Division of Compensation Analysis and Support Technical Basis Document for the Hooker Electrochemical Company Niagara Falls, New York	Document Number: DCAS-TKBS-0009 Effective Date: 06/17/2011 Revision No.: 1 Page 1 of 16
Subject Expert: David Allen Approval: Signature on file — James W. Neton, Associate Director for Science — Date: 06/17/2011	Supersedes: DCAS-TKBS-0009 Rev. 0

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RECORD OF ISSUE/REVISIONS

ISSUE AUTHORIZATION DATE	EFFECTIVE DATE	REV. NO.	DESCRIPTION
4/4/2011	4/4/2011	0	Changes Battelle-TBD-6001 Appendix to a standalone document. Revises dose models to eliminate dependence on Battelle-TBD-6001. Provides more detailed description of dose models. Incorporate review comments.
06/16/2011	06/17/2011	1	Revision initiated to correct errors in Tables 2, 3, and 6. Renumber tables after Table 4. Added language on page 10 to indicate the 95th percentile of the airborne values was used. Corrected typographical error on page 7 and 14.

1.0 Introduction

Technical basis documents and site profile documents are not official determinations made by the National Institute for Occupational Safety and Health (NIOSH) but are rather general working documents that provide historic background information and guidance to assist in the preparation of dose reconstructions at particular sites or categories of sites. They will be revised in the event additional relevant information is obtained about the affected site(s). These documents may be used to assist NIOSH staff in the completion of the individual work required for each dose reconstruction.

In this document the word “facility” is used as a general term for an area, building, or group of buildings that served a specific purpose at a site. It does not necessarily connote an “atomic weapons employer [AWE] facility” or a “Department of Energy [DOE] facility” as defined in the Energy Employees Occupational Illness Compensation Program Act of 2000 [EEOICPA; 42 U.S.C. § 7384I(5) and (12)]. EEOICPA, as amended, provides for employees who worked at an AWE facility during the contract period and/or during the residual period.

Under EEOICPA, employment at an AWE facility is categorized as either (1) during the DOE contract period (i.e., when the AWE was processing or producing material that emitted radiation and was used in the production of an atomic weapon), or (2) during the residual contamination period (i.e., periods that NIOSH has determined there is the potential for significant residual contamination after the period in which weapons-related production occurred). For contract period employment, all occupationally derived radiation exposures received at covered facilities must be included in dose reconstructions. This includes radiation exposure related to the Naval Nuclear Propulsion Program and any radiation exposure received from the production of commercial radioactive products that were concurrently manufactured by the AWE facility during the covered period. NIOSH does not consider the following exposures to be occupationally derived (NIOSH 2010):

- Background radiation, including radiation from naturally occurring radon present in conventional structures
- Radiation from X-rays received in the diagnosis of injuries or illnesses or for therapeutic reasons

For employment during the residual contamination period, only the radiation exposures defined in 42 U.S.C. § 7384n(c)(4) [i.e., radiation doses received from DOE-related work] must be included in dose reconstructions. Doses from medical X-rays are not reconstructed during the residual contamination period (NIOSH 2007). It should be noted that under subparagraph A of 42 U.S.C. § 7384n(c)(4), radiation associated with the Naval Nuclear Propulsion Program is specifically excluded from the employee’s radiation dose. This exclusion only applies to those AWE employees who worked during the residual contamination period. Also, under subparagraph B of 42 U.S.C. § 7384n(c)(4), radiation from a source not covered by subparagraph A that is not distinguishable through reliable documentation from radiation that is covered by subparagraph A is considered part of the employee’s radiation dose. This site profile covers only exposures resulting from nuclear weapons-related work. Exposures resulting from non-weapons-related work, if applicable, will be covered elsewhere.

The following information from the Department of Energy's Office of Health, Safety and Security EEOICPA Find Facilities webpage defines the EEOICPA covered periods for the Hooker Electrochemical Company.

Site:	Hooker Electrochemical Company
Location:	Niagara Falls, New York
Covered Period:	1943-1948, Residual Radiation 1949-1976

This document contains a summary of the description of the site as well as the Atomic Energy Commission activities performed there, and provides the technical basis to be used to evaluate the occupational radiation doses for EEOICPA claims.

2.0 Site Description and Operational History

The Hooker Electrochemical Company (HEC) was located in Niagara Falls, New York. From January, 1943 until June, 1948 under contract No W-7405 eng-28 with the Manhattan Engineering District (MED), HEC manufactured various organic chemicals including xylene hexafluoride (P-45), xylene hexachloride, and Miller's Fluoro Lubricant (MFL). While these processes in themselves did not involve radioactive materials, during part of this period, hydrochloric acid, a byproduct of the P-45 process, was used to chemically treat uranium bearing C-2 slag as a precursor to uranium recovery (DOE 1985, pg 58).

The HEC site used under the MED program was the "D" area, 5.5 acres located on the north bank of the Niagara River in Niagara Falls, NY, about 2 miles east of the falls. Five buildings on this site, D-5, 6, 7, 8 and 9 were used under the contract with MED (1943-48). The bulk of uranium handling was conducted outdoors in an area by the railroad siding north of these buildings. This activity involved the chemical processing of uranium-bearing slag for recovery purposes (DOE 1985, Olotka 1979).

The covered period for Hooker Electrochemical is listed by the Department of Energy's Office of Worker Advocacy as 1943 through 1948 and includes both radioactive material processing and nonradioactive chemical production activities for the Manhattan Engineer District (MED) (DOE 2009). The only weapons-related radiation exposure occurred while processing uranium contaminated slag for MED. A 49' x 28' x 25' cinder block building to contain some of the necessary equipment was constructed under a letter of intent dated May 1944. Construction was completed and the building turned over to the Operating Department on July 11 1944 (Dowling 1944). No documentation was found indicating there were other sources of radiation, commercial or weapons-related, at Hooker Electrochemical.

A process description indicates this process was sufficient to take care of the excess HCl from the P-45 process (MED 1944). The P-45 process ended on January 15, 1946 (Mears 1946). This document establishes the period of operational radiation exposure from July 11, 1944 to January 15, 1946. It is possible that the slag-processing occurred for an even shorter period since some start up period would be expected. This analysis assumes a period of residual radioactivity exposure from January 16, 1946 to October 11, 1976, the date when measurements for radiation and radioactivity onsite were made and it was concluded that no elevated levels of radioactivity were onsite (DOE 1977).

3.0 Process Description

The MED radiation work at Hooker Electrochemical was the concentration of uranium from slag, which had been sent to the Hooker site from the Electrometallurgical Company (DOE 1985). This material was primarily reduction bomb (dolomite) liners with an approximate composition of 90% magnesium fluoride and 10% calcium oxide. (The term bomb, as used here, refers to a device used to contain a particular chemical process.) The slag reportedly contained approximately one pound of uranium per 500 pounds of slag (MED 1944). A description of the process is contained in a Data Sheet for Industrial Hazards, dated December 8, 1944 (MED 1944).

Slag is received in barrels containing about 500 lbs. The barrels are opened and the material is dumped on a conveyor belt which carries it up a ramp to one of the three digest tanks. 40 barrels are added to each tank. Waste HCl from the P-45 plant is passed into the digest tank and the pH is adjusted to 4.0 by the addition of water. After the tank has been filled, the contents are agitated for 20 hours. About once in two days a tank is emptied, which is sufficient turn-over to take care of waste HCl. At the completion of the digest the slurry is neutralized by dumping 100-lb. bags of lime into the tanks from an overhead platform, pumped to a plate and frame press, and filtered. The filtrate is passed off into the sewer; the precipitate is washed several times and rebarreled. Slag is concentrated from about 1 lb. [of uranium] to 5 or 10 lbs. [of uranium] by weight.

3.1 Uranium Concentration

The incoming material is assumed to have a uranium concentration of 0.2% by mass. This comes from the process description of 1 pound of uranium in 500 pounds of slag. The description indicates the uranium was concentrated ***from*** one pound ***to*** five or ten pounds indicating the incoming slag had a concentration of 1 pound of uranium per 500 pounds of slag. It should be noted that the first page of the Data Sheet indicates the uranium concentration was as high as 1% uranium in the slag. This page indicates the material was 90% Magnesium fluoride, 10% calcium oxide and 1% "X" (an MED code for uranium). These values add up to 101% indicating they are an approximation. Also, it should be noted that the process was to concentrate uranium and there is no indication whether these values are describing the incoming slag or the outgoing concentrate.

In order to address this, two documents from Mallinckrodt Chemical Works in St. Louis (Mallinckrodt) were found. The first document from 1949 indicates the slag from the metal process contains about 0.3% uranium (Lynch 1949). The second from 1965 indicates 4000 tons of C-liner slag containing 49 tons of uranium was stored at a waste site (Miller 1965). This equates to approximately 1.2% uranium concentration. To reconcile these values, it should be noted that the second document also indicates that Mallinckrodt began recycling MgF_2 liners in 1953. In that process, the MgF_2 was used as a liner multiple times. This would increase the concentration of uranium after each use. Since the first document was written before this recycling began (1949) and the second written after the recycling began, it is possible some or all of the slag mentioned in the second document was recycled. Since the 0.3% value was documented before recycling began, the value should be considered most applicable to the material that would have been found at Hooker while the 1.2% value is questionable.

Lastly, if the incoming material had a uranium concentration of 1%, the Hooker process description does not appear to make sense. A 1% concentration would equate to 5 pounds of uranium in 500 pounds of slag. If that were true, the mention of one pound of uranium in the description makes no sense. Also stating that the slag was concentrated ***to*** 5 pounds would make no sense.

Therefore, based on the indications in the Hooker process description, the uranium concentration will be assumed to be 0.2% for the incoming slag and 2% (10 pounds in 500 pounds of concentrate) in the outgoing concentrate.

3.2 Monthly Production Rate

The Data Sheet indicates approximately 10 tons of material per month was processed. This appears to correlate well with a War Department memo dated 3/8/1946 that requested medical clearance for the termination of the Hooker Electrochemical contract. This memo indicated a total of 152 tons of slag were processed through this system and that it operated from July 1944 through January 15, 1946 (Mears 1946). At 10 tons per month, this timeframe would equal 180 tons. The difference in the two values is likely due to a slower rate at the beginning of the work and the likelihood that the work was performed for a shorter time frame.

It is not clear from this documentation if the values above are related to the incoming slag or the outgoing concentrate. In order to determine this, an evaluation of the quantity of MgF_2 produced by the MED was performed. The MED produced 2969 tons of uranium metal between 1942 and the end of 1945 (AEC 1951). There is approximately 0.432 pounds of liner per pound of UF_4 (Thayer 1955). This correlates to 0.523 pounds of liner per pound of uranium or 1554 tons of liner produced by the MED between 1942 and 1945. Much of this was produced at Mallinckrodt. Even assuming that Electromet produced as much uranium metal as Mallinckrodt, the total amount of slag produced at Electromet would be 777 tons. Not all of this slag was sent to Hooker. At least some was sent to Lake Ontario Ordnance Works for storage (AEC 1949). Also, the description of the process at Hooker (MEC 1944) indicates the rate was sufficient to take care of the waste HCl. This implies neutralizing the HCl was the limiting factor, not on the rate that slag was produced at Electromet. Therefore, the rate the slag came into Hooker should be less than the rate it was produced at Electromet.

If the 10 tons per month describes the outgoing concentrate and the material was concentrated by only a factor of 5, the incoming would have to be 50 tons per month. Over an 18 month period, that is 900 tons of material coming in. Since some of the material was too large for the process and was thus redrummed without processing, the incoming would have to be even higher. Combining that with the fact that much of the slag was sent to LOOW, it appears the 10 tons per month cannot be describing the outgoing concentrate. Therefore, the 10 tons per month will be assumed to describe the incoming slag.

3.3 Daily Production Rate

Slag coming in at a rate of 10 tons per month represents 40 barrels weighing 500 pounds each. There are only limited indications as to how long it took workers to empty these barrels. One former worker remembered the process started by dumping approximately 20 to 25 barrels per day then increasing to 40 barrels per day (Personal Communication 2009). It is questionable however whether this employee was discussing this particular project. Several inconsistencies in his recollection combined with the fact that the employee indicated they were not told what the material was leads to the realization that he may have been working on some other project at Hooker. However, the process he described includes many of the same aspects as the MgF_2 slag project (emptying drum, screening the material, redrumming oversized material) and is therefore a good indication of the typical pace of such work at Hooker at the time. Therefore, it is assumed that the 10 tons per month of slag contained in 40 barrels was emptied in one day.

4.0 Internal Dose

No data were found in the Site Research database related to occupational internal dose during MED work. The work performed at Hooker Electrochemical involved concentrating C-2 slag. Much of that work involved either liquid or material with a high moisture content which would result in little or no airborne activity. The one task involving dry material was the dumping of barrels of MgF_2 slag. The slag came directly from the nearby ElectroMet facility. Two air sample results from handling this material at ElectroMet were found. The first result was an average of an unknown number of samples taken on December 24, 1947, March 30, 1948 and May 14, 1948. The average of the samples was 456 dpm/m^3. The second result was an average of three samples taken between August 17th and the 19th of 1949. The average value was 398 dpm/m^3. Work associated with these samples included shoveling the material into the barrels.

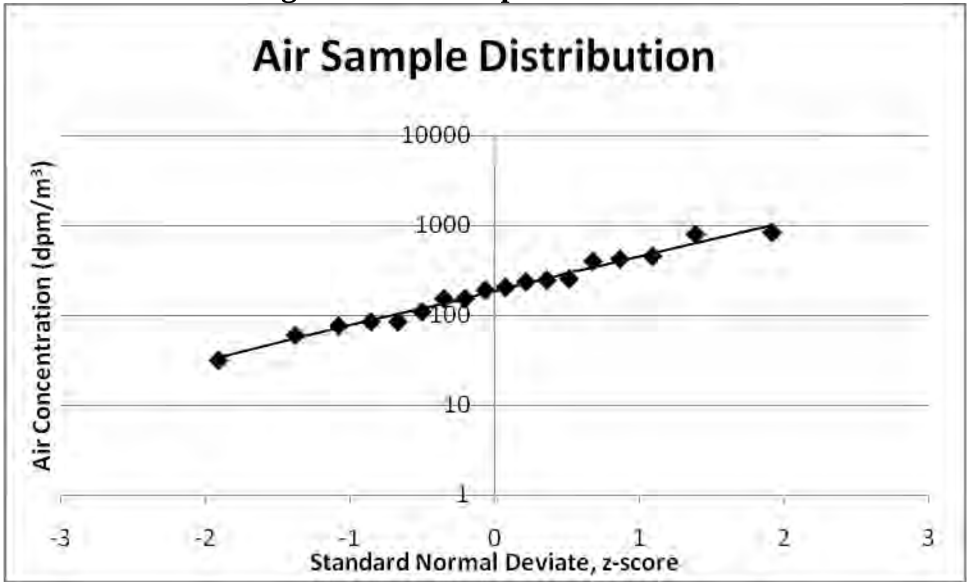
Since there are only two results and they were reported as averages, they provide little information about the variability of the data. Therefore, additional samples associated with handling MgF_2 were found at Mallinckrodt and Fernald. These samples are listed in Table 1.

Table 1: Magnesium Fluoride Air Samples

Site	Task	Air Concentration (dpm/m3)	Comments	SRDB reference
ElectroMet	Loading slag into barrels and weighing	456	Average of unknown number of samples	8917 pg 7
ElectroMet	Shoveling slag into drums	398	Average of three	8930 pg 19
Mallinckrodt	Slag Man	154		9340 pg 4
Mallinckrodt	Slag handling	154		11553
Mallinckrodt	Slag Man	77		9341 pg 5
Mallinckrodt	Removing slag drum	237		9443 pg 19
Mallinckrodt	Removing slag drum	60.8		9443 pg 19
Fernald	BZ – dumping can of C-liner	247		34544
Fernald	BZ – dumping can of C-liner	191		34544
Fernald	BZ – dumping can of C-liner	255		34544
Fernald	BZ – dumping can of C-liner	206		34544
Fernald	BZ – dumping drum of C-liner	793		42627
Fernald	BZ – dumping drum of C-liner	829		42627
Fernald	BZ – dumping drum of C-liner	424		42627
Fernald	BZ – dumping drum of slag outdoors	32		42628
Fernald	BZ – dumping drum of slag outdoors	110		42628
Fernald	BZ – dumping drum of slag outdoors	85	Value calculated from average, min and max	42628
Fernald	BZ – dumping drum of slag outdoors	85	Value calculated from average, min and max	42628

These samples were used to determine the parameters of a lognormal distribution. The analysis resulted in determining a geometric standard deviation (GSD) of 2.43 and a geometric mean (GM) value of 187.7 dpm/m^3. The 95th percentile of this distribution is 806 dpm/m^3. Figure 1 shows the individual data points along with the fit associated with these parameters.

Figure 1: Air Sample Distribution



Drum dumping is the highest airborne causing evolution at Hooker but it was performed only one day per month. The next highest airborne causing evolution would be the filtering and drumming of the concentrate after digestion. The remaining operations were performed in a liquid system. In order to determine an intake associated with filter operations, measurements associated with the digestion of uranium concentrates were considered. Digestion of concentrates involves many of the same basic steps as the concentration of MgF_2 at Hooker. A report by Christofano and Harris (Christofano 1960) determined the range of airborne activity associated with digesting uranium concentrates to be between 17 dpm/m^3 and 100 dpm/m^3 with an average concentration of 40 dpm/m^3. They also noted the uranium concentration in the incoming concentrate was 70% to 90% U_3O_8. Using the average (80%) equates to a uranium concentration of 68%. The concentrate being filtered at Hooker is 2% uranium. Adjusting the highest air concentration (100 dpm/m^3) down to 2% uranium produces a uranium airborne concentration of 2.95 dpm/m^3.

The internal dose estimate for Hooker will assume individuals are exposed to slag dumping 5% of the time (1 day per month) and the airborne concentration associated with filter operations the remaining 95% of the time. The 95th percentile of the slag distribution (806 dpm/m^3) will be used along with the bounding value (2.95 dpm/m^3) for the filter operation. This produces an average airborne concentration of 43.1 dpm/m^3. It is further assumed that the operators worked 48 hours per week for 50 weeks per year resulting in 2400 hours of work per year. This results in an intake rate of 340 dpm/calendar day.

The airborne concentration was also used to determine an ingestion intake per OCAS-TIB-0009 (OCAS 2004). This results in an ingestion intake of 5.9 dpm/calendar day.

5.0 External Dose

No external dosimetry data were found related to occupational external dose at Hooker during the MED work. Therefore, external dose was modeled using the computer code MCNPX (LANL 2009). External dose associated with the incoming barrels of slag (0.2% uranium) was modeled as well as with a barrel of uranium concentrate (2% uranium) and surface contamination.

5.1 Slag Barrel

The slag was reported to have arrived in wooden barrels with 500 pounds of slag in each barrel. The barrel was modeled as a cylinder. The material was assumed to be contained within a 50 gallon volume 36 inches high. The reported composition of the slag was 90% MgF (assumed to mean MgF_2), 10% CaO and 1% X (a code for uranium). These values sum to 101% and therefore must be adjusted. The uranium was assumed to be in the form of UO_2 since small particles of uranium would readily oxidize. As discussed in section 3.1 the uranium concentration is assumed to be 0.2% by weight. The percentages of MgF_2 and CaO were reduced proportionally so that the entire composition added to 100%. This results in a composition of 0.23% UO_2 (0.2% uranium), 89.80% MgF_2 and 9.98% CaO. 500 pounds of material contained in a 50 gallon space results in an average density of 1.2 g/cc. The uranium was assumed to be naturally enriched with short-lived decay products in equilibrium with their parent radionuclides. The shielding that would be provided by the barrel walls was ignored.

MCNPX was utilized to calculate the dose rate from direct photons and bremsstrahlung x-rays at a distance of one foot and one meter from the barrel. Dose conversion coefficients listed in ICRP 1996 Table A.1 were utilized for this calculation. The dose rate from beta particles was determined directly above the barrel on contact and one foot above the barrel. Dose conversion coefficients from ICRP 1996 Table A.43 were utilized for this calculation. The resulting dose rates are shown in Table 2.

Table 2: Slag Barrel External Dose Rates

	Photons (mr/hr)	Betas (mrem/hr)
Contact	N/A	1.91E-01
1 foot	1.94E-03	4.61E-02
1 meter	5.78E-04	N/A

5.2 Concentrate Barrel

After digestion and filtering, the filtered concentrate was placed into barrels. This was also modeled using the same assumptions as the slag barrel except the uranium concentration was assumed to be 2%. The composition of the concentrate was then 2.27% UO_2 (2% uranium), 87.96% MgF_2 and 9.77% CaO.

The calculated dose rates from the concentrate barrel are shown in table 3.

Table 3: Concentrate External Dose Rates

	Photons (mrem/hr)	Betas (mrem/hr)
Contact	N/A	1.93E+00
1 foot	1.65E-02	4.44E-01
1 meter	4.91E-03	N/A

5.3 External Dose from Surface Contamination

Next the external dose rate from surface contamination was calculated again utilizing the computer code MCNPX. The model assumed a large area of contamination (circle with a 100 meter diameter). The contamination was assumed to be evenly distributed over the area. The radioactive components of the contamination were assumed to be naturally enriched uranium in equilibrium with its short-lived decay products. The dose rate one foot from the surface was calculated assuming a contamination of 1 dpm/m^2 alpha activity. This produced conversion factors that could then be multiplied by the surface contamination values to obtain external dose rates. The result of these calculations is shown in Table 4.

Table 4: Surface Contamination External Dose Rates

	Conversion factor	Dose Rate
Photon	6.79E-10 mr/hr per dpm alpha/m^2	1.90E-04 mr/hr
Beta	6.04E-08 mrem/hr per dpm alpha/m^2	1.69E-02 mrem/hr

The surface contamination level was estimated by assuming the airborne activity deposited with a velocity of 0.00075 m/s. The airborne activity used was the average activity from section 4.0 (43.1 dpm/m^3). The airborne was assumed to deposit for 2400 hours (one full work year) without any removal mechanism. This resulted in a surface contamination level of 279410 dpm/m^2. This value was multiplied by the conversion factors in Table 4 to obtain the estimate of external dose rates due to surface contamination. The resulting dose rates are also contained in Table 4.

All beta exposure is entered into IREP as electrons >15keV. Energy distribution of the photon exposure rate from surface contamination was also calculated using MCNPX. The energy distribution was determined to be 80.2% <30keV, 12.3% 30 to 250 keV and 7.5% >250 keV. These values should be used in calculating photon dose.

5.4 External Dose Summary

Operators are assumed to spend 1 day per month (5%) emptying barrels of slag. A similar amount of time is assumed to be spent loading concentrate into barrels. Additionally, operators are assumed to be exposed to external radiation from surface contamination 100% of the time. Laborers are assumed to be in the area 100% of the time but not directly handle the material. As such, they are assumed to be exposed 100% of the time to external radiation from surface contamination. Supervisors are assumed to spend 50% of their time in the area but not directly handle material. Clerical or other individuals are assumed to be in the area 5% of the time but not directly handle material.

While handling the material directly, operators are assumed to spend 50% of their time one foot from the barrels and the remaining 50% of the time one meter from the barrels. The operators' hands are assumed be in contact with the material the entire time they are one foot from the barrels. The annual doses were calculated for photon dose, skin of the whole body (WB-skin) and the hands and forearms. The overall external dose estimates for operational periods are shown in Table 5.

Table 5: External Dose Summary

	Photon (mr/yr)	WB-Skin (mrem/yr)	Hands and forearms (mrem/yr)
Material Dose			
Operators	1.43E+00	2.94E+01	1.27E+02
Contamination Dose			
Operators	4.55E-01	4.05E+01	4.05E+01
Laborers	4.55E-01	4.05E+01	4.05E+01
Supervisors	2.28E-01	2.03E+01	2.03E+01
Clerical	2.28E-02	2.03E+00	2.03E+00

The photon doses from material should be entered into IREP as 30keV to 250 keV photons with a constant distribution. Photon doses from contamination should be entered into IREP as a constant distribution with the energy distributed as 80.2% <30 keV, 12.3% 30 to 250 keV and 7.5% >250 keV. The WB-skin and hands and forearms doses should be entered as electrons greater than 15 keV with a constant distribution. The 1944 and 1946 doses should be prorated to the fraction of the year the operation occurred based on a start date of July 11, 1944 and an end date of January 15, 1946.

6.0 Residual Contamination

For the purposes of this document, the residual contamination period at Hooker Electrochemical is considered to begin on January 15, 1946 and end on October 11, 1976. The end date is based on the Residual Contamination report (NIOSH 2009) and the date of the radiological survey that concluded that no elevated levels of radioactivity were onsite (DOE 1977 pg 11).

The external dose rates used during this period are the dose rates contained in section 5.3 from the surface contamination.

The internal dose rates are based on the surface contamination values derived in section 5.3 combined with a resuspension factor of $1\text{x}10^{-6}$ m^{-1}. NUREG-1720 provides this value as the Nuclear Regulatory Commission's recommendation of an appropriate resuspension factor for license termination screening. The recommendation indicates a resuspension factor of $1\text{x}10^{-6}$ m^{-1} is more realistic than the previous value of $1.42\text{x}10^{-5}$ m^{-1} and sufficiently conservative for screening analysis. In this analysis, the NRC noted a significant difference between those studies conducted in areas with freshly deposited contamination versus those involving "operating facilities or those undergoing decommissioning". Since the NRC report was associated with decommissioning, they chose to not use those studies involving freshly deposited contamination.

The basis for this decision was the assumption that any area undergoing decommissioning would likely be washed down.

At Hooker, the majority of the airborne contamination (and thus the surface contamination) was located where the slag drums were emptied. This work was accomplished outdoors on a concrete pad near the railroad spur. As such, the contamination was exposed to the elements in western New York State. Wind, rain, and snow melt would quickly accomplish the same effect as washing down the area with a water hose. Therefore the resuspension factor from NUREG-1720 appears to be applicable at Hooker.

The surface contamination value is based on a bounding estimate of the airborne levels deposited for 2400 hours with no removal mechanisms. The surface contamination value is then a bounding value. Since both the internal and external exposure estimates are based on this bounding value, the dose estimated during the residual period will be entered into IREP as a constant.

The internal and external values applicable to the residual period are shown in Table 6.

Table 6: Residual Period Dose Summary

Internal Dose			
Job Category	Years	Nuclide	Intake (dpm/calendar day)
All jobs	1946-1976	U-234	2.20
External Dose			
Job Category	Years	Photons (mr/yr)	Skin (mrem/yr)
Operators	1946-1976	4.55E-01	4.05E+01
Laborers	1946-1976	4.55E-01	4.05E+01
Supervisors	1946-1976	2.28E-01	2.03E+01
Clerical	1946-1976	2.28E-02	2.03E+00

All internal dose is entered into IREP as alpha radiation with a constant distribution. External photon dose should be entered into IREP as a constant distribution with an energy distribution of 80.2% <30keV photons, 12.3% 30 to 250 keV photons and 7.5% >250 keV photons. External skin doses should be entered into IREP as a constant distribution of electrons >15keV.

7.0 Occupational Medical Dose

The War Department memo dated March 8, 1946 indicated the medical requirements included a pre-employment exam including a chest x-ray as well as a monthly blood count and monthly urinalysis. It also indicates there were no special exams and that this schedule was not adhered to after the first year of operation (Mears 1946). No other information regarding occupational medical dose specific to Hooker Electrochemical was found. 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. The assigned frequency should be only a pre-employment PA chest x-ray.

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