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<b>Division of Compensation Analysis and Support</b>	Document Number: Battelle-TBD-6000
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Site Profiles for Atomic Weapons Employers that Worked Uranium Metals - Appendix D Bliss and Laughlin Steel	
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RECORD OF ISSUE/REVISIONS			
ISSUE AUTHORIZATION DATE	EFFECTIVE DATE	REV. NO.	DESCRIPTION
03/14/2012	03/14/2012	0-A	Appendix to Battelle-TBD-6000 describing the use of the TBD for claims at Bliss and Laughlin Steel
09/04/2012	09/04/2012	0-B	Minor changes made including typos and clarification of some points.

## D.1 Introduction

This document serves as an appendix to Battelle-TBD-6000, *Site Profiles for Atomic Weapons Employers that Worked Uranium Metals*. This appendix describes the results of document research specific to this site. Where specific information is lacking, research into similar facilities described in the body of this Site Profile is used.

## D.2 Site Description

Under contract to the National Lead Company of Ohio (Fernald), Bliss and Laughlin Steel rolled uranium rods for the Atomic Energy Commission (AEC) and also provided uranium slug machining services. Bliss and Laughlin was part of a complex called the "The Buffalo Works" portions of which were operated by Bliss and Laughlin, Bethlehem Steel, and American Car and Foundry, which fashioned components for the early weapons program.

The former Bliss and Laughlin Steel Company site was located at 110 Hopkins Street in Buffalo, New York. The facility consisted of a single building with a floor area of approximately 129,600 square feet. Bliss and Laughlin operated the site from 1929 to 1971, producing cold-finished steel bars for heavy equipment such as automobiles, appliances, construction machinery, and farm equipment.

### D.2.1 Site Activities

During September and October of 1952 the Bliss and Laughlin Steel Company machined

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and straightened uranium rods for the AEC to improve the rod diameter tolerance. Machining operations were performed at a location in the building designated as the “Special Finishing Area” which occupied approximately 3,230 square feet of floor space and was open (without inside walls or partitions) (ORAUT 1992). The floor in that area was characterized as rough surface concrete with several shallow utility trenches providing water, electricity, lubricant, and pneumatic plant services.

Available records indicate that Bliss and Laughlin performed five normal assay rod-machining campaigns for the AEC; one in April 1951 and four in September and October 1952 (Hershman 1952). During September and October 1952 Bliss and Laughlin was under contract to National Lead of Ohio (NLO), a contractor for all operations at the Feed Material Production Center at Fernald, Ohio, to machine and straighten uranium rods.

#### **D.2.1.1 Operations - 1951**

On April 24, 1951 at least twenty 1-5/8” diameter rough-rolled rods were shipped from Lake Ontario Ordnance Works to Bliss and Laughlin and machined to a slightly smaller diameter and then water quenched. That same day the machined rods were shipped back to Lake Ontario Ordnance Works (AEC 1951) where they would subsequently be shipped to Bethlehem Steel for further rolling. This work resulted in the accumulation of four drums of dry uranium oxide (Koenig 1951) that the AEC shipped to Mallinckrodt Chemical Works in St. Louis, probably in November or December 1951.

#### **D.2.1.1 Operations - 1952**

In September and October 1952 machining operations were conducted on one Friday and three Saturdays (ORAUT 1992). Weekend schedules were used to avoid significantly impacting normal operations, and possibly, to enhance security and radiological safety. The exact quantity of uranium and duration of the operations is not known (ORAUT 1992), but due to the relatively short duration of the operations, total quantities can be assumed to have been somewhat limited.

Rods were shipped from Lake Ontario Ordnance Works to Bliss and Laughlin Steel for machining and straightening. The finished rods were shipped to NLO at Fernald, Ohio and 53 drums of turnings were sent via AEC trucks to Lake Ontario Ordnance Works for packaging. The turnings were then sent from Lake Ontario Ordnance Works to Fernald in November of 1952 (ORAUT 1992).

AEC personnel arranged for the transportation of all raw materials, wastes, and products to and from the site. Bliss and Laughlin personnel were not involved with these aspects of the operation.

### **D.3 Occupational Medical Dose**

No information regarding occupational medical dose was found in any of the site research. Information to be used in dose reconstructions, for which no specific information is available, is provided in ORAUT-OTIB-0006, the dose reconstruction project technical information bulletin covering diagnostic X-ray procedures.

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#### **D.4 Occupation Internal Dose**

Air sample data was collected during the 1952 rod-turning operations at Bliss and Laughlin. Air samples were taken on September 26th, September 27th, October 4th, and October 11<sup>th</sup> (NLO 1952). Samples included general area (GA), process (P), and breathing zone (BZ) data.

Two notations in the data in written reports forced some BZ and GA data to be excluded. On the air sample data sheets a fan is noted as being used for some samples and is also discussed in a memo from NLO. These data were not included in the evaluation of air sampling to determine internal dose. Additionally, some samples were noted as being obtained when AEC operations were not being conducted. These samples were also excluded.

An analysis of 20 total samples (13 BZs and 7 GAs) was conducted. The measured air concentrations from the samples were distributed and produced a geometric mean of 2,602 dpm/m<sup>3</sup> with a geometric standard deviation (GSD) of 2.04. This was compared to the default air concentration value of 5,800 dpm/m<sup>3</sup> contained in Table 7.5 of Battelle-TBD-6000 for an operator machining uranium. Because of the limited number of air samples, the air concentration value from Battelle-TBD-6000 was determined to be more claimant-favorable and was utilized to determine inhalation and ingestion quantities during years of AEC operations at Bliss and Laughlin.

Inhalation quantities for operational days 1951 and 1952 were determined by using the air concentration value of 5,800 dpm/m<sup>3</sup> and multiplying by the number of AEC operational days per year and assuming an 8.8 hour work day.

Inhalation quantities for non-operational days in 1951 and 1952 were determined by using the air concentration value of 5,800 dpm/m<sup>3</sup> to determine a surface contamination value and applying a contamination decay constant 0.0001888 (0.01888% per day). This value was calculated using assumptions on the deposition velocity and using claimant favorable data from FUSRAP measurements (Battelle 2011). The average air concentration for the non-operational days was multiplied by the number of non-operational days per year and an 8.8 hour workday producing an inhalation quantity for non-operational days.

The residual activity decay factor was determined by assuming an air concentration value of 5480 dpm/m<sup>3</sup>, a deposition velocity of 7.50E-4 m/s, five rolling days of 8.8 hours to derive a surface contamination value of 6510 dpm/100 cm<sup>2</sup>. Since the highest removable alpha surface contamination value of 430 dpm/m<sup>3</sup>, the resulting decay constant was determined to be 0.0001888 per day.

The total inhalation values for operational and non-operational days for each year were summed and then divided by the number of calendar days in the performance period to produce an inhalation rate for each year. Ingestion doses were calculated using OCAS-TIB-009 (NIOSH 2004).

All workers at Bliss and Laughlin are assumed to have worked daily in the Special

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Finishing Area during the AEC operational time period. Table D.1 contains inhalation and ingestion intakes in dpm per calendar day which are applied as a lognormal distribution with a GSD of 5. Solubility types M and S should be considered to maximize the radiation dose. The ingestion  $f_1$  value used should be the same as that used for inhalation.

## **D.5 Occupation External Dose**

No external dosimetry data are available for the AWE operations conducted at Bliss and Laughlin in 1951 and 1952. Therefore, external dose rates from Battelle-TBD-6000, contamination surveys conducted at Bliss and Laughlin, and conservative estimates on the amount of material that may have been at Bliss and Laughlin were used to estimate external dose received during the AEC operations.

### **D.5.1 Dose from Contaminated Surfaces and Air Submersion**

External dose from residual contamination was received from exposures to contaminated surfaces and from submersion in contaminated air. Dose from these sources was determined by using the default air concentration value of 5,800 dpm/m<sup>3</sup> to determine the initial loading of the surfaces following each AEC production campaign. A deposition velocity of 7.5E-04 meters per second and the number of hours of exposure per work day were applied to produce surface contamination values in dpm/m<sup>2</sup>. A contamination decay constant of 1.888E-04 per day was applied to the air and surface contamination values beginning on April 25, 1951. An 8.8 hour work day is assumed. This dose was then normalized for 251 days for 1951 and 365 days for 1952.

### **D.5.2 Dose from Uranium Metal**

The external whole body dose from exposures to the uranium metal used in the uranium machining operations at Bliss and Laughlin were determined by using the dose values in Tables 6.2 and 6.3 Battelle-TBD-6000 for an Operator working with or near bare metal for 44 hours per week. These dose rates were adjusted to 8.8 hours of contact time per work day. For each uranium operations work day, two additional drum handling days are also assumed at the same dose rates and hours of contact as the bare metal exposures. This dose was then normalized for the number of operational days per year.

All workers at Bliss and Laughlin are assumed to have worked daily in the Special Finishing Area during the AEC operational time period. Table D.2 contains external dose values in mrem per year which are applied as a lognormal distribution with a GSD of 5. Penetrating radiation was assigned as photons 100% in the 30-250 keV energy range. Non-penetrating radiation was assigned as 100% electrons with energies >15 keV.

## **D.6 Residual Contamination**

After the contract period, employees were potentially exposed to residual contamination left over from the AEC related operations. The residual contamination time period at Bliss and Laughlin was from 1953 through 1998.

### **D.6.1 Internal Dose**

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Residual radioactivity was determined to be present at Bliss and Laughlin and documented in a 1992 Formerly Utilized Site Remediation Action Program (FUSRAP) report (ORAUT 1992). The surface activity measurements in the Special Finishing Area showed several areas had total beta-gamma activity levels ranging from 4,700 dpm/100 cm<sup>2</sup> to 700,000 dpm/100 cm<sup>2</sup> and showed the highest level of removable alpha activity to be 430 dpm/100 cm<sup>2</sup>.

As a claimant-favorable measure the default air concentration value of 5,800 dpm/m<sup>3</sup> was used to determine the initial loading of the surfaces following each AEC production campaign ended in 1952. An initial air concentration was then calculated based on that surface contamination value. A contamination decay constant of 0.0001888 per day was applied based as described previously instead of the default value (Battelle 2011). This value was then multiplied by an 8.8 hour workday for 365 days each year. Ingestion doses were calculated using OCAS-TIB-009 (NIOSH 2004).

All workers at Bliss and Laughlin are assumed to have worked daily in the Special Finishing Area during the residual contamination time period. Table D.1 contains inhalation and ingestion intakes in dpm per calendar day which are applied as a lognormal distribution with a GSD of 5. Solubility types M and S should be considered to maximize the radiation dose. The ingestion  $f_1$  value used should be the same as that used for inhalation.

### **D.6.2 External Dose**

External dose from residual contamination was received from exposures to contaminated surfaces and from submersion in contaminated air. Dose from these sources was determined by using the default air concentration value of 5,800 dpm/m<sup>3</sup> to determine the initial loading of the surfaces following each AEC production campaign. A deposition velocity of 7.5E-04 meters per second and the number of hours of exposure per work day were applied to produce surface contamination values in dpm/m<sup>2</sup>. A contamination decay constant of 1.888E-04 per day was applied to the air and surface contamination values. An 8.8 hour work day is assumed through 1955 and an 8 hour work day from 1956 through 1998. This dose was then normalized for 251 days for 1951 and 365 days for 1952 through 1998. The calculated dose from exposure to contaminated surfaces and the calculated dose from submersion in air were combined and applied as a total photon dose per year.

All workers at Bliss and Laughlin are assumed to have worked daily in the Special Finishing Area during the residual contamination time period. Table D.3 contains external dose values in mrem per year which are applied as a lognormal distribution with a GSD of 5. Penetrating radiation is assigned as photons 76.7% in the >30 keV energy range, 10% in the 30-250 keV energy range, and 13.3% in the >250 keV energy range.

### **D.7 References**

AEC (Atomic Energy Commission), 1951, Memo "Uranium Fabrication Test" to W. Kirkman, Director Security Division, Risenbud, Director of Health and Safety, J. Smith, Jr., Chief, Operations Branch, Production Division, New York, 1951. (SRDB ID 7016).

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Hershman, 1952, Memo “Monthly Progress Report for October 1952 Covering Activities Under the Tonawanda Sub-Office” from H. J. Hershman, Chief, Tonawanda Sub-Office, to R.J. Smith, Jr. Chief, Operations Branch, Production Division, New York, October 21, 1952. (SRDB ID 10751).

Koenig, 1951, Memo “Shipment of Uranium Oxide” from J. Koenig, Chief Operations Branch, St. Louis Area, St. Louis, MO, to P.W. Malone, Chief, Tonawanda Sub-Office, Model City, New York, October 1, 1951. (SRDB ID 59173).

NLO (National Lead Company of Ohio), 1952, Air Sample Data Sheets for Bliss and Laughlin for September 26, 1952, September 27, 1952, October 4, 1952, and October 11, 1952. (SRDB ID 3794).

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NIOSH, 2009, *SEC Petition Evaluation Report, Petition SEC-00131*, National Institute for Occupational Safety and Health, June 30, 2009.

NIOSH, 2010, *Radiation Exposures Covered for Dose Reconstructions Under Part B of the Energy Employees Occupational Illness Compensation Program Act, Rev 0*, DCAS-IG-003, Division of Compensation Analysis and Support, Cincinnati, Ohio.

ORAUT, 1992, Radiological Survey of the Former Bliss and Laughlin Steel Company Facility, Buffalo, New York, J.D. Berger, Environmental Survey and Site Assessment Program, Energy/Environmental Systems Division, Oak Ridge Institute for Science and Education, June 1992. (SRDB ID 6980).

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**Table D.1 Internal Dose Pathways – Inhalation of Airborne Radionuclides**

**Assumptions:**

Derivation of values described in Sections D.4 and D.6.1,

Operations Period: Inhalation and ingestion values were based on an 8.8 hour work day and were normalized for the number of operational days per year.

Residual Period: Inhalation and ingestion values were calculated assuming an 8.8 hour workday through 1955 and an 8 hour work day from 1956 through 1998.

All employees worked in the Special Finishing Area.

Values represent the geometric mean of a lognormal distribution.

Time Period	Operation Phase	Nuclide	Inhalation (dpm/calendar day)	Ingestion (dpm/calendar day)	GSD	TBD Reference or Research Justification
04/24/1951 – 12/31/1951	Operations	U-234	2.315E+02	4.567E+00	5	TBD-6000 Table 7.5 for Operator
1952	Operations	U-234	7.947E+02	1.568E+01	5	TBD-6000 Table 7.5 for Operator
1953	Residual	U-234	5.284E+00	1.043E-01	5	Residual from operations: assume deposition and resuspension
1954	Residual	U-234	4.931E+00	9.729E-02	5	Residual from operations: assume deposition and resuspension
1955	Residual	U-234	4.602E+00	9.080E-02	5	Residual from operations: assume deposition and resuspension
1956	Residual	U-234	3.904E+00	8.134E-02	5	Residual from operations: assume deposition and resuspension
1957	Residual	U-234	3.644E+00	7.591E-02	5	Residual from operations: assume deposition and resuspension
1958	Residual	U-234	3.400E+00	7.084E-02	5	Residual from operations: assume deposition and resuspension
1959	Residual	U-234	3.173E+00	6.611E-02	5	Residual from operations: assume deposition and resuspension
1960 - 1969	Residual	U-234	2.215E+00	4.614E-02	5	Residual from operations: assume deposition and resuspension
1970 - 1979	Residual	U-234	1.112E+00	2.316E-02	5	Residual from operations: assume deposition and resuspension
1980 - 1989	Residual	U-234	5.579E-01	1.162E-02	5	Residual from operations: assume deposition and resuspension
1990 - 1998	Residual	U-234	2.888E-01	6.016E-03	5	Residual from operations: assume deposition and resuspension

\*Exposure rates for 1960 – 1998 can be overestimated by using the 1959 data for all later years.

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**Table D.2 External Dose Pathways – Operational Period**

**Assumptions:**

Derivation of values described in Section D.5.

Dose values were based on an 8.8 hour work day and were normalized for the number of operational days per year.

All employees worked in the Special Finishing Area.

Values represent the geometric mean of a lognormal distribution.

<b>Annual Values (mrem)</b>							
<b>Year</b>	<b>Air Submersion</b>	<b>Contaminated Surfaces</b>	<b>Whole Body</b>	<b>Non-Penetrating (hands and forearms)</b>	<b>Non-Penetrating (other skin)</b>	<b>GSD</b>	<b>TBD Reference or Research Justification</b>
1951	1.194E-04	1.574E-01	3.762E+01	4.158E+03	3.780E+02	5	TBD-6000 Section 3.2, Tables 6.2 and 6.3
1952	5.952E-04	3.322E-01	1.881E+02	2.079E+04	1.890E+03	5	TBD-6000 Section 3.2, Tables 6.2 and 6.3



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**Table D.3 External Dose Pathways – Residual Contamination Period**

**Assumptions:**

Derivation of values described in Sections D.6.2.

Dose values were calculated assuming an 8.8 hour workday through 1955 and an 8 hour work day from 1956 through 1998.

All employees worked in the Special Finishing Area.

Values represent the geometric mean of a lognormal distribution.

<b>Annual Values (mrem/year)</b>			
<b>Year(s)</b>	<b>Photon Dose</b>	<b>GSD</b>	<b>TBD Reference or Research Justification</b>
1953	1.318E+00	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1954	1.230E+00	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1955	1.148E+00	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1956	9.741E-01	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1957	9.082E-01	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1958	8.476E-01	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1959	7.910E-01	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1960 - 1969	5.521E-01	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1970 - 1979	2.771E-01	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1980 - 1989	1.392E-01	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.
1990 - 1998	7.917E-02	5	Residual from operations; air submersion and contaminated floors/surfaces, TBD-6000 Section 3.2, Tables 6.2 and 6.3.