

**TECHNICAL EVALUATION REPORT  
COMPLETION OF DECOMMISSIONING ACTIVITIES  
STEPAN COMPANY FACILITY, MAYWOOD, NEW JERSEY  
DOCKET NO: 40-8610, LICENSE NO: STC-1333**

## **1. Background**

Maywood Chemical Works processed thorium ore at its Maywood facility in northeastern New Jersey between 1916 and 1956. Radioactive contamination resulted from these processing operations and associated material storage and waste disposal practices. In 1959, Stepan Chemical Company (now Stepan Company) purchased the Maywood facility. In the late 1960s, Stepan took corrective measures at some of the former disposal areas by re-locating approximately 19,000 cubic yards of thorium wastes and consolidating the wastes into three on-site pits. The three on-site burial pits were subsequently licensed by the NRC under materials license STC-1333. Stepan currently conducts chemical processing activities at its Maywood, NJ site that do not include the use of NRC-licensed radioactive materials.

In 1983, the U.S. Environmental Protection Agency (EPA) included the site on its National Priorities List for cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In 1984, the U.S. Department of Energy (DOE) assumed responsibility for remediating the Stepan Maywood facility (including the NRC-licensed burial pits) and 87 other designated residential, commercial, and government properties that were contaminated by the thorium processing activities at the former Maywood Chemical Works. The Stepan Maywood facility was included in the Formerly Utilized Sites Remedial Action Program (FUSRAP) along with the other 87 radiologically contaminated properties. The Stepan site and the additional properties discussed above are collectively known as the FUSRAP Maywood Superfund Site.

In October 1997, the management and administration of FUSRAP was transferred from the DOE to the U.S. Army Corps of Engineers (USACE). In July 2001, a Memorandum of Understanding (MOU) was executed between the NRC and the USACE to facilitate remediation of NRC-licensed sites (including the Stepan facility) that were to be remediated under FUSRAP. The purpose of the MOU was to minimize dual regulation and coordinate activities of the two agencies under their respective programs. In September 2003, the Record of Decision (ROD) for Soils and Buildings at the FUSRAP Maywood Superfund Site was issued. The publicly available ROD explains which methods will be used to clean up the Maywood facility. In the ROD, the specific concentration-based cleanup criteria for the radioactive contamination in soil for commercial properties (relevant to the Stepan burial pits) was determined to be an average of 15 picocuries/gram (pCi/g) of the combined radium-226 (Ra-226) plus thorium-232 (Th-232) concentrations above background, with an "As Low As is Reasonably Achievable" (ALARA) goal of 5 pCi/g. The ROD also includes a criterion of 100 pCi/g above background for total uranium, which equates to approximately 50 pCi/g of uranium-238 (U-238).

On October 21, 2008, the NRC executed a Confirmatory Order to suspend Stepan's license, contingent upon the USACE notifying the NRC of their intent to take physical possession of all, or part, of the licensed portions of the site. The Order provided the USACE with the mechanism to request that the NRC suspend (put into abeyance) the NRC license for the Stepan burial pits. In December 2008, August 2009, and January 2010, the USACE notified the NRC that it had taken physical possession of Burial Pits #2, #3, and #1, respectively.

On February 14, 2012, the USACE notified the NRC that the remediation response action had been completed for all three of the NRC-licensed burial pits, and pursuant to the MOU, the USACE also provided notification of its intent to terminate physical possession of all three licensed burial pits in May 2012. On May 7, 2012, NRC license STC-1333 was reinstated when Stepan re-established possession of the burial pits in accordance with the Confirmatory Order. Stepan has since submitted a request to the NRC for the termination of their materials license.

This Technical Evaluation Report (TER) documents the NRC's review of the results of the Final Status Survey (FSS) activities and evaluates whether these clean-up activities satisfy the NRC's 0.25 mSv/yr (25 mrem/yr) radiological dose criterion defined in 10 CFR 20.1402. Meeting these requirements would allow the NRC to consider terminating Stepan's materials license for the Maywood facility.

## 2. Evaluation of Dose Assessment

### 2.1 Source Term

Radioactive waste contents in the burial pits included soil contaminated with radionuclides related to previous thorium processing activities performed by the former Maywood Chemical Works. The original source ore included radionuclides associated with the natural thorium series, natural uranium series, and actinium series. The indicator radionuclides of concern measured by the USACE are Thorium-232 (Th-232), Radium-226 (Ra-226), Uranium-238 (U-238), and their progeny. The average concentrations measured during the FSS, which occurred after remediation but before backfill activities have taken place, are included in Table 1. Use of these concentrations can be considered conservative since the addition of backfill would further dilute the radionuclide concentrations. Progeny of the indicator radionuclides are also included in the RESRAD analyses with identical concentrations as they are considered to be in equilibrium. The reported radionuclide concentrations also include the background concentrations for the area around the Stepan site, adding additional conservatism to the radionuclide concentrations used in the RESRAD analyses.

**Table 1.** Radionuclide concentrations following excavation<sup>1</sup>

Burial Pit	Total Survey Area (m <sup>2</sup> )	Average Concentration (pCi/g)		
		Ra-226	Th-232	U-238
1	2621	1.55	5.13	1.24
2	2069	1.11	1.35	0.94
3	6147	1.30	2.69	0.96
Combined	10837	1.37	3.46	1.06

<sup>1</sup> Adapted from Table 1 of Radiological Dose Assessment

As part of the review, the NRC staff did note that the gamma walkover surveys performed as part of the FSS identified an area of elevated activity in Burial Pit #1, Survey Unit 10A-30 that required further investigation. Additional analyses, including the collection of soil samples, determined that the activity associated with the entire survey unit plus the activity from the elevated area were acceptable in accordance with the unity rule presented in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)".

The NRC staff finds that the use of radionuclide concentrations measured prior to the addition of backfill and the retention of the background concentrations to be an acceptable method for establishing conservative radionuclide concentrations for use in dose calculations associated with the Stepan site. The NRC staff also finds the process used to evaluate the impacts from the elevated area found in Survey Unit 10A-30 to be acceptable.

## **2.2 Land Use**

Stepan proposes that future land use at the site will remain industrial. This prediction is based on the fact that the Stepan property is located in an urban industrial area containing a manufacturing facility that has operated continuously for more than 100 years. Stepan has been operating the current manufacturing plant on the property since 1959 and intends to continue operations on the site for the foreseeable future. Current land use immediately surrounding the site includes a mixture of commercial and industrial facilities as well as transportation corridors, including highways and a railway. Numerous residential areas do exist in the area surrounding the industrial area. However, residential use is not expected in the foreseeable future due to municipal government zoning restrictions and the recommendations of the current Maywood Master Plan. Future use of the site for industrial activities is further justified by the fact that the USACE, DOE, and EPA have based their cleanup standards for chemical and radiological remedial actions on the site and surrounding properties for nonresidential uses.

## **2.3 Critical Group and Exposure Pathways**

Based on the land use scenarios discussed in Section 2.2, industrial workers are considered to be the most critical exposure scenario for the foreseeable future. Modeling the dose to the industrial workers on the site considers exposure directly from external exposure to material in the ground, inadvertent ingestion of soil, and inhalation of dust suspended in the air. There are no surface water sources on the site and the site receives water from the municipal water supply. Groundwater is not currently a drinking water source, nor is it expected to be in the foreseeable future. Moreover, restrictions established by the EPA further prevents the use of groundwater as a drinking water source.

Impacts from these exposure pathways as well as the overall doses to the industrial workers on the site are actually less than the values calculated below as a result of remediation activities previously performed by the USACE. These include placing clean fill in all of the former burial areas and, in the cases of Burial Pits #2 and #3, covered them with crushed stone.

## **2.4 Site-Specific Dose Modeling**

Stepan used RESRAD, Version 6.4, to calculate the Total Effective Dose Equivalent (TEDE) to an average member of the critical group (i.e., the industrial worker). Stepan performed the modeling using the radionuclide concentrations measured in the burial pits following soil removal and prior to the addition of backfill material and gravel cover. A combination of site-specific and default parameter values were used to model the industrial worker scenario. Contaminated zone area values used were larger than the actual sizes, providing more conservatism to the analyses. The basis for the use of specific values for some key parameters are provided in Table 2.

In addition to reviewing the dose analyses performed by Stepan for the industrial worker scenario, the NRC staff calculated doses associated with additional, more conservative exposure scenarios using RESRAD, Version 6.5. These more conservative exposure scenarios included the suburban resident and the resident farmer. The resident farmer scenario, a scenario which is not likely to occur in the foreseeable future, incorporates the most exposure pathways and therefore provides the most conservative dose values related to the exposure to contaminants at the Stepan site. Although not considered by Stepan to be reasonably foreseeable, the large number of residential establishments in the area surrounding the site makes the suburban resident scenario another logical scenario to consider. Specific parameter values considered for these scenarios are included in Table 3. It should be noted that doses to a suburban resident or a resident farmer residing on the site would require the implicit assumption that all institutional controls fail, including the loss of all backfill placed in the excavated ponds, and that land use on the site changes significantly from the industrial activities currently occurring on the site. Although possible, the NRC staff considers these scenarios to be highly unlikely.

A summary of all doses calculated for the various scenarios are included in Table 4.

**Table 2.** Summary for Key Parameter Values Used By Stepan for Dose Modeling of the Industrial Worker Scenario

<b>Input Parameter</b>	<b>Parameter Values Used</b>	<b>Basis/Comment</b>
Area of contaminated zone (m <sup>2</sup> ) <sup>1</sup>	Burial Pit 1 → 4000 m <sup>2</sup> Burial Pit 2 → 4000 m <sup>2</sup> Burial Pit 3 → 8000 m <sup>2</sup> Combined → 12000 m <sup>2</sup>	Larger assumed contaminated area increases dose by airborne dust inhalation
Thickness of contaminated zone (m)	1.00	Larger than depth at which maximum irradiation from ground is demonstrated to occur (0.3 m)
Cover depth (m)	0	Modeled with no cover despite each pit being backfilled with clean backfill and Burial Pits #2 and #3 being paved over
Soil mixing layer thickness (m)	0.15	Conservative value used as the mixing layer is assumed to range from 0 to 0.6 m deep; 0.15 m assures some contaminated airborne dust for inhalation. There is no expectation of mixing to occur since surface soil is now clean backfill.
Occupancy time (fraction of a year)	Indoors → 0.1825 Outdoors → 0.04566	Comparable to the standard industrial worker values estimated by ANL
Inhalation rate (m <sup>3</sup> /hr)	1.4	Equivalent to 1.2x10 <sup>4</sup> m <sup>3</sup> /yr; value is similar to the established RESRAD value for an industrial worker
Mass loading for inhalation (g/m <sup>3</sup> )	3.5E-05	

Soil ingestion rate (g/yr)	36.5	The most conservative value as likely amounts have been found to range from 0 to 36.5 g/yr.
Wind speed (m/s)	4.6	The annual average wind speed reported for Newark, New Jersey
Precipitation (m)	1.18	The average annual precipitation reported for northern New Jersey

<sup>1</sup> Stepan used conservative values for the “Area of contaminated zone” parameter. The actual land areas for the burial pits are: Pit 1 = 2621 m<sup>2</sup>; Pit 2 = 2069 m<sup>2</sup>; Pit 3 = 6147 m<sup>2</sup>; the combined area of all three burial pits is 10837 m<sup>2</sup>

**Table 3.** Scenario-Specific Parameter Values for Calculating Doses to the Resident Farmer and the Suburban Resident

Parameter	Resident Farmer	Suburban Resident
Exposure duration (yr)	30	30
Inhalation rate (m <sup>3</sup> /yr)	8400	8400
Fraction of time indoors	0.50	0.50
Fraction of time outdoors	0.25	0.25
Contaminated fractions of food		
Plant food	0.5	0.1
Milk	1.0	Not used
Meat	1.0	Not used
Aquatic food	0.5	Not used
Soil ingestion (g/yr)	36.5	36.5
Drinking water intake (L/yr)	510	Not used

**Table 4.** Dose Modeling Results for the Industrial Worker, Resident Farmer, and Suburban Resident Scenarios

Exposure Scenario	Burial Area	Radiological Dose (mrem/yr)	
		Stepan Results	NRC Staff Results
Industrial Worker	1	8.7	8.7
	2	3.0	3.0
	3	5.1	5.1
	1+2+3	6.3	6.3
Suburban Resident	1	--	80.8
	2	--	32.3
	3	--	50.3
	1+2+3	--	60.2
Resident Farmer	1	--	86.4
	2	--	34.8
	3	--	53.9
	1+2+3	--	64.4

Note: Stepan doses were calculated using RESRAD, v. 6.4; NRC doses were calculated using RESRAD, v. 6.5

## **2.5 Findings**

From the analyses summarized herein, the NRC staff concludes that the doses associated with Stepan's FSS activities satisfy the NRC's radiological dose criterion defined in 10 CFR 20.1402. Although doses associated with the suburban resident and resident farmer scenarios exceed the 0.25 mSv/yr (25 mrem/yr) dose requirement, the NRC staff concludes that activities related to these scenarios are not likely to occur in the foreseeable future and provide these to demonstrate the variability in the scenario criteria. Based on the results of these findings, the NRC staff finds it acceptable to terminate Stepan's materials license for the Maywood facility.

## **3. NRC Inspections and Confirmatory Assessments**

In accordance with the MOU between the USACE and the NRC for Coordination on Cleanup and Decommissioning of the FUSRAP sites with NRC-Licensed Facilities, NRC Region I staff conducted a number of visits to the Stepan Company Maywood, New Jersey site to observe in-process remediation and waste transportation activities during the time that remediation activities were being performed. Observations of FSS activities were conducted on the following dates: December 8, 2009, for Burial Pit #2; June 15, 2010, for Burial Pit #3; and November 10, 2010, for Burial Pit #1. During these visits, inspectors observed technicians performing walkover gamma radiation surveys and the collection of FSS soil samples for each of the three NRC-licensed burial pits. The inspectors received aliquots of selected soil samples from each of the three pits for confirmatory radiological analysis by the NRC's contractor, the Oak Ridge Institute for Science and Education. As these samples were actual FSS samples for USACE, the samples were also submitted to the USACE on-site laboratory. All results were below the 10 CFR 20.1402 criteria for unrestricted use.

During a site visit on August 17, 2010, the inspectors reviewed on-going remediation activities in Burial Pit #1, with a focus on control of water in excavations and treatment, analysis of samples, and discharge of the water collected from excavations. Information was obtained through tours of the remediation area, water collection and treatment facilities, and the on-site laboratory. The inspectors found that the water in excavations was controlled for the purpose of removing contaminated soil and subsequently performing FSS measurements in the remediated pit. Water was treated and released in accordance with an agreement with the local water authority.

During the November 10, 2010, site visit, the inspectors also reviewed activities related to the consolidation of contaminated soil and debris at the interim waste storage site adjacent to the Stepan property and preparations for transportation of the waste soil and debris to a licensed waste disposal facility. Information was obtained through tours of the interim waste storage site, observations during loading of railcars, discussions with technical staff, and review of documents. The inspectors noted that appropriate radiological surveys and analysis of waste soil samples were conducted and appropriate records of these activities were maintained.

## **4. FUSRAP Maywood Superfund Site**

From 1980-1983, radiological testing by the State of New Jersey, the EPA, and the DOE revealed widespread low-level radioactive and chemical contamination both on and off Stepan's

property. In 1983, the area was added to the National Priorities List for Superfund cleanup. In 1984, the U.S. Congress appropriated funds under FUSRAP for cleanup of the site. A total of 88 residential, commercial, municipal, and government-owned properties in the Boroughs of Maywood and Lodi, and the Township of Rochelle Park, NJ, were designated as the FUSRAP Maywood Superfund Site. The Stepan property, including the three burial pits, constitutes one of the 88 identified properties that were contaminated by thorium from activities conducted at the former Maywood Chemical Works site. Although many of the properties have been cleaned up, remediation activities are still on-going on some of the properties, including some portions of the Stepan site. The USACE will continue its remediation activities on areas of the Stepan property not associated with NRC-licensed activities.

## **5. Conclusions**

This Technical Evaluation Report was prepared as part of the NRC staff's review of Stepan's request to terminate License No. STC-1333 and release the Maywood, NJ, site for unrestricted use following completion of decommissioning activities at the site. The NRC staff also conducted periodic site visits during decommissioning activities and conducted survey measurements and sample analyses at the site to confirm FSS data. The NRC's technical evaluation included the staff's review of FSS results, review of NRC survey and sample results, and confirmation that waste shipments have been received by a licensed disposal facility and that appropriate records have been received. The NRC determined that Stepan has adequately demonstrated that the site meets the NRC's requirements for release for unrestricted use in accordance with 10 CFR 20.1402 and has satisfied the requirements of 10 CFR 40.42(j), including the submission of a completed NRC Form 314. Thus, the staff concludes that the NRC license for the facility can be terminated.

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