



Project Summary

Survey of Materials-Handling Technologies Used at Hazardous Waste Sites

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The objective of this study was to summarize the types of debris, material, and contaminants found at Superfund and other hazardous waste sites and the materials-handling equipment and general procedures used to perform site restoration and cleanup. The intent of this report is to provide the U.S. Environmental Protection Agency (EPA) with information on state-of-the-art materials-handling equipment and procedures that would be useful for addressing difficult, site-specific materials-handling problems.

The following factors affect the selection of equipment and procedures for materials handling at hazardous waste sites:

- Type and quantity of contaminated materials present
- Amount and type of contaminants on site
- Type of removal or remedial action selected (capping, excavating, pumping, etc.)
- Treatment process used on site
- General site characteristics (soil type and moisture, topography, climate)

The full report includes information concerning the capabilities, performance, and applicability of a variety of materials-handling equipment and procedures at various hazardous waste sites and the cost of their implementation. Case studies for 22 sites distributed throughout all 10 EPA Regions have also been included to provide detailed information concerning the debris, material, and contaminants found

on site; the specific materials-handling needs; and the problems encountered.

Because of the diversity of the debris, material, and contaminants found on Superfund and other hazardous waste sites, each site must be evaluated individually to select and implement materials-handling equipment and procedures. To date, adequate published information concerning the debris and material handled is not available for EPA personnel and response contractors. Although attempts have been made to categorize the debris and material present onsite, this report represents the first attempt to compile information regarding materials-handling equipment and techniques that have been implemented at hazardous waste sites. Quantity estimates would be helpful to response contractors and EPA personnel for estimating the cost of equipment operations.

This Project Summary was developed by EPA's Risk Reduction Engineering Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Superfund and other hazardous waste sites in the United States contain many different types of materials that require physical separation, classification, and decontamination. These various materials are often contaminated with hazardous chemical residues. In some instances, however,



although a material found onsite contains no hazardous substance, it still must be handled or disposed of offsite.

A typical Superfund or other hazardous waste site contains hazardous chemicals that are frequently mixed with the remnants of razed structures (wood, steel, concrete blocks); municipal and/or industrial solid wastes; metallic debris (refrigerators, abandoned cars, drums, transformer casings); and contaminated soils, sludges, and liquids. Materials-handling and classifying technologies are needed to deal with the large quantities of these various materials prior to, or in conjunction with, their decontamination and disposal.

Materials-handling procedures also may be required for other types of activities that occur at a hazardous waste site. Site preparation may require the use of heavy equipment to build access roads, containment trenches, or concrete decontamination pads. Pretreatment processes requiring materials-handling techniques (screening, size reduction, dewatering) may be necessary before a remedial treatment technology is applied. Many sites are not concerned with cleanup but are instead, construction projects involved with the building of treatment facilities or new wells for dealing with groundwater contamination of unknown origin. Such projects may require a variety of materials-handling equipment and procedures not normally encountered during cleanup operations (e.g., the laying of pipe or deep-well excavation techniques).

Because published information concerning materials handling at hazardous waste sites is sparse, an engineering and economic analysis is needed to develop a data base for EPA personnel and response contractors searching for equipment or procedures to address difficult materials-handling problems.

Debris/Materials Found at Hazardous Waste Sites

Debris can be defined as any unused, unwanted, or discarded solid or liquid that requires staging, loading, transporting, pretreating, treatment, and/or disposal on a hazardous waste site. The amount of debris occurring on hazardous waste sites is estimated to range from less than 1% to greater than 80% of the total waste found on site. In addition to debris, other materials (e.g., soil, sludge, asbestos, and various liquids) must also be handled. A comprehensive listing, including both debris and other materials that require special materials handling, can be presented in the following 12 general categories:

- Textiles
- Wood/vegetation
- Glass
- Construction debris

- Paper
- Metal
- Plastic
- Rubber
- Soil
- Sludge
- Liquids
- Asbestos

For this study, information from 100 hazardous waste sites in all 10 EPA Regions was reviewed to learn the frequency of occurrence of debris or materials that required material handling. The materials most commonly requiring handling are contaminated soil, liquids, and metals (drums, scrap, etc.).

Equipment Used at Hazardous Waste Sites

Information from these 100 hazardous waste sites was reviewed to obtain a profile of equipment used for material handling onsite. This information was also used to prepare the case studies for 22 sites distributed throughout all 10 EPA Regions. Projects at the reviewed sites ranged from major removal/excavation efforts involving sludge, soil, drums, tanks, and liquids to simple removal actions involving only a few drums.

This report has been so written that the appendix of equipment use at specific hazardous waste sites is cross-referenced with the appendix for debris/material profiles for the same sites to give an indication of the equipment needed to deal with various debris/material categories. In addition to the equipment and debris/material profiles, this report presents an overview of 67 of the 100 sites, including contaminant, debris/material handling, and the primary debris/material handling procedures and equipment implemented.

Equipment usage/modification/fabrication was found to be very site-specific and often involves trial and error. Typical examples of site-specific solutions are:

- Hydraulic systems were modified to adapt a backhoe for drum handling (grappler).
- Rubber or foam tires instead of pneumatic tires were used at sites with large quantities of sharp metal/glass objects.
- Splash shields were installed on heavy equipment.
- Larger bulldozers were used to winch smaller dozers up and down the steep grades of asbestos tailings piles.
- Propane-powered instead of diesel-powered loaders were used for inside work to reduce fumes.
- Heavy equipment failed because of weather (e.g., cracked hydraulic lines from cold, tractability during icy conditions, metal fatigue from digging in frozen soil).

- A drum crusher instead of backhoe was used to crush drums.
- Rolloff boxes were converted into treatment chambers for cyanide-contaminated film chips.

Materials-Handling Equipment and Procedures

Within the context of hazardous waste site remediation, materials handling can encompass everything from site preparation (e.g., the building of access roads) to the actual treatment processes. In general, onsite materials-handling equipment and procedures are used for:

- Physical separation and classification
- Site preparation
- Construction
- Feedstock preparation and handling
- Equipment, structure, and building decontamination
- Loading and hauling

Equipment selection usually depends on such site-specific considerations as:

- General site characteristics (vegetation, soil type and moisture, topography)
- Quantity of material present
- Treatment technology implemented (pretreatment needs)
- Debris characteristic (metal, plastics, construction, etc.)
- Waste characteristics (solid, liquid, sludge)
- Packaging of waste materials (drums, tanks, lagoons, etc.)
- Ease of startup and demobilization
- Climate (temperature, precipitation)
- Size of working area

The suitability of a particular piece of equipment for general onsite use usually depends on:

- Cost
- Availability
- Personnel requirements for operation, maintenance, and safety
- Versatility
- Storage requirements
- Objectives of treatment

When equipment requirements have been determined, the job cost for each piece of equipment can be estimated. Equipment can be purchased, rented, or leased. Rented or leased equipment is initially less expensive to use, but the cost of purchased equipment can be amortized over several projects.

Frequently used materials-handling procedures at hazardous waste sites can be categorized as follows:

- Excavation and removal
- Dredging
- Pumping
- Size and volume reduction

- Separation and dewatering
- Conveying systems
- Storage containers, bulking tanks, and containment
- Drum handling and removal
- Compaction
- Miscellaneous equipment and procedures
- Asbestos remediation
- Handling of low-level radioactive waste
- Emission control
- Equipment decontamination

Although most of the equipment used for excavation and removal work at hazardous waste sites is standard heavy construction equipment, selection is site-specific because of the varying quantity and physical properties of the debris and materials present. Excavation or removal processes take place at most sites with backhoes being the most common piece of equipment used. Excavation techniques are most applicable for dealing with solid and thickened sludge materials. Conventional excavation techniques are less suitable when debris/materials have a high liquid content.

Excavation equipment generally operates in a batch rather than in a continuous mode. The advantage of this is being able to deal with localized areas of contamination within a hazardous waste site. Excavation and removal equipment can be used under virtually all site conditions; however, such application may be cost-prohibitive at great depths or under varied hydrogeologic conditions. The capacities, horsepower, and size of equipment used for excavation and removal vary widely, and a variety of attachments, accessories, and options are available for individual pieces of equipment. The report contains an appendix with examples of specific models of equipment that have been or have the potential to be used on hazardous waste sites (including specifications, attachments, and options).

Conclusions

The following conclusions were reached during this study:

1. The diversity of debris, material, and contaminants found on Superfund and other hazardous waste sites requires that the selection and implementation of materials-handling equipment be made on an individual, site-specific basis. Factors affecting the selection of equipment and procedures for materials handling are:
 - Type and quantity of contaminated materials present
 - Amount and type of contaminants found on site

- Type of removal/remedial action selected (capping, excavation, pumping, etc.)
 - Treatment processes implemented on site
 - General site characteristics
2. No technical data base currently exists that characterizes both the debris and material to be handled and the equipment and procedures to be used with these materials at hazardous waste sites. References to debris/material found and equipment used are random and often fall under the heading of "miscellaneous."
 3. The equipment and procedures that industry uses for materials handling (e.g., sand/gravel, demolition, etc.) have not yet been adequately explored to take advantage of innovations that could benefit hazardous waste site remediation.
 4. Although attempts have been made to categorize the debris and materials found on hazardous waste sites, virtually no information is available concerning the quantities handled. Estimates of quantities would be helpful to response contractors and EPA personnel for estimating disposal costs.
 5. Based on the information gathered from contacts in Germany, the Netherlands, France, and the United Kingdom, it appears that the materials-handling equipment and procedures currently used for the remediation of foreign sites are essentially the same as those used in the United States. Extensive hazardous waste site work is currently being conducted in these countries, however, and contact should be maintained with these persons to monitor the future development of any new or innovative materials-handling technologies.
 6. Because of missing, misplaced, or incomplete files or confidential business information restrictions, data concerning materials-handling equipment and procedures used to remove or remediate contaminated debris and materials at hazardous waste sites are difficult to access for most of the Regions.
 7. Based on the information gathered for this report, the type of contaminant (e.g., acids, low-flash point liquids) does not appear to have a direct effect on the choice of equipment and procedures used at hazardous waste sites. Whereas the type of contaminant found onsite affects the level of personal protection required, the se-

lection of most equipment is based on cost, availability, and the ability to deal with the physical nature of the debris/material to be handled. The type of contaminant present onsite does, however, affect modifications to the equipment chosen for the site work (e.g., splash shield installation on excavation equipment).

Recommendations

The results of this study have prompted the following recommendations for further action:

1. Given the wide diversity of debris and materials found on hazardous waste sites and the different methods of site remediation used, a central computerized data base dealing solely with onsite materials handling should be compiled. This would provide EPA personnel and response contractors with a starting point for dealing with specific materials-handling problems. Workshops for all 10 EPA Regions should be developed to brief interested personnel about the content, availability, and accessing of the data base.
2. Vendors of equipment with hazardous waste site applications should be alerted to potential opportunities for hazardous waste site work. Workshops/seminars sponsored by EPA could be offered to vendors.
3. A more comprehensive analysis should be performed to investigate the feasibility of using recyclable materials found onsite (after classification and decontamination). A standard operating procedure (SOP) should be developed for dealing with materials found on hazardous waste sites that have the potential to be recycled or reclaimed.
4. Additional information should be collected concerning the effect of equipment downtime and parts availability on overall project and schedules.

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Majid Dosani and John Miller are with PEI Associates, Inc., Cincinnati, OH 45246. Naomi Barkley is the EPA Project Officer (see below). The complete report, entitled "Survey of Materials-Handling Technologies Used at Hazardous Waste Sites," (Order No. PB91-186924/AS; Cost: \$31.00, subject to change) will be available only from:

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