average (TWA) study located for Joslyn. As can be seen, each arithmetic mean (AM) of the distribution with the given geometric mean (GM) and a geometric standard deviation (GSD) of 5 is generally much higher than the 1952 TWA values obtained at Joslyn. In one location ("9-inch finishing roll east"), the Joslyn value is higher.

References

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