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Site Profiles for Atomic Weapons Employers that Worked Uranium Metals

Appendix BL – Jessop Steel Company

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RECORD OF ISSUE/REVISIONS

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5/25/2007	5/25/2007	0	Appendix to Battelle-TBD-6000 describing the use of the TBD for claims at Jessop Steel Company
3/19/2015	10/19/2015	1	Revision to update appendix based on revision to TBD-6000. Also updated for a change to the covered work by DOL.

JESSOP STEEL COMPANY

BL.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 Jessop Steel Company located in Washington, 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.

BL.2 Site Description

The Jessop Steel Company located in Washington, Pennsylvania, made stainless steel piping for the Fernald plant out of uranium contaminated nickel scrap in December 1952 (Carney 1952). A request to send two tons of nickel scrap was dated December 2, 1952 and one ton was sent during the week of December 5th, 1952 (Hershman 1952). Presumably an additional ton was sent soon after. A monthly AEC report for December 1952 indicated 3 tons of scrap nickel was shipped to Jessop and one other company to manufacture "vitally needed equipment for the Fernald plant" (Hershman 1952a). The scrap nickel appears to be in the form of nickel trays from Lake Ontario Storage Area (LOSA) (Hershman 1953). The trays likely came from the Harshaw Chemical Company since uranium contaminated nickel trays had previously been sent to LOSA from Harshaw (Harris 1953).

In addition, Jessop Steel sheared an unknown number of uranium plates for DuPont on March 2, 1954 (Fisher 1954). While the number of plates sheared is unknown, the information indicates the work was done on one particular day. Therefore, this estimate will assume the work took the entire day. The default work week from Battelle-TBD-6000 for 1954 is 44 hours per week on average. This estimate will assume a 5 day work week resulting in an average of 8.8 hour work day. However, to account for the possibility of more than one shift of work, for the purposes of estimating the contamination levels, this estimate will assume one full 24 hour day of work.

The nickel scrap was intended for stainless steel piping for the Fernald Plant likely because of its corrosion resistance. Many types of stainless steel are manufactured, not all of which include nickel. However, since the nickel was intended for this piping, it can be assumed this was intended for austenitic stainless steel which would normally be at least 6% nickel (Stainless Restorations, Stainless Sales Corporation). Assuming a minimum of 6% nickel, the 2 tons of nickel scrap would make a maximum of 33 tons of stainless steel. This amount of piping could easily be manufactured in one week so this estimate will assume the work took a full week in December 1952.

BL.3 Occupational Medical Dose

No information regarding occupational medical dose specific to the Jessop Steel 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.

BL.4 Occupational Internal Dose

No measurements of airborne uranium contamination at Jessop Steel were found. Scrap nickel was also processed at the Reduction Pilot Plant. The process there concentrated uranium in the residue. While the material is not the same as that used at Jessop, the uranium content appears to be similar based on the discussion in the external dose section of this document. Uranium content in the residue was less than 1% (NIOSH 2013). Using 1% uranium concentration and the 95th percentile of the airborne nickel concentrations measured at the Reduction Pilot Plant (NIOSH 2013), results in a uranium concentration of 0.0044 mg of Uranium per cubic meter of air. This concentration is assumed to be present at Jessop Steel for the full week of work with nickel scrap. If the uranium is assumed to be 2% enriched (NIOSH 2013) an airborne activity of 11.78 dpm/m^3 can be calculated. Based on this concentration being inhaled for a full work week (44 hours for 1952), the total activity inhaled during this week is 622 dpm.

After the nickel work was completed, the potential existed for some uranium contamination to be left behind. This is estimated by first calculating the surface contamination level based on the technique in Battelle-TBD-6000. Research into that technique indicated the settling of airborne contamination reaches a maximum value within 30 days (720 hours) of continuous operations. Since this greatly exceeds the total work hours attributed to uranium work at Jessop Steel, the total work hours was used in the calculation rather than the 720 hours. Settling the airborne concentration for 44 hours results in a surface contamination value of 1399 dpm/m^2.

A resuspension factor of 1x10^{-5} m^{-1} was applied to this surface contamination value to estimate an airborne value of 0.014 dpm/m^3. This concentration is assumed to be present starting December 1, 1952 until uranium plate shearing took place on March 2, 1954. It is also assumed to continue to cause additional airborne activity after the uranium plate shearing in 1954.

During the uranium plate shearing on March 2, 1954, the airborne activity will be estimating using Battelle-TBD-6000. Table 7.5 provides airborne samples for a variety of tasks performed on uranium metal. No listing exists for shearing uranium metal plates but a value is listed for cutoff, milling, and slotting uranium metal all of which would be expected to produce higher airborne activity than shearing. Therefore, the airborne concentration for shearing will be based on this value (45 dpm/m^3) as a favorable assumption. This value is the geometric mean of a lognormal distribution that has a geometric standard deviation of 5. The 95th percentile of this distribution (635 dpm/m^3)

will be used in this estimate. This value is assumed to be present for the entire 8.8 hour work day that shearing took place resulting in a total inhalation of 6706 dpm.

After the shearing occurred, the potential for some left over uranium contamination exists. As with the contamination after the scrap nickel work, the technique outlined in Battelle-TBD-6000 is used. Again, this technique indicates 720 hours is necessary for the contamination to reach a maximum value which far exceeds the total time the uranium was worked with at Jessop Steel. Therefore, the total work time (24 hours, assuming 3 full shifts) will be substituted for the 720 hours. Since the scrap nickel work time and the uranium plate work time do not exceed 720 hours, the contamination caused from the uranium plate shearing will be added to the contamination left behind by the nickel work. The calculation results in a surface contamination of 42547 dpm/m^2 (1399 dpm/m^2 from the nickel work plus 41148 dpm/m^2 from the uranium plate work).

As with the contamination after the scrap nickel work, a resuspension factor of $1x10^{-5}$ m^{-1} was applied to this surface contamination value. The resulting airborne activity is 0.425 dpm/m^3. This concentration is assumed to be present starting March 3, 1954 until the end of March 1954.

Table 1 includes inhalation rates from operations with uranium as well as from contamination between operations. Since the values (including the surface contamination values) are based on the 95th percentile of the airborne distribution, the values are considered bounding and doses should be entered into IREP as a constant. It should be noted that the inhalation rate in 1954 from contamination is a combination of two different inhalation rates (before and after March 2, 1954). The value in Table 1 is the time weighted average of those values.

Table 1 – Inhalation Rates

	Uranium work hours	Inhalation during U work (dpm)	Other work hours	Inhalation during Other periods (dpm)	Total inhalation (dpm)	Inhalation rate (dpm/day)
Dec 1952	44	622	142.8	2.40	624	20.14
1953	0	0	2200	36.9	36.9	0.10
Jan-March 1954	8.8	6706	559	99.4	6805	75.6

It is also possible for operators to ingest some of the uranium surface contamination. OCAS-TIB-0009 is normally used to determine the ingestion rate. OCAS-TIB-0009 relates the airborne contamination during a continuous operation to the surface contamination and then to the ingestion rate. Battelle-TBD-6000 analyzed the airborne settling parameters and determined that the contamination can build up for as many as 30 days before it reaches a maximum value. Also, the two separate campaigns at Jessop Steel involved very different airborne activities because one involved only uranium contaminated nickel scrap while the other involved uranium metal. Since uranium operations at Jessop Steel were well less than 30 days and the airborne concentrations

during the two campaigns were very different, OCAS-TIB-0009 may not be appropriate for estimating ingestion intakes at Jessop Steel.

The ingestion rate at Jessop Steel is therefore, estimated using the calculated surface contamination and an ingestion rate factor of $1.1x10^{-4}$ m^2/hr (NUREG/CR 5512). The contamination level caused by the scrap nickel work is assumed to be present starting December 1, 1952 at a constant value until the uranium plate work on March 2, 1954. Beginning on that date, the contamination level is assumed to increase to account for additional contamination from the uranium plate work.

Table 2 includes ingestion rates from operations with uranium as well as from contamination between operations. Since the values for the surface contamination are based on the 95th percentile of the airborne distribution, the values are considered bounding and doses should be entered into IREP as a constant. It should be noted that the ingestion rate in 1954 from contamination is a combination of two different ingestion rates (before and after March 2, 1954). The value in Table 2 is the time weighted average of those values.

Table 2 – Ingestion Rates

	Uranium work hours	Other work hours	Total ingestion (dpm)	Ingestion rate (dpm/day)
Dec 1952	44	142.8	28.8	0.928
1953	0	2200	339	0.928
Jan-March 1954	8.8	559	952	10.6

BL.5 Occupational External Dose

No data were found related to occupational external dose from the uranium work at Jessop Steel. External dose rates were therefore estimated using values from Battelle-TBD-6000. That document is based on uranium metal so those dose rates were adjusted to account for the fact that uranium was only a fraction of nickel scrap. The adjustment used the assumption that the uranium was 2% enriched (NIOSH 2013) and the material was 1% uranium by weight. This results in a specific activity for the scrap nickel of 12 pCi/mg of scrap (using 1200 pCi/mg of uranium for 2% enriched uranium). The uranium metal specific activity used in TBD-6000 was 684 pCi/mg (natural uranium) so the ratio is 0.0175 (12 pCi/mg divided by 684 pCi/mg). Uranium metal dose rates from TBD-6000 were reduced by this factor.

The highest 1 foot photon dose rate from Table 6.1 of TBD-6000 is 2.08 mrem/hr. The one foot beta dose rate is assumed to be 10 times this value while the contact beta dose rate is 230 mrem/hr. Correcting these dose rates for the lower specific activity of the nickel scrap results in dose rates of 0.036 mrem/hr, 0.36 mrem/hr and 4.04 mrem/hr respectively. Radiation surveys on the surface of nickel trays at Harshaw (prior to decontamination) show 0.06 mrem/hr gamma and 1.94 mrem/hr beta plus gamma

(McKelvey 1953). The beta plus gamma dose rate estimate in this document (4.04 mrem/hr) is obviously favorable. Also, since dose rates decrease with distance, the 0.036 mrem/hr estimate at 1 foot in this document compares well with the 0.06 mrem/hr taken on the surface of the tray.

Operators were assumed to be exposed to the estimated dose rates (0.036 mrem/hr gamma at 1 foot, 0.36 mrem/hr beta at 1 foot and 4.04 mrem/hr beta surface) for half of their work day per the technique in TBD-6000. They are assumed to be exposed in that manner for 44 hours in December of 1952.

For the uranium plate shearing, the unadjusted dose rates from Table 6.1 of TBD-6000 were used. Operators were again assumed to be within one foot of the material for half of their work day. Work was assumed to take place during the entire 8.8 hour work day on March 2, 1954.

In additional to the dose directly from uranium, operators would be exposed to external radiation from any contamination remaining after the work. Dose conversion factors from Table 3.10 of TBD-6000 were combined with the surface contamination levels calculated earlier to determine the dose rates from contamination. The dose rates from the contamination were applied to the work time between uranium operations.

Tables 3 and 4 list the annual photon and beta doses respectively. Doses are from operations with uranium as well as from contamination remaining between operations. Since the values for the surface contamination are based on the 95th percentile of the airborne distribution, the values are considered bounding and doses should be entered into IREP as a constant. It should be noted that the doses in 1954 from contamination are a combination of two different dose rates (before and after March 2, 1954). The values in Tables 3 and 4 are the time weighted averages of those values.

Table 3 – Annual Photon Dose

	Photon dose from material (mrem)	Photon dose from contamination (mrem)	Total photon dose (mrem)
Dec 1952	0.8	0.00008	0.8
1953	0	0.0012	0.0012
Jan-March 1954	9.15	0.0034	9.16

Table 4 – Annual Beta Dose

Year	Beta dose to skin from material (mrem)	Beta dose to hands and forearms from material (mrem)	Beta dose from contamination (mrem)	Total beta dose to skin (mrem)	Total beta dose to hands and forearms (mrem)
Dec 1952	8.0	88.8	0.0076	8.0	88.8
1953	0	0	0.118	0.118	0.118
Jan-March 1954	91.5	1012	0.331	91.9	1012

BL.6 Dose from Residual Contamination

Residual contamination potentially existed between operations with uranium at Jessop Steel as well as after. However, limited uranium work indicates the potential was low for contamination to remain after the operations ended. Therefore, no residual contamination period was designated for Jessop after March of 1954. The periods between operations are accounted for in a favorable manner in sections BL.4 and BL.5.

BL.7 References

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