Major Issues & Recommendations: Cabot Reading Slag Pile

Purpose:

The purpose of this document is to address the major issues associated with the Cabot Reading Slag Pile and to document the position and recommendations of Pennsylvania Dept. of Environmental Protection, Bureau of Radiation Protection, Decommissioning Section.

The majority of these issues and recommendations were stated previously in a memo (with attached briefing) to then-Deputy Secretary Barkanic, dated June 24, 2002. The subject of this letter was: Issues and Recommendations for the Cabot Reading Slag Pile.

This document expands on issues previously raised and brings to light new issues based on documentation recently provided by Cabot Performance Materials (Cabot).

Background:

Deputy Secretary Barkanic and BRP Director Allard met with NRC management (Camper, Lohaus, Bellamy) on July 11, 2002 to discuss the issues raised in the June 24 memo. At this meeting, it was agreed that an independent land use planner would assess the site for credible development scenarios and that Cabot would be required to do additional characterization based on this assessment. NRC held a public meeting to discuss the Cabot Reading Slag Pile on September 24, 2002. At the meeting the licensee, Cabot, committed to submit additional documentation relevant to the characterization of the Reading slag pile. Cabot also stated that it would provide comments on a July 23, 2002 Health Consultation report prepared by the Agency for Toxic Substances and Disease Registry (ATSDR) and on a Johns Hopkins University report titled: Characterization of Radioactive Slags, Draft Progress Report: 2000.

Representatives for the City of Reading were also at the July 11, 2002 meeting to discuss their plans for developing areas adjacent to, but not including the slag pile. Their plans for the adjacent land call for it to be used for light industrial purposes only. City officials expressed concern that delays in approval of Cabot's decommissioning plan could impact their development plans. It should be noted that Cabot and the City of Reading have signed an agreement that involves monetary compensation to the City provided they do not contest Cabot's decommissioning plan. The details of this agreement between Cabot and Reading have not been made publicly available.

The NRC has indicated in subsequent interactions with BRP that the agreements made at the July 11, 2002 meeting have been overtaken by events (e.g. Reading's development plans for the adjacent property).

In November 2002 Cabot provided its comments and additional historical documentation. These documents include:

- Cabot letter to Mr. Larry Camper, NRC, Subject: Characterization and Exposure Scenarios for the Reading Slag Pile Site; License No SMC-1562.
- Cabot letter to Max M. Howie, JR., ATSDR, Subject: ATSDR Health Consultation (Exposure Investigation), American Chain and Cable Cabot Corporation (a/k/a American Chain and Cable); Reading, Berks County, Pennsylvania; July 18, 2002
- Cabot Corporation Comment Report on the Johns Hopkins Draft Progress Report and Related Issues, November 21, 2002. Historical documents related to the Reading site were provided as Attachment A to this document. They are too numerous to list here but are included under references.

Major Issues & Recommendations: Cabot Reading Slag Pile

The Decommissioning Section has thoroughly reviewed this newly provided information and provides the following responses.

Major Issues:

Source term used by Cabot to assess doses may be underestimated:

Bases for the 2 largest and most significant values for "Total Th tons" listed in reference 3, table 2 are based on employee recollections (i.e., reference 3.g, a handwritten note, and reference 12, a 1979 letter from consultant- AHP) rather than data from formal reports or actual samples.

Cabot's value of 0.01 for wt % Thorium for 1977-78 Sand and Sn Slag appears to be low. This sand and Sn slag was trucked to the site from Baltimore, MD. Reference 3.e states on page 10 that "KBI's tin slag contains 0.7% thorium." Even if one accepts Cabot's questionable assumption of a 20:1 dilution (basis reference 3.g handwritten note on 1991 inspection report) this equates to 0.035%.

AHP's 12/3/76 report (reference 3.e), page 7 indicates that an "extremely large quantity of tin slag" remained in Baltimore after the M/S Holthav was loaded. Based on the referenced photos (fig. 27 & 28) it appears that the vast majority of this material could have been moved without the unavoidable dilution with soil as claimed by employee recollection.

Reference 3.e also states on page 11 that "It is fortunate that KBI has a licensed waste disposal ground... otherwise it would be necessary to ship hundreds of tons of material to... Barnwell, South Carolina" (the location of a licensed radioactive waste disposal facility). If the material was truly as diluted as Cabot now claims (i.e., 0.01% Thorium), it seems quite unlikely that KBI would have gone to the expense of trucking it to Reading for disposal. Rather they could have disposed of it locally in the Baltimore area.

If the original concentration of the tin slags was 0.7% (as stated in reference 3.e) then dilution with soil by a factor of 20:1 would have resulted in a concentration of 0.035%. This is below the concentration at which it would be classified as "source material" (i.e., 0.05%). Even at 0.035% it seems unlikely that it would have been trucked to Reading since, at that concentration, it could have been released without restrictions. The fact that it was transported to and disposed of at Reading indicates that it was between the 0.7% undiluted value and the 0.05% source material limit, not the 0.01% value used in reference 3, Table 2 nor the 20:1 dilution value of 0.035%.

Calculating the quantity of Thorium in the slag pile resulting from disposal of the sand and Sn slag using the conservative value of 0.7% (i.e., assuming no dilution) yields a quantity of 7.28 tons vs. the 0.104 tons reported in reference 3, Table 2. If the dilution value is presumed correct, the quantity would be 0.36 tons.

Reference 3.e, page 12, 1st paragraph indicates that 2447 tons of waste source material were removed by November 30, 1976. Some was salvaged for reprocessing at Boyertown and some was buried at Reading. No data is presented to indicate how much material went where. This same paragraph states that "[e]ach truckload has been sampled so that an approximation of the total amount of source material can be determined." No sample analysis results were presented to support material concentration estimates used.

Reference 3.b, page 3 states that the A.E.C. license covers possession of up to 0.3% Thorium in 60,000,000 lbs of slag. This equates to approx. 90 tons of Thorium in raw materials. This page also cites a "formal request to the A.E.C. for an exemption... to permit burial of approximately nine million pounds of slag containing 1% or less thorium." This equals up to 45 tons of Thorium.

The Pennsylvania Dept. of Health Permit for Burial of Radioactive Materials (an attachment to reference 12) allows "disposal by burial in soil of approximately 105 tons of natural thorium and uranium contained in slag residue..."

Reference 3.h, Att. #2 "Smelting Operation" indicates that 32,000 lbs of slag would be produced "Per 24 hr. Day." Cabot asserts (based on reference 3.g, a handwritten note and reference 12) that a total of only 600 tons of slag was disposed on the pile. If this figure is correct it would indicate that the plant operated for less than 38 production days during the 2-year operation of the plant.

Cabot references the photo of slag being dumped onto the slope in reference 3, page 7 apparently for the purpose of estimating the ultimate thickness (and hence volume) of the slag layer. This photo first appeared as figure 6 of AHP report #1 dated May 67. This report is an attachment to the October 1967 application for license renewal (reference 3.h) which indicated that full operation had not yet been achieved at that time. It is reasonable to assume that a great deal of additional slag would be produced and deposited during full operation and therefore the slag layer would be a great deal thicker than may be indicated in the photo.

Despite the information and uncertainties presented above, Cabot claims in reference 3, Table 2 that only 2.19 tons of Thorium were disposed.

Slag is non-homogenous and consists of large pieces that were not included in Cabot's characterization:

Cabot claims (reference 1, Cabot letter to Camper dated 11/21/02) that the "slag bearing radioactive material is mixed, not uniformly, but considerably, in a larger volume of debris..." Contrast this with the "Representative Cross Section, Reading Slag Pile" (reference 3, Att. A, figure 1) which shows a distinct layer for waste slag.

Reference 3.h (the October 1967 application for A.E.C. license renewal), supplemental information section, page 3, item 9.B. indicates that it was Kawecki's intent (and possibly their practice) to pour the molten slag from their operation "over the side of the slag dump where it will cool to form a black glassy mass containing most of the source material." This is supported by reference 12, a letter from AHP to NRC, which states "KBI waste slag was often dumped while still molten ..." The presence and effect of large solidified masses of slag deposited down the slope are not addressed in Cabot's characterization nor in their radiological assessment.

Reference 3.h, supplemental information section also states on page 14, 4th paragraph that "waste slag contains 0.2 to 0.29 percent thorium in the form of a black glass-like material which is broken into **large pieces.**" (emphasis added).

Despite this information, Cabot claims in reference 1 (Cabot letter to Camper dated 11/21/02) that "the vast majority of the slag pile consists of small particles..."

The number and location of test borings was not adequate to provide a representative characterization of the slag pile:

Cabot has not demonstrated that the limited number (17) and location of test borings meets the objective of ensuring that sufficient representative locations have been sampled. As stated in both NUREG/CR-5849 and MARSSIM, meeting this objective requires a statistically based plan for selecting measurement and sampling locations. Furthermore, NUREG/CR-5849 states that if there is unusual localized contamination, the survey should be supplemented with sampling in the areas of suspected localized contamination. Based on this guidance, the large blocks of slag that are reported to be a concentrated source should have been specifically investigated.

Sampling by split-spoon method in inappropriate for sampling slag:

Split-spoon techniques are intended for non-consolidated material (e.g., soil), not "black glass-like material which is broken into large pieces" (see page 14 of Health Physics Report # 1, attached to reference 3.h). The inappropriateness of the split-spoon technique for sampling the large pieces of slag that are known to exist in the pile is indicated in Cabot's response to NRC question 12.d. on the characterization report (reference 10, General Comments, page 12).

Cabot asserts in reference 3, page 9 that "[t]here is good reason to believe the split-spoon would penetrate and sample any large blocks of waste slag that were encountered. The fact that the slag was reportedly broken up by dropping an iron ball onto it indicates that it is possible to drill and sample it. The split-spoon technique uses a 140 pound hammer dropped 30 inches to drive a 2-inch diameter hollow tube. The impact force per unit area is likely similar to the force per unit area as of the dropped ball used to break the slag." Cabot provides no calculations to support this assertion.

In reference 6, (letter from Larry Camper to Dave Allard dated 6/20/2002), NRC clearly opposes Cabot's current position that the split-spoon sampling obtained representative samples of the slag blocks, viz. "We [NRC] agree that split-spoon techniques used for subsurface characterization would be unable to sample the larger blocks of radioactive slag."

In addition, reference 12 (letter from AHP to NRC dated 5/3/1979), includes the following statement: "The usual practice of core sampling the dump is impractical if not impossible. The dump site is actually an embankment with a treacherous 70° slope that precludes core drilling which would be meaningless anyway since most of the source materials consist of large skulls and fragments having high density and extreme hardness. Furthermore, the distribution of source materials is by no means homogeneous."

Dose from slag pile underestimated:

Reference 3.b, page 15, section II.A.1.(c).1. and reference 3.h, AHP Health Physics Report #1, page 14, 2nd paragraph indicate that the existing exposure rate of the slag dump in 1967-68 was 1.0 to 1.5 mr/hr.

Reference 3.f (a page apparently from a 1980 NRC inspection report) states that "measurements taken at the slag dump indicate a maximum radiation reading of 0.2 mr/hr on contact with the ground." These readings are lower than the readings from 1967-68. This is likely due the shielding effect of the 580 tons of soil and debris from the plant and 500 tons of crushed rock and soil placed on the slag pile during decontamination of the plant.

If excavated, individual pieces of slag would produce significant exposure rates (e.g. 100's of microR/hr). See reference 3.b, Health Physics Report #2 page 15 and reference 3.h, Health Physics Report #1, page 14. This is confirmed by recent measurements taken at the site by Decommissioning Section staff (and confirmed by Cabot).

These values may give a good indication of the dose rates that could be expected in an eroded or excavated slag pile scenario. Despite this information, Cabot scenarios that assume an eroded slag pile appear to use an external dose rate of 0.055 mrem/hr or 55 micro-rem/hr (e.g., reference 9, Case BT, Trespasser- eroded pile: external dose of 10 mrem in 180 hours).

Cabot does not consider all (or discounts) plausible land use scenarios:

Reference 1, Cabot letter to Camper dated 11/21/02 states (item 9) that future excavation is "highly unlikely" despite the existence of a right-of-way for River Road through the slag pile. Within the past 2 years interest has been expressed in extending River Road (see reference 13). Additionally Cabot states that, if the pile were excavated, "it would most likely not result in doses greater than those estimated for short-duration incidental exposures evaluated in the Cabot Radiological Assessment." (reference 9). The doses in reference 9 appear to indicate an external dose rate on the eroded slope of approximately 0.055 mrem/h (e.g., Case BT: external dose of 10 mrem in 180 hours). This is contrasted by exposure rate readings of 1 to 1.5 mr/hr taken on the slag pile by AHP during the period of April through September 1967 (reference 3.h). This was early in Kawecki's operational period, so it is safe to assume that additional radioactive slag was subsequently deposited. These readings were taken prior to any soil cover being placed on the pile. The conditions during the 1967 AHP survey could be considered a bounding condition for exposure rate from an eroded slag pile.

Reference 1 states (item 6) that the slag pile has "been used for heavy industrial applications (e.g., oil refining, etc.) for over a century." This statement is potentially contradicted by the presence of a foundation near the bottom of the slope. The date of construction and purpose of this foundation are uncertain.

Reference 1 states (item 7) that "[w]ell-developed plans for use of the site in the foreseeable future of the site are being implemented." These plans do not include the slag pile portion of the site and are therefore irrelevant.

Deed restrictions:

Reference 3.b, AHP Health Physics Report #2, page 7, 4th paragraph indicates that deed restrictions were being considered at the time the report was written (February 1968). If restrictions were written into the deed, they should be assessed to determine what effect they would have on unrestricted release of the slag pile.

Potential use of radioactive waste as site fill material:

Reference 3.d, AHP letter to Kawecki dated May 3, 1968, indicates that Kawecki may have considered using (and possibly used) sludge containing 3000 pCi/g as fill for the plant site.

Staff Position & Recommendations:

The Decommissioning Staff believes the major issues identified in the June 24, 2002 memo have not been resolved, the positions and recommendations are still valid, and

that the commitments made by the NRC at the July 11, 2002 meeting are still required. The review of additional documentation provided by Cabot in November 2002 as detailed below reinforces the need to perform additional characterization and consider alternate exposure scenarios.

Actual records or realistic, conservative values should be used to estimate the source term from the Slag Pile:

The staff's position is that the source term for the slag pile has very likely been significantly underestimated by the licensee. Information that supports this includes:

- Cabot's estimate of the amount of radioactive material present in the slag pile makes unreasonable and non-conservative reliance on employee recollection to account for the largest and most significant portions of the waste (i.e. the waste slag from production at the site and the sand and Sn slag trucked to the site from Baltimore).
- The total amount of waste slag assumed by Cabot to have been disposed on the slag pile would account for less than 38 days of full production according to data from the process used at the site. Kawecki's operations at the plant lasted for 2 years. No production records have been produced to support such a low production rate.
- Kawecki made a "formal request to the A.E.C. for an exemption... to permit burial of approximately nine million pounds of slag containing 1% or less thorium." This equals up to 45 tons of Thorium. The Pennsylvania Dept. of Health Permit for Burial of Radioactive Materials (an attachment to reference 12) allows "disposal by burial in soil of approximately 105 tons of natural thorium and uranium contained in slag residue..." These values are much greater than those assumed by Cabot.
- Cabot apparently used a photo of slag being dumped onto the slope dated May 67 to estimate the volume the slag layer. This photo was taken early in Kawecki's operation at the site and is not representative of the amount of slag deposited on the site.

The staff's recommendations are that:

- Neither employee recollections nor inconclusive photographs should be relied upon to make estimates of the amount of radioactive material present in the slag pile.
- The following records should be provided if available:
  - Production records for Kawecki's operations at the site.
  - Sample analysis results from samples taken of each truckload of sand and Sn slag from Baltimore.
  - Records of transfers of sand and Sn slag to Boyertown.
  - The request to the A.E.C. for an exemption to permit burial of nine million pounds of slag at the site.
  - Documents referenced in the Pennsylvania Dept. of Health permit for burial of radioactive materials (i.e., "letter of application dated September, 29, 1967 and amended on December 4, 1967" from Kawecki).
- Where records are not available, realistic and conservative assumptions should be used.

Slag is non-homogenous and consists of large pieces that were missed in Cabot's characterization:

The staff's position is that the slag consists of large pieces and that Cabot's characterization did not sample these pieces. Information that supports this include:

- Cabot relied on split-spoon sampling technique that is inappropriate and ineffective for obtaining representative samples of the glass-like slag.
- Cabot's assertion that split-spoon sampling would have penetrated the large pieces of slag is unsupported by any calculations.

The staff's recommendations are that:

- Trenching should be performed on the slag pile slope to obtain actual samples of the large slag pieces that are known to have been disposed on the slope.

Dose from slag pile underestimated:

The staff's position is that the potential radiation doses from the slag pile have been underestimated. Information that supports this includes:

- Historical data indicate that the exposure rate from the slag pile prior to being covered by debris and soil was 1.0 to 1.5 mr/hr and up to 0.2 mr/hr after being covered.
- Individual slag pieces produce exposure rates in the range of 100's of microR/hr.
- Cabot's radiological assessment uses a calculated dose rate of approximately 0.055 mrem/hr (i.e., 55 micro-rem/hr) for external dose from an eroded slag pile.

The staff's recommendations are that:

- Historical data should be used rather than calculated values for dose rate from the slag pile under eroded conditions.

Cabot does not consider all plausible land use scenarios:

The staff's position is that Cabot has not considered all plausible scenarios by which the public could be exposed to the radioactive material from the slag pile. Information that supports this includes:

- Based on interest expressed within the past 2 years, there is a definite possibility that the River Road right-of-way (which is currently partially covered by the slag pile) will be opened in the future. Cabot states that excavation of the right-of-way is highly unlikely.
- Cabot's assertion that the slag pile has been used for heavy industrial applications for over a century may be contradicted by the presence of a building a foundation on the slope. Since the date of construction and purpose of this foundation are uncertain it should not be assumed that it was used to support heavy industry.
- Cabot uses the fact that industrial use is currently planned for a portion of the former plant site to support their claim that land use for the foreseeable future of the slag pile would be the same. These plans do not include the slag pile and such a limitation should not be assumed to apply to it.

The staff's recommendation is that:

- In light of the uncertain future use of the site, a broader range of uses should be considered is assessing doses from the site.
- An evaluation should be made as to the doses that would result if the City of Reading decided in the future to open the River Road right-of-way and excavated and redistributed the larger pieces of slag in an uncontrolled manner.
- The possibility of use other than heavy industrial use should be evaluated (e.g., residential use).

Deed Restrictions:

The staff is concerned that there may be deed restrictions in some form related to the site. If such restrictions exist, their effect on unrestricted release of the slag pile should be evaluated.

Potential use of radioactive slag as site fill material:

The staff is concerned that indications have now come to light that Kawecki may have used sludge containing 3000 pCi/g as fill for the plant site. Previous site surveys may have missed this. Any records related to this concern should be provided for evaluation.

References:

1. Letter from Wayne M. Reiber, Cabot to Larry Camper, NRC, Subject: Characterization and Exposure Scenarios for the Reading Slag Pile Site; License No SMC-1562, November, 21, 2002
2. Letter from Wayne M. Reiber, Cabot to Max M. Howie, JR., ATSDR, Subject: ATSDR Health Consultation (Exposure Investigation), American Chain and Cable Cabot Corporation (a/k/a American Chain and Cable); Reading, Berks County, Pennsylvania; July 18, 2002, November, 21, 2002
3. Cabot Corporation Comment Report on the Johns Hopkins Draft Progress Report and Related Issues, November 21, 2002. Historical documents related to the Reading site, listed below, were provided as Attachment A to this document.
   a. AHP, 1967, Letter to John A. Cenerazzo (Kawecki), Applied Health Physics, Inc., November 10; 1967.
   b. AHP, 1968a, Health Physics Report #2 for the Kawecki Chemical Company, Applied Health Physics, Inc., February 6, 1968.
   c. AHP, 1968b, Laboratory Report, Waste Sludge from Reading, 2.p, Applied Health Physics, Inc., April 29, 1968.
   d. AHP, 1968c, Letter to Frank Coyle (Kawecki), Applied Health Physics, Inc., May 3, 1968.
   e. AHP, 1976, Health Physics Report of the Radiological Safety Aspects Associated with KBI Tin Slags Stored at the Canton Railroad Yards, Applied Health Physics, Inc., December 3, 1976.
   f. Cabot, 1991 a, Hand written notes on bottom of copy of an 1980 inspection report, stamped January 23, 1991.
   g. Cabot, 1991 b, Hand written note in file, to Tony, from W. Gannon, January 23, 1991.
   h. Kawecki, 1967, Application Renewal for Source Material License #SMB-920, with attachments including Health Physics Report #I, Kawecki Chemical Company, October 4, 1967.
   i. Kawecki, 1974, Amine Extraction - Eastern Tin Slag, Summary, Kawecki Chemical Company, March 15, 1974.
   j. Kawecki, 1976a, Radioactive Materials Transfer Records, Kawecki Berylco Industries, Inc., May - June 1976, Untitled, 2 p.
   k. Kawecki, 1976b, Eastern T. S. Removal from reading to Baltimore, May and June 1976, Inter-Office Correspondence from W. C. Gannon to A. Zabrowski, 3 p., Kawecki Berylco Industries, Inc., June 17, 1976
4. ATSDR Health Consultation (Exposure Investigation), American Chain and Cable Cabot Corporation (a/k/a American Chain and Cable); Reading, Berks County, Pennsylvania; July 18, 2002.
5. Letter from David Allard, Pennsylvania Department of Environmental Protection to Larry Camper, NRC, July 10, 2002.
6. Letter from Larry Camper, NRC to David Allard, Pennsylvania Department of Environmental Protection, June 20, 2002.
7. Letter from David Allard, Pennsylvania Department of Environmental Protection to Larry Camper, NRC, May 2, 2002.
8. Characterization of Radioactive Slags, Draft Progress Report, Johns Hopkins University, Veblen, Linda A:, et. al., March 2000.
9. Radiological Assessment for Reading Slag Pile Site, Revision 1, ST Environmental Professionals, Inc., March 2000.
10. Characterization Report for the Reading Slag Pile, Revision 1, NES, Inc., April 22,1996.

11. Preliminary Assessment of the Cabot Corporation Reading Slag Pile Site, Reading, Pennsylvania, Sandia National Laboratories, 1999.
12. Letter from Robert G. Gallaghar, AHP to Nathan Bassin, NRC, May 3, 1979.
13. Letter from John R. Morahan, St. Joseph Medical Center to Theodore Smith, NRC, May 12, 2001.
14. Manual for Conducting Radiological Surveys in Support of License Termination, Draft Report for Comment, NUREG/CR-5849, J. D. Berger, Oak Ridge Associated Universities, 1992.
15. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), NUREG-1575, Rev.1, August 2000