Division of Compensation Analysis and Support	Document Number: Battelle-TBD-6000 Appendix B Effective Date: 06/02/2015 Revision No. 1
Site Profiles for Atomic Weapons Employers that Worked Uranium Metals **Appendix B – Birdsboro Steel and Foundry Company**	Page 1 of 8
Document Owner: David Allen	
Approval: Signature on file Date: 06/02/2015 J.W. Neton, Associate Director for Science	Supersedes: Appendix B Revision 0

RECORD OF ISSUE/REVISIONS

ISSUE AUTHORIZATION DATE	**EFFECTIVE DATE**	**REV. NO.**	**DESCRIPTION**
8/14/2007	8/14/2007	0	Appendix to Battelle-TBD-6000 describing the use of the TBD for claims at Birdsboro Steel
4/29/2015	6/02/2015	1	Revision to update appendix based on revision to TBD-6000

BIRDSBORO STEEL AND FOUNDARY COMPANY

B.1 Introduction

This document serves as an appendix to Battelle-TBD-6000, Site Profiles for Atomic Weapons Employers that Worked Uranium Metals (Battelle 2011). This Site Profile presents site-specific information for the Birdsboro Steel Company located in Birdsboro, Pennsylvania. Sufficient information has been found to provide more appropriate estimates of worker radiation dose than provided for in the technical basis document (TBD). Where specific information is lacking, research into similar facilities described in the body of this Site Profile is used.

B.2 Site Description

The Birdsboro Steel Company was under contract with the Atomic Energy Commission (AEC) to assist in the design of the rolling mill plant to be installed at the Feed Materials Production Center (FMPC), Fernald Ohio. While this activity is primarily design and engineering, two small shipments of uranium metal were sent to Birdsboro. The shipments were samples from test rolling of uranium metal at facilities with equipment similar to what was proposed for the FMPC (Bate 1952).

B.2.1 Site Activities

During the week of 11/15/1951, Birdsboro shipped 346 pounds of uranium metal to Lake Ontario Ordinance Works (LOOW). It is not known when Birdsboro received this metal but the shipment was described as 8 pieces of billets (AEC 1951, Malone 1951).

Birdsboro developed a basic rolling mill design based on information obtained from the AEC, AEC contractors and laboratories. Because of many unanswered questions the AEC established an experimental rolling program to gather data (Polson and Schiltz). The basic design was discussed and agreed to in a meeting on 2/7/1951 (Reichard 1951). A summary of uranium metal rolling associated with the Fernald operations lists four dates where uranium metal was rolled prior to the meeting (AEC 1951a). Three of these were at Simonds Saw and Steel which were apparently conducted for evaluation by DuPont. The fourth was at Allegheny-Ludlum with the added purpose to provide Birdsboro with data for the rolling mill design. The data appear to be primarily temperature data and observations. All four of these rollings consisted of rolling 5 inch diameter ingots into finished rods.

On April 16th and 17th of 1951, another rolling at Simonds Saw and Steel occurred. On the 16th, the ingots were again rolled into finished rods but on the 17th, the ingots were rolled into billets (interim product) that were to be finish rolled at Bethlehem Steel. This rolling campaign was also designated experimental rolling #1 per a meeting that occurred on April 6, 1951. Since this rolling was the first in the summary to create billets and is referred to as experimental rolling #1, the 346 pounds of uranium billets pieces likely come from this rolling or a later one. This site profile will take the favorable assumption that the uranium came from this rolling and was received by Birdsboro on 4/17/1951. The metal was shipped from Birdsboro on 11/15/1951.

Additionally 5 wafers cut from rods finished at Bethlehem Steel were shipped to Birdsboro on 2/1/1952 (Smith 1952). The wafers totaled 11.5 pounds. No information was found as to when the pieces were shipped out of Birdsboro. Therefore, this estimate will assume the wafers were at Birdsboro from 2/1/1952 until 12/31/1952 (the end of the covered period).

Pieces of billets and rods from various rollings were sent to different locations for analysis and inspections. It is not known why Birdsboro received these pieces but it is assumed they were for metallurgical analysis. From experimental rolling reports, there appears to be interest in a number of parameters but the grain size and orientation are parameters likely to be analyzed in a metallurgical laboratory (Bach 1952, Bach 1952a, Kattner 1952, Polson and Schiltz, Riches 1955, Sanderson 1952). Evaluation of the grain size and orientation would likely include cutting, grinding and polishing the surface for observation by an optical microscope (Bach 1952). The abrasive sample preparation work (cutting and grinding) could be easily accomplished in one work shift for 5 to 8 pieces of metal. While it is possible not all were processed in the same day, this site profile will take the favorable assumption that it took one full work day to cut the pieces from each shipment and that this was done the day they arrived at Birdsboro.

It is further assumed that the remaining metallurgical analyses were not dusty operations but did require the handling of the uranium pieces. It is assumed that the pieces were handled for a full work week (including the cutting) then stored until shipped off-site. Also, for 1951 and 1952, TBD-6000 assumes the standard work day is 8.8 hours, resulting in a 44 hour work week.

B.3 Occupational Medical Dose

No information regarding occupational medical dose specific to the Birdsboro was found. Information to be used in dose reconstructions for which no specific information is available is provided in ORAUT-OTIB-0006 (ORAU, 2011), the dose reconstruction project technical information bulletin covering diagnostic x-ray procedures.

B.4 Occupational Internal Dose

No air sample data or other form of internal dose data from Birdsboro were found. TBD-6000 provides intakes from a variety of tasks typical of uranium metal work. While one of those tasks is rolling uranium metal, it is not appropriate for Birdsboro since no uranium rolling occurred at the site. Table 7.6 of the TBD lists air samples for different tasks associated with slug production. These tasks include stamping, filing and cleaning the slugs. Table 7.5 includes tasks for lathe work, cutting, milling, drilling as well as sanding and grinding. The task associated with the highest airborne level is centerless grinding. However, centerless grinding is a process for grinding only the outside diameter of a cylindrical shape and normally applicable only to high volume production. As such, it is not a process that would be used for metallurgical sample preparation. The task in Tables 7.5 and 7.6 with the next highest airborne level is surface grinding. The geometric mean value of 3160 dpm/m^3 is used for this estimate.

This estimate assumed workers were exposed to the airborne activity associated with surface grinding the samples (3160 dpm/m^3) for 8.8 hours on 4/17/1951 and again on 2/1/1952. After the 4/17/1951 work, it is further assumed that residual contamination remained in the area that could cause additional intakes of uranium. To estimate these intakes, the surface contamination level was first calculated using the technique in TBD-6000. This technique assumes the airborne activity settles to horizontal surfaces at a rate of 0.00075 m/s for 30 continuous days. However, airborne generating work at Birdsboro would have been much more limited in duration. The technique was therefore modified from a 30 day settling period to an 8.8 hour period. This results in a surface contamination of 75,082 dpm/m^2 after the 4/17/1951 work. Even though normal tracking and house keeping would reduce this value, this estimate makes the favorable assumption that the contamination remained at this level. After the 2/1/1952 work, additional contamination is added to the existing contamination using the same technique. The contamination level after that date is calculated to be 150,163 dpm/m^2.

These contamination levels are assumed to be resuspended at a rate of 1x10^{-5} m^{-1} resulting in airborne contamination values of 0.751 dpm/m^3 and 1.502 dpm/m^3 for the two time periods respectively.

Ingestion of uranium contamination is also possible at Birdsboro. While OCAS-TIB-0009 is often used to calculate this intake, it is not suitable for a short duration operation. That is because the document assumes operations have continued long enough to cause the maximum level of contamination to buildup. Therefore, ingestion intakes at Birdsboro are calculated assuming the surface contamination is ingested at a rate of 1.1x10^{-4} m^2/hr (NUREG/CR 5512).

Tables B.1 through B.3 include values associated with the intake calculations. The inhalation and ingestion intake rates to be used for dose reconstruction are listed in Table B.3. Internal doses calculated from these intakes should be entered into IREP as the geometric mean of a lognormal distribution with a geometric standard deviation of 5 in accordance with TBD-6000.

Table B.1 – Inhalation during Metal Work

Start date	End date	Hours of sample preparation	Other work hours	Inhalation from preparation (dpm)	Inhalation from contamination (dpm)
4/17/1951	12/31/1951	8.8	1561	33370	1407
1/1/1952	1/31/1952	0	186	0	167.9
2/1/1952	12/31/1952	8.8	2014	33370	3629

Table B.2 – Ingestion Intakes

Start date	End date	Surface Contamination (dpm/m^2)	Ingestion rate (dpm/hr)	Total ingestion (dpm)
4/17/1951	12/31/1951	75082	8.26	12893
1/1/1952	1/31/1952	75082	8.26	1539
2/1/1952	12/31/1952	150163	16.52	33262

Table B.3 – Total Inhalation and Ingestion Intakes

Year	Calendar days	Inhalation (dpm)	Ingestion (dpm)	Inhalation rate (dpm/day)	Ingestion rate (dpm/day)
1951	259	34776	12893	134.3	96.0
1952	366	37166	34801	101.5	343

B.5 Occupational External Dose

No data were found related to occupational external dose from the uranium work at Birdsboro. The work performed at Birdsboro involved metallurgical analysis of pieces of uranium billets and rods. Therefore the one foot dose rates from table 6-1 are used to estimate the external dose. For the 1951 work, the material was 8 pieces of billets. The billets were produced from 5 inch diameter ingots and later used to make rods. The billets are then essentially thick rods somewhere between the thickness of a rod and a 5 inch ingot. Therefore dose rates associated with either billets or rods could be appropriate. Since these were pieces of billets, long billets and long rods were not considered (it should be noted that slugs are short rods approximately 8 inches in length). The dose rate associated with short billets is higher so that dose rate (0.469 mrem/hr) was be used for the 1951 work with billet pieces. The slug dose rate (0.0524 mrem/hr) was used for the 1952 work with wafers cut from uranium rods.

The beta dose rate to the body from the uranium is assumed to be 10 times the gamma dose rate per TBD-6000. Also, in accordance with TBD-6000, the contact beta dose rate is assumed to be 230 mrem/hr. As stated earlier, the work with the metal is assumed to take one full week which is assumed to be 44 working hours in 1951 and 1952. The technique used in TBD-6000 is used here which is to assume the operator was exposed to these dose rates half the time.

Table B.4 contains the calculated gamma dose from working with uranium metal while Table B.5 contains the beta dose from the same work.

Table B.4 – External Gamma Dose during Metal Work

	Uranium work hours	Gamma dose rate	Gamma dose
1951	44	0.469	10.3
1952	44	0.0524	1.15

Table B.5 – External Beta Dose during Metal Work

	Uranium work hours	Skin dose rate	Hand dose rate	Skin dose	Hand dose
1951	44	4.69	230	103	5060
1952	44	0.524	230	11.5	5060

After the uranium work is completed, the potential for residual uranium contamination remains. The contamination level (calculated in section B.4) were multiplied by the dose conversation factors found in Table 3.10 of TBD-6000 to derive a dose rate from the residual contamination. Workers are assumed to be exposed to this dose rate continuously from 4/17/1951 through the end of 1952. The contamination level is assumed to increase after 2/1/1952 as explained in section B.4.

Table B.6 – External Beta and Gamma Dose from Contamination

		Work hours	Gamma dose (mrem)	Beta dose (mrem)
4/17/1951	12/31/1951	1561	0.0462	4.48
1/1/1952	1/31/1952	183	0.0054	0.526
2/1/1952	12/31/1952	2017	0.1193	11.6

Table B.7 contains the combined annual dose from work with uranium metal and from residual contamination. Annual external doses calculated from these should be entered into IREP as the geometric mean of a lognormal distribution with a geometric standard deviation of 5 in accordance with TBD-6000.

Table B.7 – Annual External Beta and Gamma Doses

	Gamma dose	Skin dose	Hand dose
1951	10.4	108	5064
1952	1.28	23.6	5072

B.6 Dose from Residual Contamination

Residual contamination potentially existed between operations with uranium at Birdsboro. However, the limited quantity of uranium present indicates the potential was low and so no residual contamination period was designated after 1952. The periods between operations is accounted for in a favorable manner in sections B.4 and B.5.

B.7 References

AEC 1951, *Tonawanda Area Progress Report November 1951*, SRDB 9545 pp. 14-19

AEC 1951a, *Summary of Experimental Rollings Related to Fernald Operators*, unknown author, 11/17/1951, SRDB 10885 pp 23-29

Bate 1952, Letter to file from G. A. Bate, *Records and Reports with Respect to Fissionable and Source Material - Miscellaneous Information Concerning*, 8/5/1952, SRDB 61965 pg 14.

Battelle, 2011, Battelle-TBD-6000 Rev 1, *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*, June 17, 2011

Bach 1952, J. H. Bach, *Some Effects of Rolling on the Crystallography and Metallography of Uranium*, 2/18/1952, HW-23591, SRDB 28063

Bach 1952a, J. H. Bach, J. W. Riches, M. J. Sanderson, *The Effects of Rolling Temperature on the Structure of Uranium*, 4/24/1952, HW-24222, SRDB 28061

DOE web site, Office of Health, Safety and Security, EEOICPA web site. https://hsspublic.energy.gov/search/facility/findfacility.aspx

Kattner 1952, W. T. Kattner, *Program for Developing Uranium Fabrication Processes*, 1/16/1952, HW-23269, SRDB 28049

Malone 1951, Letter from F. W. Malone to R. J. Smith, *Weekly Production Report November 15th 1951*, 11/21/1951, SRDB 61144 pg. 3

NIOSH, 2004, *Estimation of Ingestion Intakes, Technical Information Bulletin*, OCAS-TIB-009, Revision 0, April 13, 2004

NIOSH, 2007a *Radiation exposures covered for Dose Reconstructions under Part B of the Energy Employees Occupational Illness Compensation Program Act Rev. 0*, OCAS-IG-003, National Institute for Occupational Safety and Health, Office of Compensation Analysis and Support, Cincinnati, Ohio

NUREG/CR 5512 Vol. 1, *Residual Radioactive Contamination From Decommissioning*, Prepared for the Nuclear Regulatory Commission, October 1992.

ORAU, 2011, *Dose Reconstruction from Occupational Medical X-Ray Procedures*, Oak Ridge Associated Universities (ORAU), ORAUT-OTIB-0006, Revision 03 PC-1, June 20, 2011

Polson and Schiltz, C. E. Polson and J. F. Schiltz, The Rolling of Uranium Rod, undated, SRDB 44130

Reichard 1951, Letter to file from H. F. Reichard, Trip to Birdsboro Steel Foundary and Machine Company – February 7, 1951, 2/15/1951, SRDB 9545 pp, 9-10

Riches 1955, J. W. Riches, *Nuclear Metallurgy Lectures Chapter 9*, 5/12/1955, HW-34868, SRDB 28021

Sanderson 1952, M. J. Sanderson, *Evaluation of Uranium Rods from the Fourth Experimental Rolling at Lackawanna, New York*, 3/21/1952, HW-23910, SRDB 16285.

Smith 1952, Letter from R. J. Smith to L. King, *Shipment of Material*, 2/1/1952, SRDB 9545 pg 11.