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# OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS DRAFT SAFETY EVALUATION RELATED TO LICENSE NO. SMC-1562 DOCKET NO. 40-9027 CABOT PERFORMANCE MATERIAL, READING, PENNSYLVANIA

## 1. INTRODUCTION

In late 1995, Cabot initiated a comprehensive site characterization at the Reading Slag Pile Site. The radiological survey included a site characterization, determination of slag leach rates, surface gamma measurements, radiological analysis of surface and subsurface samples, determination of the weathering rate of the slag, and analysis of the slag pile stability. Radiological slag was identified at two topographically distinct areas: on an embankment (Slag Pile Area) and within the River Road Right-of-Way (ROW).

In August 1998, Cabot submitted a decommissioning plan (DP) for the Reading Slag Pile Site using the decommissioning criteria in 10 CFR Part 20, Subpart E. US Nuclear Regulatory Commission (NRC) contracted with Sandia National Laboratories (SNL) to review the dose assessment in the DP. In response to a December 1999 request for additional information, Cabot submitted a revised DP and Radiological Assessment (RA) in March 2000. This safety evaluation report has been prepared in response to the latter decommissioning plan. If the latest decommissioning plan and supporting materials are approved, the Reading Site will be removed from the license and released for unrestricted use.

## 2. BACKGROUND

The possession of slag at the Reading, Pennsylvania location is licensed by the US Nuclear Regulatory Commission (NRC) License No. SMC-1562 held by Cabot Corporation (Cabot). Slag materials from metal processing activities performed in the late 1960's by the Kawecki Chemical Company (predecessor to Cabot corperation) were deposited on a preexisting slag pile. The process utilized tantalum in low grade ores by heating a mixture of iron ore, tantalum ore, and coke in an electric arc furnace. The ores contained naturally-occurring uranium and thorium in concentrations defined as "source material" by the NRC. The possession and handling of these materials was performed under an NRC license. The tantalum alloyed with the iron, leaving a glass-like silica gangue in which the naturally-occurring thorium and uranium remained. The glass-like slag residues from processing operations were placed on a preexisting slag disposal area on an embankment at the southern end of the property. Additional material including sand mixed with tin slag from a location in Baltimore was placed there in 1977 and 1978 as a result of building decontamination activities. The total estimated volume is approximately 5007 $m^3$ (180,000 $ft^3$).

The Cabot site is located in Reading, Bucks County, Pennsylvania east of the Schuylkill River. Between the slag pile area and the Schuylkill River, there are an underdeveloped extension of the River Road ROW, a Norfolk Southern (Norfolk) railroad ROW, and remnants of the former Schuylkill Canal. Another Norfolk Southern ROW is located approximately 150 feet northwest

of the slag pile. Buttonwood Street is located approximately 600 feet to the southeast of the pile. Topographical survey information was used to estimate the dimension of the radiological slag at the site. The cross-sectional area is approximately 103 $m^2$ (1125 $ft^2$). The estimated volume of the slag pile and the slag in the River Road ROW is approximately 5007 $m^3$ (180,000 $ft^3$). The top of the slag pile is a level area that is approximately 160 feet long and extends back a maximum of 15 feet from the top edge of the slag pile. The slag pile stability was evaluated using standard geotechincal engineering practices. Based on the model results and observations that the slope has been stable for approximately 30 years since the material was placed, it has been concluded that the slope is stable. Its elevation is approximately that of much larger contiguous level area upon which industrial facilities are located.

Currently, there are no licensed materials used at the industrial property, which constitutes the site. Other than the slag pile area and the River Road ROW area, all areas where licensed material was handled have been decontaminated and released for unrestricted use. Because the property is not owned by the licensee, the area encompassing the radiological slag has been defined as the "Site" for purpose of discussion in this SER.

## 3. SAFETY EVALUATION

### 3.1 Radiological Status of Uranium/Thorium Contaminated Slag

The radionuclides of interest for the dose assessment were determined using operational history and the site characterization data. The radionuclides considered are naturally occurring uranium (U-238, U-234 and U-235), naturally occurring thorium (Th-232 and Th-228) and their radioactive progeny. The radioactive materials at concentrations distinguishable from background concentrations are primarily confined to slag from processing of ores with small concentrations of naturally occurring uranium, thorium, and progeny nuclides. The slag, which retained the radioactive constituents, was deposited on the slag pile.

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 ROW, located at the base of the slag pile. Cabot considers these scenarios to

| | Pile Condition | |
|---|---|---|
| **Radionuclide** | **Intact (pCi/g)** | **Eroded (pCi/g)** |
| U-238 | 5 | 15 |
| Th-232 | 7.5 | 22.5 |

appropriately bound the likely exposure to residual radioactivity at the site. A more conventional scenario such as the resident farmer scenario is not considered to be credible because of the limited available area, the geometry of the pile, and the nature of the slag.

| Scenario | Location | Pile Condition | Dose (mrem/y) |
|---|---|---|---|
| Trespasser | Top of pile | Intact | 1.5 |
| Trespasser | Top of pile | Eroded | 4.4 |
| Worker | Top of pile | Intact | 1.2 |
| Worker | Top of pile | Eroded | 2.0 |
| Walker | Right-of-way | Intact | 0.32 |
| Excavation worker | Right-of-way | Intact | 1.7 |

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 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 15 mrem/year is calculated for the resident gardener scenario.

## 3.2 Radiological Status of Soils

Cabot reports that based on the Site characterization data and visual observations, the surface soils consist of mixed fill materials; (i.e., primarily non-radiological slag mixed with construction debris, a small volume of radiological slag, and soil). The average net activity concentration in the slag/soil/debris mix is approximately 75 pCi/g of combined thorium (Th-232 and Th-228) and uranium (U-238 and U-234). This estimate is based on the average measured concentration from the surface to a depth of 16 feet. Average net uranium and thorium concentrations in soil near the surface (to a depth of 2 feet or less) are somewhat lower. The average net activity concentration in surface soil samples the slope face is approximately 25 pCi/g total combined thorium and uranium, of which approximately 5 pCi/g is U-238 and 7.5 pCi/g is Th-232. These estimates are based on the results of surface soil measurements.

[1]In their radiological assessment, Cabot seperates 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.

3.3 Radiological Status of Surface Water and Groundwater

Monitoring of groundwater and surface water is not required by license SMC-1562. Therefore, the only information regarding the status of water on the Reading Slag Pile Site is contained in the aquifer characterization presented in the DP, which indicates the aquifer is not a practical source for drinking or irrigation of a fish pond. Analysis of groundwater directly below the radiological material meets drinking water standards for radiological parameters and is similar to Schuylkill River water.

## 4.0 EVALUATION

4.1 Decommissioning Program

No site decommissioning activities are proposed or anticipated in the DP, which concludes that the site meets criteria for unrestricted release without further cleanup. Staff agrees that a Decommissioning program is not necessary since the site meets the License Termination Rule requiring for unrestricted release. Specifically, there would be no need for a management program, radiation protection program, radioactive waste management program, QA/QC program, or emergency plan.

4.2 Dose assessment

4.2.1 NRC Staff Assessment

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 to be 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 $30^o$, but is as great as $45^o$ 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.

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

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. 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. While staff disagrees with some of the parameter values used in the SNL assessment, use of values that staff considers to be acceptable does not change the overall conclusions.

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 media). 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,*

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

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

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 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 toppling over. 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.

[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)

H ≡ number of hours per year

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 ROW 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% of new houses constructed in the northeast are less than or equal to 186 $m^2$ (2000 $ft^2$) according to 2000-Census data.

### 4.2.3 Conclusion

The most bounding scenario analyzed by the staff is the resident gardener scenario, with no cover. In this scenario, the maximum annual TEDE dose over 1000 years was calculated to be 20 mrem/yr.

Based on a review of specific aspects of the Cabot radiological assessment, staff concludes that the assessment appropriately demonstrates that the residual radioactivity at the site will not result in a dose exceeding the requirements in 10 CFR 20.1402.

Staff has found the existing survey data to be sufficient to demonstrate with reasonable assurance that the dose criterion in 10 CFR 20.1402 has been met. Since no further decommissioning activities are planned, staff concludes that no further survey is needed, and the existing surveys, with Cabot's radiological assessment, adequately demonstrate compliance with 10 CFR 20.1402 requirements.

## 5.0 SUMMARY AND CONCLUSION OF SAFETY EVALUATION

Staff finds that the site meets both the dose limitation and ALARA requirements of the License Termination Rule, (10 CFR 20.1402), and the site is acceptable for unrestricted release with no further action.

## 6.0 RECOMMENDATION

Staff recommends the Cabot Reading site be released for unrestricted release, and license amendments and SDMP delisting actions proceed accordingly.

## 7.0 REFERENCES

NRC, "*Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities",* U.S. Nuclear Regulatory Commission, Washington, DC*,* NUREG-1496, July 1997.

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