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Site Profiles for Atomic Weapons Employers that Worked Uranium Metals

Appendix Q – Allegheny Ludlum Steel Company

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ALLEGHENY-LUDLUM STEEL COMPANY

Q.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 Allegheny-Ludlum Steel Company located in Watervliet, New York. 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.

Q.2 Site Description

The Allegheny-Ludlum Steel Corporation (A-L) located in Watervliet, New York, rolled solid uranium rods from ingots in 1951 and 1952. The rods were referred to as billets because additional rolling occurred elsewhere to produce the finished rods. The operation started as a developmental scale operation but transitioned into production scale work. The work included other metal working tasks such as straightening, lathe work, cutting with shears and stamping.

Q.2.1 Site Activities

Uranium work at Alleghany Ludlum began on January 20th, 1951 rolling at least 25 uranium metal ingots from 5 inch diameter to 13/16 inch diameter rods. In April of 1951, the AEC started an experimental rolling campaign with experimental rolling #1 at Simonds Saw and Steel and Bethlehem Steel. Experimental rolling #2 involved Allegheny Ludlum on July 22, 1951. Twenty four uranium ingots were rolled at Allegheny Ludlum into billets of several different sizes between about 1.5 inches and 2.5 inches in diameter. These billets were finish rolled at Bethlehem Steel on July 29th to 1 and 1/16th inch diameter. Experimental rollings #3, #4 and #5 continued the process of rough rolling into billets at Allegheny Ludlum and finish rolling at Bethlehem Steel. However, experimental rolling #4 consisted of two separate days at Allegheny Ludlum (August 23rd and September 19th) prior to the finish rolling at Bethlehem Steel (AEC 1951).

Experimental rolling #6 occurred at Allegheny Ludlum on November 17, 1951 but not enough good billets were produced to continue the experiment at Bethlehem Steel (AEC 1951). It was intended that a salt bath furnace be used for this rolling but the furnace could not be constructed in time. DuPont (Savanah River) insisted no further rolling were worthwhile without a salt bath (Belmore 1951).

Starting on December 1, 1951, the rollings were no longer referred to as experimental but the number of ingots rolled was similar to the experimental rollings and the purpose was to gather data. A salt bath furnace was introduced at Allegheny Ludlum starting with this rolling. One of the effects of the salt bath was to reduce oxidation of the uranium metal which greatly reduced airborne contamination. All the dates for rolling at Allegheny Ludlum are listed in table Q.1.

Table Q.1 – Dates of Uranium Metal Rolling at Allegheny Ludlum

Dates	Comments	# of Ingots rolled	Reference
1/20/1951	First rolling	25	SRDB 10885 pg 23
7/22/1951	Experimental rolling #2	24	SRDB 10885 pg 24
8/11/1951	Experimental rolling #3	30	SRDB 10885 pg 25
8/23/1951	Experimental rolling #4	10	SRDB 10885 pg 26
9/19/1951	Experimental rolling #4	51	SRDB 10885 pg 27
10/26/1951	Experimental rolling #5	100	SRDB 10885 pg 28
11/17/1951	Experimental rolling #6	40	SRDB 10885 pg 29
12/1/1951	Salt bath used	50 planned	SRDB 86933 pg 14
12/15/1951	Salt bath used	50 planned	SRDB 86933 pg 14
1/19/1952	Salt bath used	190 planned	SRDB 81622 pg 3; 81429 pg 2
2/9/1952 and 2/10/1952	Salt bath used	200	SRDB 81622 pg 3; 81429 pg 2; 44230
3/8/1952	Salt bath used	211	SRDB 44232; 73513 pg 3
4/5/1952	Salt bath used	242	SRDB 67129 pg 101; 44236 pg 5; 44234
5/2/1952 and 5/3/1952	Salt bath used	465	SRDB 73547 pg 2; 73553 pg 4; 44236
6/6/1952 and 6/7/1952	Salt bath used	500 planned	SRDB 66840
6/27/1952 and 6/28/1952	Salt bath used	500 planned	SRDB 66840

Q.3 Occupational Medical Dose

No information regarding occupational medical dose specific to the Allegheny Ludlum Site 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.

Q.4 Occupational Internal Dose

Air monitoring data are available from two air sampling campaigns in 1951 and one air sampling campaign in 1952 (AEC 1951a, AEC 1952). Air monitoring in 1951 occurred prior to the use of a salt bath. By the 1952 monitoring, the use of a salt bath was in place and air concentrations were much lower.

Air sample data was divided into pre-salt bath and post salt bath period. The data from each period was analyzed as a lognormal distribution and determined to have a geometric mean of 291 and 20.5 dpm/m^3 respectively. The geometric standard deviations were 17.9 and 3.67 respectively.

Rolling occurred on 7 days prior to installing a salt bath and 13 days following the salt bath installation. Operators are assumed to be exposed to the pre-salt bath air concentration for each of the 7 days of rolling prior to the salt bath installation. Operators are assumed to be exposed to the post salt bath air concentration after that. It is further assumed that the operators were exposed the entire work day which is assumed to be 8.8 hours (44 hour week). The total uranium inhalation was then divided by the number of calendar days for each time period to obtain an average uranium intake per calendar day. The results are shown in table Q.2. Doses derived from these intakes should be entered into IREP as a lognormal distribution with a GSD listed in table Q.2 for the applicable period.

Table Q.2 – Uranium Intakes during Rolling Days

Start Date	End Date	Salt Bath	# of Rolling Days	Air Concentration (dpm/m^3)	Total inhaled U (dpm)	Calendar days	dpm/calendar day	GSD
1/20/1951	11/30/1951	No	7	291	21516	315	68.3	17.90
12/1/1951	6/27/1952	Yes	13	20.5	2814	210	13.4	3.67

It is also possible there was exposure to residual contamination between rolling days. To estimate the inhalation intakes from this exposure, the contamination levels were first estimated using the technique in TBD-6000. The higher airborne activity (pre-salt bath) was assumed to deposit for 720 hours (thirty days) at a rate of 0.00075 m/s. This resulted in a surface contamination level of 565,800 dpm/m^2. A resuspension factor of $1x10^{-5}$ was applied to this value to arrive at an airborne concentration of 5.66 dpm/m^3. Operators were assumed to be exposed to this concentration the full work day for each non-uranium work day. As a favorable assumption, the few days prior to the first rolling in 1951 are included in the estimate. The total annual inhalation activity from residual contamination was calculated and divided by 365 days to arrive at a value in dpm per calendar day. The values are listed in table Q.3 and doses derived from these intakes should be entered into IREP as a lognormal distribution. The higher of the two airborne concentrations were used for this estimate so the GSD associated with that airborne concentration will be used as the GSD of this intake.

Table Q.3 – Uranium Intakes Between Rolling Days

Start Date	End Date	Non-U work days	Air Concentration (dpm/m^3)	dpm/calendar day	GSD
1/1/1951	12/31/1952	480 (a)	5.66	39.3	17.90

(a) Assumes 250 work days per year minus uranium work days

Ingestion of uranium contamination is also a possibility at Allegheny Ludlum. In order to estimate this intake, OCAS-TIB-0009 was utilized. This document is based on the idea that the contamination levels are related to the airborne levels during operations and assumes the operations occurred often enough to reach a maximum level. It therefore provides for a factor directly related to the airborne concentration. Since rolling of uranium metal occurred intermittently at Allegheny Ludlum, this technique likely overestimates the actual ingestion intake.

The higher of the two airborne concentrations was used to estimate the ingestion intake. This results in an ingestion rate per work day. That was converted to an ingestion rate per calendar day by dividing the annual ingestion intake by 365 days. The values are listed in table Q.4 and doses derived from these intakes should be entered into IREP as a lognormal distribution. The higher of the two airborne concentrations were used for this estimate so the GSD associated with that airborne concentration will be used as the GSD of this intake.

Table Q.4 – Uranium Ingestion Intakes

Start Date	End Date	Non-U work days	Ingestion (dpm per work day)	Ingestion (dpm per calendar day)	GSD
1/1/1951	12/31/1952	480 (a)	58.2	39.9	17.90

(a) Assumes 250 work days per year minus uranium work days

Q.5 Occupational External Dose

No data were found related to occupational external dose from the uranium work at the Allegheny Ludlum. The work performed at Allegheny Ludlum involved rolling uranium ingots into uranium billets. Therefore, the highest photon dose rate at one foot from any ingot or billet in TBD-6000 table 6-1 is used to estimate the external dose. That value is 2.08 mrem/hr one foot from a rectangular ingot. The beta dose rate at one foot is assumed to be 10 times that or 20.8 mrem/hr per TBD-6000. The contact dose rate is assumed to be 230 mrem/hr per TBD-6000. Operators are assumed to be exposed to the one foot levels 50% of the time. Additionally, the hands and forearms are assumed to be exposed to the contact dose rate 50% of the time.

The estimate for the photon dose, the beta dose for the whole body and the beta dose for the hands and forearms are contained in tables Q.5, Q.6 and Q.7 respectively. These estimates should be used as the geometric mean of a lognormal distribution. The geometric standard deviation is shown in the tables.

Included in the tables is an external dose estimate for doses received from residual contamination. These values were calculated using the contamination level estimate from section Q.4. These values were multiplied by the conversion factors in table 3.10 of TBD-6000 to derive the photon and beta dose rates. Operators are assumed to be exposed to these dose rates 100% of the time on each work day. These values were added to the dose from uranium metal and included in tables Q.5, Q.6 and Q.7.

Table Q.5 – Photon Dose

Start Date	End Date	# of Rolling Days	Dose from Metal (mrem)	Work Days	Dose from contamination (mrem)	Total Photon Dose (mrem)	GSD
1/1/1951	12/31/1951	9	82.4	250	0.49	82.89	5
1/1/1952	6/27/1952	11	100.7	123	0.241	100.94	5
6/28/1952	12/31/1952	0	0	127	0.249	0.25	5

Table Q.6 – Beta Dose to the Whole Body

Start Date	End Date	# of Rolling Days	Dose from Metal (mrem)	Work Days	Dose from contamination (mrem)	Total Beta Dose (mrem)	GSD
1/1/1951	12/31/1951	9	824	250	48	872	5
1/1/1952	6/27/1952	11	1007	123	23	1030	5
6/28/1952	12/31/1952	0	0	127	24	24	5

Table Q.7 – Beta Dose to the Hands and Forearms

Start Date	End Date	# of Rolling Days	Dose from Metal (mrem)	Work Days	Dose from contamination (mrem)	Total Beta Dose (mrem)	GSD
1/1/1951	12/31/1951	9	9108	250	48	9156	5
1/1/1952	6/27/1952	11	11132	123	23	11155	5
6/28/1952	12/31/1952	0	0	127	24	24	5

Q.6 Dose from Residual Contamination

Residual contamination potentially existed between operations with uranium at Allegheny Ludlum. However, surveys showed the potential was low and so no residual contamination period was designated after 1951. The periods between operations is accounted for in a favorable manner in sections Q.4 and Q.5.

Q.7 References

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

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AEC 1952, Air sample data sheets from Allegheny Ludlum on 2/9/1952, SRDB 3803.

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