

OFFICE OF FEDERAL AND STATE MATERIALS AND
ENVIRONMENTAL MANAGEMENT PROGRAMS

ENVIRONMENTAL ASSESSMENT
RELATED TO THE APPROVAL OF THE MALLINCKRODT C-T PHASE 2
DECOMMISSIONING PLAN, FOR
MALLINCKRODT, INC.
ST. LOUIS, MISSOURI
LICENSE NO. STB-401 DOCKET NO. 40-6563

1. INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) is considering approval of the Mallinckrodt Inc. (Mallinckrodt) columbium-tantalum (C-T) Phase 2 Decommissioning Plan (DP), Revision 2, originally submitted to NRC in May 2003, and resubmitted on October 14, 2008 (ML083150652) with revisions on June 3, 2010 (ML101620140). In the DP, Mallinckrodt is proposing to decommission grade-level and below-grade building slabs, paved surfaces, and subsurface materials affected by former C-T operations, such that these areas meet NRC's criteria for unrestricted release and Mallinckrodt's license can be terminated by license amendment.

Mallinckrodt has been operating at the St. Louis Plant since 1867 producing various products including metallic oxides and salts, ammonia, and organic chemicals. From 1942 to 1957, Mallinckrodt was under contract with the Manhattan Engineering District and the Atomic Energy Commission (MED-AEC) to process uranium ore to produce uranium for development of atomic weapons.

In 1961, pursuant to 10 CFR part 40, Mallinckrodt was issued a source material license (License No. STB-401) authorizing the possession and use of materials containing uranium and thorium isotopes. Under this license, from 1961 to 1987, Mallinckrodt extracted C-T from natural uranium ores and tin slags, and purchased and processed materials for C-T production.

Radiological contamination at the site resulted from MED-AEC and C-T processing activities. MED-AEC contamination is being removed by the U.S. Army Corps of Engineers (USACE) under the Formerly Utilized Sites Remedial Action Program (FUSRAP). USACE developed a preferred cleanup approach for the MED-AEC contamination, based on the data and findings presented in four documents: (1) Remedial Investigation Report; (2) Baseline Risk Assessment; (3) Initial Screening of Alternatives; and (4) Feasibility Study.

2. PURPOSE AND NEED FOR THE PROPOSED ACTION

Mallinckrodt has requested that NRC terminate License No. STB-401. Before the license can be terminated, NRC must be assured that residual radioactive material in areas of the Mallinckrodt facility associated with the C-T project meet NRC's release unrestricted criteria as defined in 10 CFR Part 20.1402.

Mallinckrodt 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 NRC's criteria for unrestricted release. Phase 1 of the decommissioning project was completed in February 2007. Phase 2 will include the remediation of the building slabs and

foundations, paved surfaces, and all subsurface materials to the extent necessary, to meet NRC's unrestricted release criteria.

3. PROPOSED ACTION

The ultimate goal of the Phase 2 C-T decommissioning project is to remediate those areas of the site associated with C-T production, to the extent necessary, to meet NRC's unrestricted release criteria as presented in 10 CFR Part 20, Subpart E, and to terminate License STB-401. Most of the Phase 2 decommissioning activities will take place in Plant 5. However, the wastewater neutralization basins in Plant 7W will also be decommissioned.

3.1 Site History

Mallinckrodt has been operating at the St. Louis Plant since 1867 producing various products including metallic oxides and salts, ammonia, and organic chemicals. From 1942 to 1957, Mallinckrodt was under contract with the MED-AEC to process uranium ore to produce uranium for development of atomic weapons. The Mallinckrodt site, comprised of over 50 buildings on approximately 43 acres, is subdivided into smaller areas, called "plants", based on the similarity of operations being performed.

As stated above, Mallinckrodt was issued License No. STB-401 in 1961, and from 1961 to 1985, Mallinckrodt purchased and processed materials for C-T production. 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 Ci of natural uranium and 19 Ci of natural thorium isotopes were contained in the ores and tin slags processed under License STB-401. C-T processing and support occurred in 21 buildings, mainly within Plant 5, but also within Plants 1, 3, 6, 7 and 8. C-T decommissioning activities have been completed in Plants 1, 3, 6, and 8. Therefore, the Phase 2 DP addresses only decommissioning activities within Plants 5 and 7.

3.2 Site description

The facility is located adjacent to the west bank of the Mississippi River. The area surrounding the site is completely developed, and includes a mixture of commercial, industrial and residential uses. The Mallinckrodt site is located within Census Tract 1267. The residential population within this tract was 2,867 in 1990, and the total residential population within one mile of the plant was approximately 10,000. Section 1 of the DP provides maps showing the site location, and C-T production and process areas.

The Mississippi, Missouri, and Meramec rivers are the main surface water bodies near the facility. Storm runoff from the Mallinckrodt site flows via the sewer system to the Metropolitan Sewer District. The City of St. Louis municipal water intakes are located up stream from the Mallinckrodt site. The Mississippi River is subject to flooding. A levee constructed in 1964 on City of St. Louis property protects the Mallinckrodt site from flood waters.

The Mallinckrodt site is underlain by two unconsolidated soil units and one bedrock unit. The upper soil unit consists of fill material and is between 12 and 30 feet (ft) thick. This unit contains a perched groundwater unit at depths of three to nine feet below the surface. The lower soil unit

is composed of silt and clay above sandy alluvium, and ranges between 0 - 60 ft thick. Groundwater in the sandy alluvium is saline and very hard, and flows to the east towards the Mississippi River. The bedrock unit is limestone. Groundwater in the bedrock is saline and non-potable. Groundwater beneath the Mallinckrodt site and surrounding area is not used for drinking water, and there is no drinking water wells located near the site.

The climate in the St. Louis area is warm and moist in the summer and cold and dry in the winter. The annual average high and low temperatures are 88 degrees Fahrenheit and 23 degree Fahrenheit, respectively. The average annual precipitation is 36 inches.

3.3 Release Criteria

Release criteria or Derived Concentration Guideline Levels (DCGLs) have been determined for each medium for each residual radionuclide of interest regulated under the NRC license. These criteria do not apply to other radioactive material, such as background radioactivity, for example, or to unregulated radionuclides such as K-40. The following release criteria will be used at the Mallinckrodt site:

Soil Release Criterion

Radionuclide Group	Composite Dose Factor (mrem/yr)/(pCi/g)	DCGLw (pCi/g)
Th series	1.05	23.9
Natural Uranium	0.0347	721.
6 Th230 + Ra226 + Pb210	0.852	29.4

Composite Dose Factor and DCGLw Derived Separately

Dose factor and DCGLw of the thorium series is referenced to Th232.

Dose factor and DCGLw of natural uranium is referenced to U238.

Dose factor and DCGLw of Th230, Ra226, and Pb210 is referenced to Ra226

Surface Contamination Limits

Maximum Acceptable Surface Radioactivity on Items to be Released for Removal from a Restricted Area Without Restriction on Use.

Nuclides	Average (α /min·100 cm ²)	Maximum (α /min·100 cm ²)	Removable (α /min·100 cm ²)
U + Th mix in Plant 5	2800	8400	600

- A As used in this table, dpm α means the rate of emission of alpha rays determined by correcting instrument counts per minute for background, efficiency, and geometric factors
- B Measurements of average contaminant should not be averaged over more than 1 square meter. For an object of lesser surface area, the average should be derived for each such object.
- C The maximum contamination level applies to an area of not more than 100 cm².

- D The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

Pavement Release Criterion

Radionuclide	Dose Factor	Radioactivity on Pavement Surface Producing 20 mrem/yr	
		Areal Density Equal to 20 mrem/yr	
		(mrem/yr)/(pCi/g)	(pCi/100 sq cm) (dpm/100 sq cm)
U-238	8.57E-04	1.05E+06	2.33E+06
U-234	7.02E-05	1.28E+07	2.85E+07
U-235+DI	2.16E-02	4.17E+04	9.26E+04
Th-230	1.51E-04	5.94E+06	1.32E+07
Ra-226	4.54E-02	1.98E+04	4.41E+04
Pb-210	1.28E-03	7.04E+05	1.56E+06
Th-232	2.37E-03	3.80E+05	8.43E+05
Ra-228	2.98E-02	3.02E+04	6.70E+04
Th-228	3.20E-02	2.82E+04	6.25E+04
U nat ^{b,c}	1.91E-03	4.71E+05	1.05E+06
Th ²³⁰ +Ra ²²⁶ +Pb ²¹⁰ d	4.67E-02	1.93E+04	4.28E+04
Th series ^a	6.42E-02	1.40E+04	3.11E+04

- A Th232 series is the limit for Th232 with all its progeny nuclides present in equilibrium concentration (i.e., radioactivity concentration of each equal to the Th232 concentration). Because Th232 progeny grows in to equilibrium within about 30 years, and because the C-T facilities have existed for nearly that long, Th232 progeny can be expected to be near equilibrium.
- B U nat is the limit for U238 with U234, and their short-lived progeny present in equilibrium and the U235 series is present in equilibrium in the proportion occurring in natural uranium.
- C Radioactivity ratio of U235 -to- U238 = 0.0455 in natural uranium.
- D Th230 series includes Th230, Ra226, Pb210, and their short-lived progeny and is referenced to Ra226 radioactivity concentration.

3.4 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.

The radiological status of each C-T process and support area associated with Phase 2 decommissioning is provided in Appendix A of the DP and summarized below.

3.4.1 Contaminated Systems and Equipment

Systems and equipment to be addressed during Phase 2 include the utility systems used to support operations at the site. These utilities are water, electric, gas, sewer, and communications. The utilities, with the exception of sewer, will be relocated or worked around as necessary to facilitate remediation of surrounding contaminated soil.

Analytical information and knowledge of process obtained from the characterization studies indicate that portions of the Plant 5 sewer system have radiological constituents in concentrations greater than the proposed DCGLs. Samples from manholes indicate that the contaminated sewer line is confined to segments immediately southwest, west, and north of the former Building 238 site.

3.4.2 Pavement and Building Slabs

Direct survey results and scabble samples from the characterization studies indicate that almost all of the pavement of Plant 5 may be released for unrestricted use. Three of the 1670 measurement results exceeded the proposed DCGL release limit, and only one of the three pavement samples exceeded the exempt concentration limit for release of source material of 0.05% weight, described in 10 CFR 40.13(a).

Based on the measurement results, an area of pavement near former Building 238 (30 ft by 105 ft on the west side, and about 109 ft by 46 ft on the south side), totaling about 8200 square feet (ft²) has been designated as a NUREG 1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 2 survey unit.

In addition to the contaminated pavement, slabs from Plant 5 Buildings 213, 213A, 213B, 214, 238, 246, 246B, 247, 247A, 247B, and 248 are prospectively contaminated. The combined area of process and support building floor slabs equal 25000 ft². The total volume of the slabs is estimated to be 13000 cubic feet (ft³).

3.4.3 Subsurface Material

Characterization studies indicate that some soils in the Plant 5 area contain radionuclide concentrations exceeding the proposed DCGL release limits. The estimated volume of contaminated subsurface soil expected to exceed DCGL is approximately 42,000 ft³. Approximately 70,300 ft³ of unreacted C-T ore buried in 10 burial pits in Plant 6W is being excavated under License Amendment 4 which was approved on May 12, 2008 (ML080940414), and therefore, outside the scope of this EA. Contaminated subsurface material located in Plant 7 will be addressed during Phase 2, but only after an agreement on delineation of responsibility between Mallinckrodt and USACE is reached.

3.4.4 Surface Water

The only surface water in the area is the Mississippi River, adjacent the east side of the Mallinckrodt site. The river flow and site drainage characteristics are described in Section 3 of the DP. Due to the large flow volume of the Mississippi River and the environmental controls established for the site, there will be no detectable impact to surface water from decommissioning activities.

3.4.5 Ground Water

Total uranium, radium-226, and thorium-230 were analyzed in samples collected from eight monitoring wells during four quarterly sampling events between July 1988 and April 1989 (USACE, 1998). The groundwater was sampled again during a single event in late 1997/early 1998 that included 17 monitoring wells. Samples were analyzed for actinium-227, lead-210, protactinium-231, radium-226, radium-228, thorium-228, thorium-230, thorium-232, and total uranium. Summary data are presented in Appendix A of the DP. Total uranium (i.e. uranium-234, uranium-235 and uranium-238) was the only radionuclide detected in filtered samples at concentrations above background levels. The elevated concentrations were detected in only a single well, B16W02S, which is screened in perched groundwater in the upper zone in Plant 1 (to be addressed by USACE under FUSRAP, if necessary). The total uranium concentrations in this well have ranged from a 1988/1989 average of 228 micrograms per liter ($\mu\text{g/l}$) to a 1997/1998 value of 1,187 $\mu\text{g/l}$. These detections do not present a groundwater ingestion hazard since the perched groundwater in the upper zone is not a drinking water source. Although protactinium-231 was detected at concentrations up to 45 picocuries per liter (pCi/l) in unfiltered groundwater samples from three wells (none in the C-T process areas), it was not detected in filtered samples from these three wells. USACE has concluded that the protactinium is bound to sediment particles and that the unfiltered results are not representative of groundwater quality at the site. No radionuclides were detected above U.S Environmental Protection Agency (EPA) maximum concentration limit (MCL) in filtered groundwater samples from the lower zone. This finding suggests that the low-permeability silt and clay layers between the upper and lower zones retard contaminant migration between the two zones.

3.5 Areas to be Remediated

Most of the decommissioning activities will take place in Plant 5; however, the wastewater neutralization basins in Plant 7W will also be decommissioned. C-T process and support areas to be remediated are as follows:

3.5.1 Street Pavement

Plant 5 is paved with macadam or concrete. Upon removal of C-T process and support buildings in Plant 5 during Phase 1, a seal-coat of macadam was applied to building floor slabs. This temporary pavement will be removed from areas subject to survey to permit accurate survey of the pavement and slab surfaces of interest. Debris of the seal-coat will be confirmed to be contamination-free by bulk survey before disposal in an industrial waste landfill or recycling it in ready-mix asphalt pavement.

3.5.2 Building Slabs and Foundations

Plant 5 C-T process and support building floor slab and foundation surfaces exposed above grade that are subject to decommissioning include the floor slabs of former Buildings 213, 213A, 213B, 214, 238, 246, 246B, 247A, 247B, and 248. Floor slabs or foundation surfaces requiring remediation will either be decontaminated (e.g., by scabbling), or will be removed. In the event a floor slab or foundation is removed, its debris will be characterized for disposal and will be managed in accordance with the radioactive waste management program.

If access to contaminated subsoil is necessary, pavement or floor slabs will be removed. If contaminated soil is not present beneath pavement or floor slabs, they may be left in place. Where gross removal is necessary, it will be completed using standard construction equipment such as excavators, bulldozers, front-end loaders, dump trucks, compactors, water trucks, forktrucks, and miscellaneous small tools. Debris size reduction will be performed during excavation as required for transportation and disposal. Excavated pavement and associated soil and debris will either be loaded into shipping containers at the excavation site or will be transported to the soil handling area for characterization, segregation, staging and shipment.

3.5.3 Wastewater Neutralization Basins

The former wastewater neutralization basins in Plant 7W may either be removed and disposed by NRC-authorized transfer to a disposal facility or be decontaminated, if necessary, left in place, and subjected to final status survey (FSS). The wastewater neutralization basins and surrounding areas will be remediated, as necessary, using the following steps:

- basin liners will be removed and packaged for shipment and disposal;
- exposed concrete surfaces will be surveyed either for the purpose of establishing cost-effective disposal or final radiation status to compare with DCGL; and
- exposed surfaces of concrete structures may be decontaminated, as appropriate, by scabbling, grit blasting or similar techniques, or broken into appropriate size pieces for disposal, and loaded into transport containers using conventional demolition equipment and techniques.

The former wastewater neutralization basins in Plant 7W are contaminated with material from C-T process activities and MED-AEC activities. Mallinckrodt and USACE have not yet determined responsibility for the residual radioactive material located in Plant 7W. Decommissioning of the wastewater neutralization basins will proceed after Mallinckrodt and USACE prepare a delineation agreement defining responsibility for areas of residual radioactive contamination.

3.5.4 Sewerage Systems

3.5.4.1 Drains and Subsurface Sewerage That Served C-T Process Buildings

The drains and sewers that served Plant 5 C-T process buildings are the most likely to contain residues of licensed radioactive material. Interpretation of the manhole samples indicates that radioactive contamination in sewerage is confined to segments immediately southwest, west, and north of Building 238. Drains and sewerage that served C-T process Buildings 238, 246B, 247A&B, and 248 will either be plugged to prevent use or will be removed during removal of building floor slabs and shallow soil, if any. Figure 4.1 of the DP shows the location of manhole samples and sewer lines.

Main sewer lines immediately to the west and north of Building 238 will be removed or plugged in the process of remediation of subsurface soils beneath Building 238. If they are removed, the sewers and the sludge in them will be treated as radioactive waste. If plugged, the sewer line may be released for unrestricted use if warranted by a FSS as described in Section 14 of the DP. It is anticipated that sewers remaining downstream of Building 238, beginning even with the

west end of Buildings 236 and 245, and extending to the Waste Water Treatment Basin area, will remain in service after FSS and released for unrestricted use.

Plugging sewerage will prevent future use, contain sediment that might be in it, and prevent backflow from sewers remaining in use downstream, especially at the juncture of a sewer line upstream to be removed. If sewerage north and west of Building 238 is to be removed, the juncture in sewerage will be plugged before sewer line upstream of the plug will be removed in order that sewerage downstream may remain in use. Any sewerage north and west of Building 238 to be plugged rather than removed would be plugged at strategic points before excavation to remove connected sewer lines in order to prevent backflow from downstream. FSS of sewerage downstream remaining in use would be done after plugging upstream and after building slab, foundation, and soil remediation.

3.5.4.2 Drains and Subsurface Sewerage That Served C-T Support Buildings

Mallinckrodt does not anticipate that drains and subsurface sewerage that served Plant 5 C-T support buildings will contain C-T related contamination in excess of the release criteria. Access points, including such drains, traps, and other at-grade locations that may have been exposed to C-T materials will be identified and surveyed for radioactivity. If these surveys identify contamination, interior surveys, i.e., sediment sampling, will be performed. The access points, sampling locations, and survey findings will be recorded. If surveys in access points do not identify the presence of radioactivity above the DCGL, it is assumed that radioactivity in downstream sewerage will also be less than the DCGL.

3.5.4.3 Drains and Subsurface Sewerage That Served C-T Yard Areas

Drains and subsurface sewerage that served C-T yard areas will be addressed in a manner similar to that employed for drains and subsurface sewerage that served C-T support buildings.

3.5.4.4 Plant 7 Lift Station

The Plant 7 Neutralization basin lift station interior surfaces will be surveyed for radioactive contamination, including any exposed joints. Areas exceeding the DCGL for pavement will be decontaminated using scabbling, grit blasting, or other techniques, or will be removed.

3.5.4.5 Sewerage That Served MED/AEC Operations

USACE is addressing sewerage serving MED/AEC operations under the FUSRAP program, including sewerage that may contain commingled C-T residue. Those sewers are not within the scope of the DP.

3.5.4.6 Sewerage That Served Neither C-T Nor MED/AEC Operations

No decommissioning activity will be performed in other sewers as they cannot reasonably be expected to contain C-T contamination in excess of criteria.

3.5.5 Soil

Characterization data indicate that radioactive residue in some soils beneath and adjacent to C-T process Building 238 exceeds the DCGL. Soil remediation will generally be performed as follows:

- three-dimensional modeling of characterization data will define the gross outline of areas exceeding the soil DCGL;
- the areas where the DCGL is exceeded will be excavated using conventional construction equipment;
- radiation measurements will be employed to guide remedial excavation;
- excavated soils will be loaded into trucks or containers at the site of remediation and moved to the material handling area or shipped in accordance with NRC-authorized transfer to a state-regulated disposal facility;
- a FSS will be performed in each remediated area;
- excavated soil demonstrated to contain lower radioactivity concentration than the DCGL may be returned into an excavation pit; and
- remediated areas will be backfilled, compacted, graded, and resurfaced, as appropriate.

In the event groundwater were to prevent direct access to survey the bottom of an excavation cavity, an alternative would be to backfill as much as one meter and do final status core sampling through the backfill into the unexcavated bottom. Adjacent land not requiring excavation in the same survey unit will be subject to soil core sampling and analysis to complement the FSS.

Mallinckrodt and USACE have not yet finalized an agreement delineating responsibility for soil beneath the former wastewater neutralization basins in Plant 7W. Mallinckrodt's license will be amended to state that Mallinckrodt must receive NRC approval of the Plant 7W delineation agreement before conducting any remediation activities in that area.

3.5.6 Ground Water

No groundwater remediation is anticipated below C-T process areas because: (1) there is no evidence that radiological contamination exists below C-T process areas; and (2) there is no groundwater exposure pathway at the site.

Groundwater monitoring has been performed at the site by Mallinckrodt, U.S Department of Energy (DOE) and USACE and is described in Appendix A of the DP. Based on the site well monitoring data, there is no evidence that radiological contamination exists in the ground water beneath the C-T process areas. Total uranium is the only radionuclide detected in filtered samples at elevated concentrations at the Mallinckrodt site. The elevated concentrations were detected in only a single well, B16W02S, which is screened in perched groundwater in the upper zone in Plant 1, which is not a C-T process area. The total uranium concentrations in this well have ranged from a 1988/1989 average of 228 µg/l to a 1997/1998 value of 1,187 µg/l. These levels are not a groundwater ingestion hazard because the perched groundwater in the upper zone is not a drinking water source.

Although protactinium-231 was detected at concentrations up to 45 pCi/l in unfiltered groundwater samples from three wells (none in C-T process areas), it was not detected in

filtered samples from these three wells. USACE has concluded that the protactinium is bound to sediment particles and that the unfiltered results are not representative of groundwater quality at the site. No radionuclides were detected above EPA MCLs in filtered groundwater samples from the lower zone within the Mallinckrodt site boundary.

Mallinckrodt will monitor water in the C-T process areas for radionuclide contamination as part of waste handling process. Water collected in excavations during remediation, either from runoff or groundwater, will be collected and sampled before being discharged in accordance with 10 CFR 20.2003 and Mallinckrodt's Metropolitan St. Louis Sewer District discharge permit. Mallinckrodt will be required, by license condition, to notify NRC if filtered water samples exceed the contain radionuclides exceeding the EPA MCLs.

There is not a complete groundwater exposure pathway at the site. The NRC has concluded that an industrial use exposure scenario, without a ground water exposure pathway, is appropriate for the C-T process areas. The groundwater beneath the site is not a current source of drinking water, nor will it likely be a source of drinking water in the future. The City of St. Louis operates and maintains a municipal water system and there are no groundwater withdrawal wells in the site vicinity. Furthermore, a City ordinance prohibits installation of drinking water wells in areas such as the Mallinckrodt site, and groundwater discharges to the Mississippi River immediately downgradient of the site.

3.6 Approach to Decommissioning

Mallinckrodt will continue to engage in its non-licensed pharmaceutical business at the St. Louis site while decontamination and remediation are performed at the C-T processing areas. Mallinckrodt selected the following decommissioning strategy: (1) remediate remaining floor slabs and subsurface soils and systems by decontamination or excavation and disposal followed by a final survey; (2) remediate former wastewater neutralization basins by decontamination or demolition and disposal followed by FSS where appropriate; and (3) remediate sewerage.

Mallinckrodt will determine whether decontamination and FSS of individual materials is preferred over excavation and disposal. The Phase 2 DP is based on the following preferences: (1) excavation or demolition and disposal when it is cost-effective; (2) decontamination when it is judged to be cost-effective compared to disposal; and (3) decontamination or removal of selected contaminated areas of pavement and subsurface material to < DCGL, to reduce the volume of waste and therefore minimize the cost of disposal.

Mallinckrodt's general technical approach for decommissioning is: 1) decontamination, if necessary, or removal of remaining C-T building floor slabs and foundations; 2) removal or plugging of contaminated sewers and soils; 3) packaging and shipping of contaminated materials for transfer to an appropriate facility; 4) final radiation status survey; 5) backfilling and compaction of remediated areas; and 6) final grading and paving.

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.

Surveying, decontamination, excavation, and removal of drains and subsurface sewerage do not entail unique construction or remediation safety issues. Mallinckrodt has safely and effectively performed such activities during the ongoing operation and maintenance of the facility.

3.7 Final Survey Plan

Mallinckrodt has committed to conducting a FSS consistent with the approach presented in the MARSSIM, to the extent possible. The residual radioactive material release criteria or DCGLs have been derived for soil, pavement and equipment surfaces. 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."

The FSS 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. Table 14.1 of the DP lists the types of instrumentation that will be used for final status survey activities.

3.8 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;
- potential sources of contamination exposure; and
- ALARA.

The DP 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.

3.9 ALARA Plan

Mallinckrodt will keep radiation exposures to workers, the public, and the environment ALARA mainly through the use of safety 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 during remediation. NRC staff will evaluate implementation of the Environmental Safety Program during routine inspections to ensure that Mallinckrodt is adequately monitoring effluent releases.

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. Phase 2 decommissioning activities will not involve the use of significant chemicals requiring treatment and disposal. Mallinckrodt expects minimal use of water for dust control during soil remediation and demolition of paved surfaces. Mallinckrodt will not generate free water during dust control. The most likely source of potentially contaminated liquids is stormwater from active remediation areas. Stormwater may contain contaminated soil particles. Soil management activities will minimize the exposure of contaminated soils to stormwater. Stormwater will in active remediation areas will be collected and stored in temporary, above ground tanks. Collected water will be sampled and filtered, as necessary, to remove the solids, and analyzed to estimate the concentration in the sewerage. The 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 met.

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.

4. ALTERNATIVES TO THE PROPOSED ACTION

The remediation approach proposed by Mallinckrodt provides for the systematic remediation of the C-T process areas at the Mallinckrodt site. This approach provides Mallinckrodt the opportunity to remove residual radioactive material resulting from C-T processing activities from the site, to the extent necessary that C-T process areas meet NRC's criteria for unrestricted release. The "No Action" is the only alternative to the proposed action.

The No Action alternative is not acceptable because the C-T process areas contain residual contamination exceeding NRC's release criteria. Further, taking no action on the Phase 2 DP would be contrary to 10 CFR 40.42(d) which requires that decommissioning proceed after licensed operations permanently cease.

5. AFFECTED ENVIRONMENT

As stated in the Introduction, MED-AEC contamination at Mallinckrodt facility is being removed by USACE under FUSRAP. USACE developed a preferred cleanup approach for the MED-AEC contamination, based on the data and findings presented in four documents: (1) Remedial Investigation Report; (2) Baseline Risk Assessment; (3) Initial Screening of Alternatives; and (4) Feasibility Study.

Section 2.2 of the Feasibility Study provides an evaluation of the affected environment surrounding the Mallinckrodt facility. The findings in Section 2.2 of the Feasibility Study also apply to remediation of the C-T process areas. The following issues are addressed: (1) Land use and recreational and Aesthetic resources; (2) Climatology, meteorology, and air quality; (3) Geology and soils; (4) Water resources; (5) Biological resources; (6) Threatened and endangered species; (7) Wetlands and floodplains; (8) Population and socioeconomics; and (9) Historical, archeological, and cultural resources.

6. ENVIRONMENTAL IMPACTS

6.1 Radiological Impacts

Remediation of the C-T process area building foundations, soil, pavement and sewers creates a potential for radiological environmental impacts. Radiological environmental impacts that could result from remediation activities include exposure, inhalation, and ingestion hazards to workers and the public. These hazards could occur during excavation and loading of radioactively contaminated material.

Mallinckrodt has committed to perform work activities in accordance with a Health and Safety Program as described in Section 3 of the DP. The Health and Safety Program will consist of: (1) an Industrial Safety Program; (2) a Radiation Protection Program; and (3) an Environmental Safety Program. The Radiation Protection Program will contain controls to monitor exposures to workers. Action levels have been established based on 10 CFR 20, Appendix B. If action levels are exceeded, Mallinckrodt will take corrective action, as necessary. The Radiation Protection Program will keep exposures due to ingestion and inhalation ALARA by controlling and monitoring airborne releases in work areas, and by utilizing respiratory protection, as necessary.

Mallinckrodt will implement an Environmental Safety Program to monitor air and water effluents discharged during decommissioning. Mallinckrodt is proposing to collect air and water samples routinely to determine the extent of environmental discharges. Mallinckrodt does not anticipate the need for effluent air monitoring since there will likely be no point sources of effluent air. However, if Mallinckrodt uses a decommissioning process exhaust ventilation system, the effluent air will be sampled and analyzed. Mallinckrodt will provide environmental monitoring stations to verify that there are no significant adverse impacts to the workers or the environment.

Mallinckrodt has committed to minimize the production of contaminated liquids. Phase 2 decommissioning activities will not involve the use of significant chemicals requiring treatment and disposal, and the use of water for dust control during soil remediation and demolition of paved surfaces will be kept to a minimum. However, stormwater may contain contaminated soil particles. Soil management activities will minimize the exposure of contaminated soils to stormwater. Stormwater in active remediation areas will be collected and stored in temporary, above ground tanks. Collected water will be sampled and filtered, as necessary, to remove the solids, and analyzed to estimate the concentration in the sewerage. The 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 MSD following confirmation that MSD specifications for sampling, analysis, and pre-treatment have been met.

Mallinckrodt has also committed to monitor direct radiation using 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.

Mallinckrodt has established action levels for air and water effluents based on the levels provided in 10 CFR 20, Appendix B, Tables 2 and 3. The action levels for environmental air, effluent water and sewage are 0.75, 0.6, and 0.6 of the limits, respectively. If action levels are exceeded, Mallinckrodt will take corrective actions.

6.2 Nonradiological Impacts

The Mallinckrodt site is located in an area which is completely developed with no pre-settlement vegetation existing. Land use within a one mile radius from the site is a mixture of commercial, industrial, and residential. Commercial or industrial properties in the area include McKinley Iron Company, Thomas and Proetz Lumber Company, and several railroad properties. The USACE Feasibility Study states that there was no sign of federal or state designated endangered or threatened species present at the Mallinckrodt facility. The Feasibility Study also states that the Mallinckrodt facility does not contain any historic buildings. Further, available data indicate that there are no archeological sites in the area.

The residential population within one mile of the site is approximately 10,000, with most of the residences located on the opposite side of Interstate 70. Mallinckrodt estimates that approximately 14 workers will be required to Phase 1 decommissioning activities. Due to the small number of workers required for decommissioning, and the short duration of the project, this effort should have minimal socioeconomic impact on the local community.

NRC staff performed an environmental justice review of the Mallinckrodt site for Phase 1 decommissioning activities. The review concluded that since Phase 1 decommissioning activities result in an insignificant risk to the public health and safety, and the human

environment. The scope of Phase 2 decommissioning activities is similar to the Phase 1 activities and thus there are no environmental justice issues with this action.

Air quality and noise impacts will result from demolition of foundations, excavation of soil and sewerage, and transport of waste. Mallinckrodt will use appropriate dust control measures during demolition and excavation. These activities will be sporadic in nature and short in duration; and, therefore, will have minimal impact on the surrounding community and environment.

The Mallinckrodt facility can be serviced by road, rail, and river barge. Interstate 70 (east and west) can be accessed within one mile from the Mallinckrodt site. Rail lines from the Chicago, Burlington, and Quincy Railroad, the Norfolk and Western Railroad, and the St. Louis Terminal Railroad Association, transect the Mallinckrodt site from north to south. Waste will be shipped from the site by rail. Mallinckrodt estimates that the total volume of waste to be shipped from the site will be approximately 59,100 ft³. This volume of waste will require less than 50 rail cars spread over an 18 month time period. Therefore, the impact of transporting waste from the site should be insignificant.

7. AGENCIES AND PERSONS CONSULTED AND SOURCES USED

Much of the information contained in this Environmental Assessment (EA) was taken directly from the Mallinckrodt DP and the USACE Feasibility Study. In preparation of the Feasibility Study, USACE consulted with the U.S. Fish and Wildlife Service and the State Historic Preservation Office. Since Phase 2 decommissioning activities will be occurring at the same site as USACE decommissioning activities, with a much more limited scope, NRC has utilized the input of the U.S. Fish and Wildlife Service and the State Historic Preservation Office by reference of the Feasibility Study. NRC staff provided a draft of this EA to the State of Missouri for review, and the States concerns were addressed in the final EA as described in a letter dated May 24, 2010 (ML101370174).

8. CONCLUSION

Radiological exposures to workers and the public will be in accordance with 10 CFR Part 20 limits. NRC believes the DP contains sufficient controls to keep potential doses to workers and the public from direct exposure, airborne material, and released effluents, ALARA. The staff also believes that the remediation alternative proposed by Mallinckrodt minimizes the potential dose to workers and members of the public, and other environmental impacts.

9. LIST OF PREPARERS

This EA was prepared by John Buckley, Senior Project Manager, Division of Waste Management and Environmental Protection. No other sources were used beyond those referenced.

10. FINDING OF NO SIGNIFICANT IMPACT

Pursuant to 10 CFR Part 51, NRC has prepared this EA related to the approval of Mallinckrodt's DP. On the basis of this EA, NRC has concluded that this Federal action would not have any significant affect on the quality of the human environment and does not warrant the preparation

of an Environmental Impact Statement. Accordingly, it has been determined that a Finding of No Significant Impact is appropriate.

Since the conclusion of this EA is that the remediation of the C-T project areas of Mallinckrodt's St. Louis Plant represents no significant risk to the public health and safety and the human environment, NRC concludes that there are no environmental justice issues related to remediation.

The aforementioned documents related to this proposed action are available for public inspection and copying at NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, MD 20852-2738.

11. LIST OF REFERENCES

- 11.1 Mallinckrodt Chemical, Inc., Mallinckrodt C-T Decommissioning Project, C-T Phase II Decommissioning Plan, Revision 2, October 14, 2008.
- 11.2 U.S. Army Corps of Engineers, Proposed Plan for the St. Louis Downtown Site, April 1998.
- 11.3 U.S. Army Corps of Engineers, Feasibility Study for the St. Louis Downtown Site, April 1998.
- 11.4 NRC, Policy and Guidance Directive FC 83-23, "Termination of Byproduct, Source, and Special Nuclear Material Licenses," November 1983.
- 11.5 NRC, 10CFR Part 20, "Radiological Criteria for License Termination: Final Rule," July 1997.
- 11.6 NRC, NUREG/CR-5512, "Residual Radioactive Contamination From Decommissioning," October 1992.