POLICY ISSUE
(NEGATIVE CONSENT)

July 26, 2001 SECY-01-0138

FOR: The Commissioners

FROM: William D. Travers /RA/
Executive Director for Operations

SUBJECT: REMOVAL OF CABOT CORPORATION'S REVERE SITE FROM THE SITE DECOMMISSIONING MANAGEMENT PLAN

PURPOSE:

To inform the Commission that the Cabot Corporation (Cabot) site licensed by the U.S. Nuclear Regulatory Commission (NRC) under 10 CFR Part 40, in Revere, Pennsylvania, meets the radiological criteria for unrestricted use in 10 CFR 20.1402. The staff plans to release the site for unrestricted use and remove the site from the Site Decommissioning Management Plan (SDMP).

BACKGROUND:

The Kawecki Chemical Company - Penn Rare Division (Cabot's predecessor), was first licensed to store uranium (U) and thorium (Th) at the Revere site in October 1969, by NRC's predecessor, the Atomic Energy Commission, under License SMC-920. The license was amended in June 1970, authorizing the licensee (then known as Kawecki Berylium Industries) to process up to 1800 kilograms (kg) [4000 pounds (lbs)] of ore concentrates containing up to 2 percent natural Th and 1.5 percent natural U. Beginning in July 1970, approximately 23,000 kilogram (kg) (50,000 pounds) of columbium-tantalum ore were processed at the Revere site.

CONTACT: Theodore Smith, NMSS/DWM
301-415-6721

Although the site was eligible to decommission under the concentration-based guidelines published in the October 1981, Branch Technical Position ("Disposal or Onsite Storage of Thorium or Uranium Wastes from Past Operation;" 46 FR 52601; October 23, 1981), Cabot chose to pursue decommissioning the site in accordance with criteria in 10 CFR Part 20 Subpart E, the License Termination Rule (LTR).

The Cabot facility is located in Revere, Bucks County, Pennsylvania, about 60 kilometers (km) [36 miles (mi)] north of Philadelphia and about 26 km (16 mi) southeast of Allentown. Contamination at the site consists of slag materials containing U and Th that were generated from columbium/tantalum processing that occurred in the 1970s. These materials were deposited in four areas on the site: the parking area near the sandblasting building, the former container storage area, the buildings 4 and 5 area, and the old pit area. Cabot conducted characterization of the surface water, ground water, and surface and subsurface radiological conditions at the Revere site in the early- to mid-1990s.

DISCUSSION:

Cabot proposed unrestricted release of the Revere site in a series of proposals culminating with a Decommissioning Plan (DP) and Radiological Assessment (RA) dated March 2001 (Revision 1) and an additional information letter dated April 2001. Subsequently, staff reviewed Cabot's DP, RA, and additional information, and performed an independent dose assessment of the site, to determine whether current site conditions are acceptable to release the Cabot Revere site for unrestricted use.

On March 30, 2001, staff provided a copy of the draft safety evaluation report and draft environmental assessment to the Pennsylvania Department of Environmental Protection (PADEP) for review and comment. PADEP and NRC staffs participated in a joint site visit and inspection on April 23, 2001, to review site conditions. In an April 26, 2001 letter to NRC, PADEP agreed with NRC staff's conclusion that the site meets NRC's regulatory requirements for unrestricted release.

However, the letter also indicated that PADEP is concerned about slag material being left adjacent to Rapp Creek, and that it would discuss the matter internally and directly with the licensee. In a subsequent telephone conversation with NRC staff in May 2001, PADEP indicated it is considering whether Pennsylvania state regulations on residual materials are applicable to the slag material near Rapp Creek, which PADEP believes may be an "exceptional value waters." Exceptional value waters are surface waters of high quality (chemical purity and low toxicity) which the state has determined to have exceptional ecological significance. In their June 12, 2001 verification survey report, PADEP stated it will address this issue separately, that this effort is independent of NRC's actions, and confirmed their agreement that the site meet's NRC's regulatory requirements for unrestricted release.

Cabot proposes no further remediation of the Revere site. In the DP, Cabot determines the source term using a mass-balance, rather than characterization-based approach. In the mass-balance approach, the total amount (and total activity) of radiological material is calculated based on review of production records, inventory reports, inspection reports, site decontamination reports, isotopic analyses of slag samples, and quality assurance records. The average isotopic concentrations are calculated by dividing the total activity of radiologically contaminated slag at the site by the total contaminated volume of material. However, the staff doesn't agree with Cabot's volume estimate used in this calculation, and the staff used its own volume estimate. Specifically, NRC staff questioned the total contaminated volume described

in various site characterization reports and the DP and RA. Cabot's April 2001, letter to NRC provided revised contaminated volume estimates, however, NRC staff still believed a more conservative, smaller volume estimate was warrented. The staff does agree with Cabot's estimate of the total amount of radioactive material at the site being a maximum of 240 megabecquerel (MBq) [0.0065 curies (Ci)] of Th and 590 MBq (0.016 Ci) of U. There is no known off-site contamination from this site. NRC staff concludes that this value is appropriate because of the number and detail of historical documentation of the limited amount of material processed at the site. Staff's analysis using the licensee's estimate of the radioactivity on site and the more conservative volume resulted in a dose estimate of 0.20 millisieverts per year(mSv/yr) [20 millirem per year (mrem/yr)]. It should be noted that the mass-balance approach was previously applied to the Minnesota Mining and Manufacturing Company's Kerrick Site in SECY-00-0172.

In its DP and RA, Cabot's dose assessment for the existing radioactive material is based on a residential gardener scenario, but excludes the aquatic pathway, since the radiological contamination is contained in waste slag, and is not likely to leach into nearby surface waters. NRC staff concludes this exclusion is appropriate.

Cabot's dose assessment also excludes the ground water pathway, since wells in the area are deep, and the radiological contamination is contained in waste slag, which is demonstrably not leaching into the environment. NRC staff concludes this exclusion is appropriate, and is consistent with the site conditions at Revere.

Cabot's dose assessment estimates plant uptake of radionuclides using the readily available uranium (RAU), which is a fraction of the total uranium concentration. Cabot uses the RAU to account for the low leachability of the contaminated slag. NRC staff review concludes that using the RAU to model contaminated slag is acceptable.

In its base-case resident gardener scenario, Cabot assumes there would be a soil cover over the contaminated material (the waste slag). However, Cabot includes a scenario variant that excludes the cover, and meets the LTR criterion. NRC staff concludes that there is insufficient justification for assuming the presence of a cover on the contaminated material (none is currently present), and uses the no-cover variant in its independent analysis.

Based on site-specific information Cabot has provided, review of dose assessments Cabot has performed, and staff independent analysis, the staff concludes that the dose is less than the dose criterion in 10 CFR 20.1402 [0.25 mSv/yr (25 mrem/yr), and the residual radioactivity has been reduced to levels that are as low as is reasonably achievable]. Therefore, the staff concludes that the Cabot Revere site is suitable for release for unrestricted use. NRC staff intends to inform the U.S. Environmental Protection Agency, PADEP, and Cabot of NRC's intent to release the Cabot Revere site for unrestricted use and remove it from the SDMP. Draft letters and the SDMP site delisting Federal Register notice are enclosed (see Attachments 1, 2, 3, and 4). The attached Environmental Assessment (EA) and Safety Evaluation Report (SER), provide a detailed discussion of the licensee's dose assessment, the staff's independent assessment, and the technical basis for the action (see Attachments 5 and 6). A Notice of Availability of the EA and SER was published in the Federal Register on June 12, 2001.

COORDINATION:

The Office of the General Counsel has reviewed this paper and has no legal objections.

RECOMMENDATION:

Although we consider this action to be within the delegated authority of the Director of the Office of Nuclear Material Safety and Safeguards, action will not be taken until the staff requirements memorandum is received. The staff requests action within 10 days of the date of this memorandum.

/RA/

William D. Travers
Executive Director
for Operations

Docket No. 040-09027
License No. SMC-1562

Attachments:
1. Draft letter to EPA
2. Draft letter to PADEP
3. Draft letter to Cabot
4. Draft FRN
5. Revere EA
6. Revere SER

Mr. Stephen D. Luftig, Director
Office of Emergency and Remediation Response
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Dear Mr. Luftig:

This letter is to inform the U.S. Environmental Protection Agency (EPA) that the U.S. Nuclear Regulatory Commission (NRC) is authorizing release of land from NRC license for unrestricted use at the Cabot Corporation, Inc (Cabot) site near Revere, Pennsylvania and removal of the Revere site from License SMC-1562 and the Site Decommissioning Management Plan (SDMP).

The staff is providing this information to EPA in accordance with NRC policy contained in the "Action Plan to Ensure Timely Cleanup of Site Decommissioning Management Plan Sites" (57 FR 13389), which states that NRC will inform EPA about specific decommissioning actions at SDMP sites.

In 1969, the Atomic Energy Commission issued a license to Kawecki Chemical Company - Penn Rare Division (Cabot's predecessor), which authorized the storage of source materials at the Revere, Pennsylvania, site. The license was amended in 1970, authorizing the licensee (then known as Kawecki Berylium Industries) to process ore concentrates containing natural thorium and uranium in the extraction of columbium and tantalum metals. Processing of source-material-bearing ores ceased in 1978, and the license was subsequently amended to authorize storage-only at the Revere site in 1983. Cabot became the licensee of record in 1987. The Cabot Revere site was placed on the SDMP list in 1990.

Cabot has supplied, and NRC has reviewed, site characterization and dose assessment information. A dose assessment, which incorporates site-specific data recently supplied by Cabot and reviewed by NRC staff, demonstrates that the unrestricted release criteria in 10 CFR 20.1402 have been met. Based on staff's review of the dose assessment, NRC concludes that the Revere site is suitable for release for unrestricted use, and is being removed from License SMC-1562, and the SDMP.

draft

S.D. Luftig

The project manager for the Cabot Revere site is Theodore B. Smith. If you have any questions on this matter, please contact him at (301) 415-6721.

Sincerely,

Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 040-09027
License No. SMC-1562

draft

Mr. David J. Allard, CHP
Director, Bureau of Radiation Protection
Pennsylvania Department of Environmental Protection
Rachel Carson State Office Building
P.O. Box 2063
Harrisburg, PA 17105-2063

Dear Mr. Allard:

This letter is to inform the Pennsylvania Department of Environmental Protection (PADEP) that the U.S. Nuclear Regulatory Commission (NRC) is authorizing release of land from NRC license for unrestricted use at the Cabot Corporation, Inc (Cabot) site near Revere, Pennsylvania and removal of the Revere site from License SMC-1562 and the Site Decommissioning Management Plan (SDMP).

In March, 2001, Cabot submitted its revised decommissioning plan (DP) and radiological assessment (RA), in response to additional information requests from both NRC and PADEP. The revised DP and RA incorporated site-specific data that supports a dose assessment which meets the unrestricted release criteria in 10 CFR 20.1402. On April 23, 2001 you participated in the joint site visit and inspection, and in an April 26, 2001 letter and subsequent telephone conversation agreed that the site meets NRC regulatory requirements for radiological unrestricted release.

Based on staff's independent review of the dose assessment, NRC concludes that the Revere site is suitable for release for unrestricted use, and is being removed from License SMC-1562, and the SDMP.

draft

D.J. Allard

The project manager for the Cabot Revere site is Theodore B. Smith. If you have any questions on this matter, please contact him at (301) 415-6721.

Sincerely,

Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 040-09027
License No. SMC-1562

cc:
Mr. Robert Maiers, PE
Pennsylvania Department of Environmental Protection
Ms. Ivna Shanbaky,
Pennsylvania Department of Environmental Protection

draft

Mr. Timothy Knapp
Radiation Safety Officer
Cabot Performance Materials
Cabot Corporation
P.O. Box 1608
County Line Road
Boyertown, Pennsylvania 19512-1608

Dear Mr. Knapp:

This letter is to inform the Cabot Corporation (Cabot) that the U.S. Nuclear Regulatory Commission (NRC) is authorizing release of land for unrestricted use at the Cabot site near Revere, Pennsylvania.

Cabot submitted dose assessments, in November 1997, and March 2001, to demonstrate that remediation at the site was not necessary, and that the calculated dose was below the limits in 10 CFR 20.1402 for unrestricted use of the site. Based on staff's independent review of Cabot's dose assessment, NRC concludes that the site is suitable for release for unrestricted use. Therefore, the Cabot Decommissioning Plan for the Revere site is approved, the site is removed from License SMC-1562, and the Site Decommissioning Management Plan. A copy of the amended license, with the Revere site removed, is enclosed.

The project manager for the Cabot Revere site is Theodore B. Smith. If you have any questions on this matter, please contact him at (301) 415-6721.

Sincerely,

Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 040-09027
License No. SMC-1562

cc:
Robert Maiers, PADEP
Ivna Shanbaky, PADEP

Enclosure:
Cabot License SMC-1562, Amendment 8

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MATERIALS LICENSE

Amendment No. 8

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and the applicable parts of Title 10, Code of Federal Regulations, Chapter I, Parts 19, 20, 30, 31, 32, 33, 34, 35, 36, 39, 40, 51, 70, and 71, and in reliance on statements and representations heretofore made by the licensee, a licensee is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee	
1. Cabot Corporation	3. License Number SMC-1562
2. County Line Road Boyertown, PA 19512	4. Expiration Date June 30, 2006
	5. Docket or Reference 40-9027*

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
A. Natural uranium and thorium	A. Any	A. 100 tons as elemental uranium and thorium

9. Authorized Use: In accordance with the statements, representations, and conditions specified in the licensee's application dated September 15, 1977, and supplements dated June 18, 1982, and May 13, 1987, the following use is authorized:

A. Possession only of contaminated material in the slag disposal area at the Reading, Pennsylvania, site. Further waste disposal at this site is specifically prohibited.

CONDITIONS

10. Authorized Place of Use: The licensee's facility at Tulpehocken Street, Reading, Pennsylvania.

11. Remediation of the slag disposal area is not authorized.

12. The licensee will prepare and retain waste manifests for the waste generated from the decommissioning of the Reading facility for the purpose of final disposal. The licensee is authorized to transfer these wastes in accordance with 10 CFR §40.51(b)(5) for storage at the Cabot facility in Boyertown, Pennsylvania, under license SMB-920.

*Prior to 12/93, reference Docket No. 40-6940.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

License Number	SMC-1562
Docket or Reference Number	40-9027
	Amendment No. 8

13. Access to the site will be controlled during decontamination and decommissioning activities; access to areas where radioactive waste is stored will be controlled at all times.

14. The licensee's ALARA review committee shall meet at least annually to review and make recommendations concerning radiation exposure, effluents, and contamination survey data. The committee membership shall include, as a minimum, the Radiation Safety Officer (RSO), and a representative of plant production supervision. The findings of this committee shall be documented in a report provided to the plant manager and higher levels of management as appropriate.

15. The RSO for this license is Timothy M. Knapp. The minimal technical qualifications for the position of RSO shall be a bachelor's degree in the biological or physical sciences, completion of a basic radiation safety course, and 2 years of experience in the handling of radioactive materials.

16. Deleted.

17. Deleted.

18. Release of equipment, facilities, or packages from the plant site or the uncontrolled areas onsite shall be in accordance with the attached "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," dated April 1993.

19. The licensee shall conduct at least quarterly at the Reading slag dump a monitoring program that consists of the following:

    a. Inspection for erosion.

    b. Sampling groundwater at the base of the embankment and analyzing for, at a minimum, gross alpha and conductivity.

    c. Measurement of direct radiation levels at 1 meter above the ground at all boundaries of the dump site.

    The licensee shall maintain a record of all monitoring results obtained in accordance with this license condition.

20. At the end of plant life, the licensee shall decontaminate the facilities and grounds so that they can be released for unrestricted use.

MATERIALS LICENSE
SUPPLEMENTARY SHEET

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	Amendment No. 8

21. The Reading site main processing building and surrounding areas, as delineated in Figure 1.4 on page 6 of the "Final Decommissioning Project Report for the Main Processing Building and Surrounding Area, Reading, Pennsylvania," dated May 1995 and amended by letter dated June 2, 1995, is released for unrestricted use.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

Dated: _____

_____
Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

MEMORANDUM TO: Michael T. Lesar, Chief
Rules and Directives Branch
Division of Administrative Services
Office of Administration

FROM: Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: REMOVAL OF THE CABOT CORPORATION, INC., SITE IN REVERE, PENNSYLVANIA FROM THE CABOT LICENSE AND THE SITE DECOMMISSIONING MANAGEMENT PLAN

Attached please find one signed original of the subject Federal Register notice for your transmittal to the Office of the Federal Register, for publication. Also, attached are five copies of the signed notice and a 3.5" diskette with the notice in WordPerfect.

Docket No.: 040-9027
License No.: SMC-1562

Enclosures:
1. One signed original FRN
2. Five copies of signed FRN
3. 3.5" diskette of FRN

CONTACT: Theodore Smith, NMSS/DWM
301-415-6721

draft

[7590-01-P]

U.S. NUCLEAR REGULATORY COMMISSION

DOCKET NO. 40-9027

LICENSE NO. SMC-1562

REMOVAL OF THE CABOT CORPORATION, INC.,

SITE IN REVERE, PENNSYLVANIA FROM THE CABOT LICENSE

AND THE SITE DECOMMISSIONING MANAGEMENT PLAN

AGENCY: U.S. Nuclear Regulatory Commission

ACTION: Notice of license amendment

This notice is to inform the public that the United States Nuclear Regulatory Commission (the Commission) is amending Source Material License SMC-1562 issued to Cabot Corporation, Inc. (Cabot, formerly Kawecki Chemical Company - Penn Rare Division, and Kawecki Berylco Industries) to remove the Revere, Pennsylvania, site. Cabot processed pyrochlore-bearing ores to extract columbium and tantalum metals for use in high-strength alloys and electronic component manufacture. The ore processing generated waste slag contaminated with natural uranium and thorium. The Commission is releasing the Cabot site in Revere, Pennsylvania, for unrestricted use, is removing the site from the Site Decommissioning Management Plan (SDMP), and is removing the site from License SMC-1562. In 1990, the Commission developed the SDMP program for sites that warranted special attention to ensure timely decommissioning. This list included the Cabot Revere site. Cabot has supplied, and the

draft

Commission has reviewed, site characterization and dose assessment information. Based on the Commission's review, the Commission concludes that the unrestricted release dose criteria in 10 CFR 20.1402 have been met. Therefore the Commission concludes that the site is suitable for release for unrestricted use, and the Revere site is being removed from the SDMP and License SMC-1562.

This termination will be reopened only if additional contamination is found indicating a significant threat to the health and safety of the public and the environment, or if the licensee had provided false information.

Dated at Rockville, Maryland, this day of July 2001.

FOR THE NUCLEAR REGULATORY COMMISSION

Larry W. Camper, Chief
Decommissioning Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

draft

ENVIRONMENTAL ASSESSMENT
OF SITE DECOMMISSIONING PLAN AND RADIOLOGICAL ASSESSMENT
FOR CABOT PERFORMANCE MATERIALS, REVERE, PA

LICENSE NUMBER SMC-1562
DOCKET NUMBER 40-9027

CABOT PERFORMANCE MATERIALS

FOREWORD

This Environmental Assessment (EA) reviews the environmental impacts of releasing the Cabot Performance Materials site, contaminated with uranium and thorium slag, for unrestricted use. In connection with the review of the proposed action, the U.S. Nuclear Regulatory Commission (NRC) staff is also preparing a Safety Evaluation Report (SER) which evaluates conformance of the proposed action with NRC regulations and guidance. The SER may conclude that Cabot's proposed action should be modified in one or more respects to fully comply with NRC regulations and guidance. Such modifications to the proposed plan, should they come about and be implemented, would have no significant bearing on the overall environmental impact of the proposed decommissioning and would not change the conclusions of this EA. On issuance, the SER will be available for inspection and copying at the NRC Public Document Room, in NRC's One White Flint North Headquarters building, located at 11555 Rockville Pike (first floor) in Rockville, Maryland; and in the Agency-wide Documents Access and Management System (ADAMS) Public Electronic Reading Room at Web address <http://www.nrc.gov/NRC/ADAMS/index.html>.

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SUMMARY AND CONCLUSIONS

The Cabot Performance Materials site near Revere, Pennsylvania, processed approximately 23,000 kilograms (50,000 pounds) of thorium- and uranium-bearing ores beginning in 1970. The resulting slag from metals-removing processing is currently located in four distinct areas on the 400,000-square meter (100-acre) site. A site-specific dose analysis was conducted using RESRAD version 6.0 dose-modeling software. Based on the total amount of radioactive material available at the Revere site, and the physical characteristics of the slag material, Cabot has demonstrated that the annual total effective dose equivalent to the average member of the critical group within the first 1000 years after decommissioning is less than 0.25 millisieverts (mSv) [25 millirem (25 mrem)], and the dose is as low as is reasonably achievable (ALARA). As discussed in the Generic Environmental Impact Statement (NUREG-1496), the 0.25 mSv (25 mrem) plus ALARA dose limit provides an ample margin to ensure protection of public health and safety, as well as protection of the environment. Therefore, the site is acceptable for unrestricted release and may be removed from License SMC-1562.

ENVIRONMENTAL ASSESSMENT OF SITE DECOMMISSIONING PLAN FOR CABOT PERFORMANCE MATERIALS FACILITY IN REVERE, PENNSYLVANIA

1.0 Introduction

1.1 Background

Cabot Performance Materials holds Nuclear Regulatory Commission License SMC-1562, covering activities occurring at both its Revere and Reading sites in Pennsylvania. Former ore processing at the Revere facility generated waste slag contaminated with uranium and thorium. Beginning in July 1970, approximately 23,000 kilograms (kg) (50,000 pounds) of columbium-tantalum ore were processed at the Revere site [Cabot (b), 2001]. A 1975 radiological safety study conducted by Applied Health Physics, Inc. identified radiologically contaminated areas and a slag burial site [Gallaghar, 1975].

In late 1988, Cabot initiated decommissioning activities at the Revere facility. A radiological survey was conducted from February to March 1990 by Bullinger's Mills, Inc., [Appendices A.6 and A.7 of RA, 2001] which included a site characterization, determination of slag leach rates, surface gamma measurements, and radiological analysis of surface and subsurface samples. This survey indicated high readings in four areas on site. Contaminated slag was removed and shipped to the Cabot facility in Boyertown, PA.

Cabot submitted a Final Decontamination and Decommissioning Survey to NRC in January 1991 [Cabot, 1991], using decommissioning criteria established in the NRC's October 5, 1981, Branch Technical Position (BTP) [NRC, 1981]. NRC contracted the Oak Ridge Institute for Science and Education (ORISE) to conduct a confirmatory radiological survey of the four identified areas of the Revere site. The July 1991 ORISE [Berger and Smith, 1991] survey results found that the average soil concentrations of natural uranium and thorium met NRC limits, but noted discrete pieces of slag with concentrations exceeding the BTP guidelines. Further site evaluation was initiated.

A site characterization report and a subsurface sampling report were completed by Cabot contractors (Enserch, and NES, respectively) in April and August 1994 [Cabot, 1994 and Craig 1994]. A Decommissioning Plan (DP) and Risk Assessment were submitted to NRC in April 1996 [Cabot and Cabot (b), 1996], which analyzed the site using the October 1981 BTP methodology. Cabot subsequently replaced this DP by a new DP and Radiological Assessment (RA) in November 1997 [Cabot and Cabot (b), 1997], which analyzed the site in accordance with the July 1997 License Termination Rule (LTR) [NRC, 1997].

In response to a December 2000 request for additional information [NRC, 2000], Cabot issued a revised DP and RA in March 2001 [Cabot and Cabot (b), 2001], and provided additional information in an April 27, 2001 letter [Knapp, 2001].

This environmental assessment has been prepared to support NRC's evaluation of Cabot's March 2001 DP and RA submission and April 27 letter. Approval of this plan and supporting materials would support removal of the Revere site from License SMC-1562 and release of the site for unrestricted use.

1.2 The Proposed Action

Cabot requests approval of its DP and removal of the Revere, Pennsylvania, site from its source materials license. In its DP, Cabot proposes to release the site for unrestricted use, with no further onsite decommissioning or survey.

1.3 Purpose and Need for the Proposed Action

The purpose of this action is to remove the site, which no longer uses source materials, from a source material license. Furthermore, the intent is to allow unrestricted release of the site, thereby removing limitations on the future use of the property. This action is required by the Decommissioning Timeliness Rule (10 CFR 40.42).

2.0 Facility Description/Operating History

2.1 Site Locale and Physical Description

The Cabot facility is located in Revere, Bucks County, Pennsylvania about 60 kilometers (36 miles) north of Philadelphia and about 26 kilometers (16 miles) southeast of Allentown. Slag materials containing uranium and thorium were generated from columbium/tantalum processing that occurred in the 1970s. These materials were deposited in four areas on the site: the parking area near the Sandblasting building, the former container storage area, the buildings 4 and 5 area, and the old pit area. Additionally, two pieces of slag were located and removed from the area next to warehouse building 25 in the early 1990s.

As reported by the licensee, these four areas vary in size from 1400 to 3200 square meters (m^2) [15,070 to 34,450 square feet (ft^2)], with at least 122 meters (m) [400 feet (ft)] separating them. The total property area is 405,000 m^2 (4.4 million ft^2).

2.2 Facility Operating History

The Kawecki Chemical Company - Penn Rare Division (Cabot's predecessor), was first licensed to store uranium and thorium at the Revere site in October 1969, by NRC's predecessor, the Atomic Energy Commission. The license was amended in June 1970, authorizing the licensee [then known as Kawecki Berylium Industries (KBI)] to process up to 1,800 kilograms (4,000 pounds) of ore concentrates containing up to 2 percent natural thorium and 1.5 percent natural uranium.

The uranium and thorium were contained in pyrochlore-bearing ores purchased for production of columbium and tantalum. The end product from the licensee's process was purified columbium and tantalum used for manufacturing high-strength metals and electronic components. At the Revere site, columbite and pyrochlore ores were blended with aluminum and iron powder. The mixture was ignited in a crucible wherein the aluminum reduced the columbium oxide in the ore by a thermite process. The iron alloyed to form ferrocolumbium, whereas the spent aluminum and other oxides, and the uranium and thorium from the ore, were melted into process slag. The thorium- and uranium-bearing slag was stored on site in four different locations. Processing of source material-bearing ores ceased in 1978, although the license was not changed until December 1983, when it was amended to authorize only

possession of uranium and thorium at Revere. KBI maintained the Revere site for source material possession-only, with no activity until 1987, at which time Cabot Corporation became the licensee of record through acquisition of KBI.

In 1988, Cabot began onsite decommissioning activities for Revere, including site characterization, determination of slag leach rates, surface gamma measurements, and radiological analysis of surface and subsurface samples. Contaminated areas were remediated in a series of clean-up actions and site surveys in the early 1990's. The first site DP and RA submitted to NRC in April 1996 [Cabot and Cabot (b), 1996], was replaced in November 1997 by a DP and RA that analyzed the site in accordance with current license termination requirements. This DP and RA were amended in March 2001, in response to additional questions from NRC staff.

The DP (as amended in April 2001) and accompanying RA assert that residual radioactivity distinguishable from background at Revere meets the release criteria established in 10 CFR 20.1402 of the LTR. The LTR requires that the total effective dose equivalent (TEDE) to an average member of the critical group does not exceed 0.25 millisieverts per year (mSv/yr) [25 millirem (mrem/yr)], from all exposure pathways, and that the residual radioactivity has been reduced to levels that are as low as is reasonably achievable (ALARA). Although Cabot's Revere site is a Site Decommissioning Management Plan (SDMP) site, Cabot decided to demonstrate compliance with the newer LTR requirements and not the SDMP action criteria.

Currently, there are no source materials being used on site and no activities occurring in the four areas where the slag was deposited.

Cabot now holds license SMC-1562, allowing the company to possess the slag material produced by Kawecki Chemical Company from 1970 to 1978.

3.0 Radiological Status of the Facility

3.1 Radiological Status of Uranium-/Thorium-Contaminated Slag

As previously stated, in 1988, Cabot began performing decommissioning activities at the site. ORISE performed a confirmatory survey in July 1991 [Berger and Smith, 1991], and found that although the average concentrations of natural uranium and thorium met NRC limits, individual fragments of slag exceeded NRC guidelines.

Radionuclide concentrations for slag are estimated by calculating a mass balance of the remaining activity on the site from process records and information on the amount of material removed during prior decommissioning activities. Based on inventory records, it is estimated that a maximum of 240 megaBecquerel (Mbq) [0.0065 curies (Ci)] of thorium and 590 MBq (0.016 Ci) of uranium remain on the site. The thorium and uranium are contained in slag fragments that are distributed with building debris and uncontaminated slag in the four areas. Assuming a density of 2.0 grams per cubic centimeter (g/cm^3) for the slag/debris and a total volume of 23,000 cubic meters (m^3) [820,000 cubic feet (ft^3)], a total mass of 46.4×10^6 kg (102 million pounds) of affected material remains at the four locations on the site. [Cabot (b), 2001]. Using a more conservative estimate of the volume of contaminated material results in a 35 percent decrease in the total volume and approximately a 50 percent increase in radionuclide

concentrations and dose. [Knapp, 2001] These estimates are considered to be conservative estimates of the total activity remaining at the site, as a low average concentration was assumed for all material removed during earlier decommissioning work.

The licensee's derived average radionuclide concentrations for natural uranium and thorium in equilibrium are shown in Table 1.

Table 1. Radionuclide concentrations used in the February 2001 Cabot assessment

Radionuclide	**Concentration** Bq/g (pCi/g)
Actinium-227	0.00028 (0.0077)
Protactinium-231	0.00028 (0.0077)
Lead -210	0.0063 (0.17)
Radium-226	0.0063 (0.17)
Radium-228	0.0031 (0.083)
Thorium-228	0.0031 (0.083)
Thorium-230	0.0063 (0.17)
Thorium-232	0.0031 (0.083)
Uranium-234	0.0063 (0.17)
Uranium-235	0.00028 (0.0077)
Uranium-238	0.0063 (0.17)

Note: Bq/g = Bequerels per gram, pCi/g = picocuries per gram

For the base scenarios, Cabot estimates that the TEDE for a worker from all the affected material is 0.00015 mSv/yr (0.015 mrem/yr) and for a resident is 0.0029 mSv/yr (0.29 mrem/yr). Using the minimum volume, and the resulting 50 percent increase in radionuclide concentrations and dose received, results in the estimate of a TEDE to a worker from all the affected material, of 0.00023 mSv/yr (0.023 mrem/yr) and to a resident at 0.0044 mSv/yr (0.44 mrem/yr).

However, NRC considers Cabot's Resident Gardener scenario, described in the RA as a sensitivity analysis, to be a more appropriate dose calculation model. This analysis differs from the base-case scenario in that it assumes no soil cover over the slag and includes the ingestion of vegetables in the analysis, resulting in a TEDE for a resident gardener of 0.017 mSv/yr (1.7 mrem/yr), which would be 0.026 mSv/yr (2.6 mrem/yr) when adjusted for the minimum volume. NRC staff independently calculated the TEDE, using the same scenario with different parameters, to be no greater than 0.2 mSv/yr (20 mrem/yr). The NRC "Radiological Criteria for License Termination: Final Rule" (10 CFR Part 20, Subpart E) limit for unrestricted release is 0.25 mSv/yr (25 mrem/yr) from all pathways.

3.2 Radiological Status of Soils

Cabot reports there is little soil in the slag areas; it is mostly clean slag and rubble. Furthermore, the "Radiological Subsurface Sampling Report" submitted in 1994 [Craig, 1994] determined that radioactivity is limited to the slag and no detectable concentrations had leached into the soil. The ORISE report [Berger and Smith, 1993] indicated that other than two soil samples that may have contained small pieces of slag, the average concentrations of total uranium and thorium in the soil were well below the guideline levels and less than twice

background levels. The elevated direct readings in the four areas were from slag fragments deposited in the area.

3.3 Radiological Status of Surface Water and Ground Water

Monitoring of ground water and surface water is not required by License SMC-1562. However, 90 percent of the wells in the Brunswick Group Formation are deeper than 3.69 m (12 ft) and the median depth to ground water is 22.52 m (74 ft) [Sloto, 1994]. In addition, the licensee conducted leach rate tests to demonstrate that contamination would not extend to surface and ground water. Cabot reports total available uranium to be 0.824 microgram total available uranium, per g of slag. A distribution coefficient (K_d) value of 137,500 cubic centimeters per gram (cm^3/g) [3.8 million cubic inches per pound (in^3/lb)] was used to calculate the leach rate constant of radionuclides from the source zone (i.e., slag). The same K_d value was also used for the uranium-238 progenies and thorium-232 and its progenies, consistent with the approach described in Appendix A of the DP, since thorium and radium (the other key radionuclides) have been shown to leach at a slower rate. The leach rate constant assumed in Cabot's assessment is on the order of $1x10^{-6}$ to $1x10^{-5}$ yr^{-1}.

Water sampling and analysis for the Revere site are contained in the "Radiological Subsurface Sampling Report" submitted in August 1994. [Craig, 1994] Analysis of water flowing through the container storage area showed total uranium and thorium concentrations in the range of typical background values.

4.0 Decommissioning Alternatives

4.1 Alternative 1: No-Action

The no-action alternative would leave NRC License SMC-1562 unmodified, and allow the Revere facility to continue to operate with the contaminated slag piles on site. The Cabot Revere site would remain on the SDMP list.

4.2 Alternative 2: Proposed Action

The licensee-proposed action involves removal of the Revere site from NRC License SMC-1562. It proposes no further onsite decommissioning activities, removal of the site from the SDMP list, and unrestricted release of the site.

4.3 Alternative 3: Further Remediation of the Site

The licensee examined the possibility of conducting further remediation of the site. The approach proposed was to separate the slag containing elevated concentrations, for shipment to a licensed disposal facility, and to store the remaining materials on site.

4.4 Decision Rationale for Alternatives

Alternative 1 is undesirable because the Revere site is on the SDMP list and should be proceeding toward cleanup, and restricted, or unrestricted release. The licensee's proposed action suggests unrestricted release and claims no further source materials are going to be used or generated on site. Alternative 3 includes further remediation of the site. However, after conducting a cost benefit analysis, the licensee concludes that the cost of Alternative 3 exceeds the value of the dose expected to be saved, that the ALARA condition has been met, and that no further dose reduction is necessary.

5.0 Radiation Protection Program

As the licensee proposes to release the site for unrestricted use, no radiation protection program is delineated in the site decommissioning plan. The licensee reports no known radiological operating occurrences that would affect the safety of its personnel during decommissioning.

6.0 Environmental Impacts

6.1 No-Action Alternative

Not pursuing decommissioning of the site would be in violation of NRC's requirements for "Timeliness in Decommissioning of Material Facilities" (10 CFR 40.42). The purpose of the Decommissioning Timeliness Rule is to reduce the potential risk to the public and environment that may result from delayed decommissioning of inactive facilities and sites. Specific concerns addressed by the Timeliness Rule include the potential risk of safety practices becoming lax because of attrition of key personnel, and lack of management interest at facilities after operations cease, as well as the potential for bankruptcy, corporate takeover, or other unforeseen changes, in a company's financial status, that may complicate or delay decommissioning.

The No-Action Alternative would be in violation of the Timeliness Rule, and therefore counter to established NRC environmental regulations, policy, and practice.

6.2 Licensee's Proposed Action

6.2.1 Radiological impacts on workers and the public

Cabot considered two scenarios in its RA; a worker and a resident scenario. In addition, hybrids of these scenarios were considered as a sensitivity analysis.

6.2.1.1 Radiological impacts on workers

For the worker dose analysis scenario, Cabot assumed that the site would continue to be used for industrial purposes. The industrial worker is assumed to be exposed to external gamma radiation and inhalation of re-suspended dust. The hypothetical worker is assumed to spend very limited time in the contaminated area (40 hr/yr). No indoor exposure is assumed to occur because there are currently no buildings in the contaminated areas. In the November 1997 RA, Cabot considered two additional scenarios. In the first, Cabot

considered a worker spending 1920 hr/yr in a building constructed in the contaminated area, along with 80 hr/yr outdoors. In the second scenario, Cabot considered a worker spending 1600 hr/yr in a building along with 400 hr/yr outdoors as part of its sensitivity analysis. Although both of these scenarios increased the dose by slightly more than an order of magnitude, the analysis still demonstrated that the dose limit of 0.25 mSv/yr (25 mrem/yr) would not be exceeded. Although the base scenario (40 hr/yr in the contaminated area, with no indoor exposure) is less realistic, NRC staff believes that the two additional worker scenarios demonstrate that the potential dose to workers is acceptable. As the source term used in the November 1997 RA exceeded the February 2001 source term for every isotope (see Tables 1 and 2), there are no significant radiological impacts on workers as a result of Alternative 2.

Table 2. Radionuclide concentrations used in the November 1997 Cabot assessment

Radionuclide	**Concentration** Bq/g (pCi/g)
Actinium-227	0.015 (0.41)
Protactinium-231	0.015 (0.41)
Lead -210	0.33 (9.0)
Radium-226	0.33 (9.0)
Radium-228	0.037 (1.0)
Thorium-228	0.037 (1.0)
Thorium-230	0.33 (9.0)
Thorium-232	0.037 (1.0)
Uranium-234	0.33 (9.0)
Uranium-235	0.015 (0.41)
Uranium-238	0.33 (9.0)

Note: Bq/g = Bequerels per gram, pCi/g = picocuries per gram

6.2.1.2 Radiological impacts to the public

To estimate radiological exposure to the general public, Cabot assumed the residence is constructed entirely in a contaminated area and the resident spends 78 percent of his/her time in the area (85 percent outdoors and 15 percent indoors). Exposure is assumed to occur through direct gamma radiation, inhalation, soil ingestion, and ingestion of drinking water. A 15 centimeter (cm) [6 inch (in)] layer of topsoil is assumed to be permanently maintained over the slag to support grass, but would not be deep enough to support growing edible vegetables. Given that the current land use around the site includes residences and agriculture, future residential use of the site is highly credible. However, NRC staff concludes that it is not appropriate to assume that a cover will be permanently maintained over the slag without active maintenance.

As a variation of the resident scenario, Cabot also looked at a resident scenario assuming that there is no 15 cm (6 in) soil layer. The results of this sensitivity

analysis give a calculated dose significantly below the release limit, but roughly 6 times higher than the dose calculated for the base-case resident scenario.

As another variation of the resident scenario, Cabot assumed that the resident maintains a garden in the contaminated area and thus is exposed through ingestion of plant foods grown in the contaminated slag. For this assessment, Cabot conservatively assumed that the plant foods are grown directly in the slag without an intervening soil layer. Again, the calculated dose was significantly below the release limit.

NRC considers that the resident garden scenario appropriately bounds the potential exposure pathways for future use of the site. Cabot also evaluated an excavation scenario, where it is assumed that some of the slag is excavated and used as foundation fill in the construction of a house. However, NRC considers that the resident gardener scenario appropriately bounds the excavation scenario.

Because the surficial layer of the contaminated areas is composed principally of slag that does not readily support the growth of vegetation (as evident by current site conditions), staff believes that it is unlikely that the contaminated areas will be used for growing commodity crops or raising livestock. Because of the cost, it is difficult to envision someone purchasing enough topsoil to cover an area large enough to grow commodity crops or raise livestock. Further, because soil-less gardening requires more management than more traditional gardening methods and given that the presence of slag in the area would not lend itself to mechanized agriculture, staff believes that it is unlikely that the contaminated areas will be used to grow commodity items such as grains or livestock fodder. Therefore, staff believes that it is appropriate to exclude these pathways in the assessment. In addition, the relative small size of the container storage and former buildings 4 and 5 areas, which are both less than the default area assumed in NRC's screening approach for the residential farmer scenario [i.e., 2400 m^2 (2900 square yards, or 0.59 acres)], would also tend to support an argument that these areas will not be used for growing commodity items.

The most bounding scenario analyzed by staff is of the buildings 4 and 5 area containing one-half of the total volume of contaminated slag in a residential gardener scenario, with no cover. This scenario conservatively models the average member of the critical group, which must be evaluated, for maximum annual TEDE, over 1000 years. The maximum calculated annual dose in this scenario is 0.2 mSv/yr (20 mrem/yr).

6.2.2 Impacts on surface waters and ground waters

The area surrounding the site is generally rural, with land uses including industrial, commercial, residential, and agricultural. Rapp Creek flows through the northwest portion of the site, originating near Lake Warren, 3.2 kilometers (km) (2 miles) north of the site, and flowing southward to the confluence with Beaver Creek, where it becomes

Tinicum Creek. The Delaware River is 5.6 km (3.5 miles) north of the site, flowing eastward and eventually southward.

Bucks County has a temperate, humid, maritime climate. The average annual precipitation is approximately 114 cm (45 in). Bedrock beneath the site is mapped as the Triassic age Lockatong Formation in the eastern portion of the site and the Triassic age Brunswick formation in the western portion of the site. The Lockatong Formation is generally a poor source of water and its ability to transmit water is low, with reported yields of wells ranging from 0.00013 - 0.0016 cubic meters/second (m^3/s) [2- 25 gallons per minute (gpm)]. The range of water yielded from the Brunswick Formation is 0.00013 -0.16 m^3/s (2-260 gpm), with an average of 0.0025 m^3/s (40 gpm).

Because of the relatively immobile nature of the radionuclides, it is unlikely that any contaminants will reach nearby surface waters. Further, the depth of the ground water [approximately 20 m (66 ft)] would likely make it rather expensive to maintain a fish pond. Consequently, aquatic pathways have been excluded from the dose analyses.

6.2.2.1 Ground water leaching

To estimate releases of radioactivity from the slag[1], Cabot calculated a distribution coefficient (K_d) using the readily available uranium concentration measured in a leach test performed on a slag sample. A K_d value of 137,500 cm^3/g (3.8 million in^3/lb) was used to calculate the leach rate of radionuclides from the source zone (i.e., slag). The same K_d value was also used for the uranium-238 progenies and thorium-232 and its progenies. Although radionuclides are believed to leach incongruently from the slag, it is reasoned that using the uranium K_d value is appropriate because, based on available literature, thorium and radium (the other key radionuclides) are believed to leach at a slower rate.

Because of the glass-like structure of the slag and its low weathering rate [estimated to be on the order of $2x10^{-6}$ to $1.5x10^{-5}$ millimeters per year ($2.2x10^{-10}$ to $1.6x10^{-9}$ in/day)], the leach rate of radionuclides from the source zone should be low (i.e., radionuclides should be fairly immobile). Based on the range of leach rates reported for uranium and thorium for slag [Felmy, et al., 1999], the leach rate for uranium and thorium at the Cabot site would be expected to be on the order of $1x10^{-12}$ to $1x10^{-10}$ yr^{-1} for thorium and $1x10^{-11}$ to $4x10^{-9}$ yr^{-1} for uranium. The leach rate assumed in the Cabot assessment is on the order of $1x10^{-6}$ to $1x10^{-5}$ yr^{-1}.

6.2.2.2 Monitoring of ground water and surface water

Periodic monitoring is not required by the license for either ground or surface water. Analysis of surface water flowing through the container storage area showed total uranium and thorium concentrations in the range of typical background values.

[1]In its radiological assessment, Cabot assumed that only slag is radioactively contaminated.

6.2.3 Non-radiological impacts

Since the proposed action does not involve any onsite activity, no further impacts are anticipated from this decision. The cognizant regulatory entities, the Pennsylvania Department of Environmental Protection (PADEP), and the U. S. Environmental Protection Agency (EPA) are aware of the site and have or are in the process of conducting their own evaluations.

Cabot indicates (DP, 2001) that there are no known historic areas or endangered species in the area of the Revere site. Under the proposed alternative, no impacts would be expected, as no further remediation activity will be done at the site.

6.3 Further Remediation of the Site

6.3.1 Impacts on workers, the public, and the environment

Since no further remediation is anticipated in the proposed alternative, there are no remediation impacts on workers, the general public, or the environment.

6.3.2 Cost

Based on 1996 dollars, if remediation were to be done on the site, the cost would total about $8.8 million dollars (RA, 2001). Approximately one-half of the total cost is estimated for the disposal fee.

7.0 Agencies and Individuals Consulted

PADEP

8.0 References

Berger, J. D. and Smith, B. M., “Confirmatory Radiological Survey for Portions of the Cabot Corporation Revere Plant,” Oak Ridge Institute for Science and Education, Oak Ridge, TN, April 1993.

Cabot Performance Materials Inc., “Final Decontamination and Decommissioning Survey - 1990 for NRC License SMB-920, Docket 40-6940,” Cabot Corporation, Revere Pennsylvania Plant, January 1991.

Cabot Performance Materials Inc., “Radiological Characterization Survey Report for the Cabot Performance Materials Revere Plant,” Revere, PA, April 1994.

Cabot Performance Materials Inc., “Decommissioning Plan for Cabot Performance Materials, Revere, Pennsylvania - Revision 1," Boyertown, PA, April 1996.

Cabot Performance Materials Inc. (b), “Risk Assessment for the Decommissioning of the Revere, Pennsylvania Site,” Cabot Corporation, Boyertown, PA, April 1996.

Cabot Performance Materials Inc., “Decommissioning Plan for Revere, Pennsylvania Site - Revision 0," Boyertown, PA, November 17, 1997.

Cabot Performance Materials Inc. (b), “Radiological Assessment for Revere, Pennsylvania Site - Revision 0,” Boyertown, PA, November 17, 1997.

Cabot Performance Materials Inc., “Decommissioning Plan for Revere, Pennsylvania Site - Revision 1," Boyertown, PA, February 28, 2001.

Cabot Performance Materials Inc. (b), “Radiological Assessment for Revere, Pennsylvania Site - Revision 1,” Boyertown, PA, February 28, 2001.

Craig, K., “Radiological Subsurface Sampling Report for Cabot Performance Materials Revere, Pennsylvania,” NES, Danbury, CT, August 1994.

Felmy, A.R., D. Raj, and V.L. LeGore, “Solubility and Leaching Controls on Radionuclides in SDMP Wastes: Data Summary,” PNNL, 1999.

Gallaghar, R. G., Applied Health Physics, Inc., Bethel Park, PA, May 1975.

Knapp, T., “Area of Slag Areas,” Cabot Corporation, Boyertown, PA, April 27, 2001.

Sloto, R.A. and C. Schreffler, “Hydrogeology and Groundwater Quality of Northern Bucks County, Pennsylvania,” U.S. Geological Survey Water-Resource Investigations Report 94-4109, 1994.

U.S. Nuclear Regulatory Commission, “Disposal or On-site Storage of Residual Thorium or Uranium from Past Operations, SECY-81-576,” Washington, DC, October 1981.

U.S. Nuclear Regulatory Commission, “Radiological Criteria for License Termination; Final Rule,” Washington, DC, July 1997.

U.S. Nuclear Regulatory Commission, “Request for Additional Information Regarding the Cabot-Revere Site Decommissioning Plan and Radiological Assessment,” Washington, DC, December 27, 2000.

8.1 Additional Documents Considered (Bibliography)

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

U.S. Nuclear Regulatory Commission, “Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes, NUREG/CR-6676,” Washington, DC, July 2000.

U.S. Nuclear Regulatory Commission, “Probabilistic Modules for the RESRAD and RESRAD-BUILD Computer Codes-User Guide, NUREG/CR-6692,” U.S. Nuclear Regulatory Commission, Washington, DC, November 2000.

U.S. Nuclear Regulatory Commission, “Timeliness in Decommissioning of Material Facilities,” U.S. Federal Register, Washington, DC, 59 FR 36026 - 36040, July 15, 1994.

DOCKET NO. 40-9027

LICENSE NO. SMC-1562

LICENSEE: CABOT PERFORMANCE MATERIALS, REVERE, PA

SUBJECT: SAFETY EVALUATION REPORT, SITE DECOMMISSIONING PLAN, AND RADIOLOGICAL ASSESSMENT, DATED MAY 24, 2001

1.0 Introduction

Cabot Performance Materials (Cabot) holds U.S. Nuclear Regulatory Commission (NRC) License SMC-1562, covering storage of radioactive materials at both its Revere and Reading sites in Pennsylvania. Former ore processing at the Revere facility generated waste slag contaminated with uranium and thorium. In 1988, Cabot began onsite decommissioning activities for the Revere facility, including site characterization, determination of slag leach rate constants, surface gamma measurements, and radiological analysis of surface and subsurface samples. Contaminated areas were remediated in a series of clean-up actions in the early 1990s. A site decommissioning plan (DP) and risk assessment were submitted to NRC in April 1996 [Cabot and Cabot (b), 1996]. The DP and risk assessment were later replaced by a completely rewritten DP and Radiological Assessment (RA) in November 1997 [Cabot and Cabot (b) 1997]. In December 2000, NRC requested additional information [NRC, 2000] from Cabot, to complete the review of the proposed DP. In response, Cabot developed a revision to the 1997 DP and RA [Cabot and Cabot (b), 2001] which included information it had not previously submitted. Cabot also provided more information in an April 27, 2001, letter [Knapp, 2001].

This safety evaluation report (SER) has been prepared in response to the latter DP, RA and informational letter. If the latest DP and supporting materials are approved, the Revere site will be removed from the license and released for unrestricted use.

1.1 Description of Proposed Action

Cabot proposes to remove the Revere, Pennsylvania, site from its source materials license, and requests that NRC release the site for unrestricted use without further onsite decommissioning.

1.2 Purpose and Need for the Proposed Action

The purpose of this action is to remove the site, which no longer uses source materials, from a source materials license. Furthermore, the intent is to allow unrestricted release of the site, thereby removing limitations on the future use of the property. This action is required by the Decommissioning Timeliness Rule (10 CFR 40.42).

1.3 Release Criteria

The site release criteria are found in NRC's Final Rule "Radiological Criteria for License Termination" [License Termination Rule (LTR)] as 10 CFR Part 20, Subpart E (10 CFR 20.1402). This rule established a 0.25 millisieverts per year(mSv/yr) [25 millirem per year (25

mrem/yr)], plus As low as is reasonably achievable (ALARA) dose limit for license termination, without restrictions on future site use.

2.0 Facility Description/Operating History

2.1 Description of Revere Site

The Cabot facility is located in Revere, Bucks County, Pennsylvania. Slag materials containing uranium and thorium were generated from columbium and tantalum metal processing in the 1970s. These materials were deposited in four areas on the site: (1) the Old Pit Area; (2) the Parking Area; (3) the Former Container Storage Area; and (4) the Buildings 4 and 5 Area. As reported by the licensee, these four areas vary in size from 1400 to 3200 square meters (m^2) [15,070 to 34,450 square feet (ft^2)], with at least 122 meters (m) [400 feet (ft)] separating them. The total property area is 405,000 m^2 (4.4 million ft^2).

Each of the above areas contain mixtures of building debris, slag, rock, and soil. The Old Pit Area is located near Rapp Creek, away from the manufacturing buildings. The Parking Area is next to the former sandblasting area, west of the principal manufacturing buildings. The Former Container Storage Area is located in the central portion of the property. The Buildings 4 and 5 area is behind Buildings 4 and 5, just north of the principal manufacturing buildings. See Table 1 for a brief description of volumes and areas of each location.

The area surrounding the site is generally rural, with land uses including industrial, commercial, residential, and agricultural. The facility is located between the Rapp Creek and Beaver Creek Drainage Basins. Rapp Creek originates near Lake Warren, 3.2 kilometers (km) (2 miles) north of the site, and flows through the northwestern portion of the site. The creek then flows southward to the confluence with Beaver Creek, where it becomes Tinicum Creek. Tinicum Creek flows generally north-east from the basin into the Delaware River. The Delaware River is 5.6 km (3.5 miles) north of the site, flowing eastward and eventually southward.

Bucks County has a temperate humid, maritime climate. The average annual precipitation is approximately 1140 millimeters [45 inches (in)]. Bedrock beneath the site is reported to be the Triassic age Lockatong formation in the eastern portion of the site and the Triassic age Brunswick formation in the western portion of the site. These formations result in a rolling terrain of low hills, dictated by the occurrence of argillite and sandstone, which are more resistant to weathering. The gray/black argillite of the Lockatong formation grades into the red shales and sandstones of the Brunswick formation. The Lockatong formation at the site was metamorphosed by the intrusive diabase occurring near the eastern edge of the site. Around the diabase intrusives, common copper-bearing minerals such as azurite and malachite occur. In some areas near the site, the argillite gradually becomes a black hornfels. The highest topographic points near the site occur as a result of the highly resistant diabase.

The Lockatong formation is generally a poor source of water and its ability to transmit water is low, with reported yields of wells ranging from 0.00013 - 0.0016 cubic meters/second (m^3/s) [2-25 gallons per minute (gpm)]. The range of water yielded from the Brunswick Formation is 0.00013 -0.16 m^3/s (2-260 gpm), with an average of 0.0025 m^3/s (40 gpm).

2.2 Facility Operating History

Cabot's predecessor, Kawecki Chemical Company, used a thermite reduction process to produce steel-grade niobium metal. This process involved the use of pyrochlore, containing natural uranium and thorium. On completion of the processing, uranium and thorium remained in the form of a waste silica slag.

In the early 1970s, Kawecki Chemical obtained a source materials license from NRC to possess the waste slag containing greater than 0.05 percent by weight uranium and thorium. The processing of pyrochlore was discontinued in 1976. Cabot now holds License SMC-1562, allowing the company to possess the slag material produced by the Kawecki Chemical Company. Currently, there are no source materials being used on site and no activities occurring in the four areas where the slag was deposited.

Cabot began performing decommissioning activities at the site in 1988. In 1991, Cabot Corporation submitted a final survey of the Revere site to NRC and expressed its desire to obtain unrestricted release of the site and removal of it from the License [Cabot, 1991]. The Oak Ridge Institute for Science and Education (ORISE) performed a confirmatory survey in July 1991 [Berger and Smith, 1993], and found that although the average concentrations of natural uranium and thorium met NRC limits, individual fragments of slag exceeded NRC guidelines.

Cabot performed a Radiological Characterization Survey Report [Cabot, 1994], which included a gamma survey at 1 m (3 ft) and 1 centimeter (0.4 in) above ground surface, establishment of background levels, and collection and analysis of surface samples. Additionally, Cabot developed a Radiological Subsurface Sampling Report [Craig, 1994] consisting of collection and analysis of subsurface slag, soil, and selected water samples. Subsurface slag samples were used to measure the readily available uranium (RAU) leach rate constant of uranium from slag. The leach rate constants of thorium and radium were also determined, along with an evaluation of the weathering rate of slag.

Subsequently, Cabot prepared a site DP in April 1996 [Cabot, 1996] using the Interim "Radiological Cleanup Criteria for Decommissioning," specifically the concentration-based limits given in NRCs Office of Nuclear Material Safety and Safeguards (NMSS) Policy and Guidance Directive FC 83-23. This DP included an ALARA analysis, and Risk Assessment [Cabot (b), 1996] for the Revere Site. This plan was later replaced by an DP and RA submitted November 1997 [Cabot and Cabot (b), 1997], using the dose-based limits in Part 20 Subpart E. In December 2000, NRC requested additional information regarding the DP and RA [NRC, 2000]. Cabot responded to NRC's request in March 2001, with revision 1 to the 1997 DP and RA [Cabot and Cabot (b), 2001].

3.0 Radiological Status of the Facility

3.1 Radiological Status of Uranium-/Thorium-Contaminated Slag

According to Cabot, based on inventory records and site assessment reports, approximately 23,000 kilograms (kg) [50,000 pounds (lb)] of thorium- and uranium-bearing ore were delivered

and processed at the Revere site. Resulting slag waste was disposed of in four locations on site.

Buildings that were used for storage and processing of licensed materials have been completely demolished or removed and replaced, with the exception of three walls of the former blending building, located in the Old Pit Area.

The residual radionuclide concentrations for slag are estimated by calculating a mass balance of the remaining activity on the site from process records and information on the amount of material removed during prior decommissioning activities. Based on inventory records, it is estimated that a maximum of 240 megaBecquerel (MBq) [0.0065 curies (Ci)] of thorium and 590 MBq (0.016 Ci) of uranium remain on the site. The thorium and uranium are contained in slag fragments which are distributed with building debris and uncontaminated slag in the four areas. Assuming a density of 2.0 grams per cubic centimeter (g/cm^3) for the slag/debris and a total volume of 23,000 cubic meters (m^3) [820,000 cubic feet (ft^3)], a total mass of 46.4×10^6 kg (102 million lb) of affected material remains at the four locations on the site [Cabot (b), 2001].

The derived average radionuclide concentrations for natural uranium and thorium (assumed to be in equilibrium) are based on an analysis of process slag samples and recovered slag or waste samples. The residual contaminated slag mass is estimated at 57,000 kg (125,000 lb), from normal processing, which exceeds the original ore mass of 23,000 kg (50,000 lb) due to other added materials. Thus, the average slag concentration would be expected to be less than the average ore concentration. Five of nine thorium process slag samples were from test melts conducted in 1970, with lower amounts of added materials, which concentrated the radionuclides in the ore by a factor of 1.6. To ensure the activity used for the dose assessment did not underestimate the potential dose, the highest average activities for thorium- and uranium-bearing slag (i.e., with the 1.6 concentration factor) were used to represent the activity in the original ore. This resulted in using measured radionuclide concentrations (in slag) of 11.4 becquerels per gram (Bq/g) [309 picocuries per gram (pCi/g)] thorium and 26.9 Bq/g (726 pCi/g) uranium, to represent the radionuclide concentrations in the 23,000 kg (50,000 lb) of ore.

3.2 Radiological Status of Soils

Cabot reports there is little soil in the slag areas; it is mostly clean slag and rubble. Furthermore, the Radiological Subsurface Sampling Report submitted in 1994 [Craig, 1994] determined that radioactivity is limited to the slag and no detectable concentrations had leached into the soil. The ORISE report [Berger and Smith, 1993] indicated that other than two soil samples that may have contained small pieces of slag, the average concentrations of total uranium and thorium in the soil were well below the guideline levels and less than twice background levels. The elevated direct readings in the four areas were caused by slag fragments deposited in the area.

3.3 Radiological Status of Surface Water and Ground Water

Monitoring of ground water and surface water is not required by License SMC-1562. However, there is some information on the status of water on the Revere site contained in the Radiological Subsurface Sampling Report submitted in August 1994 [Craig, 1994]. Analysis of

water flowing through the container storage area showed total uranium and thorium concentrations in the range of typical background values for the site.

In addition, the licensee conducted leach-rate tests to demonstrate that contamination would not extend to surface and ground water [Cabot, 2001]. Based on leach-rate test results, Cabot reports the total available uranium to be 0.82 microgram per gram of slag.

To estimate releases of radioactivity from the slag[1], Cabot modeled releases of radionuclides as a surface process where the radionuclides are assumed to be adsorbed onto the surface of the contaminated medium (i.e., slag). Because the radioactivity is actually tightly bound in the slag matrix, modeling releases as a surface process requires an assumption of strong adsorption (i.e., represented by a high-distribution coefficient) between the radionuclide and the solid medium. Cabot calculated a distribution coefficient (K_d) of 137,500 milliliters per gram (ml/g) using the readily available uranium (RAU) concentration measured in a leach test performed on a slag sample. The RAU was determined using a modified Toxicity Characteristic Leaching Procedure leach in water adjusted to a pH of 2.9 (10 - 100 times more acidic than the natural environment) using acetic acid and performed four times sequentially on the same sample aliquot. The sample aliquot was ground before the procedure, greatly increasing the available contact surface area.

A K_d value of 137,500 cubic centimeters per gram (cm^3/g) [3.8 million cubic inches per pound (in^3/lb)] was used to calculate the leach rate constant of radionuclides from the source zone (i.e., slag). The same K_d value was also used for the uranium-238 progenies and thorium-232 and its progenies, consistent with the approach described in Appendix A of the DP, since thorium and radium (the other key radionuclides) have been shown to leach at a slower rate. The leach rate constant assumed in Cabot's assessment is on the order of $1x10^{-6}$ to $1x10^{-5}$ yr^{-1}.

3.4 ALARA

The July 21, 1997, Final Rule, "Radiological Criteria for License Termination" (LTR) as Part 20, Subpart E, established a 0.25 mSv/yr (25 mrem/yr) total effective dose equivalent (TEDE) limit plus ALARA for license termination without restrictions on future site use. Cabot's ALARA analysis [Cabot (b), 2001] used a simplified approach by assuming a conservatively high dose savings and a conservatively low remediation cost estimate. For calculating the dose savings, Cabot assumed a dose of 0.25 mSv/yr (25 mrem/yr) (that is 100 percent cleanup of radioactive material); a dose time of 1000 years, a population density of 0.001 persons per square meter (man/m^2) [4 persons per acre (man/ac)], and a dose value of $200,000 per man-sievert ($2000 per man-rem), discounted at 3 percent per year. For calculating disposal costs, Cabot estimated approximately (all in 1996 dollars) $4.2 million for planning, mobilization, and site cleanup, and $4.6 million for waste disposal, for a total remediation cost of $8.8 million.

Cabot estimates a dose benefit of between $0.04- $2.00 per m^2 ($160 - $8,000/ac) of remediated contamination, and a remediation cost of $312 per m^2 ($1.3 million/ac).

4.0 Evaluations

[1]In its RA, Cabot assumed that only slag is radioactively contaminated.

4.1 Decommissioning Program

No site decommissioning activities are proposed or anticipated in the DP, which concludes that the site meets the criteria for unrestricted release without further cleanup. Staff agrees that a Decommissioning Program is not necessary if it is found that the site meets the LTR requirements for unrestricted release. Specifically, there would be no need for a management program, radiation protection program, radiological accident analysis, radioactive waste management program, quality assurance/quality control program, or emergency plan.

4.2 Radiological Assessment

Staff reviewed the RA using guidance provided in NUREG-1727 [NRC, 2000] for conducting dose assessments, to demonstrate compliance with the LTR. Specifically, the following aspects of the assessment were reviewed: site characterization and source term abstraction; the critical group, scenario, and pathways identification; the conceptual model development; and calculations and input parameter selections. Staff review of these aspects of the assessment is addressed separately below, followed by staff conclusions regarding the RA.

4.2.1 Site Characterization and Source Term-Abstraction

As previously stated, radioactively contaminated slag is present in four known areas at the site. A summary of the licensee's description of these areas is provided in Table 1.

NRC staff had concerns regarding not including the loading dock/warehouse area as a contaminated area. This was in part because of two small samples of radioactive slag found during the 1991 ORISE survey in the loading dock/warehouse area [Berger and Smith, 1993]. The licensee confirmed that these samples have been removed and NRC inspection reports have verified that no elevated direct radiation remains in the loading dock/warehouse area. However, given that part of the loading dock/warehouse area is paved, the possibility of additional subsurface contamination in this area cannot be completely ruled out. Gamma surveys would be inconclusive because of the shielding from the pavement. In response to this concern, Cabot has provided statements from former employees that the area was paved before the use of radioactive material on the site. Further, Cabot has provided a 1970 aerial photo that shows the area as paved before the use of radioactive material in the early 1970s. Therefore, staff believes that it is unlikely that there is additional contamination in the loading dock/warehouse area.

All that remains of buildings within the four contaminated areas is three walls of the old blender building in the Old Pit Area. In 1991, ORISE performed alpha and beta surface scans of the three walls and did not identify any areas of elevated direct radiation. NRC staff considers that the building remains do not contain embedded residual radioactivity that is distinguishable from background.

In its RA, Cabot estimated radionuclide concentrations for slag by calculating a mass balance of the remaining activity on the site from process records and information on the amount of material removed from the site. Based on inventory records, Cabot estimates a maximum of 240 MBq (0.0065 Ci) of thorium and 590 MBq (0.016 Ci) of uranium remains on the site. The total volume of contaminated material (slag, rubble, and soil for each location, as described in

Table 1) from all four areas was initially estimated as 23,000 m^3 (820,000 ft^3) [Cabot, 2001]. Assuming a contaminated material density of 2.0 g/cm^3, a total mass of 46.4 x 10^6 kg (102 million lb) of contaminated material is believed to remain on the site. Based on the assumed activities of thorium and uranium remaining at the site, and uniform dispersion among the four areas, an estimated concentration of 0.0052 Bq/g (0.14 pCi/g) of thorium (thorium-232 plus thorium-228) and 0.013 Bq/g (0.34 pCi/g) of uranium (uranium-234 plus uranium-238) was derived by Cabot. Cabot's RA analysis used 0.0063 Bq/g (0.17 pCi/g) of thorium and 0.013 Bq/g (0.34 pCi/g) of uranium in the RESRAD analyses (see Table 2).

Table 2. Radionuclide concentrations used in the Cabot Radiological Assessment.

Radionuclide	**Concentration** Bq/g (pCi/g)
Actinium-227	0.00028 (0.0077)
Protactinium-231	0.00028 (0.0077)
Lead -210	0.0063 (0.17)
Radium-226	0.0063 (0.17)
Radium-228	0.0031 (0.083)
Thorium-228	0.0031 (0.083)
Thorium-230	0.0063 (0.17)
Thorium-232	0.0031 (0.083)
Uranium-234	0.0063 (0.17)
Uranium-235	0.00028 (0.0077)
Uranium-238	0.0063 (0.17)

Note: Bq/g = Bequerels per gram, pCi/g = picocuries per gram

In an April 27, 2001, letter, Cabot revised the volume estimate for each area by reviewing site characterization reports and using the minimum reported area, and thus volume, for each of the four contaminated locations. This resulted in a contaminated volume of 15,180 m^3 (536,010 ft^3), which is a 35 percent reduction in volume from the RA estimate. This results in a radionuclide concentration and dose increase of approximately 50 percent, which is still an order of magnitude below the LTR limit. [Knapp, 2001].

Staff considers the radionuclide activities used in the assessment to be appropriate because they are believed to be conservative. Cabot's estimate of the activity of uranium and thorium removed from the site is probably low in that it assumed the concentrations in the slag previously removed from the site was only slightly above background. In reality, concentrations of uranium and thorium in the slag removed from the site were probably significantly above background as reflected by the concentrations in the recovered slag left on the site. Therefore, the total activity remaining at the site is probably significantly less than that assumed by Cabot.

The radionuclide concentrations used by Cabot in the RA are listed in Table 2. The isotopic ratios are based on those commonly expected for natural thorium and natural uranium. All daughter radionuclides are assumed to be in secular equilibrium with their parents. In addition, external gamma measurements at the site suggest a uranium-238 concentration of less than 0.074 Bq/g (2 pCi/g) and a thorium-232 concentration essentially at background for the upper several inches of the contaminated areas. Subsurface measurements in the Container Storage, Parking, and Old Pit Areas indicated near-background conditions. Therefore, the concentrations used by Cabot are consistent with exposure rate measurements.

By using the total estimated volume of radioactive slag [i.e., 23,000 m^3 (820,000 ft^3) in the RA, or 15,180 m^3 (536,000 ft^3) in the April 2001 letter] in deriving radionuclide concentrations, Cabot is implicitly assuming that contamination is equally distributed among the four contaminated areas This assumption could result in an underestimation of potential impacts if one or more of the areas are more heavily contaminated than the other areas. This assumption is satisfactorily addressed by the staff's analysis (see Section 4.2.4).

Staff agrees that, based on the glass-like structure of the slag and its low weathering rate [believed to be on the order of $2x10^{-6}$ to $1.5x10^{-5}$ mm/yr ($8x10^{-8}$ to $6x10^{-7}$ in/yr)] the leach rate of radionuclides from the source zone should be low (i.e., radionuclides should be fairly immobile). Based on the range of leach rate constants reported for uranium and thorium for slag [Felmy, et al., 1999], the leach rate constant for uranium and thorium at the Cabot site would be expected to be on the order of $1x10^{-12}$ to $1x10^{-10}$ yr^{-1} for thorium and $1x10^{-11}$ to $4x10^{-9}$ yr^{-1} for uranium. The leach rate constant assumed in the Cabot assessment is on the order of $1x10^{-6}$ to $1x10^{-5}$ yr.

Additionally, Cabot assumes that the leach rate constant of thorium, radium, and all other radionuclides are the same as the leach rate constant of uranium, based on evidence that indicates that other radionuclides would leach at a slower rate.

4.2.2 Critical Group, Scenario, and Pathways Identification and Selection

Scenarios represent possible realizations of the future state of the site. They are needed in a dose assessment to establish potential future conditions that might lead to human exposure to residual radioactivity at the site. The area surrounding the Cabot-Revere site is characterized as generally rural, with land uses that include industrial, commercial, residential, and agricultural.

Cabot considered two scenarios in its RA; specifically, both worker and resident scenarios were considered. In addition, hybrids of the residential scenario were considered as a means of conducting a sensitivity analysis. Cabot's sensitivity analysis shows that the calculated dose is highly sensitive to the assumptions made about the future use of the site. The residential gardener scenario was shown to be the most restrictive analysis in the RA, when compared with other plausible land-use scenarios for the site.

For its worker scenario, Cabot assumed that the site will continue to be used for industrial purposes. The industrial worker is assumed to be exposed to external gamma radiation from the slag and inhalation of re-suspended dust. The hypothetical worker is assumed to spend a very limited time in the contaminated area [40 hours per year (hr/yr)]. No indoor exposure is assumed to occur because there are currently no buildings in the contaminated areas. A more realistic worker scenario was conducted in the sensitivity analysis portion of Revision 0 of the RA, but was omitted in Revision 1. The Revision 0 analysis used higher radionuclide concentrations and evaluated the case of a worker spending 1920 hr/yr in a building constructed in a contaminated area, along with 80 hr/yr outdoors; and a second case with 1600 hr/yr indoors and 400 hr/yr outdoors. Dose estimates from these scenarios demonstrated that the dose limit would not be exceeded, even though the estimated dose increased by slightly more than order of magnitude than the base scenario evaluated in Revision 1. Since a similar analysis done using the lower radionuclide concentration values presented in Revision 1 of the RA is bounded by the previous analysis, the additional sensitivity analysis is not required.

Additionally, staff analysis of Revision 1 shows that the resident gardener scenario (see below) would bound a realistic worker scenario.

For its resident scenario, Cabot assumed that the residence is constructed entirely in the contaminated area and that the resident spends 78 percent of his time in the area (85 percent indoors and 15 percent outdoors). Exposure is assumed to occur through direct gamma radiation, inhalation, soil ingestion, and drinking water. A 0.15 m (6 in) layer of topsoil is assumed to be permanently maintained over the slag, to support grass, but would not be deep enough to support growing edible vegetables. It should be noted that the assumption of a permanent soil layer, even one as thin as 0.15 m (6 in), obviates the need for considering doses from the inhalation pathway; that is, the hypothetical future resident will not receive any doses through inhalation of dust as long as a soil layer is kept over the slag. Given that the current surrounding land use around the site includes residences and agriculture, staff believes that some type of future residential use of the site is highly credible. However, staff does not believe that it is appropriate to assume that a cover will be permanently maintained over the slag without active maintenance.

As a hybrid of the resident scenario, Cabot also looked at a resident scenario assuming that there is no 0.15 m (6 in) soil layer. The results of this sensitivity analysis give a calculated dose significantly below the release limit, but roughly 6 times higher than the dose calculated for the base-case resident scenario. This reflects the importance of the assumption that a 0.15 m (6 in) soil layer will be permanently maintained over the whole area.

As another hybrid of the resident scenario, Cabot assumed that the resident maintains a garden in the contaminated area and thus is exposed through ingestion of plants grown in the contaminated slag. For this assessment, Cabot conservatively assumed that the plants are grown directly in the slag without an intervening soil layer. Again, the calculated dose was significantly below the release limit.

Staff finds that the resident garden scenario appropriately bounds the potential exposure pathways for future use of the site, including an excavation scenario evaluated by Cabot. In the excavation scenario, it is assumed that some of the slag is excavated and used as foundation fill in the construction of a house. Staff finds that the resident gardener scenario appropriately bounds the excavation scenario, because of the higher exposure times. Additionally, in the 1997 DP and RA, Cabot completed a sensitivity analysis of worker scenarios that included acceptable estimates of worker exposure times. Staff finds these earlier, more appropriate worker scenarios are also bounded by the resident gardener scenario provided in the 2001 RA.

Staff supports the exclusion of the aquatic pathway in the Cabot resident scenario. Because of the relative immobile nature of the radionuclides it is unlikely that any contaminants will reach nearby surface waters. Further, the depth of the ground water [approximately 20 m (66 ft)] would likely make it rather expensive to maintain a fish pond.

Because the surficial layer of the contaminated areas is composed principally of slag, which does not readily support the growth of vegetation (as evident by current site conditions), staff believes that it is unlikely that the contaminated areas will be used for growing commodity crops or raising livestock. Because of the cost, it is difficult to envision someone purchasing enough

topsoil to cover an area large enough to grow commodity crops or raise livestock. Further, because soilless gardening requires more management than more traditional gardening methods and given that the presence of slag in the area would not lend itself to mechanized agriculture, staff believes that it is unlikely that the contaminated areas will be used to grow commodity items such as grains or livestock fodder. In addition, the relative small size of the Container Storage and Buildings 4 and 5 areas, which are both less than the default area assumed in NRC's screening approach for the residential farmer scenario [i.e., 2400 m^2 (26,000 ft^2)], would also tend to support an argument that these areas will not be used for growing commodity items. Therefore, staff believes that it is appropriate to exclude these pathways in the assessment.

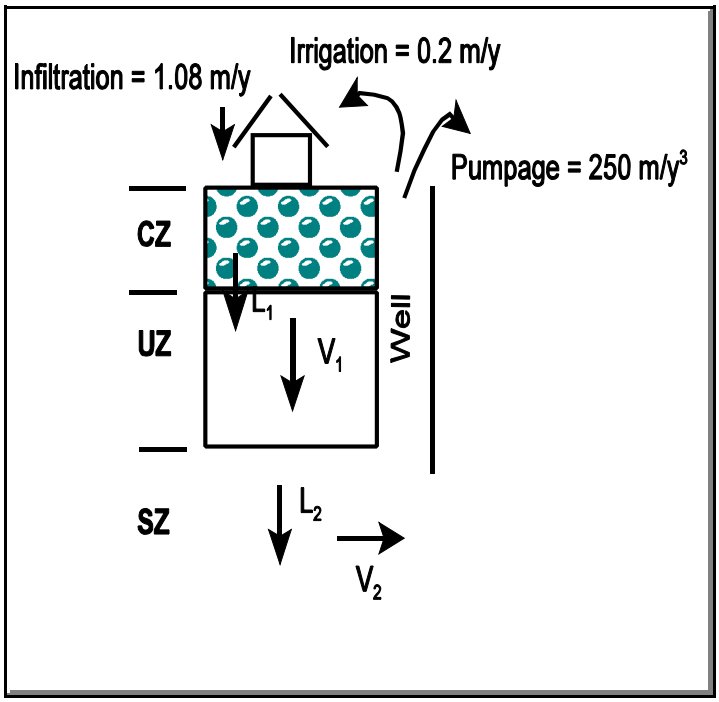

Figure 1. Generalized conceptual model used in the Cabot-Revere assessment.
Note: CZ-Contaminated Zone; UZ-Uncontaminated Zone, SZ-Saturated Zone; L1-Leach Rate from the CZ; L2- Leach Rate from the UZ; V1-Velocity in UZ V2- Velocity in SZ

4.2.3 Conceptual Model Development

Analyzing the release and migration of radionuclides through the environment is an essential part of assessing potential doses someone might receive from exposure to various concentrations of the radionuclides in the accessible environment. Dose assessment analyses require an interpretation of site conditions and processes that are likely to affect the transport of radionuclides through the environment to receptors. The interpretation of site conditions and processes as reflected in the dose assessment forms the conceptual model.

The predefined conceptual model in RESRAD was used in the Cabot-Revere RA with a limited number of input parameters tailored to model the site conditions and features. The predefined conceptual model in RESRAD is described in the RESRAD User's Manual [Yu, et al., 1993]. Specifically, the predefined conceptual model assumes that the individual resides immediately atop the contaminated media. Further, the individual is assumed to have a well located either in the center of the contaminated area or immediately down-gradient from the contaminated area. For the Cabot-Revere assessment it was assumed that the well is located in the center of the contaminated area. As stated in NUREG-1727 [NRC, 2000], no justification is required for making this assumption as it will generally give greater estimates of ground-water impacts than assuming that the well is located down-gradient of the contaminated area.

Figure 1 shows a schematic of the general conceptual model used in the Cabot-Revere RA, based on the staff's interpretation of the information presented in the report.

It should be noted that a default irrigation rate of 0.2 m/yr (0.7 ft/yr) was used in the analysis, although the licensee only assumed irrigation as part of its residential gardener scenario.

Based on regional information, the unsaturated zone is believed to be roughly 20 m (66 ft) thick; however, for the assessment, nominal credit is taken for the possible hold-up of contaminants migrating through the unsaturated zone. This is reflected by the small unsaturated zone thickness [0.01 m (0.03 ft)] assumed for the analysis. Staff believes that this adds conservatism to the calculated doses for the water-dependent pathways.

4.2.4 Calculations and Input Parameters

RESRAD Version 6.0 was used to calculate doses for the two base-case scenarios, and the residential and residential gardener sensitivity scenarios. In addition, RESRAD-Build Version 3.0 was used to calculate doses for the excavation scenario. As previously noted, staff believes that potential impacts from future exposure to residual radioactivity at the site are appropriately bounded by the residential gardener scenario.

As previously stated, for its assessment, Cabot assumes that the radioactivity is uniformly distributed in the total volume of radioactive slag remaining on the site. Thus for the residential gardener scenario, Cabot assumes that the total 23,000 m^3 (820,000 ft^3) of contaminated material are uniformly spread out over an area of 23,000 m^2 (250,000 ft^2) to a depth of 1 m (3.3 ft). (See the “Combo” column in Table 3.)

However, because the slag is currently located in four distinct areas, this assumption would appear to be unrealistic. In addition, as previously stated, assuming that the radioactivity is uniformly distributed in the total volume of slag could be non-conservative if one or more of the contaminated areas are more contaminated than the others. To address these concerns, staff performed its own independent assessment by assuming that the residual radioactivity is limited to just two of the four areas. For the staff assessment, the total activity of uranium and thorium conservatively estimated by Cabot as remaining at the site was equally proportioned between the slag remaining in the Old Pit and Building 4 and 5 Areas. Information on remediation activities at the site suggests that less remediation may have occurred in these two areas than in the Container Storage and Parking Areas.

Table 3. Values of parameters reflected in the schematic in Figure 1

Parameter	Contaminated Area Section				
	Parking Area	**Container Storage**	**Bldgs 4&5**	**Old Pit**	**Combo**
CZ≡ cont. zone thickness (m)	1.8	1.22	0.61	2.7	1.0
UZ≡unsat. zone thickness (m)	0.01	0.01	0.01	0.01	0.01
L_1≡leach rate from CZ (pCi/yr)	1.9e-5	2.7e-5	5.5e-5	1.2e-5	4.1e-6
V_1≡ velocity in UZ (m/yr)	6.4	6.4	6.4	6.4	0.02
V_2≡ velocity in SZ (m/yr)	0.2	0.2	0.2	0.2	0.2
Note: SZ≡ saturated zone, L_2≡leach rate from the UZ = L_1- radioactive decay. The reported V_1 is uranium; for thorium the value is 1.7e-5.					

Note: nonmetric conversions omitted for brevity

Table 4 shows the concentrations used in the staff's independent dose assessment.

In addition, staff questioned the volume estimate for the Old Pit Area provided by Cabot in both the RA and the April 2001 Cabot letter. A conservative NRC staff estimate of the volume for the Old Pit Area, based on direct observation, would be still be greater than the volume of the Buildings 4 and 5 Area, resulting in a higher calculated concentration in the Buildings 4 and 5 Area. Therefore, NRC staff considers that the dose estimated is bounded by the above NRC staff analysis for the Buildings 4 and 5 area. Additionally, the April 2001 Cabot letter provided a slightly reduced volume for the Building 4 and 5 Area. This reduction in volume is minimal (5 percent) and would not affect the results of staff's assessment.

Table 5 shows parameter values used in the staff assessment that were different from those used by Cabot. For both areas, the staff assessment give calculated doses that are less than the 0.25 mSv/yr (25 mrem/yr) limit for unrestricted release of the site[2].

Table 4. Radionuclide concentrations used in the staff assessment

Radionuclide	Concentration Bq/g (pCi/g)	
	Old Pit Area	**Buildings 4&5 Area**
Actinium-227	0.00024 (0.0066)	0.0037 (0.1)
Protactinium-231	0.00024 (0.0066)	0.0037 (0.1)
Lead -210	0.00544 (0.147)	0.0825 (2.23)
Radium-226	0.00544 (0.147)	0.0825 (2.23)
Radium-228	0.0022 (0.06)	0.00336 (0.9075)
Thorium-228	0.0022 (0.06)	0.00336 (0.9075)
Thorium-230	0.00544 (0.147)	0.0825 (2.23)
Thorium-232	0.0022 (0.06)	0.00336 (0.9075)
Uranium-234	0.00544 (0.147)	0.0825 (2.23)
Uranium-235	0.00024 (0.0066)	0.0037 (0.1)
Uranium-238	0.00544 (0.147)	0.0825 (2.23)

The calculated doses derived by both the staff and Cabot primarily result from direct exposure to the gamma radiation from thorium and radium. This is expected because the very low leachability of the slag will result in very little of the radionuclides being transported through the environment during the next thousand years. Although Cabot performed no sensitivity nor uncertainty analysis to identify key parameters, it is known that calculated doses from direct exposure to gamma radiation are largely dependent on the assumed exposure time. For both the Cabot and staff assessments, the default exposure times recommended by NRC for doing screening analyses for a residential farmer scenario were used. Therefore, the parameter value used is considered appropriate.

[2]The concentration of radionuclides in food is dependent on their availability for uptake by plants, which is dependent upon their solubility. Because the slag is fairly insoluble, the uptake of radionuclides by plants is expected to be small. In NUREG/CR-6232 (Amonette, et al., 1994) it is suggested that doses from the ingestion pathway for uranium in slag be calculated on the basis of the total available uranium derived from leaching experiments. Therefore, for the staff assessment, the dose from the plant ingestion pathways is calculated as the fraction of the total available uranium obtained in the leaching experiment to the total uranium in the sample.

Table 5. Parameter values used in the staff assessment.

Parameter	Staff's value	Cabot's value	Comment
Well pumping rate (m^3/yr)	118	250	Screening value used by staff
Unsaturated zone K_d (cm^3/g)	0	RESRAD defaults	No basis provided for the licensee's value
Saturated zone K_d (cm^3/g)	0	10	No basis provided for the licensee's value
Inhalation rate (m^3/yr)	11690	8400	Screening value used by staff
Mass loading (g/m^3)	3.14e-6	3.4e-5	Screening value used by staff
Shielding factor	0.5512	0.59	Screening value used by staff

4.2.5 Conclusion of Radiological Assessment

The most bounding scenario analyzed by staff is of the Buildings 4 and 5 Area containing one-half of the total volume of contaminated slag in a residential gardener scenario, with no cover. In this scenario, the maximum calculated annual TEDE dose within 1000 years was calculated to be 0.2 mSv/yr (20 mrem/yr).

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

Staff has found the existing survey data to be sufficient to demonstrate with reasonable assurance that the dose criterion of 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 RA, adequately demonstrate compliance with 10 CFR 20.1402 requirements.

4.3 ALARA Analysis Evaluation

Staff has reviewed the information submitted by Cabot to demonstrate that the preferred decommissioning option is ALARA, as required in Part 20, Subpart E, in accordance with the criteria in the NMSS Decommissioning Standard Review Plan (NUREG-1727) Section 7.0 ("ALARA Analysis"). Cabot's dose savings estimate used a higher population density of 0.001 man/m^2 (4 man/ac). than the NUREG-provided value of 0.0004 man/m^2 (1.6 man/ac). This results in an overestimate of the dose benefit from further remediation, which is conservative. The remediation cost estimate estimates the total volume at 17,000 m^3 (600,000 ft^3). This estimate may be non-conservative (too high), based on a Cabot revised estimate of the

minimum volume of 15,178 m^3 (536,010 ft^3) [Cabot, 2001]. However, this overestimate, although not insignificant, does not invalidate Cabot's ALARA analysis, since there is considerable margin in its findings. Cabot did not provide detailed information about unit cost factors, contingency factors, salvage credits, and details of site activities, although staff did not need this information to satisfactorily analyze Cabot's ALARA evaluation.

In accordance with Section 1.5 of Appendix D of the Standard Review Plan, "For residual radioactivity in soil at sites that will have unrestricted release, generic analyses show that shipping soil to a low-level waste disposal facility is unlikely to be cost-effective, largely because of the high costs of waste disposal. Therefore, shipping soil to a low-level waste disposal facility generally does not have to be evaluated for unrestricted release." For purposes of the cost analysis for remediation work, the contaminated slag/soil/debris mixture at the four contaminated areas would be excavated and disposed of in the same way as soil. Therefore, staff concludes that the preferred option provides reasonable assurance that the sites' current residual radioactivity levels are ALARA.

5.0 Summary and Conclusion of Safety Evaluation

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

6.0 Recommendations

Staff recommends that the Cabot Revere site be released for unrestricted release, and license amendments and Site Decommissioning Management Plan delisting actions proceed accordingly.

7.0 License Conditions

Revere site to be removed from license, Reading site will remain on license.

8.0 References

Amonette, J.E., G.R. Holdren, K.M. Krupa, and C.W. Lindenmeier, "Assessing the Environmental Availability of Uranium in Soils and Sediments, NUREG/CR-6232," U.S. Nuclear Regulatory Commission, June 1994.

Berger, J. D. and Smith, B. M., "Confirmatory Radiological Survey for Portions of the Cabot Corporation Revere Plant," Oak Ridge Institute for Science and Education, Oak Ridge, TN, April 1993.

Cabot Performance Materials Inc., "Final Decontamination and Decommissioning Survey - 1990 for NRC License SMB-920, Docket 40-6940," Revere Pennsylvania Plant, January 1991.

Cabot Performance Materials Inc., “Radiological Characterization Survey Report for the Cabot Performance Materials Revere Plant,” Revere, PA, April 1994.

Cabot Corporation, “Decommissioning Plan for Cabot Performance Materials, Revere, Pennsylvania - Revision 1," Boyertown, PA, April 1996.

Cabot Corporation (b), “Risk Assessment for the Decommissioning of the Revere, Pennsylvania Site,” Boyertown, PA, April 1996.

Cabot Corporation, “Decommissioning Plan for Revere, Pennsylvania Site - Revision 0," Boyertown, PA, November 17, 1997.

Cabot Corporation (b), “Radiological Assessment for Revere, Pennsylvania Site - Revision 0," Boyertown, PA, November 17, 1997.

Cabot Corporation, “Decommissioning Plan for Revere, Pennsylvania Site - Revision 1," Boyertown, PA, February 28, 2001.

Cabot Corporation (b), “Radiological Assessment for Revere, Pennsylvania Site - Revision 1," Boyertown, PA, February 28, 2001.

Craig, K., “Radiological Subsurface Sampling Report for Cabot Performance Materials Revere, Pennsylvania,” NES, Danbury, CT, August 1994.

Felmy, A.R., D. Raj, and V.L. LeGore, “Solubility and Leaching Controls on Radionuclides in SDMP Wastes: Data Summary,” PNNL, 1999.

Knapp, T., letter, “Area of Slag Areas,” to U.S. Nuclear Regulatory Commission, Theodore Smith, Cabot Corporation, Boyertown, PA, April 27, 2001.

U.S. Nuclear Regulatory Commission, “Timeliness in Decommissioning of Material Facilities,” U.S. Federal Register, Washington, DC, 59 FR 36026 - 36040, July 15, 1994.

U.S. Nuclear Regulatory Commission,“NMSS Decommissioning Standard Review Plan, NUREG-1727,” Washington, DC, September 2000.

U.S. Nuclear Regulatory Commission, “Request for Additional Information Regarding the Cabot-Revere Site Decommissioning Plan and Radiological Assessment,” Washington, DC, December 27, 2000.

Yu, C., et al., “Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, ANL/EAD/LD-2," Argonne National Laboratory, Argonne, IL, September 1993.

Other documents considered (Bibliograpy):

Meyer, P.D., Rockhold, M.L., and Gee, G.W.; “Uncertainty Analyses of Infiltration and Subsurface Flow and Transport for SDMP Sites, NUREG/CR-6565,” U.S. Nuclear Regulatory Commission, Washington, DC, September 1997.

U.S. Nuclear Regulatory Commission, “Disposal or On-site Storage of Residual Thorium or Uranium from Past Operations, SECY-81-576,” Washington, DC, October 1981.

U.S. Nuclear Regulatory Commission, “Policy and Guidance Directive PG-8-08 - Scenarios for Assessing Potential Doses Associated with Residual Radioactivity,” Office of Nuclear Material Safety and Safeguards, May 1994.

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

U.S. Nuclear Regulatory Commission, “Radiological Criteria for License Termination; Final Rule,” Washington, DC, 10 CFR Part 20, Subpart E, July 1997.

U.S. Nuclear Regulatory Commission, “Probabilistic Dose Analysis Using Parameter Distributions Developed for RESRAD and RESRAD-BUILD Codes,NUREG/CR-6676,” Washington, DC, July, 2000.

U.S. Nuclear Regulatory Commission, “Probabilistic Modules for the RESRAD and RESRAD-BUILD Computer Codes-User Guide, NUREG/CR-6692,” Washington, DC, November 2000.