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Engineering Bulletin

Control of Air Emissions From Materials Handling During Remediation

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 (RPMs), on-scene coordinators (OSCs), 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. Engineering Bulletins that are specific to issues related to Superfund sites and cleanups provide the reader with synopses of important considerations required either in the planning of the field investigation or in the decisions leading to the selection of remediation technologies applicable to a specific site. Addenda will be issued periodically to update the original bulletins.

Abstract

This bulletin presents an overview discussion on the importance of and methods for controlling emissions into the air from materials handling processes at Superfund or other hazardous waste sites. It also describes several techniques used for dust and vapor suppression that have been applied at Superfund sites.

Air emission control techniques have been utilized for Superfund cleanups at the McColl site (CA) and at the LaSalle Electric site (IL). Foam suppression has been used at Rocky Mountain Arsenal (CO), Texaco Fillmore (CA), and at a petroleum refinery (CA) site. A number of temporary vapor suppression techniques have also been applied at other sites. Additionally, the experience gained in the mining industry and at hazardous waste treatment, storage, and disposal sites will yield applicable methods for Superfund sites.

This bulletin provides information on the applicability of air emission controls for materials handling at Superfund sites, limitations of the current systems, a description of the control methods that have found application to date, site requirements, a summary of the performance experience, the status of the existing techniques and identification of future development expectations, and sources of additional information.

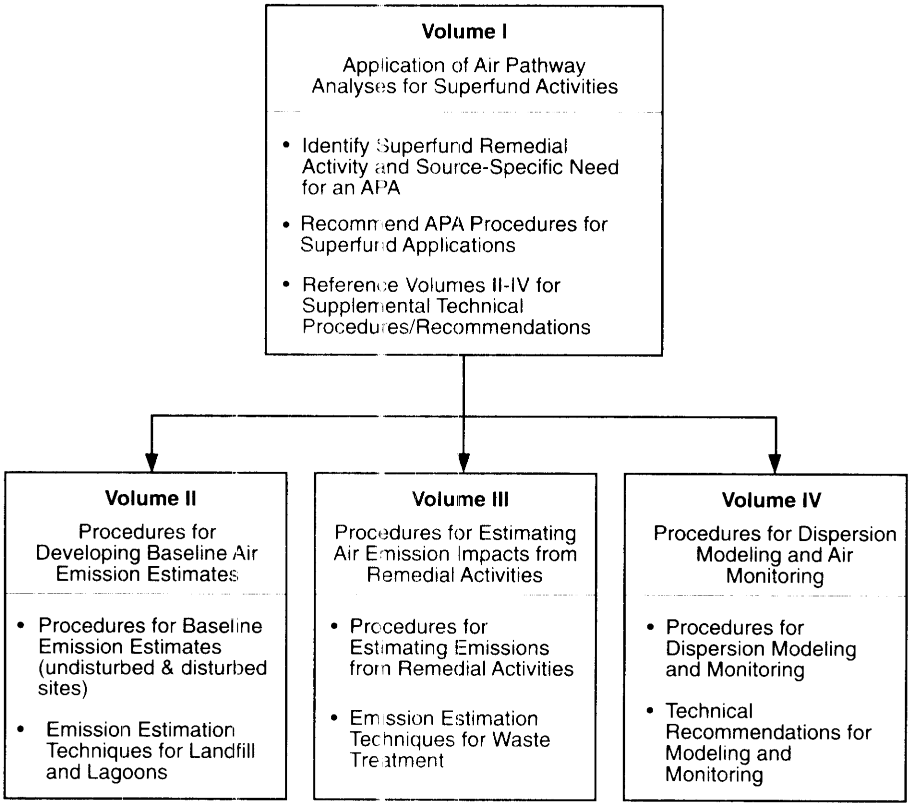
Applicability of Materials Handling Controls

Estimation of the potential releases to the air and an analysis of the impacts to the air pathway are applicable to every activity in the Superfund process. Since nearly every Superfund site has a potential air emissions problem, the focus of this bulletin is to assist RPMs and OSCs in considering the appropriate methods for material handling at Superfund sites. To do that, the first step is to estimate the potential releases using the air pathway analysis (APA) process.

The amended National Contingency Plan expands upon the requirement to conduct and fully document a regimented process called an air pathway analysis (APA). The process is defined as a "systematic approach involving a combination of modeling and monitoring methods to assess actual or potential receptor exposure to air contaminants" [1 p. 1-1]*. When considering removal or remedial responses (i.e., technologies), an APA detailing emission estimates is useful for determining the potential compliance with applicable or relevant and appropriate requirements (ARARs) during remedial action, particularly at a State or local level. Compliance with National Ambient Air Quality Standards during a remediation or the excavation and processing of the contaminated media must be addressed. With the passage of the Clean Air Act Amendments in November 1990 and the advent of numerous state air toxics programs, remediation of Superfund sites must address the

* [reference number, page number]

Figure 1
Procedures for Conducting APA for Superfund Application—Overview [1, p.1-4]



media transfer that excavation and materials handling (before and after treatment) will create, and the ARARs these regulations represent. Figure 1 [1, p. 1-4] indicates the applicability of the guidance study series documents on the air pathway analysis to remedial project managers/on-scene coordinators and to contractors and other technical staff.

The potential for short-term risk (i.e., during the remedial action) is a major criterion when selecting the best remedial alternative. The general classes of contaminants of concern are gaseous and particulate emissions. Particulate matter (PM) becomes airborne via wind erosion, mechanical disturbances (such as excavation and material processing), combustion, and desorption. Gaseous species are primarily volatilized contaminants (VCs), but natural processes such as biodegradation and photo-decomposition can result in releases once the site has been disturbed. Since volatilization is the primary mechanism for gaseous emissions, any volatile contaminant in the soil, a lagoon, a landfill, or even in open containers may be released to the air. The carcinogenic and noncarcinogenic hazards that gases and particulates present in the air pathway must be assessed.

When initially considering remediation technologies applicable to a site, the APA process can play an integral role in estimating the risk that excavation and materials processing pose to the receptors in the area. Any ex situ process that requires such excavation and material sizing, screening, or other pretreatment processing will result in losses of particulate and volatile contaminants.

Similarly, emissions generated during the operation of the technology (i.e., losses from air pollution control equipment or fugitive losses from the treatment process itself) must be estimated in order to complete the air emissions source assessment prior to final selection of the remedial technology. The ambient concentrations of air contaminants may have to be monitored during the remediation process to ensure compliance with local air toxics regulations. All of these considerations should be assessed, a cost estimate prepared, and the results should become an integral input to the selection of alternative technologies according to the National Contingency Plan process. Of these criteria, overall protection of human health and the environment, ARAR compliance, implementability, cost, short-term effectiveness and State and community acceptance become paramount concerns for the air pathway impact.

Results of a recently published study [16] indicate significant VC losses during typical soil excavation, transport, and feed/preparation operations. The contribution of each remedial step to the VC emissions was examined. Table 1 presents the results for each step. Although different chemical constituents and concentrations were present in two different site zones, the contribution of each remedial step to the VC emissions during

Table 1
Remedial Step Fractional Contribution to VCs [16, p. 39]

Remedial Activity	Overall Site
Excavation	0.0509
Bucket	0.0218
Truck Filling	0.0905
Transport	0.3051
Dumping	0.5016
Incinerator	0.0014
Exposed Soil	0.0287
Total	1.0000

Table 2
Common Control Technologies Available For Materials Handling [*]

Remedial Operation	Control Technology
Excavation	Water sprays of active areas Dust suppressants Surfactants Foam coverings Enclosures Aerodynamic considerations
Transportation	Watersprays of active areas Dust suppressants Surfactants Road carpets Road oiling Speed reduction Coverings for loads
Dumping	Water sprays of active areas Water spray curtains over bed during dumping Dust suppressants Surfactants
Storage (waste/ residuals)	Windscreens Orientation of pile Slope of pile Foam covering and other coverings Dust suppressants Aerodynamic considerations Cover by structure with air displacement and control
Grading	Light water sprays Surfactants
Waste feed/ preparation	Cover by structure with air displacement and control

*Adapted from [1].

the excavation process remained constant. This contribution was dependent on the parameters of the soil and the remedial activity pattern. At this site, dumping and temporary storage at the incinerator accounted for 50 percent of the VC emissions; transport from the excavation zone was the second highest contributor of emissions. All activities were assumed to be uncontrolled. The use of tarps and/or foam suppressants could substantially reduce these emissions from transport and storage.

Limitations

The control methods for dust and vapor suppression rarely remove 100 percent of the contaminants from the air. These releases have to be estimated, along with the cost estimate for application of the control method to properly assess the feasibility of implementating the remediation technology being considered. Site conditions determine the effectiveness of specific control methods.

Some methods have very limited periods of effectiveness, making multiple applications or specialized formulations necessary. The scheduling of media excavation and processing may be impacted, for example, in matching the length of effectiveness of a foam or spray suppression technique being used.

If gaseous emissions are expected to be high, or local fugitive limitations apply, costly areal containment methods may be required. If a very large site is to be excavated and the materials classified or preprocessed, portable versions will have to be designed for local air emission control. The use of such portable containment strategies will affect the overall schedule of the remediation and will mandate unique worker safety plans to ensure that the proper level of protective apparel and monitoring devices are used during the excavation process.

Control Methods

A list of the most commonly used control technologies applicable to VCs and PMs released during soils handling is presented in Table 2 [1, p. 5-31].

Volatilization of contaminants from a hazardous waste site may be controlled by reducing soil vapor pore volume or using physical/chemical barriers [2, p. 116]. The rate of volatilization can be reduced by adding water to reduce the air-filled pore spaces or by reduction of the spaces themselves through compaction techniques. Compaction, however, would displace the volatiles occupying the free spaces (soil venting); water suppression might result in mobilizing the contaminant into a groundwater medium if not properly applied. Wastes amenable to this form of suppression include most volatile organic (e.g., benzene, gasoline, phenols) and inorganic (e.g., hydrogen sulfide, ammonia, radon, methyl mercury) compounds in soil. Contaminants with a high vapor phase mobility and low water phase partition potential are particularly amenable to this vapor control technique. However, the initital application of water will force VCs from the soil-free spaces.

Physical/chemical barriers have found broad utility in temporary vapor and particulate control from hazardous waste sites [3, p. 4-1 to 4-10]. Evaporation retardants such as foams may be applied, while simpler windscreens, synthetic covers, and water/surfactant sprays have been used during excavation and transportation operations. The most exotic system applied to a Superfund site included a special domed structure erected over the excavation area and equipped with carbon adsorption beds through which the internal vapors were drawn [4]. The domed structure was designed to limit emissions through the structure and was capable of being transported to the next excavation site when required. A similar structure may be necessary at the point of materials processing, prior to a proposed incinerator for the site. This facility might be fixed, provided a centralized location for the incinerator can be established.

Sound engineering practices include a multitude of methods for vapor and dust suppression; these techniques are shown in Table 3 [5, p. vi]. More than a dozen different techniques have been identified. Several of the methods in Table 3 can be used collectively to achieve fugitive emissions control. Application of foams during excavation operations and tarps for overnight storage can achieve a greater overall control efficiency at significantly lower cost than the use of an enclosure with carbon adsorption control. Good engineering practices employing the use of windscreens or other aerodynamic considerations may provide adequate control at some sites; other sites may require application of nearly every method in the list. Cost estimates of many control techniques for VCs are presented in Reference 6 [6, p. 68]. The cost estimates in Reference 6 are not specific to any particular Superfund site. Cost estimates vary significantly according to the site conditions, contaminant type, and ARARs to be met. Table 3 presents a relative cost index for illustrative purposes.

Table 3
Realtive PM/VC Supression Technologies

Suppression technique	Relative Effectiveness Low	Medium	High	Relative Cost
Minimize waste surface area	✖	✖	✖	1
Aerodynamic considerations	✖			1
• Windscreens	✖			1
• Wind blocks	✖			1
• Orientation of activities	✖			1
Covers, mats, membranes, and fill materials	✖	✖		2–3
Water application	✖	✖		2–3
Water/additives	✖	✖		2–3
Inorganic control agents	✖	✖		2–3
Organic dust control		✖		2–3
Foam suppressants		✖	✖	7-10
Enclosures			✖	10

Site Requirements

General site conditions that dictate the estimated magnitude of air emissions are provided in Table 4 [7, p. 16]. The requirements for implementation of the dust/vapor control techniques are a function of the estimated emissions once these site conditions have been assessed. Baseline estimation techniques are available for both undisturbed and disturbed sites, as well as mathematical modeling and actual direct measurement methods to verify estimates. Consideration of the particular weather conditions relative to the proposed remediation schedule is critical to efficient control of air emissions. Tables 3 and 4 should be considered concurrently when structuring an air emissions control strategy for the site and the remediation activities.

Table 4
Important Parameters Affecting Baseline Air Emission Levels [7]

Parameter	Qualitative Effect[a] Volatiles	Particulate Matter
Site Conditions		
Size of landfill or lagoon	Affects overall magnitude of emissions, but not per area.	Affects overall magnitude of emissions, but not per area.
Amount of exposed waste	High	High
Depth of cover on landfills	Medium	High
Presence of oil layer	High	High
Compaction of cover on landfills	Medium	Low
Aeration of lagoons	High	High
Ground cover	Medium	High
Weather Conditions		
Wind speed	Medium	High
Temperature	Medium	Low
Relative humidity	Low	Low
Barometric pressure	Medium	Low
Precipitation	High	High
Solar radiation	Low	Low
Soil/Waste Characteristics		
Physical properties of waste	High	High
Adsorption/absorption properties of soil	Medium	Low
Soil moisture content	High	High
Volatile fraction of waste	High	Low
Semivolatile/nonvolatile fraction of waste	Low	High
Organic content of soil and microbial activity	High	Low

[a]High, medium, and low in this table refer to the qualitative effect that the listed parameter typically has on baseline emissions.

Table 5
Summary of VOC Air Emissions Control Technologies For Landfills [*]

Control	Advantages	Disadvantages
Foams	• Easy to Apply • Effective • Allow for Control of Working Faces • Can Reduce Decontamination	• Moderately Expensive • Requires Trained Operators
Complete Enclosure/ Treatment System	• May Provide the Highest Degree of Control For Some Applications	• High Cost • Air Scrubbing Required • High Potential Risk • Must Work Inside Enclosure
Fill Material	• Inexpensive • Equipment Usually Available	• Hard to Seal Air-Tight • No Control for Working Face • Creates More Contaminated Soil
Synthetic Membrane	• Simple Approach	• Worker Contact with Waste on Application • Hard to Seal Air-Tight
Aerodynamic Modification	• Simple • Lower Cost • Low Maintenance	• Variable Control • Requires Additional Controls
Fugitive VC/PM Collection Systems	• Can Be Used in Active Areas	• Limited Operational Data Exist • Effective Range Limited • Maintenance Required
Minimum Surface Area, Shape	• Inexpensive • Can Be Included in Plan	• Must Maintain • Cannot Always Dictate Shape
Water	• Easy to Apply	• A Potential Exists for Leaching to Groundwater
Inorganic/Organic Control Agents	• Similar to Foams	• Not as Effective as Foams For Working Areas

* Adapted from [14]

Performance Experience

A study of fugitive dust control techniques conducted with test plots at an active cleanup area documented decreasing effectiveness of foam suppressants within 2 to 4 weeks of application. The effectiveness of water sprays on dump trucks and at the loading site was in the 40 to 60 percent range for the site and 60 to 70 percent range for the truck [8, p. 2]. Surfactants increased the effectiveness of the water sprays.

Foam suppressants have been thoroughly studied by at least two vendors: 3M and Rusmar Foam Technology [9][10]. Laboratory data for highly volatile organics, such as benzene and trichloroethylene contaminated sand, indicated more than 99 percent suppression effectiveness for several days. Complementary data indicated better barrier performance of foams over 10-mil polyethylene film in controlling volatilization [11, p. 7 & 8]. A burning landfill was doused and the vapors suppressed by more than 90 percent using foam at a site in Jersey City [12, p. 3]. Similarly, vapors from a petroleum waste site were compared using three different test agents: temporary foam, rigid urea-formaldehyde foam, and a stabilized foam. The temporary foam yielded an average 81 percent control for 20 minutes, rigid foam produced 73 percent control for about 2 hours, and the stabilized foam was 99 percent effective for 24 hours after application [13, p. 4-7].

The performance data reported are specific to the sites and contaminants controlled. There is no direct applicability of the performance data to general Superfund sites or conditions.

Table 5 presents a summary of VC air emissions control technologies for landfills [14, p. 38]. Many of the techniques used can control fugitive particulate emissions as well.

Technology Status

The use of vapor and particulate control techniques has been directly applied to at least three Superfund sites: McColl (California), Purity Oil Site (California), and LaSalle Electric (Illinois). The McColl work is available as a Superfund Innovative Technology Evaluation demonstration of excavation techniques. Although the domed structure used controlled sulfur dioxide and VOC releases to the atmosphere, working conditions within the dome were difficult. High concentrations of dust and contaminants mandated use of a high level of personal protective apparel. Consequently, personnel were able to work within the dome for only short periods of time [15].

A variety of dust and vapor control techniques may be applied at Superfund sites. A systematic approach to estimate the quantities of air emissions to be controlled, the ambient impact, and the selection of the most appropriate control technique requires a thorough understanding of the site, wastes, emissions potential, and the most relevant combinations of control methods.

EPA Contact

Technology-specific questions regarding air emissions may be directed to:

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