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EPA

Engineering Bulletin Thermal Desorption Treatment

Purpose

Section 121(b) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) mandates the Environmental Protection Agency (EPA) to select remedies that "utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable" and to prefer remedial actions in which treatment "permanently and significantly reduces the volume, toxicity, or mobility of hazardous substances, pollutants and contaminants as a principal element." The Engineering Bulletins are a series of documents that summarize the latest information available on selected treatment and site remediation technologies and related issues. They provide summaries of and references for the latest information to help remedial project managers, on-scene coordinators, contractors, and other site cleanup managers understand the type of data and site characteristics needed to evaluate a technology for potential applicability to their Superfund or other hazardous waste site. Those documents that describe individual treatment technologies focus on remedial investigation scoping needs. Addenda will be issued periodically to update the original bulletins.

Abstract

Thermal desorption is an ex situ means to physically separate volatile and some semivolatile contaminants from soil, sediments, sludges, and filter cakes. For wastes containing up to 10% organics or less, thermal desorption can be used alone for site remediation. It also may find applications in conjunction with other technologies or be appropriate to specific operable units at a site.

Site-specific treatability studies may be necessary to document the applicability and performance of a thermal desorption system. The EPA contact indicated at the end of this bulletin can assist in the definition of other contacts and sources of information necessary for such treatability studies.

Thermal desorption is applicable to organic wastes and generally is not used for treating metals and other inorganics. Depending on the specific thermal desorption vendor selected, the technology heats contaminated media between 200-1000°F, driving off water and volatile contaminants. Offgases may be burned in an afterburner, condensed to reduce the volume to be disposed, or captured by carbon adsorption beds.

Commercial-scale units exist and are in operation. Thermal desorption has been selected at approximately fourteen Superfund sites [1]* [2]. Three Superfund Innovative Technology Evaluation demonstrations are planned for the next year.

The final determination of the lowest cost alternative will be more site-specific than process equipment dominated. This bulletin provides information on the technology applicability, limitations, the types of residuals produced, the latest performance data, site requirements, the status of the technology, and sources for further information.

Technology Applicability

Thermal desorption has been proven effective in treating contaminated soils, sludges, and various filter cakes. Chemical contaminants for which bench-scale through full-scale treatment data exist include primarily volatile organic compounds (VOCs), semivolatiles, and even higher boiling point compounds, such as polychlorinated biphenyls (PCBs) [3][4][5][6]. The technology is not effective in separating inorganics from the contaminated medium. Volatile metals, however, may be removed by higher temperature thermal desorption systems.

Some metals may be volatilized by the thermal desorption process as the contaminated medium is heated. The presence of chlorine in the waste can also significantly affect the volatilization of some metals, such as lead. Normally the temperature of the medium achieved by the process does not oxidize the metals present in the contaminated medium [7, p. 85].

The process is applicable for the separation of organics from refinery wastes, coal tar wastes, wood-treating wastes, creosote-contaminated soils, hydrocarbon-contaminated soils, mixed (radioactive and hazardous) wastes, synthetic rubber processing wastes, and paint wastes [8, p. 2][4][9].

Performance data presented in this bulletin should not be considered directly applicable to other Superfund sites. A number of variables, such as the specific mix and distribution

* [reference number, page number]

Table 1
RCRA Codes for Wastes Treated by Thermal Desorption

Wood Treating Wastes	K001
Dissolved Air Flotation (DAF) Float	K048
Slop Oil Emulsion Solids	K049
Heat Exchanger Bundles Cleaning Sludge	K050
American Petroleum Institute (API) Separator Sludge	K051
Tank Bottoms (leaded)	K052

Table 2
Effectiveness of Thermal Desorption on General Contaminant Groups for Soil, Sludge, Sediments, and Filter Cakes

	Contaminant Groups	*Effectiveness*			
		Soil	*Sludge*	*Sedi-ments*	*Filter Cakes*
Organic	Halogenated volatiles	■	▼	▼	■
	Halogenated semivolatiles	■	▼	▼	■
	Nonhalogenated volatiles	■	▼	▼	■
	Nonhalogenated semivolatiles	■	▼	▼	■
	PCBs	■	▼	▼	▼
	Pesticides	■	▼	▼	▼
	Dioxins/Furans	■	▼	▼	▼
	Organic cyanides	▼	▼	▼	▼
	Organic corrosives	❑	❑	❑	❑
Inorganic	Volatile metals	■	▼	▼	▼
	Nonvolatile metals	❑	❑	❑	❑
	Asbestos	❑	❑	❑	❑
	Radioactive materials	❑	❑	❑	❑
	Inorganic corrosives	❑	❑	❑	❑
	Inorganic cyanides	❑	❑	❑	❑
Reactive	Oxidizers	❑	❑	❑	❑
	Reducers	❑	❑	❑	❑

■ Demonstrated Effectiveness: Successful treatability test at some scale completed
▼ Potential Effectiveness: Expert opinion that technology will work
❑ No Expected Effectiveness: Expert opinion that technology will not work

of contaminants, affect system performance. A thorough characterization of the site and a well-designed and conducted treatability study are highly recommended.

Table 1 lists the codes for the specific Resource Conservation and Recovery Act (RCRA) wastes that have been treated by this technology [8, p. 2][4][9]. The indicated codes were derived from vendor data where the objective was to determine thermal desorption effectiveness for these specific industrial wastes. The effectiveness of thermal desorption on general contaminant groups for various matrices is shown in Table 2. Examples of constituents within contaminant groups are provided in "Technology Screening Guide For Treatment of CERCLA Soils and Sludges" [7, p. 10]. This table is based on the current available information or professional judgment where no information was available. The proven effectiveness of the technology for a particular site or waste does not ensure that it will be effective at all sites or that the treatment efficiencies achieved will be acceptable at other sites. For the ratings used for this table, demonstrated effectiveness means that, at some scale, treatability was tested to show the technology was effective for that particular contaminant and medium. The ratings of potential effectiveness or no expected effectiveness are both based upon expert judgment. Where potential effectiveness is indicated, the technology is believed capable of successfully treating the contaminant group in a particular medium. When the technology is not applicable or will probably not work for a particular combination of contaminant group and medium, a no expected effectiveness rating is given. Another source of general observations and average removal efficiencies for different treatability groups is contained in the Superfund Land Disposal Restrictions (LDR) Guide #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions," (OSWER Directive 9347.3-06FS, September 1990) [10] and Superfund LDR Guide #6B, "Obtaining a Soil and Debris Treatability Variance for Removal Actions," (OSWER Directive 9347.3-06BFS, September 1990) [11].

Limitations

The primary technical factor affecting thermal desorption performance is the maximum bed temperature achieved. Since the basis of the process is physical removal from the medium by volatilization, bed temperature directly determines which organics will be removed.

The contaminated medium must contain at least 20 percent solids to facilitate placement of the waste material into the desorption equipment [3, p. 9]. Some systems specify a minimum of 30 percent solids [12, p. 6].

As the medium is heated and passes through the kiln or desorber, energy is lost in heating moisture contained in the contaminated soil. A very high moisture content can result in low contaminant volatilization or a need to recycle the soil through the desorber. High moisture content, therefore, causes increased treatment costs.

Material handling of soils that are tightly aggregated or largely clay, or that contain rock fragments or particles greater than 1-1.5 inches can result in poor processing performance due to caking. Also, if a high fraction of fine silt or clay exists in the matrix, fugitive dusts will be generated [7, p. 83] and a greater dust loading will be placed on the downstream air pollution control equipment [12, p. 6].

The treated medium will typically contain less than 1 percent moisture. Dust can easily form in the transfer of the treated medium from the desorption unit, but can be mitigated by water sprays. Normally, clean water from air pollution control devices can be used for this purpose.

Although volatile organics are the primary target of the thermal desorption technology, the total organic loading is limited by some systems to up to 10 percent or less [13, p. II-

30]. As in most systems that use a reactor or other equipment to process wastes, a medium exhibiting a very high pH (greater than 11) or very low pH (less than 5) may corrode the system components [7, p. 85].

There is evidence with some system configurations that polymers may foul and/or plug heat transfer surfaces [3, p. 9]. Laboratory/field tests of thermal desorption systems have documented the deposition of insoluble brown tars (presumably phenolic tars) on internal system components [14, p. 76].

High concentrations of inorganic constituents and/or metals will likely not be effectively treated by thermal desorption. The maximum bed temperature and the presence of chlorine can result in volatilization of some inorganic constituents in the waste, however.

Technology Description

Thermal desorption is any of a number of processes that use either indirect or direct heat exchange to vaporize organic contaminants from soil or sludge. Air, combustion gas, or inert gas is used as the transfer medium for the vaporized components. Thermal desorption systems are physical separation processes and are not designed to provide high levels of organic destruction, although the higher temperatures of some systems will result in localized oxidation and/or pyrolysis. Thermal desorption is not incineration, since the destruction of organic contaminants is not the desired result. The bed temperatures achieved and residence times designed into thermal desorption systems will volatilize selected contaminants, but typically not oxidize or destroy them. System performance is typically measured by comparison of untreated soil/sludge contaminant levels with those of the processed soil/sludge. Soil/sludge is typically heated to 200 - 1000° F, based on the thermal desorption system selected.

Figure 1 is a general schematic of the thermal desorption process.

Waste material handling (1) requires excavation of the contaminated soil or sludge or delivery of filter cake to the system. Typically, large objects greater than 1.5 inches are screened from the medium and rejected. The medium is then delivered by gravity to the desorber inlet or conveyed by augers to a feed hopper [8, p. 1].

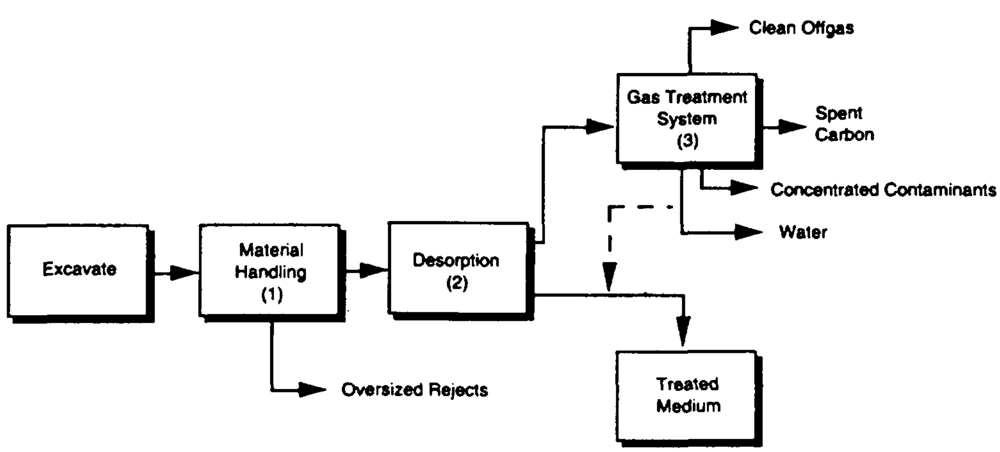
Significant system variation exists in the desorption step (2). The dryer can be an indirectly fired rotary asphalt kiln, a single (or set of) internally heated screw auger(s), or a series of externally heated distillation chambers. The latter process uses annular augers to move the medium from one volatilization zone to the next. Additionally, testing and demonstration data exist for a fluidized-bed desorption system [12].

The waste is intimately contacted with a heat transfer surface, and highly volatile components (including water) are driven off. An inert gas, such as nitrogen, may be injected in a countercurrent sweep stream to prevent contaminant combustion and to vaporize and remove the contaminants [8, p. 1][4]. Other systems simply direct the hot gas stream from the desorption unit [3, p. 5][5].

The actual bed temperature and residence time are the primary factors affecting performance in thermal desorption. These parameters are controlled in the desorption unit by using a series of increasing temperature zones [8, p. 1], multiple passes of the medium through the desorber where the operating temperature is sequentially increased, separate compartments where the heat transfer fluid temperature is higher, or sequential processing into higher temperature zones [15][16]. Heat transfer fluids used to date include hot combustion gases, hot oil, steam, and molten salts.

Offgas from desorption is typically processed (3) to remove particulates. Volatiles in the offgas may be burned in an afterburner, collected on activated carbon, or recovered in condensation equipment. The selection of the gas treatment system will depend on the concentrations of the contaminants, cleanup standards, and the economics of the offgas treatment system(s) employed.

Figure 1
Schematic Diagram of Thermal Desorption



Process Residuals

Operation of thermal desorption systems typically creates up to six process residual streams: treated medium, [illegible]sized medium rejects, condensed contaminants and wa- particulate control system dust, clean offgas, and spent carbon (if used). Treated medium, debris, and oversized rejects may be suitable for return onsite.

Condensed water may be used as a dust suppressant for the treated medium. Scrubber purge water can be purified and returned to the site wastewater treatment facility (if available), disposed to the sewer [3, p. 8] [8, p. 2] [4, p. 2], or used for rehumidification and cooling of the hot, dusty media. Concentrated, condensed organic contaminants are containerized for further treatment or recovery.

Dust collected from particulate control devices may be combined with the treated medium or, depending on analyses for carryover contamination, recycled through the desorption unit.

Clean offgas is released to the atmosphere. If used, spent carbon may be recycled by the original supplier or other such processor.

Site Requirements

Thermal desorption systems are transported typically on specifically adapted flatbed semitrailers. Since most systems consist of three components (desorber, particulate control, and gas treatment), space requirements on site are typically less than 50 feet by 150 feet, exclusive of materials handling and decontamination areas.

Standard 440V, three-phase electrical service is needed. Water must be available at the site. The quantity of water needed is vendor and site specific.

Treatment of contaminated soils or other waste materials require that a site safety plan be developed to provide for personnel protection and special handling measures. Storage should be provided to hold the process product streams until they have been tested to determine their acceptability for disposal or release. Depending upon the site, a method to store waste that has been prepared for treatment may be necessary. Storage capacity will depend on waste volume.

Onsite analytical equipment capable of determining site-specific organic compounds for performance assessment make the operation more efficient and provide better information for process control.

Performance Data

Several thermal desorption vendors report performance data for their respective systems ranging from laboratory treatability studies to full-scale operation at designated Superfund sites [17][9][18]. The quality of this information has not been determined. These data are included as a general guideline to the performance of thermal desorption equipment, and may not be directly transferrable to a specific Superfund site. Good site characterization and treatability studies are essential in further refining and screening the thermal desorption technology.

Chem Waste Management's (CWM's) X*TRAX™ System has been tested at laboratory and pilot scale. Pilot tests were performed at CWM's Kettleman Hills facility in California. Twenty tons of PCB- and organic-contaminated soils were processed through the 5 TPD pilot system. Tables 3 and 4 present the results of PCB separation from soil and total hydrocarbon emissions from the system, respectively [4].

During a non-Superfund project for the Department of Defense, thermal desorption was used in a full-scale demonstration at the Tinker Air Force Base in Oklahoma. The success of this project led to the patenting of the process by Weston Services, Inc. Since then, Weston has applied its low-temperature thermal treatment (LT^3) system to various contaminated soils at bench-scale through full-scale projects [19]. Table 5 presents a synopsis of system and performance data for a full-scale treatment of soil contaminated with No. 2 fuel oil and gasoline at a site in Illinois.

Canonie Environmental has extensive performance data for its Low Temperature Thermal Aeration (LTTA℠) system at full-scale operation (15-20 cu. yds. per hour). The LTTA℠ has been applied at the McKin (Maine), Ottati and Goss (New Hampshire) and Cannon Engineering Corp. (Massachusetts) Superfund sites. Additionally, the LTTA℠ has been used at the privately-funded site in South Kearney (New Jersey). Table

Table 3
PCB Contaminated Soils
Pilot X*TRAX™ [4]

Matrix	*Feed (ppm)*	*Product (ppm)*	*Removal (%)*
Clay	5,000	24	99.3
Silty Clay	2,800	19	99.5
Clay	1,600	4.8	99.7
Sandy	1,480	8.7	99.1
Clay	630	17	97.3

Table 4
Pilot X*TRAX™
TSCA Testing - Vent Emissions [4]

Total Hydrocarbons (ppm-V)				
Before Carbon	*After Carbon*	*Removal (%)*	*VOC (lbs/day)*	*PCB* (mg/m³)*
1,320	57	95.6	0.02	<0.00056
1,031	72	93.0	0.03	<0.00055
530	35	93.3	0.01	<0.00051
2,950	170	94.2	0.07	<0.00058
2,100	180	91.4	0.08	<0.00052

*Note: OSHA permits 0.50 mg/m³ PCB (1254) for 8-hr exposure.

6 presents a summary of Canonie LTTA℠ data [5]. The Cannon Engineering (Mass) site, which was not included in Table 6, successfully treated a total of 11,330 tons of soil, containing approximately 1803 lbs. of VOC [20].

T.D.I. Services, Inc. has demonstrated its HT-5 Thermal Distillation Process at pilot- and full-scale for a variety of RCRA-listed and other wastes that were prepared to simulate American Petroleum Institute (API) refinery sludge [8]. The company has conducted pilot- and full-scale testing with the API sludge to demonstrate the system's ability to meet Land Ban Disposal requirements for K048 through K052 wastes. Independent evaluation by Law Environmental confirms that the requirements were met, except for TCLP levels of nickel, which were blamed on a need to "wear-in" the HT-5 system [21, p. ii].

Remediation Technologies, Inc. (ReTec) has performed numerous tests on RCRA-listed petroleum refinery wastes. Table 7 presents results from treatment of refinery vacuum

Table 5
Full-Scale Performance Results for the LT³ System [19]

Contaminant	*Soil Range (ppb)*	*Treated Range (ppb)*	*Range of Removal Efficiency*
Benzene	1000	5.2	99.5
Toluene	24000	5.2	99.9
Xylene	110000	<1.0	>99.9
Ethyl benzene	20000	4.8	99.9
Napthalene	4900	<330	>99.3
Carcinogenic Priority PNAs	<6000	<330–590	<90.2–94.5
Non-carcinogenic Priority PNAs	890–6000	<330–450	<62.9–94.5

Table 6
Summary Results of the LTTA℠ Full-Scale Cleanup Tests [5]

Site	*Processed*	*Contaminant*	*Soil (ppm)*	*Treated (ppm)*
S. Kearney	16000 tons	VOCs PAHs	177.0 (avg.) 35.31 (avg.)	0.87 (avg.) 10.1 (avg.)
McKin	>9500 cu yds 2000 cu yds	VOCs PAHs	ND-3310	ND-0.04 <10
Ottati & Goss	4500 cu yds	VOCs	1500 (avg.)	<0.2 (avg.)

Table 7
ReTec Treatment Results-Refinery Vacuum Filter Cake (A) [3]

Compound	*Original Sample (ppm)*	*Treated Sample (ppm)*	*Removal Efficiency (%)*
Naphthalene	<0.1	<0.1	---
Acenaphthylene	<0.1	<0.1	---
Acenaphthene	<0.1	<0.1	---
Fluorene	10.49	<0.1	>98.9
Phenanthrene	46.50	<0.1	>99.3
Anthracene	9.80	<0.1	>96.6
Fluoranthrene	73.94	<0.1	>99.8
Pyrene	158.37	<0.1	>99.9
Benzo(b)anthracene	56.33	1.43	97.5
Chrysene	64.71	<0.1	>99.9
Benzo(b)fluoranthene	105.06	2.17	97.9
Benzo(k)fluoranthene	225.37	3.64	98.4
Benzo(a)pyrene	174.58	1.89	98.9
Dibenz(ab)antracene	477.44	10.25	97.8
Benzo(ghi)perylene	163.53	5.09	96.6
Indeno(123-cd)pyrene	122.27	4.16	96.6

Treatment Temperature: 450°F

Table 8
ReTec Treatment Results-Creosote Contaminated Clay [3]

Compound	*Original Sample (ppm)*	*Treated Sample (ppm)*	*Removal Efficiency (%)*
Naphthalene	1321	<0.1	>99.9
Acenaphthylene	<0.1	<0.1	---
Acenaphthene	293	<0.1	>99.96
Fluorene	297	<0.1	>99.96
Phenanthrene	409	1.6	99.6
Anthracene	113	<0.1	>99.7
Fluoranthrene	553	1.5	99.7
Pyrene	495	2.0	99.6
Benzo(b)anthracene	59	<0.1	>99.99
Chrysene	46	<0.1	>99.8
Benzo(b)fluoranthene	14	2.5	82.3
Benzo(k)fluoranthene	14	<0.1	>99.8
Benzo(a)pyrene	15	<0.1	>99.9
Dibenzo(ab)anthracene	<0.1	<0.1	---
Benzo(ghi)perylene	7	<0.1	>99.4
Indeno(123-cd)pyrene	3	<0.1	>99.3

Treatment Temperature: 500°F

Table 9
ReTec Treatment Results-Coal Tar Contaminated Soils [3]

Compound	*Original Sample (ppm)*	*Treated Sample (ppm)*	*Removal Efficiency (%)*
Benzene	1.7	<0.1	>94
Toluene	2.3	<0.1	>95
Ethylbenzene	1.6	<0.1	>93
Xylenes	6.3	<0.3	>95
Naphthalene	367	<1.7	>99
Fluorene	114	<0.2	>99
Phenanthrene	223	18	91.9
Anthracene	112	7.0	93.8
Fluoranthrene	214	15	93.0
Pyrene	110	11	90.0
Benzo(b)anthracene	56	<1.4	>97
Chrysene	58	3.7	93.6
Benzo(b)fluoranthene	45	<1.4	>97
Benzo(k)fluoranthene	35	<2.1	>94
Benzo(a)pyrene	47	<0.9	>98
Benzo(ghi)perylene	24	<1.1	>95
Indeno(123-cd)pyrene	27	<6.2	>77
Treatment Temperature: 450°F			

lter cake. Tests with creosote-contaminated clay and coal tar-contaminated soils showed significant removal efficiencies (Tables 8 and 9). All data were obtained through use of ReTec's 100 lb/h pilot scale unit processing actual industrial process wastes [3].

Recycling Sciences International, Inc. (formerly American Toxic Disposal, Inc.) has tested its Desorption and Vaporization Extraction System (DAVES), formerly called the Vaporization Extraction System (VES), at Waukegan Harbor, Illinois. The pilot-scale test demonstrated PCB removal from material containing up to 250 parts per million (ppm) to levels less than 2 ppm [12].

RCRA LDRs that require treatment of wastes to best demonstrated available technology (BDAT) levels prior to land disposal may sometimes be determined to be applicable or relevant and appropriate requirements for CERCLA response actions. Thermal desorption can produce a treated waste that meets treatment levels set by BDAT but may not reach these treatment levels in all cases. The ability to meet required treatment levels is dependent upon the specific waste constituents and the waste matrix. In cases where thermal desorption does not meet these levels, it still may, in certain situations, be selected for use at the site if a treatability variance establishing alternative treatment levels is obtained. Treatability variances are justified for handling complex soil and debris matrices. The following guides describe when and how to seek a treatability variance for soil and debris: Superfund LDR Guide #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions" (OSWER Directive 9347.3-06FS, September 1990) [10], and Superfund LDR Guide #6B, "Obtaining a Soil and Debris Treatability Variance for Removal Actions" (OSWER Directive 9347.3-06BFS, September 1990) [11]. Another approach could be to use other treatment techniques in series with thermal desorption to obtain desired treatment levels.

Technology Status

Significant theoretical research is ongoing [22][23], as well as direct demonstration of thermal desorption through both treatability testing and full-scale cleanups.

A successful pilot-scale demonstration of Japanese soils "roasting" was conducted in 1980 for the recovery of mercury from highly contaminated (up to 15.6 percent) soils at a plant site in Tokyo. The high concentration of mercury made recovery and refinement to commercial grade (less than 99.99 percent purity) economically feasible [24].

In this country, thermal desorption technologies are the selected remedies for one or more operable units at fourteen Superfund sites. Table 10 lists each site's location, primary contaminants, and present status [1][2].

Most of the hardware components of thermal desorption are available off the shelf and represent no significant problem of availability. The engineering and configuration of the systems are similarly refined, such that once a system is designed full-scale, little or no prototyping or redesign is required.

On-line availability of the full-scale systems described in this bulletin is not documented. However, since the ex situ system can be operated in batch mode, it is expected that component failure can be identified and spare components fitted quickly for minimal downtime.

Several vendors have documented processing costs per ton of feed processed. The overall range varies from $80 to $350 per ton processed [6][4, p. 12][5][3, p. 9]. Caution is recommended in using costs out of context because the base year of the estimates vary. Costs also are highly variable due to the quantity of waste to be processed, term of the remediation contract, moisture content, organic constituency of the contaminated medium, and cleanup standards to be achieved. Similarly, cost estimates should include such items as preparation of Work Plans, permitting, excavation, processing itself, QA/QC verification of treatment performance, and reporting of data.

EPA Contact

Technology-specific questions regarding thermal desorption may be directed to:

Michael Gruenfeld
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Risk Reduction Engineering Laboratory
Releases Control Branch
2890 Woodbridge Ave.
Bldg. 10 (MS-104)
Edison, NJ 08837
FTS 340-6625 or (908) 321-6625

Table 10
Superfund Sites Specifying Thermal Desorption as the Remedial Action

Site	*Location*	*Primary Contaminants*	*Status*
Cannon Engineering (Bridgewater Site)	Bridgewater, MA (1)	VOCs (Benzene, TCE & Vinyl Chloride)	Project completed 10/90
McKin	McKin, ME (1)	VOCs (TCE, BTX)	Project completed 2/87
Ottati & Goss	New Hampshire (1)	VOCs (TCE; PCE; 1, 2-DCA, and Benzene)	Project completed 9/89
Wide Beach	Brandt, NY (2)	PCBs	In design • pilot study available 5/91
Metaltec/Aerosystems	Franklin Borough, NJ (2)	TCE and VOCs	In design • remedial design complete • remediation starting Fall '91
Caldwell Trucking	Fairfield, NJ (2)	VOCs (TCE, PCE, and TCA)	In design
Outboard Marine/ Waukegan Harbor	Waukegan Harbor, IL (5)	PCBs	In design • treatability studies complete
Reich Farms	Dover Township, NJ (02)	VOCs and Semivolatiles	Pre-design
Re-Solve	North Dartmouth, MA (1)	PCBs	In design • pilot study June/July '91
Waldick Aerospace Devices	New Jersey (2)	TCE and PCE	In design
Wamchem	Burton, SC (4)	BTX and SVOCs (Naphthalene)	In design • pilot study available 5/91
Fulton Terminals	Fulton, NY (2)	VOCs (Xylene, Styrene, TCE, Ethylbenzene, Toluene) and some PAHs	Pre-design
Stauffer Chemical	Cold Creek, AL (4)	VOCs and pesticides	Pre-design
Stauffer Chemical	Le Moyne, AL (4)	VOCs and pesticides	Pre-design

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