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Site Profiles for Atomic Weapons Employers that Worked Uranium Metals - Appendix D
Bliss and Laughlin Steel

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Appendix D
Revision 00

RECORD OF ISSUE/REVISIONS

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09/04/2012	09/04/2012	0	Initial issue of appendix to Battelle-TBD-6000 describing the use of the TBD for claims at Bliss and Laughlin Steel
03/23/2017	05/02/2017	01-A	Fix errors in revision 00 and incorporate revision 01 of TBD-6000.
05/05/2017	05/18/2017	01-B	Incorporated internal comments.

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 machined uranium rods for the Atomic Energy Commission (AEC). The former Bliss and Laughlin Steel Company site was located at 110 Hopkins Street in Buffalo, New York. Bliss and Laughlin operated the site from 1929 to 1972. The facility consisted of a single building with a floor area of approximately 129,600 square feet.

During April of 1951 and September and October of 1952 the Bliss and Laughlin Steel Company machined 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.

D.2.1 Operations - 1951

On April 24, 1951 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. That same day the machined rods along with metal turnings were shipped back to Lake Ontario Ordnance Works (LOOW) where they would subsequently be shipped to Bethlehem Steel for further rolling (AEC 1951, Malone 1951). An October 1951 AEC memo indicated that at that time, LOOW had 4 drums of uranium oxide from the Bliss and Laughlin work (Malone 1951a).

D.2.2 Operations - 1952

In September and October 1952 machining operations were conducted on one Friday and four Saturdays (NLO 1952, Hershman 1952). Weekend schedules were used to avoid significantly impacting normal operations, and possibly, to enhance security and radiological safety.

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 (AEC 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.

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 11th (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 analysis showed that the measured air concentrations could be represented by a lognormal distribution with a geometric mean of 2,602 dpm/m^3 with a geometric standard deviation (GSD) of 2.04. This was compared to the default air concentration value of 5,480

dpm/m^3 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. Since the 1951 work generated only 4 drums of waste compared to 53 drums from the 5 days of work in 1952, it was assumed the Battelle-TBD-6000 values were also claimant-favorable for the 1951 work.

Inhalation quantities for operational days in 1951 and 1952 were determined by using the air concentration value of 5,480 dpm/m^3 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 first determining the surface contamination value remaining after the operations. This value was determined by assuming the 5480 dpm/m^3 airborne concentration deposited at a rate of 7.50E-4 m/s for the duration of the operation. This contamination level was then depleted at a rate of 0.01888% per day starting on the day following the operation. Additional contamination was assumed to settle each day of operation and therefore contribute to the total. The contamination values therefore increase during operations to the highest level following the last day of operations and decreased after. The days of operations were considered to be 4/24/1951, 9/26/1952, 9/27/1952, 10/4/1952, 10/11/1952 and 10/18/1952.

The 0.01888% depletion rate was calculated as the rate necessary to cause the contamination level to decrease from the estimated value on the last day of uranium work to a value of 43000 dpm/m^2 on March 14, 1992. The 1992 value represents the highest removable contamination measurement at Bliss and Laughlin on that day as part of a Formerly Utilized Site Remediation Action Program (FUSRAP) survey (ORAUT 1992). The second highest sample was recorded as 120 dpm/100 cm^2 (12000 dpm/m^2) while most were recorded as <12 dpm/100 cm^2. All samples outside the special finishing area were recorded as <12 dpm/100 cm^2.

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 the calculated surface contamination values and an ingestion coefficient of 1.1E-4 m^2/hr (NUREG/CR 5512). DCAS-TIB-0009 was not used to estimate ingestion because it is based on continuous operations causing contamination levels to reach a maximum value while Bliss and Laughlin operations with uranium were only for a limited number of days.

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.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 may have been received from exposures to contaminated surfaces. Dose from this source was determined by using the default air concentration value of 5,480 dpm/m^3 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^2. An 8.8 hour work day is assumed. A contamination depletion rate of 1.888E-04 per day was applied to the surface contamination values beginning the day after operations. The contamination value was then multiplied by dose conversion factors from Table 3.10 of Battelle-TBD-6000 to calculate the dose rate.

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. 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.

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 1999. However, the end date is based on FUSRAP cleanup verification that occurred in March of 1999. Therefore, this estimate assume no exposures occurred after March of 1999.

D.6.1 Internal Dose

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 the highest level of removable alpha activity to be 430 dpm/100 cm^2 (43000 dpm/m^2).

As described earlier, the 430 dpm/100 cm^2 value was used along with the calculated surface contamination value at the end of operations to determine the contamination value for each year of the residual contamination period. The contamination value was then used to determine an airborne concentration using a resuspension factor of 1E-6 m^{-1} (ORAUT 2012). Ingestion doses were calculated using the calculated surface contamination values and an ingestion coefficient of 1.1E-4 m^2/hr (NUREG/CR 5512).

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 may have been received from exposures to contaminated surfaces. Dose from this source was calculated using contamination values and surface contamination to dose conversion factors from Battelle-TBD-6000. Residual period doses are described as photon and beta dose in Table D.3. Annual doses through 1959 are shown. After 1959 doses are averaged and only the average annual dose is shown for each decade. For 1999, the listed annual dose should divided by four since site decontamination ended 3 months into the 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 71.8% in the <30 keV energy range, 17.8% in the 30-250 keV energy range, and 10.4% in the >250 keV energy range.

D.7 References

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ORAUT, 2011, *Technical Information Bulletin: Dose Reconstruction from Occupationally Related Diagnostic X-Ray Procedures,* ORAUT-OTIB-0006, Rev 04, June 20, 2011.

ORAUT, 2012, *Dose Reconstruction During Residual Radioactivity Periods at Atomic Weapons Employer Facilities,* ORAUT-OTIB-0070, Rev 01, March 5, 2012.

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	8.434E+01	5	TBD-6000 Table 7.5 for Operator
1952	Operations	U-234	7.947E+02	1.834E+02	5	TBD-6000 Table 7.5 for Operator
1953	Residual	U-234	5.284E+00	4.844E+02	5	Residual from operations: assume deposition and resuspension
1954	Residual	U-234	4.931E+00	4.520E+02	5	Residual from operations: assume deposition and resuspension
1955	Residual	U-234	4.602E+00	4.218E+02	5	Residual from operations: assume deposition and resuspension
1956	Residual	U-234	3.904E+00	3.579E+02	5	Residual from operations: assume deposition and resuspension
1957	Residual	U-234	3.644E+00	3.340E+02	5	Residual from operations: assume deposition and resuspension
1958	Residual	U-234	3.400E+00	3.117E+02	5	Residual from operations: assume deposition and resuspension
1959	Residual	U-234	3.173E+00	2.909E+02	5	Residual from operations: assume deposition and resuspension
1960 - 1969	Residual	U-234	2.215E+00	2.030E+02	5	Residual from operations: assume deposition and resuspension
1970 - 1979	Residual	U-234	1.112E+00	1.019E+02	5	Residual from operations: assume deposition and resuspension
1980 - 1989	Residual	U-234	5.579E-01	5.114E+01	5	Residual from operations: assume deposition and resuspension
1990 - 1999	Residual	U-234	2.888E-01	2.647E+01	5	Residual from operations: assume deposition and resuspension

*Exposure rates for 1960 – 1999 can be overestimated by using the 1959 data for all later years.

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.

Annual Values (mrem)							
Year	**Contaminated Surfaces Penetrating**	**Contaminated Surfaces Non-Penetrating**	**Whole Body Penetrating**	**Non-Penetrating (hands and forearms)**	**Non-Penetrating (other skin)**	**GSD**	**TBD Reference or Research Justification**
1951	7.582E-02	7.352E+00	2.746E+01	3.036E+03	2.748E+02	5	TBD-6000 Section 3.2, Tables 6.2 and 6.3
1952	2.397E-01	2.324E+01	1.373E+02	1.518E+04	1.374E+03	5	TBD-6000 Section 3.2, Tables 6.2 and 6.3

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 1999.
Values represent the geometric mean of a lognormal distribution.

Annual Values (mrem/year)				
Year(s)	**Photon Dose**	**Beta Dose**	**GSD**	**TBD Reference or Research Justification**
1953	6.332E-01	6.139E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1954	5.910E-01	5.730E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1955	5.515E-01	5.347E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1956	4.679E-01	4.536E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1957	4.366E-01	4.233E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1958	4.075E-01	3.951E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1959	3.803E-01	3.687E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1960 - 1969	2.654E-01	2.573E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1970 - 1979	1.332E-01	1.292E+01	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1980 - 1989	6.686E-02	6.482E+00	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.
1990 – 1999[a]	3.461E-02	3.355E+00	5	Residual from operations; contaminated floors/surfaces, TBD-6000 Section 3.4, Table 3.10.

a - FUSRAP cleanup ended in March of 1999 so the doses in the table above should be divided by four to estimate 1999 doses