Review of the Potential for Residual Contamination at Bethlehem Steel Corporation

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Introduction

In response to the National Defense Authorization Act for Fiscal Year 2002 (Pub. L. 107-107; Section 3151(b)), NIOSH evaluated the potential for the presence of significant radioactive contamination at Atomic Weapons Employer (AWE) facilities after the facility had discontinued nuclear weapons production activities. The Bethlehem Steel facility in Lackawanna, New York is an AWE facility whose operational period (i.e., the time period during which AEC activities were conducted) has been established by the Department of Labor as 1949 – 1952. As indicated by the data provided in Attachment 1, it is clear that significant quantities of uranium were processed during the operational period. NIOSH's original evaluation of the post-operational period (i.e., after 1952), however, determined that there is little potential for significant residual contamination to remain at the Lackawanna facility after the cessation of AEC-related operations in 1952[1]. A copy of the basis for this determination, as it appears in the 2011 report, is provided in Attachment 2. Consistent with the approach used to make this determination at all AWE facilities, NIOSH relied on information related to: 1) the nature of the operations conducted; 2) descriptions of clean-up activities, and; 3) available radiation contamination survey data. When surveys were available, the current federal guidelines for unrestricted use are used to establish the presence of significant radioactive contamination.

NIOSH considers contamination levels at designated facilities in excess of those indicated in 10 C.F.R. part 835, Appendix D (Occupational Radiation Protection, Surface Contamination Values), an indication that there is "significant contamination" remaining in those facilities. Areas below the levels prescribed in Appendix D are not considered contamination areas and workers are allowed unrestricted and unmonitored access to these areas. The Appendix D contamination levels for uranium are provided in Table 1 below[2].

Table 1

10 CFR 835 Appendix D Limits Surface Radioactivity Value	disintegrations per minute / 100 cm^2	
	Removable	Total (Fixed plus Removable)
Natural Uranium	1,000	5,000

The amount of removable material is determined by swiping the area with a dry filter paper or other soft absorbent paper and then assessing the amount of radioactive material on the swipe using an appropriate radiation detection instrument.

[1] In an early version of the report, a clerical error resulted in the inadvertent listing of the Bethlehem Steel facility as being contaminated to the present. The error was corrected upon discovery,

[2] When contamination surveys were available, these levels were used to evaluate the presence of significant residual contamination at all AWE facilities.

Since the original determination by NIOSH, concerns have been raised by claimants, survivors, and other interested parties that the original analysis did not consider the spread of contamination to other areas of the plant, including the sub-basement under the cooling beds and the horizontal structures (e.g., rafters and overhead cranes) above the rolling mill. While NIOSH has access to a set of survey data in around the 10-inch rolling mill, it has been argued that no such survey data exist for the areas beneath and above the mill. Because steel plants inherently produce large quantities of dust, many workers believe that it would not have been possible to adequately clean up the uranium that might have been dispersed throughout the plant.

Given the concerns raised by stakeholders, NIOSH has undertaken a reanalysis of its original determination. This reanalysis expanded on the original determination by reconsidering the information that was previously used, as well as any additional information that was obtained thereafter. To this end, NIOSH has reviewed: 1) all AEC and DOE documentation related to Bethlehem Steel that has been obtained to date; 2) the written statements describing conditions in the plant that were provided by seventy-five Bethlehem Steel workers and/or survivors; and, 3) the comments obtained from participants at a town hall meeting held August 13, 2012 in Hamburg, New York.

Review of Affidavits Received by NIOSH

Over the past year, NIOSH received a number of affidavits from former workers and survivors of workers at Bethlehem Steel. Of the 75 affidavits received, 62 were from former workers and 13 were from spouses. The dates of employment for these workers varied considerably with more than 80% of the affiants having started employment after the covered period (i.e., after 1952). Each of the affidavits received by NIOSH was reviewed for information that might be used to evaluate the potential levels of residual contamination at Bethlehem Steel.

Twelve affidavits indicated dates of employment during the current covered period (i.e., 1949-1952). Each of these was reviewed to determine if they contained any information that might discern the extent of uranium cleanup at the 10 inch bar mill area during this period. The following statements, taken directly from the affidavits, provide some indication of nature of cleanup activities at the plant:

- *Laborers swept the floors in the work area, or one of the scarfers blew the dust and dirt into the bed of our work.*
- *I worked as a laborer in the bar mill area sweeping up with a broom and dust pan. Nothing was done for a proper cleanup until 1976.*
- *I worked during the period of 1949 through 1952…. At no point was there any special cleaning done following the processing of radiated steel at the plant. The only cleaning that was done; (that I am aware of) would have been done by the laborers who worked for the plant. This was part of their daily routine. They used wheelbarrows along with brooms and shovels to clean the area. This did nothing*

for the steel particles that were airborne and rested in the dust on the rigging and beams for the crane. These areas up above the floor level could not possibly be cleaned. When the crane is moving the beams vibrate causing dust to fall. This spreads the contamination in the plant daily.

- *For many years I worked in the labor pool, which meant doing all kinds of disposal work. Cleaning slag pits beneath the rolling mills was one of them.*
- *Early in the Spring of 1952, I was a welder at the 10 inch bar mill…On Saturdays I stood by while they rolled uranium bars. When they finished men would vacuum the floors and hot bed. Men would clean up the sub-basement with brooms and shovels.*
- *Any cleanup attempt would have been incomplete without replacing certain equipment e.g. Crucibles, crane rigging, conveyors, etc. To my knowledge this was not replaced.*

From the above excerpts, there appears to be a consistent recollection among workers in the AEC period that some form of cleanup occurred regularly, whether it was part of the normal maintenance practice at the plant or in response to the rolling of uranium. This cleanup of dust in the plant included floor sweeping and routine removal of dust and debris that would accumulate in the subbasement. One worker, who recalls observing uranium rollings, has a specific recollection about workers vacuuming the floors and cleaning up the subbasement with brooms and shovels. While this could have resulted in significant intakes of uranium, the exposures during this period are already covered under the currently defined time period of 1949-1952.

There were six affidavits that described exposures that might have occurred beyond the existing covered period. Although NIOSH has seen nothing in the captured documents that supports additional AEC work beyond 1952, these affidavits have been forwarded to the Department of Labor (DOL) for their consideration. Under EEOICPA, the DOL has the responsibility for defining covered time periods at AWE facilities. For completeness, the other 69 affidavits NIOSH received were also forwarded to DOL.

The remaining affidavits from workers who were employed outside of the covered period contained one or more of the following elements: 1) a belief that the plant was not or could not have been adequately cleaned of all uranium contamination; 2) a brief description of their work history at the plant; 3) a description of medical conditions that they attribute to uranium exposure; and 4) an expression of support for the addition of the residual contamination period.

Review of Comments from the August 2012 Town Hall Meeting in Hamburg, New York

During the town hall meeting held August 13, 2012 in Hamburg, New York, NIOSH received a number of comments from those in attendance. The two key issues raised by workers were similar to those raised in the affidavits that were received by NIOSH. That is, workers expressed

concern about: 1) the adequacy of the cleanup of the area under the rolling mill; and 2) the potential for workers to be exposed to settled dust on elevated horizontal surfaces such as cranes and cat walks. Some specific points raised by participants related to these issues are provided below,

- Workers questioned the validity of the 1952 clean up as it was done under the direction of the AEC and likewise the 1976 contamination surveys that were done under the direction of company management were questioned.
- Concern was expressed that not all machinery that was possibly contaminated was disassembled and cleaned and, therefore, could be a source of potential contamination after the 1952 clean up.
- There are eye witness accounts of "dust clouds" that came off of the cranes when they were moved.
- The methods that were used for cleanup and measurement in1952 were not as developed as current methods and, therefore, call into question the effectiveness of the clean.
- There were concerns about contamination of the cat walks, roof area, and on top of the crane.
- A number of comments suggested that the current site be sampled for residual contamination.

Regarding the validity of the contamination surveys, it appears to NIOSH that industry-standard techniques were employed by the AEC contractor, the Bethlehem Steel Environmental Staff, and in the subsequent survey by Oak Ridge National Laboratory. In each case, the surveys detected no significant levels of residual contamination. It is important to note that the original surveys taken in 1952 followed protocols that were developed by the AEC's Health and Safety Laboratory, which has a reputation in the scientific community for developing and implementing scientifically-sound workplace monitoring techniques.

The remaining issues related to contamination in the subbasement and in nearby structures (e.g., overhead cranes) are specifically evaluated and addressed in the subsequent sections of this review.

Review of Documented Clean-up/Contamination Reduction Activities at the Rolling Mill

In its site research database, NIOSH has collected 396 documents related to the Bethlehem Steel site in Lackawanna, New York. Many of these documents are Atomic Energy Commission (AEC) reports that describe the conditions surrounding the rolling activities conducted during the covered time period. Attachment 3 provides a summary of the reference documents that are related to the clean-up and contamination control activities. These documents provide the basis for the discussion contained in this section.

The AEC monthly progress reports provide descriptions to indicate that the 10-inch bar mill area was routinely cleaned-up after rolling. Specific reports related to uranium accountability describe that all uranium materials were collected and shipped after the completion of rolling events. Initially, the cleaned-up material was drummed and shipped to Lake Ontario Ordnance Works for storage. There are also reports of other shipments to Vitro Manufacturing and Fernald.

Based on the experience gained from rolling uranium at Simonds Saw and Steel, the AEC implemented a significant contamination control measure at Bethlehem Steel. Unlike the original rollings at Simonds Saw and Steel, which were heated directly by a furnace, the rods at Bethlehem Steel were heat treated in a molten salt bath prior to rolling. As summarized in a 1951 AEC memo, the protective coating on the rods provided by the salt bath greatly reduced the dust levels in the plant.

The AEC documentation also indicates that the level of contamination was an AEC concern during the first "experimental rollings" conducted on April 26 and April 27, 1951. An internal April 24, 1951 AEC memorandum to Merrill Eisenbud states that:

> *We would like to have a Health and Safety Division representative to measure atmospheric uranium dust concentration in connection with the salt test on April 26 and to act as the adviser on decontamination on April 27.*

Although no contamination surveys were located following the April 1951 rollings, NIOSH has located surveys that were conducted after two rolling operations in 1952. A February 1952 report of rolling operations describes a complete survey that was performed. This survey found, "very little" contamination in the mill area. It also found that a "considerable" amount of radioactive scale was found in the shear area, but that nearly all of it was readily removed by wiping. This report recommended, "…that more attention be given to the cleanup following the rolling and that reasonable care be taken to remove all loose contamination." Subsequent surveys of the shear area taken in September of 1952 found no contamination in excess of current free release standards. Additional smears taken of the cooling table, the salt bath, the stands, and the floor all found no detectable contamination above current unrestricted release limits. Table 2 provides the results of the smear samples taken before and after cleanup of the September 14, 1952 rolling. Smear samples Q925 through Q935 were labeled as being taken after "the last rolling before cleanup," while smears Q936 through Q949 were labeled as being taken after the "last rolling after cleanup." A comparison of these results with the contamination limits in Table 1 reveals that all values are below the 1,000 dpm/cm^2 limit for removable uranium contamination. From inspection of Table 2 it can be seen that the highest levels of contamination were measured at the shear and the cooling bed. As discussed above, the shear area was known to collect "a considerable amount of scale" so additional attention was taken in the survey and subsequent cleanup of contamination in this area.

Table 2

Results of Contamination Smears Taken on September 14, 1952

Sample Number	Description	Result (dpm/100 cm^2)
Q925	Approach to shear	404
Q926	Back table shear	679
Q927	Cooling table	285
Q928	Cooling table	103
Q929	By salt bath	6
Q930	Stand 1	1
Q931	Stand 2	9
Q932	Stand 3	6
Q933	Stand 4	5
Q934	Stand 5	9
Q935	Stand 6	0
Q936	Approach to shear	979
Q937	Back table shear	568
Q938	Cooling table	301
Q939	Cooling table	343
Q940	By salt bath	5
Q941	Stand 1	4
Q942	Stand 2	1
Q943	Stand 3	4
Q944	Stand 4	3
Q945	Stand 5	4
Q946	Stand 6	1
Q947	Floor	23
Q948	Floor	7
Q949	Floor	10

In response to Bethlehem Steel being added by the Energy Research and Development Administration (AEC's successor agency) to the list of sites where uranium was handled, a contamination survey was completed in 1976 by an employee of the Bethlehem Steel Corporation. The survey, which was conducted by the environmental health engineer at the Lackawanna facility under the guidance of the corporate radiation control engineer, was much more comprehensive than those taken during rolling operations. A total of 68 samples were collected which included the rolling equipment, shears, cooling beds, and the areas under this equipment. In this survey, no contamination above natural background was identified. Because there is no evidence that a radiological decontamination effort, in addition to that performed by the AEC during rolling, was conducted between the end of uranium rolling operations in 1952

and this survey in 1976, it is reasonable to conclude that the uranium source term had been removed from both the first floor and the sub-basement. At other AWE sites, where no indication of cleaning was found to have occurred, levels of uranium well above background were easily detected in the AEC follow-up surveys in the 1970s and 80s. It should be pointed out that, at the time of this survey, the subbasement under the cooling bed area of the ten inch rolling mill area had not yet been filled in.

An additional survey, designed to specifically determine if the site could be eliminated from consideration as a contaminated site, was completed in 1980 by Oak Ridge Operations Office and Oak Ridge National Laboratory. Most of the equipment used in the operations had been removed but the shear and the areas around where the rolling equipment was previously located were surveyed. As in previous surveys, no contamination in excess of background was identified and the site was again deemed to meet the requirements for unrestricted use.

Consideration of the Potential for Residual Contamination of the Subbasement and Other Surfaces

The Subbasement

As described above, it is clear that the AEC directed efforts to clean residual contamination from the areas immediately surrounding the processing machinery, cooling beds, and shears on the first floor of the plant. As pointed out by former workers, however, much of the first floor was covered by a grating through which steel and uranium dust could accumulate. The contamination levels and cleanup efforts associated with the areas in the subbasement beneath the first floor is not as well documented. A review of the affidavits provided by former workers, however, provides some insight into the handling of dust generated during the rolling process, whether the source of the dust is from the rolling of steel or uranium ingots.

As indicated in the affidavits, the dust and debris generated during the production of steel would settle not only onto machinery surfaces but also into the basement areas underneath the rolling line and the cooling bed. The fact that this dust and debris were periodically cleaned up and removed from the basement area is reported in 14 of the affidavits/statements received by NIOSH. Although the specific details vary, they generally describe the routine removal of dust and scale by sweeping and shoveling into containers such as wheelbarrows, metal boxes or 55 gallon drums. Of particular note was one affidavit from a worker that reported being present at uranium rolling in the spring of 1952 in which he states:

> *On Saturday I stood by while they rolled uranium bars. When they finished men would vacuum the floors and hot bed. Men would clean up the sub-basement with brooms and shovels.*

Based on these statements it is evident that steel and/or uranium dust that settled into the sub-basement area was removed on a regular basis. Whether the removal occurred during the AEC

clean-up after each rolling (as indicated by one worker) or during ongoing maintenance activities is not clear. Given that the last documented rolling of uranium occurred at the end of October 1952 and the covered period ends at the end of December, it is reasonable to conclude that any uranium deposited in the sub-basement over that two month period was removed. The additional two month covered period beyond the last rolling provides SEC status to all workers at the plant, which would include those involved in the cleanup activities in the subbasement.

Other Surfaces

As described above, surveys taken in the areas at or near the uranium rollings were found to be below current contamination guidelines and the dust (both uranium and steel) that accumulated in the subbasement was routinely removed. The question remains, however, as to the levels of potential contamination in areas remote to the rolling operations that were not decontaminated after uranium rollings. This would include surfaces on the plant floor beyond the immediate clean up area and elevated horizontal structures, such as those on catwalks and overhead cranes.

To evaluate the potential contamination in these areas, NIOSH reviewed the general area air samples that were taken during rolling operations. In all, eighty-six general area air samples were taken during rolling conducted in 1951 and 1952. These samples were positioned near the various pieces of process equipment (e.g., stands, salt bath, and cooling bed) at distances that ranged from eight to thirty feet. The median general air sample concentrations were found to be 15.1 and 5.7 dpm/m^3 for 1951 and 1952, respectively. Using these air concentration values it is possible to estimate the amount of contamination that could have deposited on horizontal surfaces that were outside or the immediate cleanup area.

For each of the 13 rollings considered to have occurred in 1951, there was a median general area air concentration of 15.1 dpm/m^3. Using the terminal setting velocity of particulate of 0.00075 m/s, the amount of uranium that settles on the ground over a 10 hour shift is 4.1 dpm/100 cm^2. Thus, the amount of uranium that could accumulate on surfaces removed from the immediate area of the rolling process for 13 shifts is 4.1x13 = 53.3 dpm/100 cm^2. A similar calculation for the 15 rollings in 1952 results in a total deposition of 23.1 dpm/100 cm^2. The total deposition for both years is then 53 + 23 = 76 dpm/100 cm^2. This value is more than an order of magnitude less than the 10 CFR 835 Appendix D value of 1,000 dpm/m^2 listed in Table 1 for removable contamination. Thus, under current regulations, this level of residual contamination would not be considered a contaminated area.

The above analysis assumes that there is no cleanup of the material in between rollings and that there is no dilution of the uranium due to mixing with steel dust that would be deposited on top of the uranium between rollings. If one accounts for this dilution factor, and one assumes uniform mixing of the material, each day of steel rolling would reduce the amount of uranium on the surface. The material on the surface one day after a uranium rolling would therefore be one

part uranium and one part steel. On the following day, the material would be one part uranium and two parts steel and so on.

Conclusion

The uranium rolling operations that took place at the Bethlehem Steel plant created airborne radioactivity and exposed workers to internal and external radiation during the operational period. However, the potential for residual radioactive contamination after rolling operations ceased is very low. The evidence shows that an active cleanup program of the area surrounding the rolling operations was in place and was effective. Documentation obtained by NIOSH indicates that care was taken to clean up scale, scrap, fines and dust after the uranium rollings. This is particularly well illustrated in the February 16, 1952 "Production Report on Rolling of Uranium Billets at BSC", where surveys performed after a clean-up identified contamination in excess of acceptable limits. It was reported that "Nearly all of it was readily removed by wiping." This report made a recommendation "…that careful attention be given to the clean-up following each rolling operation." A survey was documented after a later rolling on September 16, 1952 that identified no contamination in excess of current unrestricted release limits.

Affidavits from workers indicate that the subbasement was periodically shoveled out during and after the operational period. These cleanup activities (whether specifically directed at removing uranium or part of the general cleanup of steel dust) would have removed any uranium that was deposited in the subbasement. In addition to the 1952 survey, a follow-up contamination survey was performed in 1976. As stated above, this survey, which included numerous measurements in the sub-basement, found no detectable contamination. The fact that surveys performed immediately following operations and performed in 1976 identified no significant residual contamination combined with the evidence of routine clean-up documented in trip reports and personal affidavits supports the conclusion that significant levels of residual radioactive contamination were not present at Bethlehem Steel after the end of AEC operations in 1952.

General area air sample data collected during uranium rolling operations were used to evaluate the potential levels of surface contamination that could have been deposited outside of the area of cleanup (e.g., the catwalk and the overhead crane). This analysis indicates that levels of surface contamination deposited in these areas would be less than the current regulatory limits that define a contaminated area.

Based on the review of all available documentation, NIOSH believes that there is a low potential for the presence of significant radioactive contamination at Bethlehem Steel after the facility had discontinued nuclear weapons production activities.

References

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HW-22347: Hanford works. Trip Report: Visits to AEC New York Operations Office, Lackawanna Plant, Bethlehem Steel Company, Argonne National Laboratory August 24-29, 1951. HW-22347.

HW-23399: Hanford works. Trip Report: Development of a Uranium Rolling Process for Fernald. HW-23399. January 29, 1952.

HW-23910: Hanford works. Trip Report: Evaluation of Uranium Rods from the Fourth Experimental Rolling at Lackawanna, New York. HW-23910. March 21, 1952.

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Kosanovich, P. (Compensation Agent, L.U. 2603), 1979, letter to Robert Anderson (Bethlehem Steel Corporation), October 19 [p. 36, Bethlehem Steel Site Profile.pdf].

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NLO (National Lead Company of Ohio), 1952, *Production Report on the Rolling of Two Hundred and Eighteen Uranium Billets at Bethlehem Steel Corporation's Lackawanna*

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Summary (Summary of Experimental Rollings Relating to Fernald Operations), 1951 [p. 20, Bethlehem Steel.pdf].

Thornton, W. T., 1977, "ERDA Resurvey Program – Bethlehem Steel, Lackawanna, NY," report to R. H. Kennedy, Energy Research and Development Administration, March 16 [p. 75, Bethlehem Steel.pdf].

Attachment 1

Listing of Documented Rollings at Bethlehem Steel

Date	Day	Type or designation	Billets rolled	Bath type	Air Sample Data	Reference
April 26-27, 1951	Thursday, Friday	Experimental #1	26	Lead /salt	Y	Summary 1951 AEC 1951b Sheets 6191 and 6192
July 29, 1951	Sunday	Experimental #2	24	Lead /salt	Y	Summary 1951 Sample sheets 6425, 6436, 6437
August 27, 1951	Sunday	Experimental #3	32	Lead /salt		Summary 1951 HW-22347
September 30, 1951	Sunday	Experimental #4	43	Salt	Y	HW-23910 Sample sheet 6539
October 28, 1951	Sunday	Lackawanna #5	93	Salt	Y	HW-22975 Sample sheets 6532, 6533
January 26-27, 1952	Saturday, Sunday	Production	25 plus 4 tons heat treated only	Salt	Y	AEC 1952b HW-23399 HW-24849 HW-23269 Sample sheets 6543, 6544, 6545
February 16, 1952	Saturday	Production	120 30 tons	Salt		HW2-3697
March 15, 1952	Saturday	Production	218	Salt	Y	NLO 1952b Sample sheets 6573, 6574
April 12, 1952	Saturday	Production	222	Salt		NLO 1952a
May 10-11, 1952	Saturday, Sunday	Production	461	Salt		FMPC-26
August 17, 1952	Sunday	Production	157	Salt		Bowman 1952
August 31, 1952	Sunday	Production	219	Salt		Bowman 1952
September 14, 1952	Sunday	Production	303	Salt	Y	Schneider Sample sheet IH33, IH34, IH35, IH36
September 22, 1952	Monday	Production	302	Salt		Schneider
October 20, 1952	Monday	Production	359	Salt		FMPC-84
October 25, 1952	Saturday	Production	237	Salt		FMPC-84

Attachment 2
Residual Radioactivity Evaluations for Bethlehem Steel
(Excerpted from the current Residual Contamination Report)

FACILITY NAME: Bethlehem Steel
Lackawanna, New York

TIME PERIOD: 1949-1952

FACILITY DESCRIPTION: DOE Office of Health, Safety and Security Website:
In 1949, Bethlehem Steel of Lackawanna, New York developed improved rolling mill pass schedules for uranium billets into 1.5-inch rods to be used for reactor fuel rods to later be used at the Fernald plant. Bethlehem also performed uranium rolling experiments to help design the Fernald rolling mill.

DISCUSSION:
Documentation reviewed describes the activities as being limited in scope, principally being performed on weekends, which involved uranium metals being rolled into rods.
Personnel were present during operations and provided Health and Safety coverage including documented monitoring for airborne radioactivity, and contamination surveys after operations.
Radiological surveys were performed before and after cleaning of the equipment after the last rolling and showed no contamination in excess of current guidelines for unrestricted use. Surveys of the original facility and equipment, which still existed, were performed in 1976 and 1980, both of which identified no residual contamination above natural background levels.
Based on the nature of the activity, accompanied with documented discussion of cropping and residue collection and removal for material accountability purposes; it is reasonable to assume that there was a low potential for widespread or significant contamination.

INFORMATIONAL SOURCES:
Sources of information reviewed during this evaluation included:
• DOE Office of Health, Safety and Security Website
• Preliminary Survey of Bethlehem Steel, March 1980
• Survey of Rolling Mill Used by Bethlehem Steel Corporation, September 1980
• Investigation Report: Uranium Metal Rolling, 10” Bar Mill, June 1976

EVALUATION FINDINGS:
Documentation reviewed indicates that there is little potential for significant residual contamination outside of the period in which weapons-related production occurred

Attachment 3

Summary of Available AEC Documents that Describe Clean-up and Contamination Monitoring Activities

Clean-up/Contamination Reduction Activities

The documentation NIOSH has reviewed indicates that the area was routinely cleaned-up after rolling. Specific reports related to uranium accountability describe that fines, croppings, and all uranium materials were collected and shipped after the completion of rolling events. Specific references of clean-up include:

- Special sampling and Analysis of XRO Oxides at Vitro, 9/3/1952, Hershman, H. J., (SRDB #111184)
    - This memo provides a list of drums of uranium oxides that were stored at the Lake Ontario Ordnance Works. There are three barrels listed that contain uranium dusts and oxides from Bethlehem Steel which collectively add up to over 600 pounds of material.

- Monthly Progress Report for November 1951, Malone F.W., (SRDB #75068)
    - "Uranium metal rods, oxide and scrap were received at LOOW from Allegheny-Ludlum; Simonds, Albany; Bethlehem, Lackawanna; Knolls Atomic Power Laboratory at Schenectady, Massachusetts Institute of Technology, Cambridge, Birdsboro Foundry, and Hanford Operations Office."
    - "Thirteen bundles of cobbled rods and four drums of scrap from the last Bethlehem rolling were transferred to storage at LOOW by personnel from this site."
- AEC Monthly Report of Field Activities May - June, 1951, (SRDB # 04061). pg. 14
    - This report describes use of a fused salt bath to reduce generation of airborne oxides during rollings of April 26 and 27, 1951.
    - "For a second test, one set of rods was rolled after heating in a mixed salt bath. The air samples for this set were significantly lower than those for the lead bath test."

- Weekly Progress Report May 5-9, 1952, Malone F.W., (SRDB #73547) states that:
    - "Three truckloads of rods and scraps shipped to National Lead Co. at Fernald. This was the balance of the material from the April 12th rolling at Bethlehem."

- Records and Reports with Respect to Fissionable and Source Material, August 5, 1952, Bate G.A, (SRDB #67067). This report includes an investigation of material accountability that contains the following:

- "Solid scrap and floor sweepings from both plants were delivered to Lake Ontario Storage Area for storage under XRO accountability."
- "In this program, the XRO Accountability Representative was required to be physically present at the rolling and drawing operations, usually a day in advance to receive incoming material and to supervise the shipment of such material from one plant to the next for the succeeding operation in the case of Allegheny and Bethlehem rolling on two consecutive days."
- "In all cases, incoming and outgoing material, including feed, product, scrap and residues were weighed at Allegheny, Bethlehem, Bridgeport Brass, and Crucible Steel, at the start and end of each operation."
- "At no time, as indicated on the monthly accountability reports of SF material, did either the unaccounted for loss or gain appear to be outside of reasonable limits. It would therefore appear that, on the assumption the monthly accountability report reflects the true state of affairs, any scale inaccuracies would be cumulative and that discrepancies would tend to grow each month to a total figure which would be outside of the normally accepted percentage of .3 of 1% for unaccounted loss or gain."

- Weekly Progress report August 4-8, 1952, Hershman H. J., (SRDB #73577) states that:
  - "One drum of oxide from last Natl. Lead rolling at Bethlehem was picked up at Bethlehem and brought to LOSA for storage."

- Report of Analysis, USAEC, Health and Safety Division, (SRDB #17009)
  - Shows analysis of "Unidentifiable material but appears to be floor sweepings from Simonds or Bethlehem rollings"

- Employee interview, June 1976, Fletcher H. Doran, (SRDB#14806)
  - An individual that had "…firsthand knowledge of the operation because the contract and the development work were his prime responsibility." reported that, "The operations at Lackawanna were remembered as being quite clean. At the end of each campaign special care was taken to recover and package scale, crops and other residues."

- Signed affidavits from workers, June 25, 2005, multiple authors, (SRDB #17619 pg. 5) state that:
  - "Clean-up crews with push brooms, shovels and wheelbarrows periodically removed this buildup of metal particles and steel dust but they could not reach the build-up on top of the motors, boxes and piers and conduit because of the height, limited space and configuration."

- "Men had to use shovels and brooms to just remove some of the scale and dust. At times they would try to get into areas with a high pressure air hose. This procedure would blow the dust back through the rollers where the heat would then carry the dust back up through the rollers into the mill."
- "I also witnessed the uranium rods being lifted from the salt and lead bath, read (sic) hot and dripping all over the salt bath and on to the floor. This also was not cleaned up."

- Summary Notes from Bethlehem Steel Meeting June 2006, Division of Compensation and Analysis Support (SRDB #27972). Former workers stated:
  - "They used to roll in one or two shifts – one shift and some overtime. They cleaned up the dust after they did the rolling. They had big vacuum cleaners."
  - "Uranium would fall into the basement area."
  - "I worked in the subbasement when it needed to be cleaned up. We cleaned up scale down there. We would be shoveling it. We did not use air hoses to my knowledge."

Contamination Monitoring Activities

The documentation that NIOSH has obtained indicates that contamination monitoring was performed during operations and after rollings were completed. Specific references include:

- Report of Rolling Operations Attended by the Health and Safety Division, 2/18/1952 Heatherton R. C. , (SRDB #81429)
  - A complete survey was performed on January 27, 1952. This survey reported that, "Very little contamination was detected in the mill area or the runout to the kickoff." It also found that, "A considerable amount of radioactive scale was found in the shear area." and that, "Nearly all of it was readily removed by wiping."
  - This report recommended, "…that more attention be given to the cleanup following the rolling and that reasonable care be taken to remove all loose contamination."
  - Subsequent surveys of the shear area (SRDB #9529) taken on 9/16/52 found no contamination in excess of current free release standards.

- Production Report on Rolling of Uranium Billets at BSC, 2/16/1952, Stewart, R. S., (SRDB #44231)
  - This report included in the discussion that: "In the contamination survey following the clean up after the rolling considerable scale which appeared to be uranium contaminated was found around the shear"

- It then recommended that "It is recommended that careful attention be given to the clean-up following each rolling operation"
- Subsequent surveys of the shear area (SRDB #9529) taken on 9/16/52 found no contamination in excess of current free release standards.

- Contamination Survey Report, 9/16/1952, Blase, National Lead Company of Ohio (SRDB #9529)
  - Contains removable contamination levels from multiple locations including a shear, cooling table salt bath, stands and floor.
  - Measurements were taken both before and after clean-up of last rolling.
  - All measurements were less than current unrestricted release levels.

- Investigation Report: Uranium Metal Rolling, 10" Bar Mill, Lackawanna Plant 6/29/1976, LaMastra, A., (SRDB #26845). Some of the findings of this report include:
  - "According to comments received from National Lead personnel, from a former superintendent of the 10- and 12-inch Bar Mill at Lackawanna, and from ERDA, the Lackawanna rolling was considered "clean". Scale, residue and cropped ends were collected and fine debris was vacuumed. AEC personnel were in attendance during all rolling operations and reportedly performed air and surface radioactive monitoring."
  - "On May 11, 56 locations on the 10-inch Bar Mill and associated equipment were tested for radioactive contamination using dry wipes. On May 17, 12 additional rolls for the 10-inch mill, some of which are believed to date back to the time of subject rolling, were found and wiped. All samples were analyzed for both alpha and beta radiation using an internal gas flow proportional counter. No radioactive contamination above natural background was found on any wipe."
  - "In an intensive survey made subsequent to the news item, no radioactive contamination was found in the mill used during the project."
  - "The high monetary value and the military use of the uranium would result in a high degree of accountability. This would substantiate the extensive clean-up measures taken during the rolling operations."
  - "In summary, there is no evidence to indicate that handling and cleanup activities were lax during the Lackawanna rolling operation, that there is any of the uranium buried on Lackawanna property or in the Buffalo area as a result of the rolling operation, or that there was a spread of contamination to any areas. There is no evidence to indicate that any person has ever been significantly exposed to radiation from this operation. All evidence found thus far indicates that there is no hazard at this operation from radioactive materials."

It is important to note that these surveys were performed prior to the addition of the new concrete floor and included multiple points on the 10-inch roller, the basement area, the mill

floor, and underneath the cooling bed. As stated above, no radioactive contamination above natural background was found.

- Radiological Clearance Report May 27, 1977, Thornton, William T., (SRDB #16443)
    - "Based on radiation measurements made by Bethlehem Steel and confirmed during a visit by ERDA representatives to the Lackawanna Plant on August 26, 1976, it is concluded that no potential for radiation-related safety problems exists in the involved facilities and that further formal ERDA radiation surveys are not warranted."

- Preliminary Survey of Bethlehem Steel, Lackawanna, New York, March 1980, Health and Safety Research Division, Oak Ridge National Laboratory, (SRDB #26846)
    - "Rolling operations involving uranium were conducted only on weekends due to work commitments at the mill during the weekdays."
    - "Apparently, all scale, residue and cropped ends were collected and fine debris was vacuumed as the mills were prepared for other work each week"
    - "All measurements taken at this site resulted in radiation levels that were within typical background levels"

- Survey of Rolling Mill Used by Bethlehem Steel Corporation, Lackawanna, New York, September 1980, Oak Ridge National Laboratory, (SRDB #32735)
    - "A radiological survey was performed on the surfaces of the shear. Measurements included a gamma-scan of all accessible equipment surfaces, a beta-gamma scan of selected equipment surfaces, and alpha activity at random locations on equipment surfaces. All measurements taken of equipment surfaces resulted in no radiation levels significantly above background levels."

- Certification Docket for Bethlehem Steel Corporation, 1985, Department of Energy, Office of Nuclear Energy, (SRDB #26846)
    - "DOE has determined that the conditions at this site are in compliance with current radiological guidelines and standards and that no potential for radiological exposure to persons exists beyond those resulting from natural background."
    - "Material accountability procedures required collection of scale, residues, and cropped ends and vacuuming of fine debris for return to the AEC."
    - "The AEC personnel were present during all rolling operations and apparently made radiological surveys."