OFFICE OF FEDERAL AND STATE MATERIALS
AND ENVIRONMENTAL MANAGEMENT PROGRAMS
SAFETY EVALUATION REPORT FOR THE
REMOVAL OF UNREACTED ORE FROM PLANT 6W
LICENSE NO. STB-401 DOCKET NO. 40-6563
MALLINCKRODT INC.
ST. LOUIS, MISSOURI

1. INTRODUCTION

The ultimate goal of the columbium - tantalum (C-T) project decommissioning is to remediate those areas of the site associated with C-T production, to the extent necessary, to terminate License STB-401. Mallinckrodt Inc. (Mallinckrodt) has elected to decommission the C-T project areas of the site in two phases. In Phase 1, Mallinckrodt decommissioned the buildings and equipment to the extent necessary to meet the Nuclear Regulatory Commission's (NRC's) guidelines for unrestricted release. Phase 2 will include the remediation of the building slabs and foundations, paved surfaces, and all subsurface materials. Mallinckrodt completed Phase 1 decommissioning activities in February 2007. Mallinckrodt submitted the Phase 2 decommissioning plan (DP) to the NRC for review and approval in 2003. The NRC staff is working with Mallinckrodt to resolve a number of regulatory and technical issues associated with Phase 2 decommissioning activities.

Removal of unreacted ore (URO) from Plant 6W is one of the decommissioning activities included in the Phase 2 DP. However, in order to coordinate schedules for remediation of Plant 6W with the U.S. Army Corp of Engineers (USACE), Mallinckrodt is proposing to remove the URO buried in Plant 6W under a separate licensing action prior to approval and implementation of the Phase 2 DP. This Safety Evaluation Report (SER) applies only to activities associated with removal of URO from Plant 6W. Much of the information contained in this SER was taken directly from Mallinckrodt's license amendment request.

2. BACKGROUND

Mallinckrodt has been operating at the St. Louis Plant since 1867 producing various products including metallic oxides and salts, ammonia, organic chemicals, and various uranium compounds for the Manhattan Engineering District and the Atomic Energy Commission (MED-AEC). The St. Louis Plant, comprised of over 50 buildings on approximately 43 acres, is subdivided into smaller areas, called plants, based on the similarity of operations being performed. C-T processing and support occurred in 21 buildings. Although C-T production occurred within Plant 5, support activities were conducted in portions of Plants 1, 3, 6, 7 and 8.

In 1961, Mallinckrodt was issued License No. STB-401, to extract C-T from natural ores and tin slags. From 1961 to 1985, Mallinckrodt purchased and processed materials for C-T production. The ores and processing byproduct materials contained uranium and thorium isotopes. C-T processing was shut down from 1985 through early 1987, when Mallinckrodt began a two month pilot production run. During the pilot production run, approximately 20,000 pounds of tin slag were processed. In July 1993, NRC amended Mallinckrodt's license to a possession only license for decommissioning and license termination. Approximately 6 Curies (Ci) of natural uranium and 19 Ci of natural thorium isotopes were contained in the ores and tin slags processed under License STB-401.

MED-AEC activities resulted in radioactive contamination in some areas of the St. Louis Plant site and adjacent properties. Contamination consists of uranium series, thorium series and actinium series radionuclides from the refining of uranium ore and concentrate. Remediation of MED-AEC contamination at the St. Louis Plant site is being performed by USACE under the Formerly Utilized Sites Remedial Action Program (FUSRAP).

Plant 6W contains MED-AEC contamination and URO from C-T operations in ten burial pits. Mallinckrodt and USACE worked cooperatively to reach an agreement covering nine of these pits, that defines a geographical boundary between buried URO and surrounding land within Plant 6W. Under the agreement Mallinckrodt is responsible for removal of all material within the geographical boundary, including the URO in the burial pits, and USACE is responsible for remediation of the remainder of Plant 6W. Mallinckrodt and USACE plan to reach a similar agreement covering the tenth burial pit.

3. SAFETY EVALUATION

3.1 Objective

Mallinckrodt plans to remove URO and adjacent soil from the set of ten trenches in Plant 6W, and ship the material by rail to a regulated disposal facility. The specific disposal facility will depend on whether the URO and soil contains more or less than the exempted quantity of source material – 0.05 % by weight – as set forth in 10 CFR Part 40.13(a). Non-URO and soil materials with surface contamination meeting the NRC Policy and Guidance Directive FC 83-23 standards can be released from the site in accordance with license condition 16.

Mallinckrodt's removal of the URO will assure that the potential dose to people on site from C-T process material will be less than 25 millirem per year (mrem/yr), without the necessity for post-remediation activity.

3.2 Criteria

Mallinckrodt has committed to dispose of URO and soil which contains more than the exempted quantity of source material as defined in 10 CFR Part 40.13, at a regulated disposal facility. URO and soil with activity exceeding natural background radioactivity, but less than the exempted quantity of source material will be disposed of by NRC-authorized transfer to a disposal facility subject to approval of the cognizant state regulatory agencies. Equipment with surface contamination meeting the requirements of NRC Policy and Guidance Directive FC 83-23 can be released in accordance with license condition 16.

EQUIPMENT SURFACE RELEASE LIMITS

Equipment Location	**Average (dpmα/100 cm$^{2)}$**	**Maximum (dpmα/100 cm$^{2)}$**	**Removable (dpmα/100 cm$^{2)}$**
Any	2400	7200	500

At the Plant 6W site, Mallinckrodt will remove all material within a geographical boundary agreed to between Mallinckrodt and USACE. Completion of the removal action will be verified by measurement of the excavation width and depth. Because this URO source removal action is based upon agreed geographical boundaries, a residual radioactivity concentration criterion – applicable in decommissioning actions -- will not be applicable here. Similarly, a final status survey will not be required. Mallinckrodt will demonstrate completion of the URO removal action by documenting the removal of the volume of material specified in the Mallinckrodt/USACE delineation agreements.

3.3 Site Characterization

URO was buried in Plant 6W in ten excavated trenches. URO is comprised of columbite ore and tin slag that did not dissolve by acid leaching and portions that precipitated as insoluble fluoride compounds UF_4 and ThF_4. Mallinckrodt estimates that the URO contains about 1.8 wt% thorium and about 0.15 wt% uranium. Approximately 290 cubic yards (yd^3) of URO was packaged in 305 thirty-gallon steel drums. The drums were placed in the trenches in a two foot layer with approximately 3-4 feet of clean cover consisting of compact soil.

3.4 Areas to be Remediated

Mallinckrodt and USACE have agreed upon a defined geographic boundary for nine of the trenches in Plant 6W. Mallinckrodt initially planned to remove URO buried in Trench 10 later, during Phase 2 decommissioning. However, if removal of URO from Trench 10 benefits Mallinckrodt/USACE remediation activities in Plant 6W, Mallinckrodt may elect to establish a delineation agreement with USACE for Trench 10 as well, and remove URO from Trench 10 under this proposed license amendment.

URO burials in Trenches 1- 9 occupy an area of about 418 square yards (yd^2). Allowing for sloping excavation side walls results in a total volume of excavated material of about 2605 yd^3. The URO from Trench 10 adds approximately 900 yd^3 which brings the total excavated volume to 3495 yd^3.

3.5 Approach to URO Removal

Mallinckrodt is proposing to treat removal the URO as a volume of material within specified geographical bounds. Land outside the bounds is the responsibility of USACE under FUSRAP. Mallinckrodt is proposing to remove the URO using the following steps:

- utility lines, including water, electricity, gas, etc., will be located and marked prior to initiation of remediation activities and will be relocated as necessary to perform this work;
- macadam pavement atop URO burials one through ten will be removed;
- the soil covering the buried URO will be removed by excavation;
- water misting or similarly effective dust control methods will be used as necessary to prevent the release of airborne dust during excavation and materials handling activities;
- extent of the removal is to be verified by visual inspection and, where necessary confirmed by appropriate radiation measurements;
- URO contents will be transported to the rail loading facility on site for loading and delivery to a carrier for transport;

- excavated soil and URO may be mixed in order to satisfy disposal site criteria; and
- backfill will be specified to ensure no subsidence or, by agreement with the USACE, excavation cavities may be left to facilitate FUSRAP remediation nearby.

3.6 Final Survey Plan

This URO source removal action is based upon agreed geographical boundaries and will not require a residual radioactivity concentration criterion nor a final status survey.

3.7 Health and Safety Program

Mallinckrodt has committed to perform URO removal activities in accordance with a Health and Safety Program, which includes: (1) an Industrial Safety Program; (2) a Radiation Protection Program; and (3) an Environmental Safety Program. Implementation of the Health and Safety Program will be evaluated during NRC site inspections.

Mallinckrodt will implement an Industrial Safety Program during removal of the URO. The St. Louis Plant site-wide Industrial Safety Program, or a contractor equivalent, will be used for training all unescorted individuals involved in URO removal activities. URO Removal Project workers will be trained to perform their assigned responsibilities safely. The industrial safety training program will include the following:

- weekly shop-talks on pertinent industrial safety information, injury statistics, an specific safety issues;
- specific training on specialized equipment including the use of cranes, forklift trucks, frontend loaders, and scissor lifts;
- general industrial safety training including proper lifting, hearing conservation, eye protection, slips and falls, hazardous material handling, and use of power tools;
- specialized training including first aid, CPR, fire fighting, use of respirators, and HAZWOPER; and
- safety work permits addressing asbestos removal, lock-out/tag-out, etc.

The Radiation Protection Program includes procedures to protect workers and the public from ionizing radiation and keep exposures to radiation “as low as reasonably achievable” (ALARA). Mallinckrodt has stated that the remediation contractor will be required to implement a Radiation Safety Program which incorporates the following elements:

- health and safety protection measures and policies;
- instrumentation, calibration and equipment;
- use of air samplers, monitoring policy methods, frequency and procedures;
- contamination control and personnel decontamination;
- external exposure control;
- airborne releases and monitoring;
- Safety Work Permits, including ALARA;
- engineering controls;
- transportation;
- accident response;

- posting and labeling;
- records and reports; and
- potential sources of contamination exposure.

Mallinckrodt has committed to implement an Environmental Protection Program to monitor air and water effluents discharged during the URO removal project. During soil handling activities, Mallinckrodt has committed to routinely collect samples or take measurements at on-site and site boundary or off-site locations to determine the extent of environmental discharges during remediation. Environmental issues are addressed in the Environmental Assessment for this source removal action.

The amendment request states that Mallinckrodt will be responsible for overall project direction and ensuring that NRC requirements are met. The remediation contractors will be responsible for implementation of the radiological, occupational, environmental safety and quality assurance programs. The contractor will also be responsible for providing trained personnel to conduct decommissioning activities. The amendment request describes an acceptable organizational structure and presents minimum qualifications for safety related personnel.

3.8 ALARA

Mallinckrodt has committed to keeping radiation exposures to workers and the environment ALARA, by implementing health safety practices specified in the Radiation Protection Program. The remediation contractor is responsible for implementing the Radiation Protection Program. Under the Radiation Protection Program, the contractor is required to consider how exposures will be kept ALARA in the preparation of safety work permits. In addition, all individuals will be trained in the concepts of ALARA before being allowed to work in controlled areas.

The Radiation Protection Program requires that workers be adequately trained. All unescorted individuals involved in C-T Project decommissioning activities will be required to receive Industrial Safety Training and Radiation Safety Training. All individuals will receive Radiation Safety Training before entering a controlled area to perform work.

Environmental sampling stations will collect continuous samples during URO source removal activities to verify that there are no significant adverse impacts to workers or the environment.

Mallinckrodt has also committed to monitor direct radiation using thermoluminescent dosimeters (TLDs). TLDs will be placed at various locations around the perimeter of the controlled area to ensure that direct radiation in unrestricted areas does not exceed the public dose limits specified in 10 CFR 20.1301.

The Radiation Control and Environmental Safety Programs described in the license amendment request are acceptable programs which should keep radiation exposures to workers, and the environment ALARA.

4. STATE CONSULTATION

The State of Missouri was notified of the proposed Federal action. On February 13, 2008, the State of Missouri, Department of Natural Resources (MDNR), submitted comments on Mallinckrodt's license amendment request. Mallinckrodt addressed MDNR's comments in a letter to the NRC dated March 17, 2008. MDNR notified the NRC on April 10, 2008, that its comments have been adequately resolved.

5. CONCLUSIONS

Based on the considerations discussed above, NRC concludes that: (1) there is reasonable assurance that the health and safety of the workers, public and environment will not be endangered by the proposed decommissioning activities; and (2) such activities will be conducted in compliance with NRC regulations.

6. REFERENCES

Federal Facilities Agreement between US Department of Energy and U.S. Environmental protection Agency, June 1990.

Mallinckrodt Chemical Inc., "Mallinckrodt C-T Project Decommissioning Plan Part 1", January 18, 2001 (ML010460285).

Mallinckrodt Inc., "License Amendment to Remove URO from plant 6W – Response to RAIs and Removal of Burial Pit #10", March 17, 2008 (ML080800076).

NRC, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material," August, 1987.

NRC, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", NUREG-1575, EPA 402-R-97-016, December 1997.

State of Missouri, "Comments Regarding the Amendment Request for License STB-401 Unreacted Ore Removal from Plant 6W, Mallinckrodt, Inc., February 13, 2008, (ML080800327).

State of Missouri, Department of Natural Resources, Environmental Assessment for the Removal of Unreacted ore from Plant 6W, April 10, 2008.