Phase II Final Status Survey Report
Mallinckrodt Columbium-Tantalum Plant

St. Louis, Missouri

Executive Summary

Project No. 137131 **Revision 0**

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EXECUTIVE SUMMARY

Mallinckrodt LLC (Mallinckrodt) is a Delaware Corporation with its principal place of business located at 675 McDonnell Boulevard, St. Louis, MO, 63042. Their former Columbium-Tantalum (C-T) Plant, located within the Mallinckrodt St. Louis Plant at 3600 North Second Street, St. Louis, Missouri, 63147, is currently licensed by the U.S. Nuclear Regulatory Commission (NRC) and is located near the west bank of the Mississippi River in the northeastern section of the City of St. Louis. This licensed facility is being decommissioned in order to terminate their NRC License STB-401 per the license termination criteria contained in the NRC approved Columbium-Tantalum (C-T) Phase II Decommissioning Plan (DP).

SITE HISTORY:

Between 1942 and 1958, Mallinckrodt refined uranium ore and concentrate to produce uranium compounds and metal in support of early Federal Government programs to develop atomic weapons under the Manhattan Engineering District (MED) and later the Atomic Energy Commission (AEC). Areas of the St. Louis Plant and vicinity properties affected by MED-AEC material are currently being remediated under the U.S. Government Formerly Utilized Sites Remedial Action Program (FUSRAP) by the U.S. Army Corps of Engineers (ACE) and are not addressed as part of this decommissioning and license termination effort.

From 1956 to 1960, Mallinckrodt extracted columbium, tantalum, uranium, thorium, and rare earth elements from euxenite mineral ore for delivery to the AEC and the General Services Administration (GSA) as part of the Defense Materials Procurement Program. The Euxenite operation was performed under AEC source material license R-226 which expired in 1960.

From 1961 to 1989 Mallinckrodt extracted columbium and tantalum compounds under NRC License STB-401 from ores in the C-T processing buildings formerly located within the city block identified as Plant 5. The C-T feed materials included ore and tin slag; process products included tantalum oxide, potassium fluotantalate, and columbium oxide. The same processing facilities used under the AEC source material license R-226 were also subsequently used for C-T processing.

APPROACH:

The goal of the decommissioning is to remediate the remaining radiological constituents associated with the C-T process to the extent required to terminate the NRC license, STB-401. The guidance as provided in US NRC NUREG-1757, Vol. 2, Section 2.5, notes that there is "flexibility in the general approach to demonstrating compliance with Title 10, Code of Federal Regulations (CFR), Part 20, Subpart E" for license termination. Two major approaches described in the NRC guidance include 1) development of derived concentration guideline levels (DCGLs) and the performance of final status surveys and 2) dose modeling following characterization and remediation as necessary. The first approach in developing DCGLs and demonstrating compliance through final status surveys is described in Chapters 5 and 14 of the C-T Phase II DP; however, the NRC guidance adds that the two approaches are not mutually exclusive and that both are acceptable to show that the residual dose is acceptable for license termination.

During decommissioning, the facility was delineated into survey units for ease of remediation and final status survey. For most survey units, Mallinckrodt was able to demonstrate compliance with the NRC-approved approach as described in Chapters 5 and 14 of the C-T Phase II DP; however, for a limited number of survey units, compliance could not be demonstrated through the application of the sum of fractions (SOF) using the DCGLs alone and a dose assessment was performed. Performance of direct dose assessment for compliance demonstration following the guidance of NUREG-1757 is not included in the C-T Phase II DP and the use of this means of compliance demonstration represents an adjustment, or change, to the approved DP. Section 9.5 of the C-T Phase II DP describes adjustments to the decommissioning process and provides a list of conditions that must be satisfied for a justified change related to the decommissioning process to be acceptable to the NRC without filing an application for amendment. All conditions of Section 9.5 of the C-T Phase II DP (a through m) were either not applicable to this change or were satisfied and approved by Mallinckrodt's and Energy*Solutions*' Project Managers and Radiation Safety Officers.

The application of the dose assessment was limited to situations where inaccessible residual contamination exceeded an SOF of one. Residual contamination was considered inaccessible if it could not be removed because remediation activities would negatively impact active plant buildings, systems and/or operations (e.g., residual contamination under the vertical pipe stands in Plant 5).

SUMMARY FINDINGS:

Final status data evaluation and statistical analyses were performed and a separate decision made for each survey unit of the C-T Plant as to its suitability for release for unrestricted use based upon the release criterion as established in Chapter 5 of the C-T Phase II DP. Data was collected and compared to the DCGLs and each survey unit assessed including an evaluation of any remaining elevated areas. Survey units that failed the DCGL (i.e. SOF > 1) and elevated area anlayses were further evaluated using a dose assessment to demonstrate compliance with the residual dose requirements for license termination. A summary of the final status results and the residual dose(s) for the survey units from Plant 5 is provided as Table ES-1 and Table ES-2 respectively.

In addition to the FSS sampling summarized in Table ES-1 and Table ES-2, any residual subsurface contamination as applicable was also evaluated across each survey unit. The vertical column of soil averaged in 1 meter increments (i.e., 0-1, 0-2, 0-3 etc) was assessed using the same screening tests as applied to evaluate the FSS data. No concerns were identified with residual subsurface contamination.

Based upon the FSS data as collected and evaluated within the Plant 5 area as summarized in Table ES-1, Table ES-2 and presented in this report, it has been shown that the C-T licensed areas meet the requirements for unconditional release as outlined in the C-T Phase II DP. As a result, it is recommended that the Mallinckrodt LLC NRC License STB-401 be terminated.

Table ES-1 Survey Unit Summary – Compliance Matrix (Surface)

Survey Unit	Chapter	Class (1, 2 or 3)	Data Set Analysis (Systematic Sample Set)					Elevated Area Analysis				Releasable
			Min/Max	Low Level [a]	DCGL [b]	WRS [b]	Retrospective Analysis	Area(s)	EMC Limit	Index $DCGL_{EMC}$	Dose Assessment [c]	
Plant 5 Pavement	6	3	Pass	Pass	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU01	7	1	Pass	N/A	N/A	N/A	Pass	EA#1	Pass	Pass	N/A	YES
SU02	8	1	Pass	N/A	N/A	N/A	Pass	EA#1	Pass	Pass	N/A	YES
SU03	9	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU04	10	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU05	11	1	Fail	N/A	Pass	Pass	Pass	EA#1	Pass	Pass	N/A	YES
SU06	12	1	Pass	N/A	N/A	N/A	Pass	EA#1	Pass	Pass	N/A	YES
								EA#2		Fail	Pass	
SU07	13	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU08	14	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU09	15	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU10	16	1	Pass	N/A	N/A	N/A	Pass	EA#1	Pass	Pass	N/A	YES
SU11	17	1	Fail	N/A	Pass	Pass	Pass	EA#1	Pass	Pass	N/A	YES
								EA#2		Fail	Pass	
								EA#3		Fail	Pass	
SU12	18	1	Fail	N/A	Pass	Pass	Pass	EA#1	Pass	Fail	Pass	YES
								EA#2		Fail	Pass	
								EA#3		Fail	Pass	
								EA#4		Fail	Pass	
SU13	19	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU14	20	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU15	21	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU16	22	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU17	23	1	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU18 [d]	24	1	N/A	N/A	N/A	N/A	N/A	EA#1	N/A	N/A	Pass	YES
SU19	25	1	Fail	N/A	Pass	Pass	Pass	EA#1	Pass	Pass	N/A	YES
SU20	26	1	Fail	N/A	Pass	Pass	Pass	EA#1	Pass	Pass	N/A	YES
								EA#2		Fail	Pass	
								EA#3		Fail	Pass	
SU21	27	3	Pass	Fail [e]	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
SU22	28	1 (3) [f]	Pass	N/A	N/A	N/A	Pass	EA#1a	Pass	Pass	N/A	YES
								EA#1b		Pass	N/A	
								EA#2		Pass	N/A	
								EA#3		Fail	Pass	
Sewerage	29	3	Pass	Pass	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
Plant 7 Pavement	30 (SU1)	2	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
	31 (SU2)	2	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
	32 (SU3)	2	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES
	33 (SU4)	2	Pass	N/A	N/A	N/A	Pass	--	N/A	N/A	N/A	YES

[a] The low level screening test was not applicable for Class 1 and 2 areas.
[b] The WRS test was not applicable if the Min/Max value was less than 1 (i.e., no systematic measurements exceed the $DCGL_W$).
[c] A dose assessment was only required if either the EMC Limit test or the index value for any individual elevated area exceeds 1.
[d] A specific FSS was not performed for SU18. SU18 was a small area that was segregated from SU21 based upon sample results. SU18 was evaluated using a dose assessment for compliance.
[e] The low level screening test failed for SU21 as several samples exceeded the investigation level for a Class 3 area. These areas were investigated further and no additional concerns were identified.
[f] SU22 was origionally classified as a Class 3 area. Based upon sample results, this survey unit was reclassified as a Class 1.

Table ES-2 Survey Unit Summary – Residual Dose (Plant 5)

Survey Unit	Systematic Samples		EMC Dose [a] (mr/yr)	Total Dose (mr/yr)	Area (m^2)	Fractional Area (%)	Fractional Dose (mr/yr)
	SOF_{Net}	Dose (mr/yr)					
SU01	0.02	0.50	N/A	0.50	353	1.56%	0.01
SU02	0.04	1.00	N/A	1.00	161	0.71%	0.01
SU03	0.06	1.50	N/A	1.50	252	1.11%	0.02
SU04	0.05	1.25	N/A	1.25	102	0.45%	0.01
SU05	0.29	7.25	N/A	7.25	480	2.12%	0.15
SU06	0.10	2.50	0.00	2.50	393	1.73%	0.04
SU07	0.04	1.00	N/A	1.00	577	2.54%	0.03
SU08	0.02	0.50	N/A	0.50	101	0.45%	0.00
SU09	0.01	0.25	N/A	0.25	269	1.19%	0.00
SU10	0.08	2.00	N/A	2.00	743	3.27%	0.07
SU11	0.05	1.25	0.00	1.25	767	3.38%	0.04
SU12	0.30	7.50	5.74	13.24	701	3.09%	0.41
SU13	0.14	3.50	N/A	3.50	2,170	9.56%	0.33
SU14	0.10	2.50	N/A	2.50	227	1.00%	0.03
SU15	0.05	1.25	N/A	1.25	338	1.49%	0.02
SU16	0.01	0.25	N/A	0.25	156	0.69%	0.00
SU17	0.03	0.75	N/A	0.75	305	1.34%	0.01
SU18	--	--	17.00	17.00	248	1.09%	0.19
SU19	0.19	4.75	N/A	4.75	303	1.34%	0.06
SU20	0.07	1.75	0.09	1.84	294	1.30%	0.02
SU21	0.04	1.00	N/A	1.00	11,131	49.05%	0.49
SU22	0.08	2.00	12.00	14.00	2,622	11.55%	1.62
Total	N/A	N/A	N/A	N/A	22,693	100 %	3.55
Average	0.08	2.11	N/A	3.59	N/A	N/A	N/A

[a] The EMC dose as presented was calculated by dose assessment for each elevated area which failed the EMC index test as specified in Table ES-1.