OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS
SAFETY EVALUATION
RELATED TO LICENSE NO. STB-401 DOCKET NO. 40-6563
MALLINCKRODT CHEMICAL, INC.
ST. LOUIS, MISSOURI

1. INTRODUCTION

On November 20, 1997, Mallinckrodt Chemical Inc., (Mallinckrodt), submitted the "C-T Project Decommissioning Plan, Part 1" (DP), for its property located at Mallinckrodt & Second Street in St. Louis, Missouri. After resolution of NRC comments Mallinckrodt submitted a revised DP on January 10, 2002, February 13, 2002, and March 8, 2002. 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 has elected to decommission the C-T project areas of the site in two phases. In Phase I, Mallinckrodt will decommission the buildings and equipment to the extent necessary to meet the Nuclear Regulatory Commission's (NRC's) guidelines for unrestricted release. Phase II will include the remediation of the building slabs and foundations, paved surfaces, and all subsurface materials. Mallinckrodt will submit the DP for Phase II to the NRC for review and approval in 2003. This Safety Evaluation Report (SER) applies only to the Phase I decommissioning activities. Much of the information contained in this SER was taken directly from the Mallinckrodt DP.

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.

3. SAFETY EVALUATION

3.1 Decommissioning Objective

Mallinckrodt is proposing to remediate C-T process buildings and equipment to meet the NRC's criteria for unrestricted release or dismantle the buildings and dispose of the waste material.

3.2 Decommissioning Criteria

Mallinckrodt is proposing: (1) to dispose of contaminated C-T process equipment in a licensed facility, or release equipment in accordance with NRC's "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material"; (2) to release buildings remaining on site in accordance with 10 CFR 20, Subpart E; and (3) to release building waste material which meets the requirements of NRC Policy and Guidance Directive FC 83-23, "Termination of Byproduct, Source, and Special Nuclear Material Licenses," November 1983, in accordance with license condition 16, or future NRC regulations on clearance of materials, or under the provisions of 10 CFR 20.2002. The following release limits have been proposed:

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

SURFACE RELEASE LIMITS FOR BUILDINGS

Location	**Average (dpm/100 cm^2)**
Any	13,000

Mallinckrodt has committed to dispose of demolition waste material which contains more than the exempted quantity of source material as defined in 10 CFR Part 40.13, at a regulated disposal facility. Waste material with activity exceeding the unrestricted release limits (13,000 dpm/100 cm^2), but less than the exempted quantity of source material will be disposed of by an NRC-authorized transfer to a disposal facility subject to approval of the cognizant state regulatory agencies. Building surfaces and material which meets the requirements of FC 83-23 can be released in accordance with license condition 16, or in accordance with future NRC regulations on clearance of materials, or under the provisions of 10 CFR 20.2002.

In the DP, Mallinckrodt derived alpha radiation limits corresponding to NRC's radiological criteria for the release of equipment and buildings. Mallinckrodt states that it intends to rely mainly on surveys for beta ray detection. Therefore, Mallinckrodt also derived composite beta equivalents for each of the alpha radiation limits. Mallinckrodt's rationale for deriving release criteria based on beta emission is; (1) direct measurement of alpha particles can be unreliable if the contaminated surface is painted, (2) direct measurement of gamma concentration on

equipment and building surfaces will not be representative due to significant gamma contributions from subsurface areas, and (3) the minimum detectable activity for beta will be lower than for combined beta-gamma since background is about one-third of the combined beta-gamma background.

3.3 Site Characterization

Several site characterization studies have been conducted at the Mallinckrodt facility to quantify the physical and chemical characteristics of the C-T process areas. The primary isotopes of concern are U-238, U234, Th-230, Ra-226, Th-232, Th-228, Ra-228 and K-40.

Mallinckrodt completed Phase 1 characterization in 1996. Characterization included direct beta measurements for fixed contamination, and alpha measurements of surface wipe samples for removable contamination. Characterization data from all site characterization programs has been compiled into a single database. Following is a summary of the site characterization data:

- 9700 direct radiation measurements were taken on building walls, floors, mezzanines, roofs, and ceilings
- 2800 surface smears were collected from buildings
- 354 pieces of equipment were surveyed
- 24 scabble samples were analyzed from paved surfaces
- 1600 direct beta measurements were performed on paved surfaces
- 63 boreholes were advanced to sample the C-T process area subsurface
- 19 manhole locations were sampled to characterize the sewer system
- 17 groundwater monitoring wells were installed

Based on the site characterization data, the C-T process buildings and equipment have been divided into 321 survey units, with each wall, roof, floor, and equipment item making up one survey unit. The areas to be remediated are identified in Section 3.4 below.

3.4 Areas to be Decommissioned

In the DP, Mallinckrodt proposes to disposition C-T process and support areas as follows:

Process and Support Area

Plant 3

Building 62 (change rooms/lockers)

Plant 5

Building 200 (organic/inorganic manufacturing process area)
Building 204 (inorganic chemical manufacturing)
Building 213 (Change and Break Rooms)
Building 214 (Transformer/Switchgear Room)
Building 222 (warehouse)
Building 223 (warehouse)
Building 235 (feed material/ URO storage (east half))
Building 236 (maintenance area/product drying)

Building 238 (C-T ore grinding/dissolving/T processing)
Building 240 (offices)
Building 245 (not used for C-T)
Building 246A (offices)
Building 246B (solvent extraction process)
Building 247A (C-T solvent extraction/product storage)
Building 247B (Columbium filtration and drying)
Building 248 (Columbium filtration/drying/calcining)
Building 250 (offices and quality control laboratories)

Plant 6

Building 101 roof
Building 101 (incinerator pad)

Plant 8

Building 90/91 (maintenance areas)

Plants 1, 6, and 7 contain some support areas used during C-T processing. However, since these areas also contain widespread contamination from MED-AEC operations, remediation will be conducted under the Federal Facilities Agreement (FFA) and Department of Energy's Formerly Utilized Sites Remedial Action Program (FUSRAP).

3.5 Approach to Decommissioning

Mallinckrodt states that its preferred approach for decommissioning is to dismantle/demolish and dispose of radioactively contaminated buildings and equipment. The general approach to decommissioning proposed by Mallinckrodt consists of:

- removing equipment and services, and demolishing Buildings 213, 214, 238, 246, 247 and 248
- roof sampling and decontaminating roof and exterior surfaces of Buildings 101, 200, 204, 222, 223, 235, 236, 240, 245, and 250, if necessary
- decontaminating and surveying selected interior areas of building 250
- surveying Building 62
- surveying Buildings 90 and 91
- removing incinerator from pad near Building 101
- crushing concrete slabs from elevated floors, block and brick in preparation for sampling and disposal
- packaging and shipping waste to an NRC authorized licensed facility or disposal at an appropriate waste disposal facility
- removing or fixing any contamination on remaining concrete ground floor slabs. Ground floor slabs will be removed during Phase II decommissioning

Mallinckrodt's DP states that C-T process equipment will be removed using standard equipment. High efficiency or HEPA filters will be used during demolition of interior walls. Localized surface contamination on building surfaces will be removed by scrubbing or abrasive cleaning. If dry abrasive cleaning is used, containment zones will be established and air will be exhausted through HEPA filters.

Roofs on the buildings to be demolished on-site, contain limited amounts of asbestos material. Mallinckrodt has committed to perform asbestos abatement work in conformance with U.S. Environmental Protection Agency (EPA), Occupational Safety and health Act (OSHA), and State of Missouri regulations. Demolition of C-T process buildings will be done in sections, starting with the brick and block sections between the structural steel, then the roof and structural steel. Surface contamination remaining on the concrete floor slabs after building demolition will either be removed or fixed in place. Process building ground floor slabs will be removed during Phase 2. Airborne dust will be controlled during demolition by air filtration and construction of temporary enclosures, as needed. Building material will be crushed using standard bulk materials handling equipment.

3.6 Final Survey Plan

Mallinckrodt has committed to conducting a final status survey consistent with the approach presented in the draft Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), to the extent possible. The residual radioactive material release criteria or derived concentration guideline limit (DCGL) have been derived for equipment, building surfaces and building waste material. The equipment release criteria is based on the limits found in NRC's "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material." Building release criteria were derived from NUREG/CR-5512, "Residual Radioactive Contamination and Decommissioning", June 1994, assuming a dose limit of 25 mrem to a worker. The release criteria for building waste material is found in NRC Policy and Guideline Directive FC 83-23.

The final status survey will consist of surface scanning, stationary dose measurements, and material sample analysis. Mallinckrodt has committed to using instruments appropriate to the type of survey and the concentration of radioactivity to be measured.

3.7 Radiation Control Plan

Mallinckrodt has committed to perform decommissioning activities in accordance with a Health and Safety Program, which will include (1) an Industrial Safety Program, (2) a Radiation Protection Program, and (3) an Environmental Safety Program. Although a detailed Health and Safety Program has not yet been developed, the DP provides the minimum requirements for each element of the program. Implementation of the Health and Safety Program will be evaluated during NRC site inspections.

The Radiation Protection Program will include 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 from Section 3.3 of the DP:

- 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
- Radiation Safety Work Permits
- engineering controls
- transportation
- accident response
- posting and labeling
- records and reports, and
- potential sources of contamination exposure
- ALARA

The DP states that Mallinckrodt will be responsible for overall project direction and ensuring that NRC requirements are met. The remediation contractors, Burns & McDonnell Engineering Company, Inc., and Nextep Environmental Inc., 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 DP 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, the public, and the environment ALARA mainly through the use of safety and work permits. 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. Workers safety performance will be reviewed annually, and workers will receive refresher training every two years.

Mallinckrodt will also implement an Environmental Safety Program to monitor air and water effluents discharged during decommissioning. Mallinckrodt will routinely collect samples or take measurements at locations on-site, site boundaries, and off-site, to determine the extent of environmental discharges.

Mallinckrodt does not expect effluent air releases because no point discharge of ventilation air is planned. However, air samples will be collected if a point discharge of process exhaust ventilation is employed. Environmental sampling stations will collect continuous samples during demolition and decontamination activities to verify that there are no significant adverse impacts to workers or the public.

Mallinckrodt has committed to minimize the production of contaminated liquids. There are expected to be three sources of contaminated liquids; sink and shower water, decontamination fluids, and water used for dust suppression. Sink and shower water is expected to contain insignificant amounts of radioactivity and will be discharged into the sewer in accordance with

10 CFR Part 20.2003. Aqueous waste containing potentially significant concentrations of radionuclides will be filtered to remove the solids, sampled and analyzed to estimate the concentration in the sewerage. This concentration will be compared with 10 CFR Part 20 concentration limits and the total inventory discharged will be calculated. All contaminated liquids will be disposed to the Metropolitan St. Louis Sewer District (MSD) following confirmation that MSD specifications for sampling, analysis, and pre-treatment have been satisfied.

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

The DP describes an acceptable Radiation Control Program which should keep radiation exposures to workers, the public, and the environment ALARA.

3.9 Financial Assurance

The C-T Decommissioning Financial Assurance Plan was submitted to NRC on August 18, 2000. The Plan included financial assurance instruments sufficient to assure funding for the estimated cost of decommissioning.

4. STATE CONSULTATION

The State of Missouri was notified of the proposed Federal action.

5. CONCLUSIONS

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

6. REFERENCES

Mallinckrodt Chemical Inc., “Mallinckrodt C-T Project Decommissioning Plan Part 1", January 18, 2000.

Mallinckrodt Chemical Inc., C-T Project Decommissioning Financial Assurance Plan, August 18, 2000.

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.