March 8, 2002

MEMORANDUM TO: Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management, NMSS

FROM: Thomas H. Essig, Chief ***/RA/***
Environmental & Performance Assessment Branch
Division of Waste Management, NMSS

SUBJECT: TECHNICAL ASSISTANCE REQUEST REGARDING THE RADIOLOGICAL ASSESSMENT FOR THE CABOT - READING, PENNSYLVANIA SITE

In response to a Technical Assistance Request (TAR), dated May 4, 2001, from the Decommissioning Branch, the Environmental and Performance Assessment Branch (EPAB) staff has completed its review of the radiological assessment for the Cabot-Reading site dated March 2000. The TAR specifically requested EPAB to determine the adequacy of the site decommissioning plan dose modeling analysis (i.e., the radiological assessment).

Based upon the staff's review of the radiological assessment document, in conjunction with the evaluation previously made by Sandia National Laboratories, we have concluded that the assessment adequately demonstrates that the site can be released for unrestricted use without additional remediation. The attachment documents our findings.

Please feel free to contact me or Mark Thaggard of my staff for any further assistance or if you have any questions.

Attachment: Staff's Assessment

CONTACT: Mark Thaggard, NMSS/DWM/EPAB
(301) 415-6718

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1.1 Background

1.2 Cabot Radiological Assessment

Revision 1 of the Cabot Corporation Decommissioning Plan, dated March 2000, concludes that based upon a radiological assessment, no further decommissioning action is required at its Reading, Pennsylvania site to comply with the requirements of 10 CFR Part 20, Subpart E. Cabot's radiological assessment contains two base-case scenarios for possible future use at the site and possible exposure to the radiological slag remaining on the site. These scenarios are a trespasser and worker scenario. Because radioactivity within the slag pile is not uniform (with the deeper slag being more radioactive than that at the surface), the assessment also considers these hypothetical individuals being exposed to the slag in an eroded state. The radiological assessment also considers a recreational walker and an excavation scenario for possible future exposure to radioactive slag remaining in the River Road right-of-way, located at the base of the slag pile. Cabot considers these scenarios to appropriately bound the likely exposure to residual radioactivity at the site. A more conventional scenario, such as the resident farmer, is not considered to be credible because of the limited available area, the geometry of the pile, and the nature of the slag.

	Pile Condition	
Radionuclide	**Intact (pCi/g)**	**Eroded (pCi/g)**
U-238	5.0	15.0
Th-232	7.5	22.5

Scenario	Location	Pile Condition	Dose (mrem/y)
Trespasser	Top of pile	Intact	1.50
Trespasser	Top of pile	Eroded	4.40
Worker	Top of pile	Intact	1.20
Worker	Top of pile	Eroded	2.00
Walker	Right-of-way	Intact	0.32
Excavation worker	Right-of-way	Intact	1.70

The Cabot radiological assessment also includes a resident gardener scenario. However, Cabot does not consider this to be a credible scenario, but included it at the request of the Nuclear Regulatory Commission (NRC), as part of their sensitivity analysis. For the resident gardener scenario, a hypothetical homeowner is assumed to reside on the property immediately

adjacent to the slag pile. The hypothetical resident is assumed to maintain a vegetable garden for a family of two. In addition to spending time on the slag pile for gardening activities, the resident is assumed to spend some fraction of his time spent outdoors on the pile for other activities. The slag pile is assumed to be in an intact state[1]. A dose of 16 mrem/year is calculated for the resident gardener scenario.

1.3 Sandia National Laboratories Assessment

Sandia National Laboratories (SNL), under contract with the NRC, provided a review of the Cabot radiological assessment. The SNL review is documented in a letter report dated June 2000. SNL concludes that it is appropriate to eliminate the ground-water pathway and pathways involving agricultural animals in scenarios of future use of the site. They also concluded that further justification should be provided for key parameters associated with the resident gardener sensitivity scenario. SNL also believes that the resident gardener scenario should be considered as a credible scenario for the site and should not be analyzed only in the context of the sensitivity analysis. SNL also states that more justification should be provided for precluding the placement of either an on-grade or subgrade structure on the site.

2.0 NRC Staff Assessment

The staff agrees that the resident gardener scenario should be considered as a credible scenario, although it is considered to have a small likelihood of occurrence. Although the property has been historically used for industrial purposes, there is no reason to believe that it will be only used for such purposes in the indefinite future. The surrounding land-use is mostly residential. Thirty-two percent of households in the mid-Atlantic region of the country have a garden (EPA, 1996); therefore, if residential use takes place, it is reasonable to believe that a garden will be maintained.

The top of the slag pile is a land area that extends back a maximum of only 4.5 meters (15 ft) from the edge; therefore, any structure placed on top of the pile would be risky. The contaminated area at the top of the pile also appears too small to support a house because it is only 223 m^2 (2430 ft^2). Typical newly-constructed houses in the northeast, as reported in the 2000-Census, have a median size of 226 m^2 (2435 ft^2); this is only for the structure. In addition, the configuration of the contaminated area would necessitate an unusual house design. The slag pile also has an estimated overall slope of 30°, but is as great as 45° in some places; therefore, very limited activity is expected to occur on the side slope of the pile. While it appears very unlikely that a structure would be built either on top of the slag pile or on the side slope, a small residential community could be built on the adjacent property because the area adjacent to the slag pile is level and much larger.

The staff concentrated its effort on evaluating Cabot's assessment of the resident gardener scenario because it is expected to provide the largest dose and is expected to bound doses from exposure to the slag. Staff disagrees with the conclusion reached by SNL that additional

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[1]In their radiological assessment, Cabot breaks the analysis into two parts. One part looks at exposure from the garden activities; the other part looks at exposure from other outdoor activities in the slag area. The garden activities are assumed to occur on the side slope of the slag pile where the exposure is higher.

justification is needed for key parameters used in the assessment. SNL felt that the method used in the Cabot radiological assessment to derive the consumption rates of homegrown vegetables were arbitrary and circuitous. While staff disagrees with some of the parameter values used in the assessment, use of values that staff considers to be acceptable does not change the overall conclusions. In the staff assessment, consumption rates are derived by relating them to the land area needed to support those rates and the anticipated vegetable yields.

The land area required to support domestic food is related to the consumption rate and crop yield for the various types of homegrown foods (Beyeler et al., 1999). For the resident gardener scenario only vegetables are assumed to be grown in the garden; however, the consumption rate has to be differentiated between leafy and non-leafy vegetables because they have different characteristics with regards to the uptake of radionuclides. Accordingly, the land area required can be derived in the following manner:

$$A = \frac{U_{leafy}}{Y_{leafy}} + \frac{U_{other}}{Y_{other}}$$

Where:

$A \equiv$ area (m^2)
$U_{leafy} \equiv$ ingestion rate of leafy vegetables (kg/y)
$U_{other} \equiv$ ingestion rate of other vegetables (kg/y)
$Y_{leafy} \equiv$ leafy vegetables yield ($kg/m^2/y$)
$Y_{other} \equiv$ other vegetables yield ($kg/m^2/y$)

In the Cabot radiological assessment, the area of the garden is arbitrarily assumed to be 40 m^2. Although this area represents only about 20% of the available area on the top of the slag pile, staff considers it to be somewhat bounding based on national data. The average size of home vegetable gardens declined nationally from 56 m^2 (600 ft^2) in 1982 to 30 m^2 (325 ft^2) in 1986 (Yu et al., 1993). Cabot assumed a leafy-vegetable yield of 1.5 $kg/m^2/y$ and an other-vegetable yield of 0.7 $kg/m^2/y$. These are default values within the RESRAD code which was used in the assessment. Again, although these values are below the minimum of the range of values reported by Beyeler et al. (1999) (Table 6.55), they should be acceptable given the nature of the growing media (i.e., the slag is not expected to be a productive medium). For their analysis, Cabot does not assume a soil cover is placed over the slag. The only vegetation currently growing on the pile is primarily drought-tolerant weedy species. Assuming a 1:5 yield ratio for

leafy to other vegetables as proposed by Kennedy and Strenge (Beyeler et al., 1999 - Table 6-20) gives two equations and two unknowns (i.e., the two ingestion rates). Thus, the two ingestion rates can be derived as follows:

$$40 = \frac{U_{leafy}}{1.5} + \frac{U_{other}}{0.7}$$

$$U_{other} = 5 * U_{leafy}$$

$$thus,$$

$$U_{leafy} = 5.1 \text{ kg / y}$$

$$\mathrm{U}_{\mathrm{other}} = 25.6 \text{ kg / y}$$

These are essentially the same values as derived by Cabot using their approach. However, in their assessment, Cabot divides these values in half because they arbitrarily assume that the residence is occupied by two people. Using the full consumption rates, along with other parameter values consistent with those used in the Cabot assessment[2], staff calculates a dose to the hypothetical resident gardener of 20 mrem/year. This is considered a bounding analysis because the slag is expected to be a really poor growing media and thus it may be difficult to maintain any type of vegetable garden in the contaminated area. In addition, the garden is assumed to be grown on the side slope of the pile where the exposures are expected to be higher. However, the steep slope of the pile will likely make it difficult to maintain a garden on the side slope. Further, while there is no basis to assume two residents, as assumed in the Cabot radiological assessment, it is likely that the residence will have more than one occupant.

As previously stated, staff does not consider scenarios involving some type of occupancy within the contaminated area as credible. Because of the shape of the contaminated area and the close proximity to the edge of the pile, it is unlikely that any structure would be placed in the area because of the risk of it over toppling. Because staff considers the trespasser scenario to be very credible, staff reviewed Cabot's evaluation of this scenario. The expected dose for this scenario is highly dependent on the time that the trespasser is assumed to spend on the site. Developing an appropriate time to assume for this scenario is highly speculative because of the wide range of activities that can be postulated. In the Cabot radiological assessment, the trespasser is assumed to spend five hours per week, nine months of the year (180 hours/year) as a bounding analysis. The trespasser is assumed to spend all of this time on the side slope of the pile to maximize their exposure. The calculated dose in the Cabot radiological assessment for this scenario is 11 mrem/year. As can be calculated with the following derived equation, the staff analysis show this hypothetical trespasser will need to spend slightly more than 400 hours/year to exceed the 25 mrem/year dose limit. This equation was derived by calculating the dose associated with various exposure times and fitting the data with a regression analysis.

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[2]Consistent with the approach used by SNL, staff assumes that the U-235 decay chain is present in the pile, at 5% of the U-238 concentration. Cabot's radiological assessment does not include the U-235 decay chain.

$$D = 0.0578 * H - 0.0125$$

where:

$D \equiv$ dose (mrem / y)

$\mathrm{H} \equiv$ number of hours per year

The staff finds it difficult to postulate a situation where a trespasser will spend that many hours on the site, especially in terms of being on the side slope of the pile.

Because the radioactivity of the slag located in the River Road right-of-way is lower than that within the pile (i.e., the side slope of the pile), exposure to the slag in the right-of-way will be generally bounded by the analysis of radioactivity in the pile. Although the contaminated area in the right-of-way is level, it is not considered large enough to support a residence. The contaminated area is estimated to be 139 m^2 (1500 ft^2). Only 18 percent of new houses constructed in the northeast are less than or equal to 186 m^2 (2000 ft^2) according to 2000-Census data.

3.0 Conclusion

Based upon the staff's independent evaluation of the Cabot radiological assessment and the review made by SNL, the staff concludes that Cabot has adequately demonstrated that the site will meet the NRC's dose limits for unrestricted release.

4.0 References

Beyeler et al., "Residual Radioactive Contamination from Decommissioning - Parameter Analysis, Draft Report for Comment," NUREG/CR-5512, Vol. 3, October 1999.

U.S. EPA, "Exposure Factors Handbook, Update to Exposure Factors Handbook EPA/600/8-89/043-May 1989," Washington, DC, August 1996.

Yu et al., "Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soils," ANL/EAIS-8, Argonne National Laboratory, Argonne, Ill, 1993.

Http://www.census.gov/pub/const/C25Ann/sftotalmedavgsqft.pdf.