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Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

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# OFF-SITE WASTE AND RECOVERY OPERATIONS: BACKGROUND INFORMATION FOR PROPOSED STANDARDS

NESHAP

EPA-453/R-94-070a

# Off-Site Waste and Recovery Operations:

## Background Information

## Document for

## Proposed Standards

Emission Standards Division

Office of Air Quality Planning and Standards
United States Environmental Protection Agency
Research Triangle Park, North Carolina 27711

September 8, 1994

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ENVIRONMENTAL PROTECTION AGENCY

Background Information for Proposed Standards
Off-Site Waste Operations
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1. The proposed standards would regulate organic hazardous air pollutants (HAP) emitted from off-site waste operations. Section 112 of the Clean Air Act requires the EPA to regulate HAP emissions from sources listed pursuant to section 112(c)

2. Copies of this document have been sent to the following Federal Departments: Labor, Health and Human Services, Defense, Office of Management and Budget, Transportation, Agriculture, Commerce, Interior, and Energy; the National Science Foundation; and the Council of Environmental Quality. Copies have also been sent to member of the State and Territorial Air Pollution Program Administrators; the Association of Local Air Pollution Control Officials; EPA Regional Administrators; and other interested parties.

3. The comment period for this document is 60 days from the date of publication of the proposed standards in the Federal Register. Ms. Jolynn Collins may be contacted at 919-541-*5671 regarding the date of the comment period.

4. For additional information contact:

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5. Copies of this document may be obtained from:

   U.S. EPA Library (MD-35)
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   5285 Port Royal Road
   Springfield, VA 22161
   Telephone: 703-487-4650

**CONTENTS**

**CONTENTS**

**CONTENTS**

**TABLES**

# 1.0 INTRODUCTION

## 1.1 BACKGROUND

Title III of the 1990 Amendments to the Clean Air Act (CAA) substantially revised section 112 of the Act regarding the development of National Emission Standards for Hazardous Air Pollutants (NESHAP). To implement the congressional directives of Title III, the U.S. Environmental Protection Agency (EPA) has initiated a program to develop NESHAP for certain categories of stationary air emission sources that emit one or more of the hazardous air pollutants (HAP) listed in section 112(b) of the CAA.

## 1.2 OFF-SITE WASTE OPERATIONS NESHAP

Under section 112(c) of the CAA, the EPA is required to develop and publish a list of all source categories emitting HAP. The EPA's initial list was published in the Federal Register on July 16, 1992 (57 FR 31576). On this initial list of HAP emission source categories, the EPA included one source category which the Agency intended to address HAP emissions from those waste management and materials recovery operations that are not included in another separate NESHAP source category or are being addressed by other EPA regulatory actions. This source category was originally titled on the initial source category list as "solid waste treatment, storage, and disposal facilities."

Since the initial source category list was published in the Federal Register, the EPA decided to change the title of this NESHAP source category to "off-site waste operations."

The EPA decided that this change is appropriate for two reasons: (1) to avoid confusion with the terms "solid waste" and "treatment, storage, and disposal facilities" which have specific meanings within the context of statutory and regulatory requirements in existing rules established by the EPA under authority of the Resource Conservation and Recovery Act (RCRA); and (2) to better distinguish the types of air emission sources addressed by this NESHAP source category from other NESHAP source categories.

The EPA published an advance notice of proposed rulemaking (ANPR) in the Federal Register on December 20, 1993 (58 FR 66336) announcing EPA's intent to develop a NESHAP for off-site waste operation source category. In the ANPR, the EPA noted that it is the Agency's intent to regulate under this NESHAP only organic chemicals which have been designated as HAP under section 112(b) of the CAA. These organic chemicals are referred to collectively hereafter in this document as "organic HAP."

## 1.3 PURPOSE OF THIS DOCUMENT

In developing NESHAP, the EPA selects and evaluates different strategies for reducing air emissions from the source category. Each strategy is referred to as a "control option." This background information document (BID) presents information and methods used by the EPA for a control option impact analysis in support of developing a NESHAP for the off-site waste operations source category.

Chapter 2 identifies the types of waste materials and off-site waste management facilities addressed by the control option analysis. The types of HAP emission points at the off-site waste operations selected for the control option impact analysis are described in Chapter 3. Chapter 4 describes the types of air emission controls used to develop control options. Chapter 5 presents a comparison of the organic HAP and volatile organic compound (VOC) emission reduction levels for the control options. Estimates of other environmental and energy impacts associated with implementing these control options are presented in Chapter 6. Chapter 7 discusses the application of enhanced monitoring to the control technologies selected for the control options. Estimates of capital and annual costs to implement the control options are presented in Chapter 8. Appendix A presents a chronology of the NESHAP development for the off-site waste operations source category. Additional details of the control option impacts estimation methods are presented in Appendices B through E.

# 2.0 SOURCE CATEGORY DESCRIPTION

This chapter presents the description of the off-site waste operations source category as used for the control option impact analysis. Section 2.1 identifies the general scope of the off-site waste operations source category addressed by the control option impact analysis. Section 2.2 describes the types of off-site waste operations selected for this analysis. Section 2.3 presents estimates of organic HAP emissions for the off-site waste operations source category.

## 2.1 GENERAL SCOPE OF CONTROL OPTION IMPACT ANALYSIS

### 2.1.1 Definition of "Waste"

For the purpose of performing a control option analysis for the off-site waste operations source category, the EPA defined "waste" to be any material generated from industrial, commercial, mining, or agricultural operations or from community activities that is recycled, reprocessed, reused, discarded, or is being accumulated, stored, or physically, chemically, thermally, or biologically treated prior to being discarded, recycled, or discharged. This definition is consistent with the definition of waste used by the EPA for other air rules promulgated under authority of the CAA. Under this definition of waste, secondary materials such as used, surplus, and scrap materials that are recycled or reprocessed to recover reusable materials or to create new products are considered by the EPA to be wastes for the purposes of this analysis.

The waste definition used for the control option analysis defines the types of materials considered to be a "waste" in a broader context than the EPA has historically used for the

Agency's solid waste management rules established under the authority of the Resource Conservation and Recovery Act (RCRA). The waste data used for the off-site waste operations control option analysis include wastes defined as hazardous waste under RCRA subtitle C and other nonhazardous solid wastes as defined under RCRA subtitle D. In addition, materials excluded from the RCRA definitions of waste under subtitles C and D (e.g., recovered materials recycled back to a process and used oil reprocessed for sale as a fuel) were included as wastes for the off-site waste operations control option analysis.

### 2.1.2 Definition of "Off-Site Waste Operations"

For the control option analysis, the EPA defined "off-site waste operations" to be operations conducted to manage wastes containing HAP that are received from other facilities. In other words, the wastes have been generated off-site at a separate location and, then, shipped or transferred to the facility for subsequent management. Waste management operations considered to be "off-site waste operations" for this analysis include waste storage, treatment, and disposal operations as well as waste recycling, recovery, and reprocessing operations.

The EPA is addressing HAP emissions from certain types of waste management operations by establishing separate NESHAP or other regulatory actions. Consequently, wastes managed in the following operations are not included in control option analysis for the off-site waste operations source category: (1) operations that exclusively managed waste generated at the off-site waste operations facility site (i.e., waste generated on-site); (2) municipal solid waste (MSW) landfill units; (3) incinerators used to burn waste; (4) boilers or furnaces used to burn waste to produce energy; (5) operations located at a publicly-owned treatment works (POTW); and (6) operations used exclusively to manage waste that has been received from remediation activities to cleanup RCRA hazardous wastes.

## 2.2 OFF-SITE WASTE OPERATIONS SELECTED FOR ANALYSIS

The off-site waste operations considered for inclusion in the control option impact analysis were classified into six types of off-site waste operations. These waste operation types are labelled:

- Hazardous waste treatment, storage, and disposal facilities (TSDF)
- Industrial waste landfills
- Industrial wastewater treatment facilities
- Recycled used oil management facilities
- Oil and gas exploration and production (E&P) waste management facilities
- Other facilities

A brief description of each of these six types of off-site waste operations is presented in the following subsections.

### 2.2.1 Hazardous Waste TSDF

The EPA has established rules under the authority of RCRA regulating the management of wastes determined to be hazardous wastes (40 CFR Parts 260 through 271). These rules establish a permit system for owners and operators of facilities where operations are conducted to treat, store, and dispose of a RCRA hazardous waste. A facility requiring a RCRA permit is referred to under the RCRA rules as a hazardous waste treatment, storage, and disposal facility (TSDF). A RCRA hazardous waste may be generated at the same site where a TSDF is located, or may be generated at one site and then transported to a TSDF at a separate location.

Waste materials not designated as RCRA hazardous wastes are also managed at TSDF. Although a waste material may not specifically be designated as a RCRA hazardous waste, this waste material can still contain significant quantities of organic constituents listed as HAP under the CAA.

The EPA has conducted nationwide surveys to collect information regarding hazardous waste management practices.[1,2] Data from the most recent surveys indicates that approximately 2,300 TSDFs were operating in the United States in 1986. At 710 of these TSDF, owners and operators reported managing RCRA hazardous wastes that are generated off-site. The EPA survey data indicates that approximately 240 of these 710 TSDFs also managed nonhazardous waste materials.

### 2.2.2 Industrial Waste Landfills

Many landfill facilities throughout the Unites States are dedicated to the disposal of solid waste materials other than those defined as RCRA hazardous wastes. Landfills accepting household wastes are defined under RCRA rules to be municipal solid waste (MSW) landfill units. No MSW landfill units are included in the off-site waste operations source category because these units are listed as a separate NESHAP source category. However, some other landfills are operated by waste management companies that will accept only industrial nonhazardous waste materials (i.e., these landfills do not accept any household wastes nor RCRA hazardous wastes).

The EPA estimates that there are approximately 10 industrial landfills currently operating nationwide that accept only nonhazardous industrial process waste materials. These industrial nonhazardous waste landfills receive a wide range of waste material, some of which may contain organic HAP. Furthermore, the EPA estimates that nationwide there are approximately 1,800 construction and demolition debris landfills that could be subject to a NESHAP for off-site waste operations. However, the EPA does not expect the construction and demolition debris landfills to contain significant amounts of organic HAP.[3]

### 2.2.3 Industrial Wastewater Treatment Facilities

Analogous to landfills, many waste treatment facilities are operated by municipal governments and private companies throughout the Unites States for the treatment of wastewaters other than those defined to be RCRA hazardous wastes. Wastewater treatment facilities accepting residential and commercial wastewaters are considered to be publicly owned treatment works (POTW). No POTW are included in the off-site waste operations source category because POTW are listed as a separate NESHAP source category. In addition to POTW, some privately-owned wastewater treatment facilities process nonhazardous wastewaters received from off-site sources.

A nationwide survey was conducted by the EPA of wastewater treatment facilities operating in 1989.[4] Using these survey data, a data base excluding POTW was created. Many of the facilities listed in this wastewater treatment facility data base are also listed in the hazardous waste TSDF data base described in Section 2.2.1 of this chapter. However, the data base also lists an additional 15 wastewater treatment facilities were operating nationwide which were neither a POTW nor a hazardous waste TSDF but do process wastewaters received from off-site sources that potentially could generate wastewaters containing organic HAP.

### 2.2.4 Recycled Used Oil Management Facilities

Used oils from motor vehicles and other sources can contain individual constituents listed as HAP under section 112(b) of the CAA. While the management of used oils which are recycled is regulated by separate rules promulgated by the EPA under section 3014 of RCRA, these rules do not specifically establish air standards for used oil management facilities.

The EPA gathered information regarding recycled used oil management practices in the United States for the development of the RCRA standards.[5] This information indicates that approximately 2,800 million liters (750 million gallons) of used oil enters the commercial used oil recycling market each year. Approximately three-fourths of this recycled used oil is sent to facilities categorized by EPA as "used oil processors." Used oil processors typically collect used motor oil and industrial lubricating oils. These oils are processed to remove water and sediments from the oils. The processors than sell the oil as a fuel for burning primarily in boilers, furnaces, and space heaters. There were 182 used oil processing facilities operating in the United States in 1991. The remainder of the recycled used oil is sent to facilities categorized as "used oil re-refiners." At these facilities the used oil is processed into base lube oil stocks and other products. In 1991, there were 4 used oil re-refining facilities operating in the United States. Several companies have expressed interest in expanding used oil re-refining capacity in the United States.

### 2.2.5 Oil and Gas E&P Waste Management Facilities

There are a variety of waste materials generated during oil and gas exploration and production (E&P). The majority of these waste materials are managed on-site at the production site. However, some E&P waste materials generated at production sites are subsequently transferred to off-site facilities for treatment or disposal. The off-site waste management operations that typically process E&P waste materials can be classified into three different types of operations. These are: crude oil reclamation; land treatment/road spreading; and produced water disposal.

The EPA gathered information regarding E&P waste management practices from EPA conducted site visits and existing industry sponsored surveys.[6] From this information, the nationwide total quantity of E&P waste materials managed at off-site facilities was estimated to be approximately 930,000 megagrams per year (Mg/yr) (1 million tons/yr). Approximately 70 percent of the E&P waste materials are contaminated waters that are managed in small produced water disposal operations by deep-well injection. Nationwide, there are approximately 16 off-site crude oil reclaimers managing approximately 100,000 Mg/yr (115,000 tons/yr) of E&P waste materials. These waste materials consist mostly of tank bottoms from crude oil storage tanks or produced water storage tanks. Approximately 135,000 Mg/yr (150,000 tons/yr) of E&P waste sludges are managed in off-site land treatment or road spreading operations.

### 2.2.6 Other Facilities

In addition to the facilities that are in business to manage waste materials received from waste generators, some facilities which provide waste management support services may indirectly receive waste materials which are potential organic HAP emission sources. Two types of such facilities have been identified by the EPA: (1) facilities where empty drums previously used to hold waste materials containing organics are cleaned and reconditioned for reuse; and (2) truck terminal facilities at which tank trucks used for chemical waste transport are cleaned and rinsed prior to being used to transport a new load. At both of these types of facilities, organic HAP emissions can occur from the wastewater treatment system operated at the facility to treat the waste materials and cleaning solutions drained from drums or truck tanks as a result of the container cleaning operation. Wastewater treatment operations are expected to be the primary source of organic HAP emissions at these types of facility.

The need for and frequency of cleaning a drum and tank truck depends on the type of service in which the container is used. If drums and tank trucks are reused for the same type of product or waste materials (i.e., dedicated service), the containers do not need to be cleaned between each use. Only when a drum or tank truck is used for different types of products or waste materials (i.e, nondedicated service) is there frequent cleaning of the containers. Of the approximately 45 million drums used annually in the United States, about 5.6 million are estimated to be in nondedicated service.[7] Approximately 20,000 tank trucks of the nationwide total of 91,000 are estimated to be in nondedicated service.[8]

## 2.3 SOURCE CATEGORY ORGANIC HAP EMISSION ESTIMATES

Under section 112(a) of the CAA, a "major source" is defined as any stationary source or group of stationary sources that emits or has the potential to emit 10 tons per year or more of any single HAP constituent or 25 tons per year or more of any combination of HAP constituents. An analysis was performed to determine if facilities in each of the off-site waste operation types described in Section 2.2 of this chapter are likely to have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source."

### 2.3.1 Individual Facility Emission Estimates

The EPA estimated organic HAP emissions for each of the six types of off-site waste operations described in Section 2.2 of this chapter using the best information available to the Agency at the time that the estimates were completed. The type, amount, and date of this information varies for each of the off-site waste operation types.

2.3.1.1 Hazardous Waste TSDF. Organic HAP emissions for hazardous waste TSDF were estimated using nationwide survey data for the year 1986 collected by the EPA and a computer model developed specifically for this analysis as described in Appendix B of this BID. Using site-specific information regarding waste management practices and waste composition, the computer model estimates organic HAP emissions for 464 individual hazardous waste TSDF locations. The results of this computer model analysis indicate that 131 of the 464 hazardous waste TSDF are estimated to have either organic

HAP emissions greater than 10 tons per year of any single organic HAP constituent or 25 tons per year of all organic HAP constituents resulting from the management of hazardous waste materials received from off-site. Also, many of the hazardous waste TSDFs may have additional organic HAP emissions resulting from the management of nonhazardous wastes received from off-site, on-site production operations as well as from the management of waste materials generated on-site. No emission estimates were made for the management of the waste at TSDF reported in the data base to be quantities generated on-site. Order-of-magnitude nationwide organic HAP emissions from the management of nonhazardous wastes received by TSDF from off-site were estimated using nationwide survey data collected for the year 1986.[9] Using compositional data for hazardous wastes managed in similar types of processes, an additional 12,000 Mg/yr (13,000 tons/yr) of organic HAP emissions are estimated nationwide at TSDFs from the management of nonhazardous wastes received from off-site. Therefore, the EPA expects many hazardous waste TSDFs have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source."

2.3.1.2 Industrial Waste Landfills. Order-of-magnitude nationwide organic emissions from industrial waste landfill facilities were estimated using data collected by EPA in 1994 from industry representatives and waste management companies.[10] Based on this information, the EPA estimates there are 10 industrial waste landfill facilities currently operating in the United States that accept industrial process waste materials likely to contain organic HAP from off-site waste generators. Nationwide organic HAP emissions from these landfill facilities are estimated to be approximately 1,300 Mg/yr (1,400 ton/yr). If it is assumed that each of the 10 landfill facilities receives approximately the same annual quantity of waste materials with similar organic HAP characteristics, the average organic HAP emissions from a single landfill facility is estimated to be on the order of 130 Mg/yr (140 tons/yr). The EPA recognizes that in actuality it is unlikely that this is the case and that some of these industrial waste landfill facilities may have significantly lower organic HAP emission levels. However, these estimates suggest that at least some industrial waste landfill facilities are likely to have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source."

2.3.1.3 Industrial Wastewater Treatment Facilities. Order-of-magnitude nationwide organic emissions from industrial wastewater treatment facilities were estimated using survey data collected by the EPA.[11] These data contain limited wastewater composition data and operation information for the 15 industrial wastewater treatment facilities identified nationwide that only accept off-site wastewaters which are not defined to be RCRA hazardous wastes. Organic HAP emission estimates for these facilities indicate that 5 of the 15 facilities have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source."

2.3.1.4 Recycled Used Oil Management Facilities. Order-of-magnitude nationwide organic emissions from used oil management facilities were estimated using nationwide estimates of annual 1991 used oil quantities and facility numbers prepared by the EPA in support of the development of recycled used oil management standards under RCRA section 3014.[12,13] The nationwide organic HAP emissions from all used oil processing facilities are estimated to be approximately 43 Mg/yr (47 ton/yr). Considering that a total of 182 used oil processing facilities were operating in the United States in 1991, the organic HAP emissions from a single used oil processing facility are expected to be less than 1 Mg/yr (approximately 1 ton/yr). The nationwide organic HAP emissions from used oil re-refining facilities are estimated to be 44 Mg/year (48 tons/yr). Thus, for the 4 used oil re-refining facilities, the average organic HAP emissions from each facility are approximately 11 Mg/yr (12 tons/year). Based on these emission estimates, it is judged most likely that used oil processing facilities do not have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source." However, some used oil re-refining facilities are likely to have annual organic HAP emissions greater than 10 ton per year of an individual organic HAP or more than 25 ton per year of total organic HAP.

2.3.1.5 Oil and Gas E&P Waste Management Facilities. An order-of-magnitude nationwide organic HAP emission estimate was developed for E&P waste management operations using the general information collected by the EPA.[14] The total nationwide organic HAP emissions from all E&P waste materials are estimated to be 600 Mg/yr (660 tons/yr). Off-site crude oil reclaimers are estimated to have organic HAP emissions of approximately 260 Mg/yr (290 tons/yr). An average off-site crude oil reclaimer is estimated to have total organic HAP emissions of approximately 16 Mg/yr (18 tons/yr). As such, it is judged likely that some crude oil reclaiming facilities may have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source." Based on the order-of-magnitude emissions estimate for crude oil reclamation, it is estimated that there are no more than 11 facilities that may have annual organic HAP emissions greater than 10 ton per year of an individual organic HAP or more than 25 ton per year of total organic HAP.

The total annual organic HAP emissions estimated for all produced water disposal operations are only 3.8 Mg/yr (4.2 tons/yr). As such, produced water disposal operations are not expected to have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a singe "major source."

The total annual organic HAP emissions for land treatment and road spreading of off-site E&P waste materials are estimated to by approximately 340 Mg/yr (370 tons/yr). Based on the number and size of road spreading operations, it is judged most likely that road spreading operations using off-site E&P waste materials do not have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source." However, it is possible that some larger land treatment operations managing off-site E&P waste materials may have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source." Based on the order-of-magnitude emissions estimate for land treatment/road spreading operations, it is estimated that there are no more than 15 facilities that may have annual organic HAP emissions greater than 10 ton per year of an individual organic HAP or more than 25 ton per year of total organic HAP.

2.3.1.6 Other Facilities. No nationwide survey data are available for drum reconditioning facilities or truck tank cleaning facilities. Therefore, estimates of organic HAP emissions were made for individual drum reconditioning and truck tank cleaning facilities considered by the EPA to be representative of the sizes of these types of waste management support services facilities.[15] Annual organic HAP emissions for a drum reconditioning facility are estimated to range from 0 to 7 Mg/yr (0 to 6 tons/yr). Annual organic HAP emissions for a truck tank cleaning facility are estimated to be less than 1 Mg/yr (less than 1 ton/yr). Based on these estimates, the EPA does not expect either drum reconditioning or truck tank cleaning facilities to have annual organic HAP emissions that exceed the HAP emission levels defined by the CAA for a "major source."

### 2.3.2 Summary of Nationwide Organic HAP Emission Estimates

Table 2-1 presents a summary of the estimated nationwide organic HAP emissions for the off-site waste operations. The table shows nationwide organic HAP emissions for the facility types described in Section 2.2 of this chapter likely to include individual facilities emitting more than 10 ton per year of an individual organic HAP or more than 25 ton per year of total organic HAP. These facility types are: hazardous waste TSDF; industrial waste landfills; industrial wastewater treatment facilities; used oil re-refining facilities; crude oil reclamation facilities; and oil and gas E&P waste land treatment facilities. For these six off-site waste operations facility types, the EPA estimates there are currently nationwide a total of 765 facilities. The EPA estimates that 710 of these off-site waste operation facilities are also hazardous waste TSDF.

The total nationwide organic HAP emissions from off-site waste operations at hazardous waste TSDF, industrial waste landfills, industrial wastewater treatment facilities, used oil re-refining facilities, crude oil reclamation facilities, and oil and gas E&P waste land treatment facilities are estimated to be approximately 51,500 Mg/yr of organic HAP. The results indicate for the off-site waste operations source category approximately 90 percent of the total nationwide organic HAP emissions occur at hazardous waste TSDF.

TABLE 2-1. ESTIMATED NATIONWIDE ORGANIC HAP EMISSIONS FOR OFF-SITE WASTE OPERATIONS SOURCE CATEGORY

| Type of Facility Receiving Materials From Off-Site[a] | Estimated Number of Existing Facilities Nationwide | Type of Material Received from Off-site[b] | Estimated Nationwide Quantity of Material Managed (1,000 Mg/yr) | Estimated Nationwide Organic HAP Emissions (Mg/yr) |
|---|---|---|---|---|
| Hazardous waste TSDF[c] | 710 | hazardous waste | 26,000 | 34,000 |
| | | nonhazardous waste | 9,400 | 12,000 |
| Industrial wastewater treatment operations[d] | 15 | nonhazardous wastewater | 22,000 | 3,600 |
| Industrial waste landfills[e] | 10 | industrial process waste | 1,800 | 1,300 |
| Crude oil reclamation and land treatment facilities[f] | 26 | E&P waste material | 230 | 600 |
| Used oil re-refining facilities[g] | 4 | used oil | 430 | 50 |

Notes:

(a) Types of off-site waste facilities estimated to include individual facilities emitting more than 10 ton per year of an individual organic HAP or more than 25 ton per year of total organic HAP.
(b) "Hazardous" refers to materials defined to be a "hazardous waste" under RCRA regulations. "Nonhazardous" refers to materials not defined to be a "hazardous waste" under RCRA regulations.
(c) Estimates based on EPA Office of Solid Waste (OSW) 1986 nationwide survey data.
(d) Estimates based on EPA Office of Water 1989 nationwide survey data.
(e) Estimates based on 1994 telephone contacts of industry representatives and waste management companies.
(f) Estimates based on information gathered during site visits of oil and gas E&P waste management facilities in 1993 and a 1985 production waste survey.
(g) Estimates based on EPA OSW estimates of nationwide used oil management practices for 1991.

## 2.4 REFERENCES


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5. U.S. Environmental Protection Agency. Hazardous Waste Management Systems; Identification and Listing of Hazardous Waste; Recycled Used Oil Management Standards: Final Rule. 57 FR 41566-41626. September 10, 1992.

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7. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 4th Edition. AP-42. September 1985.

8. Reference 7.

9. Memorandum from Coburn, J., Research Triangle Institute, to Crump, E., U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Order-of-Magnitude Emissions Estimate for Nonhazardous Waste Materials Managed at RCRA Subtitle C TSDF. March 8, 1994.

10. Reference 3.

11. Memorandum from Coburn, J. and P. Peterson, Research Triangle Institute, to Crump, E., U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Order-of-Magnitude Estimate of Organic HAP Emissions from Commercial Nonhazardous Wastewater Treatment Facilities. August 4, 1993.

12. U. S. Environmental Protection Agency. Cost and Economic Impact of Used Oil Management Standards. Regulatory Analysis Branch, Office of Solid Waste. August 4, 1992.

13. Memorandum from Coburn, J. and P. Peterson, Research Triangle Institute, to Crump, E., U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Order-of-Magnitude Organic HAP Emission Estimates for Commercial Waste Oil Recycling Facilities. May 20, 1993.

14. Reference 6.

15. Memorandum with attachments from Coburn, J. and P. Peterson, Research Triangle Institute, to Crump, E., U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Annual Total Organic HAP Emission Estimates for Drum Reconditioning Operations and Tank Truck Cleaning Operations. April 14, 1993.

# 3.0 SOURCE CATEGORY EMISSION POINTS

This chapter discusses the types of emission points at off-site waste operations facilities from which organic emissions to the atmosphere may occur. The organic vapors emitted from these emission points are composed of varying amounts of organic hazardous air pollutants (HAP) as well volatile organic compounds (VOC) depending on the specific organic constituent composition of the waste materials being managed at the emission point. Section 3.1 presents a brief overview of the types of waste management units commonly used at off-site waste operations facilities. The organic HAP emission point type classifications used for the off-site waste operations source category impact analysis are described in Section 3.2.

## 3.1 WASTE MANAGEMENT UNITS

### 3.1.1 <u>Tanks</u>

Tanks are used for many different applications at off-site waste operations facilities to accumulate, store, or treat waste materials containing organics. These tanks can be either open tanks (i.e., the surface of the waste material is exposed directly to the atmosphere), covered tanks (i.e., the surface of the waste material is enclosed by a roof or cover), or pressure tanks (i.e., the waste material is stored at pressures above atmospheric pressure).

Organic emissions result from the volatilization of organics-containing waste materials placed in the tank, and the subsequent release of these organic vapors to the atmosphere. For open tanks, the organic vapors released from the surface of the waste material are dispersed immediately into the atmosphere by diffusion and the wind effects. The rate of organic volatilization is increased when the waste material is heated or when the waste material is agitated or aerated (e.g., the use of surface aerators in open-top tanks to increase the supply of oxygen for microorganisms in biological wastewater treatment units). However, under certain operating conditions, the microbes in biological wastewater treatment process can degrade (i.e., destroy) certain organic compounds in the waste material at a rate much faster than the organic compounds can volatilize and be released into the air. In this special case, organic emissions from an aerated open-top tank are low.

Covering a tank (referred to as a "fixed-roof tank") significantly lowers organic emissions compared to open tanks. However, organic emissions still occur from fixed-roof tanks as a result of the displacement of organic vapors which have collected in the enclosed space above the waste surface through vents on the tank roof. This displacement occurs during tank filling operations when the vapors are pushed out through the tank vents by the rising level of liquid in the tank (commonly referred to as "working losses"). Organic emissions, to a lesser extent, also occur from organic vapor displacement when the volume of the vapor in the tank is increased by fluctuations in ambient temperature or pressure (commonly referred to as "breathing losses"). The quantity of organic emissions from a fixed-roof tank varies greatly depending on volatility of the organic constituents in he waste materials placed in the tank, and whether the tank vents are open to the atmosphere, equipped with a pressure-vacuum relief valves, or vented to an air emission control device.

Organic emissions from a properly operated tank using a floating roof or a pressure tank are very low. Installing a cover which floats on the waste surface essential eliminates the vapor space inside the tank in which organic vapors can collect. Small quantities of organic emissions occur from small openings for floating roof deck fittings (commonly referred to as "working losses"), and from the evaporation of the liquid that wets the inside tank wall as the roof descends during emptying operations (commonly referred to as "withdrawal losses"). Additional organic emissions from floating roof tanks occur if there are gaps or holes in the seals between the roof rim and the tank wall. Pressure tanks operate as closed systems and do not emit organic vapors under normal operating conditions.

### 3.1.2 Containers

Waste materials frequently are delivered to off-site waste operations facilities in containers such as drums, roll-off boxes, tank trucks, and rail cars. In addition, certain types of containers (e.g., drums, dumpster, and roll-off boxes) can be used at the facility to accumulate, store, and treat waste materials. Drums used for waste management are typically fitted with lids. Tank trucks and tank railcars are equipped with hatches or ports which are opened when waste materials are being loaded or unloaded. Dumpsters and roll-off boxes used for handling waste materials are frequently open-top but, in some applications, lids or covers are installed on these types of containers.

Organic emissions from containers can result by several emission mechanisms. Open containers are an emission source when organics evaporate from the exposed surface of the waste material placed in the container. Organic emissions occur during loading of liquid, slurry, and sludge waste materials into containers due to the displacement of organic vapors out through container openings (e.g., the unplugged bung on a drum lid, the open hatch on a tank truck or tank railcar) by the rising level of material in the container. The organic emissions from loading operations are greatest when splash filling is used. During this type of loading operation, the impact of the incoming waste material on the surface of material already in the container creates turbulence and splashing which tends to quickly saturate the vapors above the waste surface with organics. Organics emissions during loading operations using submerged fill are significantly lower because the incoming waste material is discharged below the waste surface eliminating the splashing and reducing the degree of saturation of the displaced vapors.

### 3.1.3 Surface Impoundments

Liquid, slurry, and sludge waste materials are managed at some off-site waste operations facilities in surface impoundments. A surface impoundment is an earthen pit, pond, or lagoon which may be lined with a synthetic membrane liner or other materials. The most common use of surface impoundments at off-site waste operations facilities is for wastewater treatment systems. Examples of surface impoundment used for wastewater treatment systems include accumulation of on-site rainfall runoff, mixing and equalization of wastewater streams collected from multiple sources, neutralization of acidic wastewaters, and biodegradation of organics in wastewaters. Surface impoundments are sometimes used for disposal of liquid, slurry, or sludge waste materials that are not defined to be a RCRA hazardous waste. The use of surface impoundments for managing RCRA hazardous wastes is decreasing as many TSDF owners and operators are choosing to convert their existing surface impoundments to tanks.

Organic emissions from surface impoundments occur as organics evaporate from the exposed surface of the waste materials placed in the impoundment. Surface impoundments containing organic-containing waste materials have a high organic emission potential because of the very large exposed surface area (typical-size surface impoundments cover several acres or more) and the long residence time that waste materials have in the impoundment (sometimes weeks or months). These two factors often allow the loss of most of the volatile organic constituents. In addition, when mechanical or diffused air aerators are used to enhance a biodegradation process performed in a surface impoundment, the aerators cause turbulent surface areas which significantly increases the rate of organic emissions near the aerators.

#### 3.1.4 Landfills

A landfill is usually an excavated, lined pit or trench into which waste materials are buried for permanent disposal. If any organics remain in the waste materials that are placed in landfill, organic emissions occur as a result of the volatilization of organics from the exposed waste material surface until the material is covered by a layer of soil. Once the waste material is covered, additional organic emissions can still occur over extended periods of time due to the diffusion of organic vapors from the waste materials upward to the soil surface as well as the migration of organic-containing gases formed by the decomposition of waste materials in the landfill.

#### 3.1.5 Land Treatment Units

For land treatment, a waste material is spread on or injected into the soil, and then the soil is tilled to allow aerobic soil bacteria adequate oxygen to compose the organic compounds contained in the material. However, tilling also increases the surface area of the waste matter that is exposed to the atmosphere. Organic emissions are generated due to the volatilization of organics from the exposed surface of the waste materials primarily during application and tilling. After application and tilling organic emissions continue to occur from the soil and/or waste material mixture, although at a decreasing rate, until all of the volatile organics originally in the applied waste material are either emitted or biologically degraded.

### 3.1.6 Wastepiles

A wastepile is used for the storage or treatment of solid, nonflowing waste materials on the ground, on a pad, or other open area exposed to the ambient air. The organic emission mechanism for waste piles is similar to that for uncovered waste material placed in a landfill; volatilization of organics from the exposed surface of the waste material and the diffusion of organic vapors from the waste material within the waste pile to the surface of the surface.

### 3.1.7 Other Treatment Processes

At off-site waste operations facilities, waste treatment processes are commonly employed when managing waste materials containing organics. Examples of these waste treatment processes include batch distillation units, thin-film evaporators, solvent extraction units, air stripping units, and steam stripping units. Emissions from these types of waste treatment processes primarily occur through the process vent.

A "process vent" is a pipe, stack, duct, or similar opening through which gases and vapors generated in a process unit or waste management unit are exhausted to the atmosphere. Organic emissions from process vents result primarily from venting organic vapors and evacuation of equipment for vacuum processing. These emissions occur at the point at which the organic-containing vapors and gases exit the process vent outlet into the atmosphere. Process vents can be used to directly vent the process column or vessel, to vent condensers serving this process equipment, and to indirectly vent the process equipment through tanks which are integral components of the process (e.g., distillate receivers, bottoms receivers, surge control tanks, separator tanks, and hot wells).

### 3.1.8 Ancillary Equipment

Ancillary equipment is needed throughout an off-site waste operations facility to operate tanks and the waste treatment processes described in Section 3.1.7 of this chapter, for container loading and unloading operations, for transfer of waste material from one waste management unit to another, and for other waste management operations. Pumps and valves are used extensively for handling liquid, slurry, and sludge waste materials. Many connectors such as flanges and threaded fittings are needed to join sections of pipe or equipment. Other ancillary equipment consist of compressors, agitators, pressure relief devices, sampling connections, open-ended lines, accumulator vessels, and instrumentation systems.

Organic emissions occur from ancillary equipment containing or contacting gases or liquids that have organic constituents. Organic vapors can be emitted directly to the atmosphere by flowing through small openings created in worn or defective pump and valve packings, flange gaskets, or other types of equipment seals. In addition, organic emissions occur when liquids leak outside the equipment exposing the leaked fluid to the ambient air. Emissions result when organics contained in the drip, puddle, or pool of leaked liquid evaporate into the atmosphere. Although the quantity of organic emissions from a single leak is small, when many equipment leaks occur at a facility, the total organic emissions from equipment leaks can be significant.

## 3.2 SOURCE CATEGORY EMISSION POINTS

For the control option impact analysis, the EPA classified the organic HAP emission sources for the off-site waste operations source category into five emission point types:

Tanks. The tank emission point type for the off-site waste operations source category represents the organic emissions from all waste material management in tanks including wastewater treatment tanks.

Containers. The container emission point type for the off-site waste operations source category represents the organic emissions from the handling of waste materials in drums, dumpsters, roll-off boxes, trucks, and railcars.

Land Disposal Units. The land disposal unit emission point type for the off-site waste operations source category represents the organic emissions from surface impoundments, landfills, land treatment units, and waste piles.

Process Vents. The process vent emission point type for the off-site waste operations source category represents the organic emissions from process vents on batch distillation units, thin-film evaporators, solvent extraction units, air stripping units, and steam stripping units.

Equipment Leaks. The equipment leak emission point type for the off-site waste operations source category represents the organic emissions from gaseous and liquid leaks in pumps, valves, flanges, compressors, agitators, pressure relief devices, sampling connections, open-ended lines, accumulator vessels, and instrumentation systems.

# 4.0 CONTROL TECHNOLOGIES

This chapter describes the organic emission reduction strategies considered by the EPA to develop organic HAP control options for the off-site waste operations source category. Organic HAP compounds in general are a subset of all organic compounds that can potentially be emitted to the atmosphere. Thus, the same control technologies used to control total organic emissions are applicable to controlling organic HAP emissions from waste operations.

One strategy for reducing organic emissions applicable to all types of waste management units is to pretreat the waste materials to reduce the organic content of the waste material before the material enters the unit. Section 4.1 discusses pretreatment processes which can be used for removing organics from or destroying organics in waste materials. An alternative strategy is to apply add-on organic emission controls on each waste management unit in which organic-containing waste materials are managed. Section 4.2 identifies the add-on organic emission controls selected by the EPA as most appropriate for waste management unit types described in Chapter 3 for the off-site waste operations source category.

Background information is not presented in this chapter regarding the selected control technologies, alternative but less effective control technologies, or emerging but not commercially available control technologies. For detailed background information on organic emission control technologies, the reader is referred to other published EPA documents as cited throughout this chapter.

## 4.1 WASTE PRETREATMENT

Pretreatment of the waste materials, to remove or destroy the organics in the waste materials, reduces organic emissions from all subsequent waste management units handling these materials without the need to apply add-on emission controls on these units. Volatile organic compounds can effectively be removed from many waste materials using conventional processes such as steam stripping, air stripping, solvent extraction, or thin-film evaporation. Biological degradation processes also can be used to destroy volatile and other organic compounds in wastewaters (e.g., activated sludge wastewater treatment processes). All forms of waste materials containing organics can be burned in an incinerator to destroy organics and produce inorganic waste materials for subsequent management at the off-site waste operations facility. Background information regarding treatment processes for waste materials containing organics is available in References 1 and 2 for this chapter.

The organic removal performance of noncombustion treatment processes is dependent on, among other factors specific to the process used, the concentration and volatility of the specific organic constituents contained in the waste materials. For organic compounds that have high volatilities (e.g., these include HAP compounds such as benzene, carbon tetrachloride, chlorobenzene, chloroform, ethylene oxide, methylene chloride, tetrachloroethene, toluene, vinyl chloride), organic removal efficiencies of 90 percent and higher can be achieved. However, it is important to note that many noncombustion treatment processes produce byproducts, residual materials, or gas streams which contain the organic compounds removed from the waste materials. Thus, to achieve actual organic emission reductions from the off-site waste operations facility, these secondary materials and gas streams must also be properly managed in units using organic emission controls to prevent subsequent release of the organics into the atmosphere.

## 4.2 ADD-ON ORGANIC EMISSION CONTROLS

When organic-containing waste materials are placed in a waste management unit, organic emissions released from the unit can be reduced by adding emission controls at the individual emission points on the unit and its ancillary equipment. The organic emission controls which are applicable and effective to a particular type of waste management unit vary depending on the source size and the organic emission mechanisms.

### 4.2.1 Tanks

Several alternative organic emission controls are available for most tank types in which organic-containing waste materials are managed depending on the concentration and volatility of the organic constituents in these waste materials as well as the tank use, design, and size. The first step to controlling tank organic emissions is to convert waste operations performed in open tanks to closed tanks. In many cases, roofs can be retrofitted to existing open tanks. Although fixed-roof tanks provide large reductions in organic emissions compared to open tanks, significant quantities of organic emissions can be emitted from a fixed-roof tank that either is used to manage waste materials composed of higher volatility organic compounds or is used to manage large quantities of low organic concentration or low volatility waste materials. In these cases, additional organic emission controls are needed to achieve low organic emission levels from the tank. These controls include using a floating roof tank, a pressure tank, or a fixed-roof tank connected through a closed vent system to an organic emission control device.

Organic emissions from a properly designed and maintained floating roof tank are very low. Floating roofs can be installed internally in fixed-roof tanks or used externally without a fixed-roof. As applied to off-site waste operations, application of floating roofs can provide effective organic emission control for cylindrical, vertical-wall tanks used for storage of waste materials or, under some circumstances, treatment of waste materials. Because the roof deck floats on the surface of the waste material placed in the tank, a floating roof cannot be used where the presence of the roof deck on the waste surface interferes with the treatment process (e.g., biological wastewater treatment tanks using surface mixing or aeration equipment).

Pressure tanks are most commonly used for the storage of gaseous waste materials but can also be used for liquid waste materials. This type of tank is designed to operate safely at internal pressures above atmospheric pressure. Consequently, a pressure tank is operated as a closed system that does not emit organic vapors at normal storage conditions or during routine loading and unloading operations. Pressure-relief valves are installed on a pressure tank to open only in the event of improper operation or an emergency to prevent the internal tank pressure from exceeding the design limit.

In all cases for tanks managing waste materials containing organics, organic emissions can be controlled by covering the tank and venting the tank through a closed vent system to an organic emission control device. These organic emission control devices can be grouped into two general categories: vapor recovery control devices and vapor destruction control devices. Vapor recovery control devices use noncombustion processes to extract the organics from the vent stream for potential recycling or reuse. These control devices include carbon adsorbers, condensers, and absorbers. Vapor destruction control devices use combustion/oxidation processes to destroy the organics in the vent stream before it is discharged to the atmosphere. These control devices include flares, thermal vapor incinerators, catalytic vapor incinerators, and boilers and process heaters. The type of control device best suited for reducing organic emissions from a tank depends on the size of the tank and the characteristics of the organic vapor stream vented from the tank.

Additional background information regarding the application of floating roofs, pressure tanks, and control devices for controlling tank organic emissions from waste operations is available in Reference 3.

### 4.2.2 Containers

Organic emissions from containers in which waste materials containing organics are handled are controlled by using vapor leak-tight covers on the containers and using submerged fill loading of liquid, slurry, and sludge type waste materials into containers. In submerged fill loading, the influent pipe used to fill the container is positioned below the surface of the waste material already in the container. This control technique significantly reduces the induced turbulence, evaporation, and liquid entrainment that occurs during splash loading operations. Submerged fill loading is applicable to the loading of liquid wastes and many sludges into containers of all types.

### 4.2.3 Land Disposal Units

If waste materials are not pretreated to remove organics prior to disposal, then organic emissions from surface impoundments, landfills, land treatment units, and waste piles must be controlled by covering the entire surface of the unit through installation of a flexible membrane cover or by enclosing the unit in a rigid or air-supported structure which is vented to a control device. Because land disposal units typically encompass very large areas (on the order of acres), the EPA considers the removal of organics from the waste material prior to disposal to be a more practical approach for controlling organic emissions from land disposal units at off-site waste operations facilities.

Add-on organic emission controls have been applied to surface impoundments. Using a floating membrane cover on a surface impoundment is analogous to using a floating roof in a tank for organic emission control. A floating membrane cover consists of large sheets of a synthetic, flexible membrane material (e.g., high-density polyethylene) seamed or welded together to form a cover that floats directly on the surface of the waste material placed in the impoundment. The level of organic emission control achieved by a floating membrane cover depends on the type and thickness of membrane material as well as the specific organic compounds composing the waste materials on which the cover is installed. Additional background information regarding the use of floating membrane covers for organic emission control is available in Reference 4 for this chapter.

When installation of a floating membrane cover is not possible such as in the case of a treatment surface impoundment using surface aerators, organic emissions from a surface impoundment have been controlled by erecting an air-supported structure over the entire surface of the impoundment and venting the enclosure through a closed vent system to a control device. An air-supported structure is a plastic-reinforced fabric shell that is inflated and therefore requires no internal rigid supports. Large fans are used to blow air through the structure and out a vent system connected to a control device. The same control devices discussed for tanks in Section 4.2.1 of this chapter generally apply to controlling organic emissions from surface impoundments. Additional background information regarding application of air-supported structures to covering surface impoundments is available in Reference 5 for this chapter.

An alternative approach to applying add-on organic emission controls to surface impoundments is to replace the surface impoundment with tanks that use the add-on organic emission controls described in Section 4.2.1 of this chapter. Many owners and operators of existing facilities that manage hazardous wastes in surface impoundments are already choosing to use this approach to comply with other regulations.

### 4.2.4 Process Vents

Controlling process vent organic emissions requires discharging the organic vapors and gases from the vent through a closed vent system to an organic emission control device. Considering process vent stream characteristics, the control devices most likely to be used to control organic emissions from process vents at off-site waste operation facilities are carbon adsorbers, condensers, flares, and thermal vapor incinerators. Additional background information regarding the application of control devices for controlling process vent organic emissions from waste operations is available in Reference 6 for this chapter.

### 4.2.5 Equipment Leaks

Two basic approaches are effective for controlling organic emissions that occur as a result of leaks from ancillary equipment containing or contacting organic waste materials: (1) implementing a work practice referred to as a leak detection and repair (LDAR) program; or (2) equipment modifications. A LDAR program is primarily applicable to controlling organic emissions from leaking pumps, valves, connectors, and, to a lesser degree, compressors. Leaks from other types of ancillary equipment are more easily controlled by equipment modifications.

A LDAR program involves periodic monitoring of ancillary equipment components (e.g., valves, pump seals, flanges) by facility personnel using a portable organic vapor detector to identify those components that are leaking. Once a leaking component is detected, the component is adjusted, repaired, or replaced as needed to stop the leak. Implementing a LDAR program is estimated to reduce organic emissions from equipment leaks on the order of 70 to 90 percent depending on the leak detection monitoring frequency and the organic concentration level used for defining a leak.

Equipment modifications minimize, if not eliminate, the potential for the equipment to leak during normal operations. Examples of effective equipment modifications include: installing dual mechanical seals with a barrier fluid on pumps; installing sealless type pumps; installing diaphragm or sealed-bellows type valves; using a rupture disk as the pressure relief device; installing closed-loop sampling lines; and installing caps or plugs on open-end lines. When the appropriate modifications are made on equipment components, leak detection monitoring of the component is not required.

Additional background information regarding the application of LDAR programs and equipment modifications for controlling organic emissions from leaking waste operation equipment is available in Reference 7.

## 4.3 REFERENCES

1. U.S. Environmental Protection Agency. Alternative Control Technology Document - Organic Waste Process Vents. Office of Air Quality Planning and Standards. Research Triangle Park, NC. EPA Publication No. EPA-450/3-91-007. December 1990. pp. 2-16 through 2-34.

2. U.S. Environmental Protection Agency. Hazardous Waste TSDF - Background Information for Proposed RCRA Air Emission Standards. Office of Air Quality Planning and Standards. Research Triangle Park, NC. EPA Publication No. EPA-450/3-89-023. June 1991. pp. 4-39 through 4-62.

3. Reference 2. pp. 4-5 through 4-12 and 4-20 through 4-39.
4. Reference 2. pp. 4-12 through 4-15.

5. Reference 2. pp. 4-15 through 4-19.

6. Reference 1. pp. 2-34 through 2-51.

7. U.S. Environmental Protection Agency. Hazardous Waste TSDF - Technical Guidance Document for RCRA Air Emission Standards for Process Vents and Equipment Leaks. Office of Air Quality Planning and Standards. Research Triangle Park, NC. EPA Publication No. EPA-450/3-89-021. July 1990. pp. 5-1 through 5-67.

# 5.0 ORGANIC EMISSION IMPACT ESTIMATES

This chapter presents organic emission impact estimates for control options to reduce organic HAP emissions from the off-site waste operations source category. The control options selected for analysis are described in Section 5.1. Section 5.2 describes the baseline used by EPA to compare reductions for each control option. A summary of the general methodology used to estimate the level of organic emission reduction each control option would achieve if implemented is presented in Section 5.3. Estimates of organic HAP and VOC emission reductions for each control options are presented Section 5.4.

## 5.1 SELECTION OF CONTROL OPTIONS

To develop the NESHAP for off-site waste operations source category, the EPA identified and evaluated a variety of possible control options for applying the organic emission controls identified in Chapter 4 of this document to the emission point types identified in Chapter 3 of this document. Different control options were identified by varying which waste management units within an emission point type that would use organic emission controls and the types of organic emission controls applied to these units.

Many possible control options can be identified for an emission point type. However, evaluating every conceivable control option regardless of the control option's potential effectiveness to reduce organic HAP emissions is not practicable. Therefore, the EPA selected only the control options for this analysis that would likely produce significant reductions in the organic HAP emission level for the emission point type. Control options judged likely to produce little or no reductions in the organic HAP emission level for an emission point type were excluded from further consideration. The control options used for the off-site waste operations source category impact analysis are described in the following subsections.

### 5.1.1 Tank Control Options

Three control options were identified for the tank emission point type (labeled Options T1, T2, and T3). All three of these control options would require that all tanks managing waste materials received from off-site and having a volatile organic HAP concentration equal to or greater than 100 ppmw use covers as a minimum level of control. The difference between the control options is whether certain of these covered tanks be required to use additional organic emission controls based on the organic HAP vapor pressure of the waste material placed in the tank.

Option T1 would require the use of covered tanks for all waste materials with a volatile organic HAP concentration equal to or greater than 100 ppmw. No additional controls would be required regardless of the organic HAP vapor pressure of the waste material placed in the tank.

Option T2 would require the use of covered tanks for all waste materials with a volatile organic HAP concentration equal to or greater than 100 ppmw. In addition, all tanks managing waste materials having an organic HAP vapor pressure action level equal to or greater than 0.75 psia would be required to use, in combination with the cover, a closed vent system with control device that achieves a total organic control efficiency of 95 percent (or use of an equivalent control technology, such as the installation of an internal floating roof inside a fixed-roof tank).

Option T3 again would require the use of covered tanks for all waste materials with a volatile organic HAP concentration equal to or greater than 100 ppmw. All tanks managing waste materials having an organic HAP vapor pressure action level equal to or greater than 0.1 psia would be required to use, in combination with the cover, a closed vent system with control device that achieves a total organic control efficiency of 95 percent (or an equivalent control technology).

### 5.1.2 Containers Control Options

Two control options are identified for the container emission point type (labeled Options C1 and C2). Both of these control options would require that containers managing waste materials received from off-site and having a volatile organic HAP concentration equal to or greater than 100 ppmw use covers as a minimum level of control. The difference between the control options is the second control option adds a requirement for submerged fill loading.

Option C1 would require the use of covers on containers handling waste materials with a volatile organic HAP concentration equal to or greater than 100 ppmw. No additional controls would be required.

Option C2 would require the use of covered tanks for all waste materials with a volatile organic HAP concentration equal to or greater than 100 ppmw. In addition, when transferring waste materials into containers by pumping, submerged fill loading would be required if the volatile organic HAP concentration of the waste material is equal to or greater than 100 ppmw.

5.1.3 Land Disposal Unit Control Options

One control option is identified for the land disposal unit emission point type (labeled Option LD1). This control option would limit the management of waste materials in open land disposal units to only those waste materials with a volatile organic HAP concentration less than 100 ppmw. No other realistic control options were identified which could produce significant additional reductions in the organic HAP emission levels for land disposal units.

5.1.4 Process Vent Control Options

One control option is defined for the process vent emission point type (labeled Option PV1). This control option would require that process vents with total organic HAP mass emissions equal to or greater than 3 tons/yr be connected to a control device with a 95 percent organic emission control efficiency. No other realistic process vent control options were identified that could produce significant additional reductions in the organic HAP emission level for the emission point type.

5.1.5 Equipment Leak Control Options

Two control options are identified for the equipment leak emission point type (labeled Options EL1 and EL2). Both control options would require the control of emissions from leaks in equipment containing or contacting waste materials with total organic HAP concentrations equal to or greater than 10 percent. The control options differ in the type of leak detection and repair (LDAR) work practice program to be implemented.

Option EL1 would require control of emissions from leaks in equipment containing or contacting waste materials with total organic HAP concentrations equal to or greater than 10 percent by implementing a LDAR program which follow the procedures specified in existing NSPS process equipment leak standards promulgated by the EPA under 40 CFR 60 subparts VV, GG, and KK, and the NESHAP for process equipment leak promulgated under 40 CFR 61 subpart V.

Option EL2 would require control of emissions from leaks in equipment containing or contacting waste materials with total organic HAP concentrations equal to or greater than 10 percent by implementing a LDAR program which follow the procedures specified in the EPA's negotiated regulation for equipment leaks consistent with the Hazardous Organic NESHAP (HON) promulgated by the EPA under 40 CFR 63 subpart H.

## 5.2 BASELINE FOR CONTROL OPTION COMPARISON

For the purposes of evaluating the relative organic emission reduction effectiveness of alternative control options, the EPA defines a "baseline" as a reference point from which each control option can be compared. The baseline represents the estimated level of organic emissions from the source category that would occur in the absence of implementing any of the control options. For the off-site waste operations source category, a baseline was chosen to reflect the level of organic emissions for each emission point type following implementation of air emission controls required by federally enforceable air regulations in effective as of July 1991. The federally enforceable air regulations that the EPA considered when developing the baseline emission estimates follow:

- RCRA organic air emission standards for TSDF process vents (40 CFR 264 subpart AA and 40 CFR 265 subpart AA)
- RCRA organic air emission standards for TSDF equipment leaks (40 CFR 264 subpart BB and 40 CFR 265 subpart BB)
- RCRA land disposal restrictions (40 CFR part 268)

- NESHAP for benzene waste operations (40 CFR 61 subpart FF)

## 5.3 ORGANIC EMISSION ESTIMATION METHODOLOGY

In developing NESHAP and other air standards, the EPA frequently uses a model plant approach for comparing alternative control options. However, for the off-site waste operations source category, it is difficult to adequately characterize the source category using a selection of several representative model plants. For many of the facilities in the source category, the quantities and characteristics of waste materials received at the facility are highly variable and can change often (as frequently as on a day-to-day basis). In addition, many different waste management unit configurations are used at off-site waste operations facilities to manage these ever changing waste materials. Consequently, the EPA decided a model plant approach is not appropriate for estimating control option impacts for the off-site waste operations source category.

Instead of using a model plant approach for the off-site waste operations source category, the EPA decided to adapt a computer model developed by the Agency to estimate nationwide organic air emission impacts from RCRA hazardous waste treatment, storage, and disposal facilities (TSDF). As presented in Table 2-1 of this document, the EPA estimates that approximately 90 percent of the nationwide total organic HAP emissions for the off-site waste operations source category occur at hazardous waste TSDF. Consequently, the EPA considers adapting this computer model to be appropriate for evaluating alternative control options for the off-site waste operations source category.

The primary sources of site-specific waste data used as input into the computer model are two comprehensive nationwide surveys that the EPA Office of Solid Waste (OSW) conducted in 1987: the National Survey of Hazardous Waste Generators (referred to hereafter as the "GENSUR"); and the National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities (referred to hereafter as the "TSDR Survey"). These data represent waste quantities, waste compositions, and waste management practices at hazardous waste TSDF in 1986, and are the most recent nationwide TSDF waste data available to the EPA on a consistent, industry-wide basis.

The data base indicates that 710 TSDF received waste materials from off-site waste generators in 1986. The EPA adapted its computer model to simulate the waste management process reported in the TSDR Survey to be operating at each of these TSDF. Organic HAP emission factors and emission control cost factors are assigned to each waste management processes using one (or in many cases a combination of several) of the model units developed for the TSDF RCRA air rules projects. Further details regarding the emission estimation methodology are provided in Appendix B to this document.

Waste management practices at some TSDF have changed since the data were collected for the GENSUR and TSDR Survey. Industry has implemented these changes either to improve services or to comply with new EPA regulations promulgated since 1986. To address these changes, assumptions were applied in the computer model to better reflect current industry-wide waste management trends (e.g., conversion of surface impoundments to tanks, treatment of certain wastes prior to or as an alternative to land disposal). These assumptions are summarized in Table 5-1 and described in further detail in Appendix B to this document.

Additional assumptions were made to simulate the implementation of the different control options in the computer model. These assumptions are summarized in Table 5-2 and described in further detail in Appendix B to this document.

## 5.4 CONTROL OPTION ORGANIC EMISSION ESTIMATES

The baseline organic HAP and VOC emissions estimated by the computer model for the 710 RCRA hazardous waste TSDF receiving waste materials from off-site are presented in Table 5-3. At the baseline conditions, the organic HAP emissions are estimated to be approximately 34,400 Mg/yr. Approximately 90 percent of these emissions are from the tank emission point type.

A comparison of the organic HAP and VOC emission reductions for the control options selected for each emission point type are presented in Table 5-4.

TABLE 5-1. SUMMARY OF BASELINE ASSUMPTIONS USED FOR ORGANIC EMISSION ESTIMATES

**RCRA Organic Air Emission Standards for TSDF Process Vents (40 CFR 264 subpart AA and 40 CFR 265 subpart AA)**

- Process vents on processes listed in data base as distillation, solvent extraction, thin-film evaporation, steam stripping, or air stripping and estimated to have a total organic mass emissions ≥ 3 tons/yr are assumed to be vented to a control device with a 95% organic emission control efficiency.

**RCRA Organic Air Emission Standards for TSDF Equipment Leaks (40 CFR 264 subpart BB and 40 CFR 265 subpart AA)**

- Waste streams reported in the data base with total organic concentrations ≥ 10 percent are assumed to be controlled by implementing a leak detection and repair (LDAR) program which results in an emission reduction ranging from 70% to 75% depending on the form of the waste materials.

**RCRA Land Disposal Restrictions (40 CFR part 268)**

- All surface impoundments reported in the data base to be used for storage or treatment are assumed to be closed and the waste materials managed in these units to be managed in new tanks.

- All surface impoundments reported in the data base to be used for disposal are assumed to be replaced by (or closed as) landfills.

- All waste streams reported to be disposed in a land treatment unit or landfill unit are assumed to be treated to meet the LDR treatment standards prior to disposal.

TABLE 5-1. (concluded)

**NESHAP for Benzene Waste Operations (40 CFR 61 subpart FF).**

- All waste streams reported in the data base to have a benzene concentration ≥ 10 ppmw use organic emission controls to comply with rule.
- Affected non-wastewater streams managed in tanks are vented to control devices with a 95% organic emission control efficiency.
- Affected wastewater streams are pre-treated by steam stripping to reduce the benzene concentration of the waste stream to 10 ppmw or to the benzene concentration corresponding to a 99% removal of benzene from the wastewater stream, whichever concentration value is higher.
- Processes handling affected waste streams are vented to control devices with a 95% organic emission control efficiency.
- Transfer of affected waste streams into containers is by submerged fill loading.

**Other Organic Emission Controls**

- Organic emission control equipment reported in data base to be in place at a facility are assumed to be in operation.

TABLE 5-2. SUMMARY OF CONTROL OPTION ASSUMPTIONS USED FOR ORGANIC EMISSION ESTIMATES

**Tank Control Options**

- Open tanks reported in the data base managing waste streams with estimated volatile organic HAP concentrations ≥ 100 ppmw are converted to covered tanks.

- All hazardous waste quantities reported in the data base to managed in surface impoundments are assumed to now be managed in tanks.

**Container Control Options**

- Organic control efficiency for submerged fill loading is assumed to be 65%.

**Land Disposal Unit Control Option**

- All hazardous waste quantities reported in the data base to managed in surface impoundments are assumed to now be managed by treatment and disposal in landfills.

- All hazardous waste streams reported to be disposed in a land treatment unit or landfill unit are assumed to be treated to meet the LDR treatment standards prior to disposal.

**Process Vent Control Option**

- All process vent streams associated waste materials with volatile organic HAP concentration ≥ 100 ppm or HAP vapor pressure ≥ 0.1 psia are assumed to be vented to control device with a 95% organic emission control efficiency.

**Equipment Leaks Control Options**

- Organic control efficiency assigned to "NSPS" type LDAR program is 70% to 75% depending on the form of the waste stream.

- Organic control efficiency assigned to "negotiated rule" type LDAR program is 88%.

TABLE 5-3. ORGANIC EMISSION ESTIMATES FOR BASELINE

| Emission Point Type | Total Organic HAP Emissions (Mg/yr) | Total VOC Emissions (Mg/yr) |
|---|---|---|
| Tanks | 30,900 | 37,400 |
| Containers | 2,530 | 3,060 |
| Land disposal units[(a)] | 420 | 510 |
| Process vents | 310 | 370 |
| Equipment leaks | 270 | 330 |
| TOTAL[(b)] | 34,430 | 41,660 |

NOTES:

(a) For analysis, it is assumed that there is no disposal of waste materials in surface impoundments. All surface impoundments are assumed to be converted to tanks.

(b) Total may differ from sum of individual values due to rounding.

TABLE 5-4. ORGANIC EMISSION ESTIMATES
FOR CONTROL OPTIONS

| Emission Point Type | Organic Emission Control Level | Total Organic HAP Emissions (Mg/yr) | Total VOC Emissions (Mg/yr) |
|---|---|---|---|
| Tanks | Baseline | 30,900 | 37,400 |
| | Option T1 | 12,200 | 14,800 |
| | Option T2 | 2,840 | 3,440 |
| | Option T3 | 2,240 | 2,710 |

| Emission Point Type | Organic Emission Control Level | Total Organic HAP Emissions (Mg/yr) | Total VOC Emissions (Mg/yr) |
|---|---|---|---|
| Containers | Baseline | 2,530 | 3,060 |
| | Option C1 | 2,530 | 3,060 |
| | Option C2 | 890 | 1,080 |

| Emission Point Type | Organic Emission Control Level | Total Organic HAP Emissions (Mg/yr) | Total VOC Emissions (Mg/yr) |
|---|---|---|---|
| Land Disposal Units | Baseline | 420 | 510 |
| | Option LD1 | 290 | 350 |

TABLE 5-4. (concluded)

| Emission Point Type | Organic Emission Control Level | Total Organic HAP Emissions (Mg/yr) | Total VOC Emissions (Mg/yr) |
| --- | --- | --- | --- |
| Process Vents | Baseline | 310 | 370 |
| | Option PV1 | 310 | 370 |

| Emission Point Type | Organic Emission Control Level | Total Organic HAP Emissions (Mg/yr) | Total VOC Emissions (Mg/yr) |
| --- | --- | --- | --- |
| Equipment Leaks | Baseline | 270 | 330 |
| | Option EL1 | 270 | 330 |
| | Option EL2 | 150 | 180 |

# 6.0 OTHER ENVIRONMENTAL AND ENERGY IMPACTS ESTIMATES

This chapter presents estimates of the environmental impacts other than organic emissions reduction and the energy impacts associated with the control options selected in Chapter 5 of this document for the off-site waste operations source category. Section 6.1 identifies the types of other environmental and energy impacts that may occur from implementing the control options. A summary of the methodology used to estimate these impacts is presented in Section 6.2. Estimates are presented in Section 6.3 of the control option secondary air impacts, water impacts, solid waste impacts, and energy impacts.

## 6.1 IDENTIFICATION OF OTHER CONTROL OPTION IMPACTS

Implementation of the control options analyzed for the off-site waste operations source category (refer to Section 5.1 in this document) would require using a variety of organic emission control techniques. Some of the control options are based on equipment requirements (e.g., installation of a cover on a tank or container) or work practices (e.g., facility workers conduct an equipment leak detection and repair program) that reduce organic emissions with essentially no other environmental or energy impacts. For other control options, the types of organic emission controls selected by the facility owner or operator may result in other environmental impacts and have energy impacts.

The primary source of other environmental and energy impacts is expected to result from the operation of control devices used to remove or destroy organics in captured vapor streams. Electric motor-driven fans, blowers, or pumps, depending on the type of control device, are used for operations such as moving the captured organic vapors to the control device, circulating cooling water through a condenser, or pumping recovered liquids to an accumulation tank. Generation of the electricity to operate the control device often requires burning of fuel in an electric utility power plant which produces air emissions, wastewater discharges, and solid wastes. When carbon adsorption systems are used, the organic HAP removed from the vapor stream are adsorbed on the activated carbon in the control device. Once the carbon becomes saturated with organics, it must be regenerated with steam, or disposed of in a landfill. Producing regeneration steam in a boiler creates both secondary air and energy impacts. Disposal of the spent carbon produces a solid waste impact.

The types of other environmental and energy impacts that may occur from implementing each of the control options are identified in the following subsections.

### 6.1.1 Tank Control Options

The first tank control option (Option T1) requires the installation of a cover on an open tank. The operation of a cover does not require an energy source nor does it generate gaseous, liquid, or solid wastes. Consequently, there are no other environmental or energy impacts associated with Option T1. However, the other two tank control options (Options T2 and T3) require certain tanks use floating roofs or be vented to a control device. Consequently, other environmental and energy impacts will occur for Options T2 and T3 at those facilities where control devices are used to implement the control option requirements.

### 6.1.2 Container Control Options

Both of the control options for containers (Options C1 and C2) require the use of covers. In addition, Option C2 requires the use of submerged fill pipes for loading certain waste materials into containers. The operation of this equipment does not require an energy source nor does it generate gaseous, liquid, or solid wastes. Consequently, there are no other environmental or energy impacts associated with the container control options.

### 6.1.3 Land Disposal Units Control Option

The land disposal control option (Option LD1) limits the management of waste materials in open land disposal units to only those waste materials with a volatile organic HAP concentration less than 100 ppmw. For the control option analysis, the EPA assumes that facility owners and operators will meet the control option requirements by pretreatment of waste materials to reduce the volatile organic HAP concentration to below 100 ppmw. Operation of pretreatment processes produces other environmental and energy impacts.

### 6.1.4 Process Vent Control Option

The process vent control option (Option PV1) requires that process vents with total organic HAP mass emissions equal to or greater than 3 tons/yr be connected to a control device with a 95 percent organic emission control efficiency. Other environmental and energy impacts will occur for Option PV1 at those facilities where control devices are used to implement the control option requirements.

### 6.1.5 Equipment Leak Control Options

For equipment leaks, both of the control options (Options EL1 and EL2) are based on a LDAR program and modification of certain equipment. A LDAR program is a work practice. The equipment modifications do not require energy to operate nor do they generate gaseous, liquid, or solid wastes. Consequently, there are no other environmental or energy impacts associated with the equipment leak control options.

## 6.2 SUMMARY OF IMPACT ESTIMATION METHODOLOGY

The general approach used to estimate the control option other environmental and energy impacts for the off-site waste operations source category follows the approach used to estimate these types of impacts for the RCRA hazardous TSDF air rules. This approach uses "control device operation factors" based on the waste material throughput in controlled units and "impact factors" based on the operating characteristic of each control device. These factors are described in further detail in Appendix C to this document.

There are different approaches that facility owners and operators may choose to implement a control option as well as different types of energy sources available at a particular off-site waste operations facility. Consequently, upper and lower boundary estimates for the "impact factors" were developed using scenarios of differing fuel sources and spent activated carbon management methods to estimate the potential range of other environmental and energy impacts. The assumptions used for the scenarios are summarized in Table 6-1.

The "control device operation factors" and the "impact factors" were developed for the waste management model units and control options used for the RCRA TSDF air rules impact analysis. The computer model developed to estimate organic HAP emissions for the control options (refer to Appendix B to this document) uses the same types of waste management model unit air emission controls that were used to develop these factors. Therefore, the application of these factors should provide a reasonable order-of-magnitude estimate of the other environmental and energy impacts for the off-site waste operations source category control options.

TABLE 6-1. SUMMARY OF ASSUMPTIONS USED FOR CONTROL OPTION OTHER ENVIRONMENTAL AND ENERGY IMPACT ESTIMATES

| Facility Control Equipment Operating Conditions | Lower Boundary Assumption | Upper Boundary Assumption |
|---|---|---|
| Electricity source | 50% coal power plant<br>25% natural gas power plant<br>25% noncombustion utility | 100% coal power plant |
| Steam source | 100% natural gas boiler | 100% fuel oil boiler |
| Spent carbon regeneration yield | 90% yield | 80% yield |
| Spent carbon canister management practice | 100% regenerated | 100% landfill disposal |

## 6.3 IMPACT ESTIMATES

Other environmental and energy impact estimates are presented for two tank control options (Option T2 and T3) and the land disposal unit control option (Option LD1). As discussed in Section 6.1 of this document, the EPA expects that implementation of all of the container control options (Options C1 and C2) and equipment leak control options (Options E1 and E2) will reduce organic emissions with essentially no other environmental or energy impacts. Finally, because all process vents in the computer model data base are assumed (at baseline) to already be vented to existing control devices for compliance with the RCRA air standards for TSDF process vents, no additional other environmental or energy impacts are estimated for the process vent control option (Option PV1).

### 6.3.1 Secondary Air Emission Impacts

The secondary air emission estimates for the control options are presented in Table 6-2. The primary source of secondary air emissions result from the generation of electricity to operate the pretreatment units used to remove organics from waste materials prior to land disposal.

### 6.3.2 Water Impacts

The water impact estimates for the control options are presented in Table 6-3. The primary source of produced wastewater is wet scrubbers used in conjunction with the operation of thermal vapor incinerators.

### 6.3.3 Solid Waste Impacts

The solid waste impact estimates for the control options are presented in Table 6-4. The primary source of generated solid waste is associated with the electricity produced to operate the land disposal pretreatment units. However, the solid waste impact presented in Table 6-4 for the land disposal control option (Option LD1) is likely to be offset by the reduced quantity of waste material entering the land disposal unit after pretreatment.

TABLE 6-2. ESTIMATED RANGE OF SECONDARY AIR EMISSIONS

| Air Pollutant | Air Emissions (Mg/yr) | | |
|---|---|---|---|
| | Option T2 | Option T3 | Option LD1 |
| CO emissions | <1 | <1 | 4 |
| NOx emissions | 2 - 7 | 3 - 12 | 50 - 86 |
| SOx emissions | <1 - 5 | <1 - 10 | 31 - 83 |
| Particulate emissions | <1 | <1 | 2 - 4 |

Range of values presented in this table for each impact represents the upper and lower boundary estimates of the impacts to reflect different approaches owners and operators may choose to implement a control option as well as different types of fuel sources available at a particular facility location.

TABLE 6-3. ESTIMATED RANGE OF WATER IMPACTS

| Wastewater Type | Wastewater Quantity (1,000 $m^3$/yr) | | |
|---|---|---|---|
| | Option T2 | Option T3 | Option LD1 |
| Power plant effluent | 0 | 0 | 2 - 3 |
| Carbon regeneration effluent | <1 | <1 | 0 |
| Incineration scrubber effluent | 0 - 19 | 0 - 33 | 0 |
| Total Wastewater Impacts | <1 - 19 | <1 - 33 | 2 - 3 |

Range of values presented in this table for each impact represents the upper and lower boundary estimates of the impacts to reflect different approaches owners and operators may choose to implement a control option as well as different types of fuel sources available at a particular facility location.

TABLE 6-4. ESTIMATED RANGE OF SOLID WASTE IMPACTS

| Solid Waste Type | Solid Waste Quantity (Mg/yr) | | |
|---|---|---|---|
| | Option T2 | Option T3 | Option LD1 |
| Power plant fly & bottom ash | 4 - 8 | 7 - 14 | 620 - 1,240 |
| Power plant scrubber sludge | 7 - 14 | 12 - 23 | 980 - 1,960 |
| Spent activated carbon | 22 - 210 | 35 - 340 | 0 |
| Total Solid Waste Impacts | 33 - 230 | 54 - 380 | 1,600 - 3,200 |

Range of values presented in this table for each impact represents the upper and lower boundary estimates of the impacts to reflect different approaches owners and operators may choose to implement a control option as well as different types of fuel sources available at a particular facility location.

### 6.3.4 Energy Impacts

Table 6-5 presents the energy impact estimates for the control options that have other environmental impacts. The energy impacts for the tank control options vary widely depending on the assumptions used regarding the energy requirements of the thermal vapor incinerator.

TABLE 6-5. ESTIMATED RANGE OF ENERGY IMPACTS

| Control Option | Energy Consumption ($10^{12}$ J/yr) |
|---|---|
| Option T2 | 20 - 5,300 |
| Option T3 | 38 - 8,900 |
| Option LD1 | 310 - 400 |

Range of values presented in this table for each impact represents the upper and lower boundary estimates of the impacts to reflect different approaches owners and operators may choose to implement a control option as well as different types of fuel sources available at a particular facility location.

# 7.0 ENHANCED MONITORING

Section 114(a)(3) of the 1990 Clean Air Act Amendments require NESHAP to include monitoring strategies that incorporate the concepts of enhanced monitoring. This approach is intended to ensure that monitoring requirements under a NESHAP provide data that can be used as a determinant of compliance with each applicable standard, including emission standards, in the rule.

Preferably, a continuous emission monitor (CEM) can be used. In cases when a CEM is not technically feasible or economically practicable, the EPA's approach is generally to establish operating parameters that can be directly related to emission control performance which must be continuously monitored to determine if the control device remains in compliance with the applicable emission standard. This chapter describes application of enhanced monitoring to each of the control options described in Chapter 5 of this document.

## 7.1 ENHANCED MONITORING LEVELS

In general, four levels of enhanced monitoring can be defined for organic HAP emission control technologies. These four monitoring levels are:

Level 1. Continuous emission monitoring of the organic HAP emission limit as defined by the standard (i.e., control option).

Level 2. Continuous emission monitoring of a surrogate of the organic HAP emission limit.

Level 3. Continuous monitoring of an operating parameter indicative of the performance of the control device for reducing organic HAP emissions as defined by the standard (i.e., control option).

Level 4. Continuous monitoring of an operating parameter indicative of the performance of the control device for a surrogate of the organic HAP emission reduction.

The technical applicability of the enhanced monitoring levels are dependent on the emission control technologies used for each emission point type and the characteristics of the waste streams managed in the controlled units. Due to the nature of the off-site waste operations, the composition of waste materials at a given site is expected to vary widely from day-to-day or week-to-week. This variability in the waste stream composition causes numerous difficulties with continuous monitoring systems, especially systems designed to analyze for specific HAP constituents. Therefore, continuous emission monitoring of the organic HAP emission limit as defined by a control option (monitoring Level 1) is not, in most cases, technically applicable for control devices operated at off-site waste operation facilities.

The enhanced monitoring levels are evaluated for each emission point type control option, in order of decreasing monitoring requirements (i.e., starting with Level 1 and continuing to Level 4), to identify the enhanced monitoring level appropriate for the control option. The following sections provide additional explanation regarding the selection of enhanced monitoring levels for each emission point type control option.

## 7.2 ENHANCED MONITORING FOR TANKS

The emission control options for tank control Option T1 are based on the use of covers. As using a cover is an equipment requirement rather than a performance standard, there are no enhanced monitoring alternatives for the tank control Option T1.

Tank control Options T2 and T3 both require the application of an additional emission control device for tanks managing waste streams that exceed a certain vapor pressure threshold. To comply with the control option, a owner or operator will in most cases do two things: 1) install a floating roof; and 2) vent the emissions to an external control device that achieves a 95 percent emission reduction.

The use of a floating roof cover is again an equipment standard rather than a performance control standard. As with fixed roofs, there are no continuous or enhanced monitoring alternatives for floating roof covers installed to comply with tank control Options T2 and T3.

External control devices include flares, vapor incinerators, condensers and carbon adsorption devices. With the external control devices, it is possible to evaluate the actual emission reduction performance of the device. Numerous monitoring strategies can be applied for these units, some of which are dependent on the actual device used. The strategies outlined here do not attempt to distinguish the specific operating parameters that could be used to monitor the performance of each of these devices separately, but rather the general monitoring strategies that can be applied to this class of emission control devices.

For most external control devices, both the inlet and the outlet streams are gaseous. This affords continuous sampling of both the control device inlet and outlet streams. In this discussion, very frequent (every 10 to 15 minutes) GC/MS sampling and analysis of inlet and outlet gas streams is considered "continuous" monitoring of HAP concentrations (Level 1). However, as mentioned previously, fluctuations in waste stream composition and flow rates, as well as the operating characteristics of the analytical equipment used to analyze for specific HAP constituents, will require pooling or averaging of the monitoring data to limit false conclusions from being made regarding the performance of the external control device. Subsequently, a control device could operate inefficiently for 30 minutes or more before noncompliance is validated. Additionally, for most off-site waste operations, the frequent changes in the organic HAP composition of the waste material being processed will require frequent recalibration and tuning of the analytical equipment associated with the continuous HAP emission monitor. Consequently, continuous organic HAP emission monitoring (Level 1) will not be technically applicable for most external control devices used to control organic HAP emissions from off-site waste operations.

Continuous monitoring of an indicator of total organics for both the control device inlet and outlet streams (Level 2) can easily be accomplished for gas streams using a flame ionization detector (FID) or photo ionization detector (PID) continuous emission monitor (CEM). Again, some pooling or averaging methodology may be necessary to limit false conclusions from being made regarding the performance of the external control device, but because the FID or similar CEM provides nearly instantaneous data, the time required to validate noncompliance is much less for monitoring Level 2 than for monitoring Level 1. Depending on the pooling or averaging methodology employed, which is dependent on the variability in composition of the organic emissions entering the control device, continuous monitoring of a surrogate of organic HAP emissions in both inlet and outlet gas streams may be used to document control device removal efficiency. However, monitoring both inlet and outlet gas streams may not provide the best or quickest method to identify inadequate control device performance.

An alternative surrogate of organic HAP removal efficiency that may be appropriate for certain external control devices is the continuous emission monitoring of the control device exhaust stream alone (Level 2). Although the tank control options (Options T2 and T3) specify a required control efficiency, an emission limit may be defined and documented through an initial source test as a surrogate of control device performance. Monitoring the exhaust for an emission limit minimizes the need to pool analytical results, and streamlines the decision-making process in determining whether the control device is operating in compliance with the standard (i.e., control option).

Continuously monitoring process operating parameters (flow rates, temperatures, etc.) that indicate acceptable control device performance in terms of either organic HAP removal efficiency (Level 3) or a surrogate of organic HAP removal efficiency (Level 4) is both accurate and timely. Both enhanced monitoring levels using operating parameters (Levels 3 and 4) would require that an initial performance test be conducted to determine that the emission control device is reducing HAP emissions (or a surrogate of HAP emissions) to the required limits while certain operating conditions exist (flow rates, temperatures, etc.). The organic HAP removal efficiency of a control device can change significantly with the physical and chemical properties of different HAP in the emission stream. For emissions that are predominantly organic HAP (e.g., 70 percent organic HAP or more) or have a consistent HAP composition, operating parameters can be a good indicator of organic HAP removal efficiency (Level 3). However, for emissions that contain a significant proportion of non-HAP organics and that have a wide variability in the organic HAP composition, operating parameters cannot be directly linked with organic HAP removal efficiency. In this case, the operating parameters provide a better indication of total volatile organic compound removal efficiency or other surrogate of organic HAP removal efficiency (Level 4).

## 7.3 ENHANCED MONITORING FOR CONTAINERS

The emission control options for containers (C1 and C2) are based on the use of covers and, for Option C2, the use of a submerged filling pipe for container loading operations. As these control techniques are equipment requirements rather than a performance standard, there are no enhanced monitoring alternatives for the container controls options.

## 7.4 ENHANCED MONITORING FOR LAND DISPOSAL UNITS

The control option for land disposal (LD1) is based on pretreatment of the waste materials to remove the volatile organic HAP to below 100 ppmw prior to land disposal. Consequently, a direct indicator of compliance would be to monitor the HAP concentration of the effluent stream from the treatment process. However, analytical techniques used to measure organic HAP content or a surrogate of organic HAP in solids require discrete sampling, and often timely sample preparation prior to analysis. Therefore, continuous monitoring of either organic HAP (Level 1) or a surrogate of organic HAP (Level 2) is not technically feasible to document continuous compliance with the land disposal control option.

Continuously monitoring process operating parameters (flow rates, temperatures, etc.) that indicate acceptable treatment device performance in terms of either organic HAP removal efficiency (Level 3) or a surrogate of organic HAP removal efficiency (Level 4) is both accurate and timely. Both enhanced monitoring levels using operating parameters (Levels 3 and 4) would require that an initial performance test be conducted to determine that the treatment device is reducing HAP concentration (or a surrogate of HAP concentration) to the required limits while certain operating conditions exist (flow rates, temperatures, etc.). The organic HAP removal efficiency of a treatment device can change significantly with the physical and chemical properties of different HAP in the waste material. For waste materials that are predominantly organic HAP (e.g., 70 percent organic HAP or more) or have a consistent HAP composition, operating parameters can be a good indicator of organic HAP removal efficiency (Level 3). However, for waste materials that contain a significant proportion of non-HAP organics and that have a wide variability in the organic HAP composition, operating parameters cannot be directly linked with organic HAP removal efficiency. In this case, the operating parameters provide a better indication of total volatile organic compound removal efficiency or other surrogate of organic HAP removal efficiency (Level 4).

Emissions from the pretreatment system will be subject to emission control requirements. Emission points from the pretreatment system consist of emissions from tanks, process vents, equipment leaks, and containers. Consequently, appropriate enhanced monitoring levels for the pretreatment system emissions are equivalent to the monitoring levels for each of the applicable emission point categories.

## 7.5 ENHANCED MONITORING FOR PROCESS VENTS

The enhanced monitoring levels for process vents are the same as the levels discussed in Section 7.2 of this chapter for external control devices used to control tank emissions.

## 7.6 ENHANCED MONITORING FOR EQUIPMENT LEAKS

The control techniques proposed for equipment leaks (Options EL1 and EL2) are based on leak detection and repair (LDAR) programs which include monitoring requirements. As LDAR programs are work practices, there are no enhanced monitoring alternatives for the equipment leak control options.

# 8.0 CONTROL OPTION COST ESTIMATES

This chapter presents estimates of the costs associated with the control options selected in Chapter 5 of this document for the off-site waste operations source category. Section 8.1 defines the control cost parameters. A summary of the methodology used to estimate these costs is presented in Section 8.2. Estimates of the capital investment, the annual operating costs, monitoring, inspection, recordkeeping, and reporting (MIRR) costs, and the total annual costs for each of the control options are presented in Section 8.3.

## 8.1 CONTROL OPTION COSTS

Costs are associated with the design, installation, operation, and maintenance of the organic emission controls required by each control option. Four different cost parameters are estimated for each control option:

- Total capital investment (TCI)
- Annual operating costs (AOC)
- Monitoring, inspection, recordkeeping, and reporting (MIRR) costs
- Total annual costs (TAC)

Total capital investment (TCI) is the total of the costs required to purchase the equipment needed for the control system, costs of labor and materials for installing that equipment, costs for site preparation and buildings, contractor fees, field expenses, start-up and performance test costs, and contingencies.

Annual operating cost (AOC) is the direct and indirect operating costs incurred while operating the control system. Direct operating costs include costs for raw materials, utilities (steam, water, electricity), waste treatment and disposal, maintenance materials, and operating, maintenance and supervisory labor. Indirect operating costs include costs for overhead, administration, property taxes, and insurance. The AOC also includes any recovery credits for materials or energy recovered by the control system which can be sold or reused at the site.

Monitoring, inspection, recordkeeping, and reporting (MIRR) costs are the costs incurred to ensure that the organic emission controls that are installed to comply with the control option requirements are properly operated and maintained.

Total annual cost (TAC) is the sum of the AOC plus the MIRR costs plus the capital recovery costs for the capital investment. Capital recovery costs are a function of the equipment service life and the interest rate used to annualize the capital investments.

## 8.2 COST ESTIMATION METHODOLOGY

The total capital investment and the annual operating costs for a control device are calculated using control cost factors developed for a specific control option. Actual TCI and AOC for an organic HAP emission controls were first calculated using the methods outlined in the OAQPS Control Cost Manual[1] for various waste throughput (or equipment sizes) and different waste characteristics. These costs were then proportioned for the waste throughput (or size) distribution of a waste management model unit to develop control cost factors for each of the control options.

The control cost factors used in the computer model to estimate the costs of applying controls to the tanks, containers, process vents, and equipment leaks emission point types are based on the control cost factors developed for the TSDF RCRA air standards projects.[2] For the off-site waste operations source category, each of the original cost factors were adjusted to update the cost factor to mid-1991 dollars.

No control cost factors applicable to the land disposal unit control option for the off-site waste operations source category were developed for the TSDF RCRA air standards projects. Consequently, new control cost factors were developed for the land disposal unit control option. Pretreatment processes potentially applicable for the treatment of waste materials in accordance with the land disposal control option include: steam stripping; air stripping; thin-film evaporation; distillation; and incineration. The pretreatment process employed by a facility is dependent on the physical and chemical characteristics of the waste material and the availability of excess treatment capacity in existing treatment processes, if any. Total capital investment and annual operating costs for pretreatment of waste material using steam stripping were estimated using the steam stripping cost algorithms developed for the industrial wastewater CTG.[3] Control cost factors were then developed for pretreatment using steam stripping following the same general methodology used to develop the control cost factors for the TSDF RCRA air standards projects. Based on the similarity in the complexity of the pretreatment process equipment and analyzing the relative accuracy of the control cost factors, the control cost factors developed for steam stripping waste materials were deemed reasonable for estimating the TCI and AOC control costs for all waste material requiring pretreatment prior to land disposal.

Monitoring, inspection, recordkeeping, and reporting costs associated are not specifically included in the cost factors used in the computer model. A separate cost analysis external to the computer model was performed to estimate the MIRR cost. This analysis is provided in Appendix E of this document.

Further details regarding the control cost estimation methodology are provided in Appendix D of this document and Reference 4 to this chapter.

## 8.3 CONTROL OPTION COST ESTIMATES

Table 8-1 presents the total capital investment (TCI) cost estimates calculated by the computer model for each control option. Table 8-2 presents the annual operating cost (AOC) estimates calculated by the computer model for each control option. The results of the separate analysis of the monitoring, inspection, recordkeeping, and reporting (MIRR) costs are summarized in Table 8-3. Table 8-4 presents the estimates for the total annual costs (TAC) for each control option.

## 8.4 REFERENCES


1. U.S. Environmental Protection Agency. OAQPS Control Cost Manual, 4th Edition, EPA 450/3-90-006. January 1990.

2. U.S. Environmental Protection Agency. Hazardous Waste TSDF - Background for Proposed RCRA Air Emission Standards. Publication No. EPA-450/3-89-023c. Office of Air Quality Planning and Standards, Research Triangle Park, NC. June 1991. pp. K-1 through K-15.

3. U.S. Environmental Protection Agency. Control of Volatile Organic Compound Emissions from Industrial Wastewater. Guideline Series. Office of Air Quality Planning and Standards, Research Triangle Park, NC. September 1992.

TABLE 8-1. ESTIMATED TOTAL CAPITAL INVESTMENT (TCI) FOR CONTROL OPTIONS

| Emission Point Type | Control Option | TCI Cost ($1,000) |
|---|---|---|
| Tanks | Option T1 | $3,960 |
| | Option T2 | $27,400 |
| | Option T3 | $41,300 |

| Emission Point Type | Control Option | TCI Cost ($1,000) |
|---|---|---|
| Containers | Option C1 | $0 |
| | Option C2 | $1,960 |

| Emission Point Type | Control Option | TCI Cost ($1,000) |
|---|---|---|
| Land disposal units | Option LD1 | $3,330 |

| Emission Point Type | Control Option | TCI Cost ($1,000) |
|---|---|---|
| Process vents | Option PV1 | $0 |

| Emission Point Type | Control Option | TCI Cost ($1,000) |
|---|---|---|
| Equipment Leaks | Option EL1 | $0 |
| | Option EL2 | $5,260 |

TABLE 8-2. ESTIMATED ANNUAL OPERATING COST (AOC) FOR CONTROL OPTIONS

| Emission Point Type | Control Option | AOC ($1,000/yr) |
|---|---|---|
| Tanks | Option T1 | $300 |
| | Option T2 | $8,200 |
| | Option T3 | $12,800 |

| Emission Point Type | Control Option | AOC ($1,000/yr) |
|---|---|---|
| Containers | Option C1 | $0 |
| | Option C2 | $100 |

| Emission Point Type | Control Option | AOC ($1,000/yr) |
|---|---|---|
| Land disposal units | Option LD1 | $700 |

| Emission Point Type | Control Option | AOC ($1,000/yr) |
|---|---|---|
| Process vents | Option PV1 | $0 |

| Emission Point Type | Control Option | AOC ($1,000/yr) |
|---|---|---|
| Equipment Leaks | Option EL1 | $0 |
| | Option EL2 | $340 |

TABLE 8-3. ESTIMATED MONITORING, INSPECTION, REPORTING, AND RECORDKEEPING (MIRR) COSTS

| Emission Point Type | Control Option | Annual MIRR Costs ($1,000/yr) |
|---|---|---|
| Tanks | Option T1 | $160 |
| | Option T2 | $1,730 |
| | Option T3 | $1,950 |

| Emission Point Type | Control Option | Annual MIRR Costs ($1,000/yr) |
|---|---|---|
| Containers | Option C1 | $640 |
| | Option C2 | $640 |

| Emission Point Type | Control Option | Annual MIRR Costs ($1,000/yr) |
|---|---|---|
| Land disposal units | Option LD1 | $160 |

| Emission Point Type | Control Option | Annual MIRR Costs ($1,000/yr) |
|---|---|---|
| Process vents | Option PV1 | $320 |

| Emission Point Type | Control Option | Annual MIRR Costs ($1,000/yr) |
|---|---|---|
| Equipment Leaks | Option EL1 | $135 |
| | Option EL2 | $135 |

TABLE 8-4. ESTIMATED TOTAL ANNUAL COST (TAC) FOR CONTROL OPTIONS

| Emission Point Type | Control Option | Total Annual Cost ($1,000/yr) |
|---|---|---|
| Tanks | Option T1 | $840 |
| | Option T2 | $13,700 |
| | Option T3 | $20,500 |

| Emission Point Type | Control Option | Total Annual Cost ($1,000) |
|---|---|---|
| Containers | Option C1 | $640 |
| | Option C2 | $960 |

| Emission Point Type | Control Option | Total Annual Cost ($1,000/yr) |
|---|---|---|
| Land disposal units | Option LD1 | $1,210 |

| Emission Point Type | Control Option | Total Annual Cost ($1,000/yr) |
|---|---|---|
| Process vents | Option PV1 | $320 |

| Emission Point Type | Control Option | Total Annual Cost ($1,000/yr) |
|---|---|---|
| Equipment Leaks | Option EL1 | $140 |
| | Option EL2 | $1,220 |

APPENDIX A

KEY DATES IN DEVELOPMENT OF BID

TABLE A-1. KEY DATES IN THE DEVELOPMENT OF THE BID

| Date | Event |
|---|---|
| July 16, 1992 | The EPA publishes initial list of hazardous air pollutant (HAP) emission source categories (57 FR 31576). |
| August 9-11, 1993 | Representatives of the EPA and their contractors conduct site visits of oil and gas exploration and production (E&P) waste management facilities in Kansas. |
| December 20, 1993 | The EPA publishes an advanced notice of proposed rulemaking (ANPR) to announce EPA's intent to develop a NESHAP for the off-site waste operations source category (58 FR 66336). |
| December 20, 1993 through January 19, 1994 | EPA public comment period on the ANPR. |

# APPENDIX B

# IMPACTS ESTIMATION COMPUTER MODEL DESCRIPTION

The EPA adapted a computer model originally developed by the Agency to estimate organic air emissions impacts from RCRA hazardous waste treatment, storage, and disposal facilities (TSDF) to estimate the emission of organic compounds, which have been listed as hazardous air pollutants (HAP) under section 112(b) of the 1990 Amendments to the Clean Air Act, from those hazardous wastes TSDF nationwide that reported receiving waste materials generated at other facilities. As discussed in Chapter 2 of this BID, the EPA estimates that approximately 90 percent of the current nationwide organic HAP emissions from the off-site waste operations source category occur at hazardous waste TSDF.

## B.1 INTRODUCTION TO THE DATA SOURCES

The major sources of waste data used for the computer model analysis are the results from two comprehensive nationwide surveys that the EPA Office of Solid Waste (OSW) conducted in 1987: (1) the National Survey of Hazardous Waste Generators[4] (referred to hereafter as the "GENSUR"), and (2) the National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities[5] (referred to hereafter as the "TSDR Survey"). These data represent waste quantities, waste compositions, and waste management practices at TSDF in 1986 but are the most recent nationwide TSDF waste data available to EPA on a consistent basis. A summary knowledge of these two data bases is needed to understand the treatment of the data as used to determine baseline emissions.

The TSDR Survey is a nationwide survey of hazardous waste TSDF conducted by OSW by sending a series of questionnaires to TSDF owners and operators. One of the questionnaires requested general facility information including the total quantity of waste managed on-site, the quantity of waste received from off-site, and the types of hazardous waste management units operated at the facility in 1986. For each hazardous waste management unit type identified, detailed questionnaires were completed by the TSDF owner or operator that provided process-specific information about the hazardous waste management practices at that TSDF (refer to Table 1). These questionnaires requested further detail regarding the type of waste management process (e.g., batch distillation for solvent recovery) and the quantity of waste managed in each process unit, but no information was requested regarding compositional analysis of these waste streams. Table 2 lists the information reported by the TSDF owners and operators in the process specific TSDR Survey questionnaires that is used for the computer modeling analysis.

The GENSUR is a nationwide survey of hazardous waste generators also conducted by OSW in 1987. The GENSUR requested detailed compositional information about each of the waste streams generated in 1986, and it requested some general information regarding the on-site and off-site treatment, storage, disposal, or recycling (TSDR) processes used to manage each waste stream. Table 3 lists the information reported by the waste generators in the GENSUR questionnaire that is used for the computer model analysis.

The GENSUR database includes a <u>sequential</u> listing of the waste management practices expected to be used by the off-site facility (from question "GB19"). The GENSUR's off-site waste management codes were basically the same as the general waste management practices listed in Table 1 for TSDR Survey Questionnaires "B" through "N". Presumably, the TSDF owner

TABLE 1. TSDR SURVEY QUESTIONNAIRES

| Questionnaire | Subject |
|---|---|
| Questionnaire A. | General facility information |
| Questionnaire B. | Incineration |
| Questionnaire C. | Reuse as fuel |
| Questionnaire D. | Fuel blending |
| Questionnaire E. | Solidification/stabilization |
| Questionnaire F. | Solvent and liquid organic recovery for reuse |
| Questionnaire G. | Metals recovery for reuse |
| Questionnaire H. | Wastewater treatment |
| Questionnaire I.[a] | Other processes (treatment or recovery) |
| Questionnaire J. | Management in waste piles |
| Questionnaire K. | Management in surface impoundments |
| Questionnaire L. | Landfill disposal |
| Questionnaire M. | Land treatment |
| Questionnaire N. | Underground injection |
| Questionnaire O. | Management in tanks |

[a] Data from Questionnaire I were not available due to the format of this questionnaire. Information was available as to whether the TSDF had a process of this type.

TABLE 2. LIST OF INFORMATION USED FROM THE TSDR SURVEY QUESTIONNAIRES

| | |
|---|---|
| 1. | Facility identification number |
| 2. | Total quantity of waste managed by this general type of waste management process |
| 3. | Number of process units in use at this facility for the specified general type of waste management process |
| 4. | Process description code for each process unit |
| 5. | Total quantity of waste managed by each process unit |
| 6. | Quantity of waste received from off-site that was managed by each process unit |
| 7. | Type of emission control device, if any, used for each process unit |

TABLE 3. LIST OF INFORMATION USED FROM GENSUR

| Question Number | Parameter Description (for each waste stream/facility combination) |
|---|---|
| | Generator ID (RTI Survey and EPA ID number) |
| GB1 | RCRA waste codes (can list up to 15) |
| GB2,GB3 | Primary and secondary waste description codes |
| GB4,GB5 | Primary and secondary waste source codes |
| GB6 | SIC codes (can list up to 3) |
| GB18 | Quantity of waste shipped off-site for management |
| GB19 | Receiving facility ID (EPA ID number) and off-site management codes |
| GB25 | Concentration of targeted metals in waste |
| GB26 | Constituent ID and concentration range for hazardous constituents with highest concentrations (top 10) |

and operator have better knowledge of which waste management operations were used, but the TSDR Survey does not request that the data regarding the process units be given in sequential order. The TSDR Survey process-specific databases offered: 1) more detail regarding the specific process units used at the TSDF (e.g., batch distillation versus generic solvent recovery); and 2) the only source of information regarding the type of air emission controls, if any, used with a particular waste management process.

## B.2 IDENTIFYING FACILITIES THAT MANAGE OFF-SITE WASTES

An initial target list of facilities for the computer modeling analysis was derived from the TSDR Survey. One of the questions in the general facility questionnaire asked if this facility managed any waste that was received from off-site. Additionally, both the general and process-specific TSDR Survey questionnaires asked a question regarding the quantity of waste received from off-site that was managed at the facility or in the specific process. The target list of facilities for this modeling effort included all facilities that indicated that they received waste from off-site by either answering the direct question affirmatively or by indicating a non-zero quantity of waste received from off-site. Based on the TSDR Survey responses in 1986, there were a total of 710 TSDF nationwide that managed waste received from off-site waste generators.

This target list of 710 facilities that manage waste received from off-site was then used to request information from GENSUR. The information outlined in Table 3 was obtained for each of the 710 target facilities that were included in GENSUR Question GB19 as the off-site facility that the hazardous waste was shipped to for treatment, storage, disposal, or recycling.

Ideally, the database developed from the GENSUR information request could be sorted by the off-site facility's ID numbers so that the quantity of waste reported by the waste generator in the GENSUR to be shipped to a TSDF location matches exactly the quantity of waste that the TSDF owner or operator reported in the TSDR Survey receiving from off-site. In reality, off-site quantities reported between TSDR Survey and GENSUR often varied significantly. Reasons for the disparity between the two data sets are outlined in Table 4.

The discrepancies between the TSDR Survey and GENSUR data bases needed to be resolved because each of the data bases contained useful but unique data. The GENSUR contained the only compositional data available for the waste streams while the TSDR Survey contained the only data available specifying the type of waste management process used and whether an air emission control device was used with each process. Discussions with the coordinator of the TSDR Survey and GENSUR indicated that the TSDR Survey data was more thoroughly reviewed and is expected to be more accurate than the GENSUR data. However, the survey coordinator also stated that the survey respondents were more likely to under-report the amount of hazardous waste that their facility generated or managed than over-report their waste quantities. Consequently, a facility quantity correction factor was developed to correlate the quantities of off-site wastes managed by each facility as reported in the TSDR Survey and GENSUR data. This facility quantity correction factor is the ratio of the total waste quantity received from off-site for a given facility as reported in the TSDR Survey (numerator) and the total waste quantity shipped off-site to a that facility as reported in the GENSUR (denominator).

Approximately 80 percent of the total waste quantity reported by waste generators in the GENSUR to be shipped off-site can be matched with the TSDR Survey data for 464 specific TSDF locations. For some of these TSDF locations, there is a discrepancy between the waste quantity values reported in the GENSUR and TSDR Survey. When this occurred, the larger of the reported waste quantity values is used based on the

TABLE 4. LIST OF POTENTIAL DISCREPANCIES BETWEEN TSDR SURVEY AND GENSUR DATA

1. The GENSUR listed different off-site waste management codes (i.e., different waste management processes) than the TSDF facility actually used. This discrepancy primarily affects the quantities of waste that a given process type is assumed to manage.

2. Total quantities of wastes shipped by the generator are accounted for differently by the receiving facility. For example, a 55-gallon drum containing 20 gallons of waste may be accounted for by the generator as 20 gallons of waste, but may be accounted for by the receiving TSDF as one drum or 55 gallons. In this case, the accounting difference could error in either direction. Another possibility is that the generator generates a nonhazardous waste, but the receiving facility manages it as a hazardous waste. Presumably the reverse situation should not occur. Consequently, the TSDR Survey is expected to have slightly higher waste quantities due to discrepancies in accounting procedures.

3. Two or more receiving off-site facilities can be listed in GENSUR question GB19 for a given waste stream. GENSUR only provides information regarding the total quantity of that waste stream, but it provides no further breakdown of what fraction of the total quantity of the waste stream went to each receiving facility. It was assumed that the waste was equally divided between the receiving facilities. This may cause errors in the facility specific quantities, but should not provide an overall bias.

4. At times, the generator indicated that waste was sent off-site, but did not list an EPA ID Number for the receiving facility. This made it impossible to match all of the GENSUR quantities with a receiving facility. Consequently, the TSDR Survey waste quantity reported for a given facility are expected to be greater than the GENSUR waste quantity for that facility.

5. The GENSUR was a survey that included the major hazardous waste generators, but not all hazardous waste generators. Therefore, the TSDR Survey waste quantities are expected to be greater than the GENSUR waste quantities.

assumption that a survey respondent would not overstate the hazardous waste quantity generated or managed at a facility. Using the site-specific information on waste management operations reported in the TSDR Survey and the organic HAP composition data for the wastes managed at the facility as reported in the GENSUR Survey, the computer model simulates the waste management practices by emission point types at each of the 464 TSDF locations.

For the remaining 20 percent of the total waste quantity reported in the GENSUR, the specific TSDF locations where the generators shipped this waste are not identified in the survey responses. However, there are also 246 TSDF locations listed in the TSDR Survey that reported receiving waste from off-site waste generators, but were not specifically identified in the GENSUR as a location to where waste generators shipped waste. The total quantity of waste received from off-site waste generators reported in the TSDR Survey for these 246 TSDF locations is approximately the same as the total quantity of waste reported in the GENSUR to be shipped off-site but for which the specific TSDF location receiving the waste was not identified. It is assumed that the waste data reported in the GENSUR to be shipped off-site to unidentified TSDF locations represent the waste managed at the 246 TSDF locations for which the GENSUR data cannot be matched. Organic HAP emissions for the "unmatched" GENSUR waste stream data (i.e., data for waste streams that were shipped to unidentified off-site TSDF locations) were estimated by using the emission fractions for the off-site waste management codes reported in GENSUR for those waste streams. The organic HAP emissions calculated by the computer model for these "unmatched" waste steams are added together with the sum of the organic HAP emissions calculated by the computer model for the 464 specific TSDF locations. This approach is considered to provide a reasonable estimate of the total organic HAP emissions from the management of hazardous waste received from off-site waste generators at all 710 of the TSDF listed in the TSDR Survey.

Using this approach correlated the quantities reported in the GENSUR with the quantities reported in the TSDR Survey on a facility-specific basis. It did not, however, equate the waste streams on a process-specific basis. To investigate the differences in the quantities of waste managed by each type of waste management process as reported in the TSDR Survey versus as calculated in the computer model, a computer program was written to summarize and compare the TSDR Survey and GENSUR data on a facility- and process-specific basis.

Table 5 presents the nationwide totals for the quantities of waste managed in each of the general types of waste management process. Comparing the relative totals presented in Table 5 shows that both TSDR Survey and GENSUR data exhibit a similar distribution of the nationwide quantities of hazardous waste by waste management process. However, the waste quantities on a process-specific basis at any given facility are, in some cases, very different.

## B.3 DATA INPUT PREPARATION

In general, the main input database (filename MAININP.DAT) for the computer model used the data as reported in the GENSUR. However, two separate programs were written to revise some of the input waste management codes and constituent data. The first program (filename PRCODEON.BAS) reads the off-site facility ID number and the off-site waste management codes for each waste stream as reported in GENSUR. The program then searches for that off-site facility ID number in the corresponding process specific TSDR questionnaire database. If the search is successful, the program then replaces the GENSUR off-site waste management code with the more specific TSDR on-site waste management code and returns an indicator of the type of organic emission control device used with the process ("0" for no control; "1" for 95% control; "2" for 98% control; and "3" for 100% control).

## TABLE 5. TOTAL WASTE QUANTITIES BY PROCESS FOR ALL FACILITIES

| TSDR Survey Waste Management Process Type | Comparable GENSUR process code | TSDR Survey Off-site Quantity, (Mg/yr)[1] | GENSUR Off-site Quantity (Mg/yr)[1] |
|---|---|---|---|
| Incineration | M01 | 257,000 | 709,000 |
| Reuse as Fuel | M02 | 410,000 | 545,000 |
| Fuel Blending | M03 | 521,000 | 498,000 |
| Fixation (S/S) | M04 | 421,000 | 597,000 |
| Solvent Recovery | M05 | 479,000 | 708,000 |
| Metals Recovery | M06 | 474,000 | 465,000 |
| Wastewater Treatment | M07,M09 (M16,M17) | 14,900,000 | 11,100,000 (29,800,000) |
| Waste Piles | M11 | 381,000 | 30,000 |
| Surface Impoundment | M08,M12 | 3,050,000 | 4,600,000 |
| Landfill | M13 | 2,250,000 | 3,610,000 |
| Land treatment | M14 | 50,400 | 115,000 |
| Underground Injection | M15 | 415,000 | 527,000 |
| Other | M10,M18 | 532,000 | 1,150,000 |
| Unknown | M19,None | 5,040,000 | 2,530,000 |
| TOTAL QUANTITIES | | 29,200,000 | 27,200,000 |

(1) Quantities are calculated by process and may double account some wastes at a given facility.

The second program (filename VOFLAG.BAS) was written primarily to calculate the total volatile organic content, as determined by Method 25D[6], and the equilibrium partial pressure (headspace organic concentration) for each waste stream. These results are subsequently used to determine the applicability of the RCRA Subpart AA[7] and BB[8] rules. Additionally, this program was used to replace missing constituent data with average constituent concentration data based on RCRA waste code and waste form (waste source code) information. The GENSUR database for the target facilities was used to calculate average constituent concentrations for a given RCRA waste code and waste form pair using the ACEVOCC.BAS (filename) program. The output file from this program was then sorted by constituent concentration for each RCRA waste code and waste form. The resulting constituent concentration database was then used to update certain missing or unreadable data in the main input database.

There were two conditions for which the VOFLAG.BAS would replace the original compositional data. The first condition occurred when a readable constituent code was paired with a non-readable concentration range code. In this case, the average compositional database was used to replace the concentration range code with the corresponding average concentration, if found, for the specified RCRA waste code, waste form, and constituent code. The second condition occurred when both the constituent codes and the concentration range codes contained no readable data (even after evaluating the first condition) and the average compositional database contained data for the specified RCRA waste code and waste form pair. Under the second condition, data for the top ten constituents with the highest concentrations were used to replace both the constituent codes and concentration range codes in the main input database. The total volatile organic content and vapor pressure for the waste stream were then evaluated using the revised constituent data.

A third program (filename TOTHAP.BAS) used the revised constituent data output from VOFLAG.BAS to calculate the total organic HAP concentration, the total organic HAP concentration using EPA Reference Method 25D[9] recovery factors, and the total organic HAP vapor pressure. These organic HAP indicators were used to evaluate application of different candidate control options.

## B.4 ORGANIC HAP EMISSION ESTIMATION PROCEDURES

The computer model uses the waste stream specific data in the GENSUR to calculate facility organic HAP emissions. Each organic HAP compound is assigned a surrogate number according to the volatility characteristics of the compound (i.e., based on the compound's vapor pressure and Henry's Law constant). The criteria used for the classification of surrogates is the same surrogate criteria used for the source assessment model[10] (SAM). Table 6 lists each of the organic HAP compounds, the corresponding GENSUR "Y-code," and the assigned surrogate number.

Waste management operations at each of the TSDF are simulated based on the waste management process types defined in the TSDR Survey. Organic HAP emission factors are assigned to each waste management process type using one (or in many cases, a combination of several) of the model units developed for the TSDF RCRA air standards projects.[11] Table 7 identifies the model unit or the combination of model units used to represent each waste management process type.

The organic HAP emission factors used for this analysis are the same factors developed for the TSDF RCRA air standards projects. However, because of the small number of biological treatment processes actually in use at the TSDF included in the data set used for this analysis, the emission fractions developed for compounds of low biodegradability were used for all HAP compounds in developing the baseline emission estimate. Table 8 provides the aqueous surrogate emission factors for each of the model units, and Table 9 provides the

TABLE 6. ORGANIC HAP COMPOUND SURROGATE ASSIGNMENTS HAPS[a]

| GENSUR Y-code | Organic HAP Compound | Aqueous Surr. # | Organic Surr. # |
|---|---|---|---|
| Y004 | Acetonitrile | 4 | 2 |
| Y005 | Acetophenone | 3 | 3 |
| Y006 | 2-Acetylaminofluorene | 4 | 6 |
| Y009 | Acrolein | 3 | 1 |
| Y010 | Acrylamide | 6 | 5 |
| Y011 | Acrylonitrile | 3 | 1 |
| Y016 | Allyl chloride | 1 | 1 |
| Y018 | 4-Aminobiphenyl | 1 | 6 |
| Y023 | Aniline | 4 | 3 |
| Y025 | Antimony compounds[b] | 0 | 0 |
| Y026 | Arsenic compounds[b] | 0 | 0 |
| Y038 | Benzene | 1 | 2 |
| Y040 | Benzidine | 6 | 6 |
| Y047 | Benzotrichloride | 1 | 4 |
| Y048 | Benzylchloride | 2 | 3 |
| Y049 | Beryllium compounds[b] | 0 | 0 |
| Y054 | Bis(2-ethylhexyl)phthalate | 5 | 6 |
| Y053 | Bis(chloromethyl)ether | 2 | 2 |
| Y056 | Bromoform | 2 | 3 |
| Y062 | Cadmium compounds[b] | 0 | 0 |
| Y064 | Calcium cyanide[b] | 0 | 3 |
| Y065 | Carbon disulfide | 1 | 1 |
| Y067 | Carbon tetrachloride | 1 | 1 |
| Y070 | Chlordane | 3 | 6 |
| Y080 | Chlorobenzene | 1 | 2 |

TABLE 6. ORGANIC HAP COMPOUND SURROGATE ASSIGNMENTS HAPS[a]

| GENSUR Y-code | Organic HAP Compound | Aqueous Surr. # | Organic Surr. # |
|---|---|---|---|
| Y081 | Chlorobenzilate | 6 | 6 |
| Y085 | Chloroform | 1 | 1 |
| Y086 | Chloromethyl methyl ether | 6 | 1 |
| Y090 | Chloroprene (neoprene) | 1 | 1 |
| Y092 | Chromium compounds[b] | 0 | 0 |
| Y098 | Cresols/Cresylic acid (isomers and mixtures) | 3 | 2 |
| Y100 | Cyanide Compounds[b] | 6 | 6 |
| Y108 | 2,4-D (including salts and esters) | 1 | 6 |
| Y111 | DDE | 1 | 6 |
| Y121 | 1,2-Dibromo-3-chloropropane | 3 | 4 |
| Y122 | Dibutylphthalate | 5 | 6 |
| Y125 | 1,4-Dichlorobenzene | 1 | 3 |
| Y127 | 3,3'-Dichlorobenzidine | 3 | 6 |
| Y051 | Dichloroethyl ether (Bis(2-chloroethyl)ether) | 3 | 3 |
| Y139 | 1,3-Dichloropropene | 1 | 2 |
| Y154 | 3,3'-Dimethoxybenzidine | 1 | 6 |
| Y155 | Dimethyl aminoazobenzene | 2 | 6 |
| Y157 | 3,3'-Dimethylbenzidine | 2 | 4 |
| Y158 | Dimethylcarbamoyl chloride | 1 | 3 |
| Y159 | 1,1-Dimehtylhydrazine | 2 | 1 |
| Y163 | Dimethyl phthalate | 4 | 5 |
| Y164 | Dimethyl sulfate | 5 | 4 |
| Y166 | 4,6-Dinitro-o-cresol (including salts) | 3 | 6 |
| Y167 | 2,4-Dinitrophenol | 5 | 4 |

TABLE 6. ORGANIC HAP COMPOUND SURROGATE ASSIGNMENTS HAPS[a]

| GENSUR Y-code | Organic HAP Compound | Aqueous Surr. # | Organic Surr. # |
|---|---|---|---|
| Y168 | 2,4-Dinitrotoluene | 4 | 6 |
| Y143 | 1,4-Dioxane (1,4-diethyleneoxide) | 3 | 2 |
| Y173 | 1,2-Diphenylhydrazine | 6 | 6 |
| Y083 | Epichlorohydrin (1-chloro-2,3-epoxypropane) | 1 | 2 |
| Y181 | Ethylbenzene | 1 | 2 |
| Y182 | Ethyl carbamate (urethane) | 3 | 4 |
| Y186 | Ethylene dibromide (1,2-dibromoethane) | 2 | 2 |
| Y187 | Ethylene dichloride (1,2-dichloroethane) | 1 | 2 |
| Y189 | Ethyleneimine (aziridine) | 4 | 1 |
| Y190 | Ethylene oxide | 2 | 1 |
| Y191 | Ethylene thiourea | 2 | 6 |
| Y192 | Ethylidene dichloride (1,1-dichloroethane) | 1 | 1 |
| Y201 | Formaldehyde | 3 | 1 |
| Y204 | Heptachlor | 1 | 6 |
| Y206 | Hexachlorobenzene | 1 | 4 |
| Y207 | Hexachlorobutadiene | 1 | 4 |
| Y208 | Hexachlorocyclopentadiene | 1 | 5 |
| Y211 | Hexachloroethane | 1 | 4 |
| Y215 | Hydrazine | 5 | 2 |
| Y217 | Hydrogen fluoride[b] (hydrofluoric acid) | 0 | 0 |
| Y226 | Lead compounds[b] | 0 | 0 |
| Y230 | Lindane | 5 | 6 |
| Y231 | Maleic anhydride | 6 | 6 |

TABLE 6. ORGANIC HAP COMPOUND SURROGATE ASSIGNMENTS HAPS[a]

| GENSUR Y-code | Organic HAP Compound | Aqueous Surr. # | Organic Surr. # |
|---|---|---|---|
| Y236 | Mercury compounds[b] | 0 | 0 |
| Y238 | Methanol | 4 | 1 |
| Y241 | Methoxychlor | 5 | 6 |
| Y242 | Methyl bromide (bromomethane) | 1 | 1 |
| Y243 | Methyl chloride (chloromethane) | 1 | 1 |
| Y245 | Methyl chloroform (1,1,1-trichloroethane) | 1 | 1 |
| Y250 | Methyl ethyl ketone (2-butanone) | 3 | 1 |
| Y252 | Methylhydrazine | 4 | 2 |
| Y253 | Methyl iodide (iodomethane) | 1 | 1 |
| Y254 | Methyl isobutyl ketone (hexone) | 3 | 2 |
| Y255 | Methyl isocyanate | 3 | 2 |
| Y257 | Methyl methacrylate | 3 | 1 |
| Y247 | 4,4'-Methylenebis(2-chloro-analine) | 6 | 6 |
| Y249 | Methylene chloride (dichloroethane) | 1 | 1 |
| Y264 | Naphthalene | 2 | 5 |
| Y269 | Nickel compounds[b] | 0 | 0 |
| Y275 | Nitrobenzene | 3 | 4 |
| Y280 | 4-Nitrophenol | 5 | 4 |
| Y281 | 2-Nitropropane | 2 | 2 |
| Y290 | N-Nitroso-N-methylurea | 3 | 3 |
| Y287 | N-Nitrosodimethylamine | 5 | 3 |
| Y293 | N-Nitrosomorpholine | 3 | 3 |
| Y302 | Parathion | 3 | 6 |

TABLE 6. ORGANIC HAP COMPOUND SURROGATE ASSIGNMENTS HAPS[a]

| GENSUR Y-code | Organic HAP Compound | Aqueous Surr. # | Organic Surr. # |
|---|---|---|---|
| Y307 | Pentachloronitrobenzene | 2 | 5 |
| Y308 | Pentachlorophenol | 4 | 6 |
| Y311 | Phenol | 5 | 4 |
| Y312 | p-Phenylenediamine | 6 | 5 |
| Y315 | Phosgene | 1 | 1 |
| Y316 | Phosphine | 1 | 1 |
| Y319 | Phthalic anhydride | 5 | 6 |
| Y321 | Polychlorinated biphenyls (Aroclors) | 2 | 6 |
| Y325 | 1,3-Propane sultone | 3 | 6 |
| Y328 | Propylene dichloride (1,2-dichloropropane) | 1 | 2 |
| Y329 | 1,2-Propylenimine (2-methyl aziridine) | 4 | 1 |
| Y046 | Quinone (benzoquinone) | 4 | 4 |
| Y338 | Selenium compounds[b] | 0 | 0 |
| Y348 | Styrene | 1 | 3 |
| Y351 | 2,3,7,8-Tetrachlorodibenzo-p-dioxin | 3 | 6 |
| Y355 | 1,1,2,2-Tetrachloroethane | 2 | 3 |
| Y356 | Tetrachloroethylene (perchloroethylene) | 1 | 2 |
| Y377 | Toluene | 1 | 2 |
| Y379 | 2,4-Toluenediamine | 6 | 6 |
| Y382 | 2,4-Toluene diisocyanate | 4 | 5 |
| Y385 | Toxaphene (chlorinated camphene) | 1 | 4 |
| Y387 | 1,2,4-Trichlorobenzene | 1 | 4 |
| Y388 | 1,1,2-Trichloroethane | 2 | 2 |

TABLE 6. ORGANIC HAP COMPOUND SURROGATE ASSIGNMENTS HAPS[a]

| GENSUR Y-code | Organic HAP Compound | Aqueous Surr. # | Organic Surr. # |
|---|---|---|---|
| Y389 | Trichloroethylene | 1 | 2 |
| Y393 | 2,4,5-Trichlorophenol | 3 | 6 |
| Y394 | 2,4,6-Trichlorophenol | 3 | 6 |
| Y407 | Vinyl chloride | 1 | 1 |
| Y132 | Vinylidene chloride (1,1-dichloroethylene) | 1 | 1 |
| Y409 | Xylenes (isomers and mixtures) | 1 | 3 |

[a] The organic HAP compounds used for the computer model were limited to the HAP compounds that were included in the list of constituents in GENSUR Instructions: Appendix D. All listed compounds are also volatile organic HAPs unless otherwise indicated.

[b] Compound is not a volatile organic HAP.

TABLE 7. WASTE MANAGEMENT PROCESS MODEL UNIT CONFIGURATIONS

| Waste Management Process | Process Code | Organic HAP Emission Sources for Waste Management Process[a] | Model Unit Configuration[b] |
|---|---|---|---|
| Incineration | 1I-11I & M01 | ! Storage/feed tanks | 2*CST |
| Reuse as fuel | 1RF-13RF & M02 | ! Storage tanks | 2*CST |
| Fuel blending | 1FB,M03 | ! Waste transfer operations<br>! Storage/blending tanks | TF<br>2*CST |
| Waste fixation | 1S-7S & M04 | ! Waste/binder mixing tanks | ATT1 |
| Solvent recovery (vented) | 1SR-4SR & 8SR,M05 | ! Batch distillation process vents<br>! Waste transfer operations<br>! Storage tanks | PV<br>TF<br>2*CST |
| Solvent recovery (non-vented) | 5SR-7SR | ! Waste transfer operations<br>! Storage tanks | TF<br>2*CST |

See notes at end of table.

TABLE 7. WASTE MANAGEMENT PROCESS MODEL UNIT CONFIGURATIONS (continued)

| Waste Management Process | Process Code | Organic HAP Emission Sources for Waste Management Process[a] | Model Unit Configuration[b] |
|---|---|---|---|
| Metals recovery | 1MR-5MR, 8MR,10MR, M06 | ! Covered treatment tanks | CTT |
| | 6MR,9MR | ! Open treatment tanks | QOTT |
| | 7MR | ! Evaporation ponds | DI |
| Wastewater Treatment | 6WT-12WT<br>14WT-19WT<br>34WT-42WT<br>47WT-49WT<br>60WT-64WT<br>66WT<br>M07,M09 | ! Open treatment tanks with no mixing or biodegradation | QOTT |
| | 1WT<br>43WT-46WT | ! Aerated treatment tanks with no biodegradation | ATT1 |
| | 2WT-5WT<br>13WT<br>20WT-26WT<br>32WT,50WT<br>51WT,57WT<br>59WT,65WT | ! Covered treatment tanks | CTT |

See notes at end of table.

TABLE 7. WASTE MANAGEMENT PROCESS MODEL UNIT CONFIGURATIONS (continued)

| Waste Management Process | Process Code | Organic HAP Emission Sources for Waste Management Process[a] | Model Unit Configuration[b] |
|---|---|---|---|
| Wastewater Treatment (continued) | 27WT | ! Steam/air stripping process vents<br>! Aerated treatment tanks | PV<br>ATT1 |
| | 28WT,29WT | ! Steam/air stripping process vents<br>! Covered storage tanks | PV<br>2*CST |
| | 30WT,31WT<br>33WT | ! Evaporation pond | DI |
| | 52WT-54WT<br>58WT | ! Aerated biotreatment tanks | ATT2 |
| | 55WT | ! Aerated biotreatment impoundments | ATI |
| | 56WT,M08 | ! Quiescent biotreatment impoundments | QTI |
| Other Treatment | 1TR,M18 | ! Treatment process vents<br>! Storage tanks | PV<br>2*CST |
| | 2TR,M10 | ! Treatment process vents<br>! Waste transfer operations<br>! Storage tanks | PV<br>TF<br>2*CST |
| Waste Accumulation and Storage in Containers | 1A,1ST | ! Waste transfer operations | TF |

See notes at end of table.

TABLE 7. WASTE MANAGEMENT PROCESS MODEL UNIT CONFIGURATIONS (continued)

| Waste Management Process | Process Code | Organic HAP Emission Sources for Waste Management Process[a] | Model Unit Configuration[b] |
|---|---|---|---|
| Waste Accumulation and Storage in Tanks | 2A,2ST | ! Waste transfer operations<br>! Storage tanks | TF<br>Aq=QOST[c]<br>Org=CST[c] |
| Waste Pile[d] | 3ST,M11 | ! Storage waste pile | WP |
| Storage Impoundment[d] | 4ST | ! Storage surface impoundments | QSI |
| Underground Injection | 5ST,4D,M15 | ! Storage tanks | Aq=QOST[c]<br>Org=CST[c] |
| Land Disposal[e] | 1D,M13 | ! Landfill | LF |
| | 2D,M14 | ! Land treatment | LT |
| | 3D,M12 | ! Disposal impoundments | DI |
| Wastewater Discharge | M16,M17 | ! POTW and NPDES discharge | not modelled |
| Unknown | M19 | ? | 2*CST |

See notes at end of table.

TABLE 7. WASTE MANAGEMENT PROCESS MODEL UNIT CONFIGURATIONS (concluded)

NOTES:

(a) All units are modelled to have equipment leak emissions.

(b) Model Unit Key

2*CST = Two covered storage tanks operated in series<br>
CTT = Covered treatment tank<br>
QOTT = Quiescent open treatment tank<br>
ATT1 = Aerated treatment tank with no biodegradation<br>
ATT2 = Aerated treatment tank with biodegradation<br>
DI = Disposal impoundment<br>
ATI = Aerated treatment impoundment<br>
QTI = Quiescent treatment impoundment<br>
QSI = Quiescent storage impoundment<br>
WP = Waste pile<br>
LF = Landfill (open)<br>
LT = Land treatment unit (with subsurface application)<br>
PV = Process vent stack<br>
TF = Splash loading of liquid wastes

(c) Storage tanks for aqueous wastes (i.e., aqueous surrogates) are assumed to be quiescent and open; storage tanks for organic wastes (surrogates) are assumed to be covered.

(d) These units are expected to be replaced by tanks. When including the land disposal restrictions[12] (LDR) in the baseline assumptions, the model unit configuration for 5ST is used for these units.

(e) LDR requires organic wastes to be pretreated prior to land disposal. Therefore, when including LDR in the baseline assumptions, wastes are first pretreated (pretreatment emissions are estimated using the model configuration for 1SR-4SR); a 90 percent organic removal efficiency is assumed, then the emissions associated with the land disposal unit is estimated using the appropriate model unit configuration for that unit.


B-24

TABLE 8. EMISSION FACTORS FOR AQUEOUS SURROGATES

| Model Unit | Description | Fraction emitted for specified aqueous surrogate (kg HAP emitted/kg HAP entering unit) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| ATT1 | Aerated treatment tank w/no biodeg. | 0.919 | 0.667 | 0.202 | 0.028 | 0.0029 | 2.0E-4 |
| ATT2 | Aerated treatment tank with low biodeg.[a] | 0.850 | 0.610 | 0.182 | 0.0256 | 2.87E-3 | 0.0 |
| ATT2 | Aerated treatment tank with high biodeg.[b] | 0.31 | 0.086 | 0.0114 | 0.0012 | 0.0 | 0.0 |
| ATI | Aerated treatment impoundment w/bio.[a] | 0.938 | 0.865 | 0.613 | 0.288 | 0.0700 | 8.53E-3 |
| CST | Covered storage tank | 0.291 | 0.0301 | 3.96E-3 | 5.86E-4 | 9.79E-5 | 1.80E-5 |
| 2*CST | Two covered storage tanks in series | 0.390 | 0.0593 | 7.88E-3 | 1.16E-3 | 1.93E-4 | 3.56E-5 |
| CTT | Covered treatment tank | 0.0581 | 6.42E-3 | 7.21E-4 | 8.79E-5 | 1.21E-5 | 1.90E-6 |
| DI | Disposal impoundment | 1.00 | 1.00 | 1.00 | 1.00 | 0.688 | 0.112 |
| QOST | Quiescent open storage tank | 0.671 | 0.666 | 0.618 | 0.368 | 0.077 | 8.70E-3 |
| QOTT | Quiescent open treatment tank | 0.100 | 0.0981 | 0.0799 | 0.0283 | 3.64E-3 | 3.26E-4 |
| QTI | Quiescent treatment impoundment w/bio.[a] | 0.446 | 0.442 | 0.407 | 0.234 | 0.0460 | 5.11E-3 |

(Continued)

TABLE 8. EMISSION FACTORS FOR AQUEOUS SURROGATES (CONTINUED)

| Model Unit | Description | Fraction emitted for specified aqueous surrogate (kg HAP emitted/kg HAP entering unit) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| WP | Waste pile storage | 0.177 | 0.0562 | 0.0179 | 5.62E-3 | 1.67E-3 | 3.95E-4 |
| LF | Landfill (open) | 0.841 | 0.349 | 0.110 | 0.0350 | 0.0107 | 0.0034 |
| LT | Land treatment[a] with subsurface application | 0.998 | 0.998 | 0.996 | 0.979 | 0.708 | 0.231 |
| PV | Process vents | 0.030 | 7.0E-3 | 2.5E-3 | 1.0E-3 | 1.0E-4 | 0.0 |
| TF | Transfer | 0.326 | 0.0326 | 3.26E-3 | 3.26E-4 | 3.26E-5 | 3.26E-6 |

[a]Emission factors for these units are dependent on the biodegradability of the HAP; the emission factors presented for these model units assume low biorates for all HAPs at baseline.

[b]Emission factors for these units are dependent on the biodegradability of the HAP; the emission factors presented for these model units assume high biorates for all HAPs if specific performance standards are met.

TABLE 9. EMISSION FACTORS FOR ORGANIC SURROGATES

| Model Unit | Description | Fraction emitted for specified organic surrogate (kg HAP emitted/kg HAP entering unit) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 |
| CST | Covered storage tank | 2.77E-3 | 3.96E-4 | 5.01E-5 | 7.26E-6 | 1.20E-6 | 1.29E-8 |
| 2*CST | Two covered storage tanks in series | 5.53E-3 | 7.92E-4 | 1.00E-4 | 1.45E-5 | 2.40E-6 | 2.58E-8 |
| CTT | Covered treatment tank | 6.31E-4 | 8.42E-5 | 9.33E-6 | 1.12E-6 | 1.52E-7 | 1.18E-9 |
| QOST | Quiescent open storage tank | 0.9998 | 0.890 | 0.268 | 0.0319 | 3.20E-3 | 5.34E-6 |
| QOTT | Quiescent open treatment tank | 0.577 | 0.131 | 0.0143 | 1.40E-3 | 1.45E-4 | 2.63E-7 |
| QSI,DI | Surface impoundment[a] | 0.9998 | 0.890 | 0.268 | 0.0319 | 3.20E-3 | 5.34E-6 |
| WP | Waste pile storage | 0.0300 | 0.109 | 3.2E-3 | 1.2E-3 | 2.0E-4 | 1.0E-5 |
| LF | Landfill (open) | 0.188 | 0.068 | 0.021 | 6.0E-3 | 2.0E-3 | 1.0E-4 |
| LT | Land treatment[b] with subsurface application | 0.998 | 0.993 | 0.943 | 0.445 | 0.0795 | 2.9E-3 |
| PV | Process vents | 0.030 | 7.0E-3 | 2.5E-3 | 1.0E-3 | 1.0E-4 | 0.0 |
| TF | Transfer | 3.35E-3 | 4.28E-4 | 4.20E-5 | 4.29E-6 | 4.29E-7 | 0.78E-9 |

[a]Impoundments were not modeled for organic wastes; used emission factors for QOST.

[b]Emission factors for this unit is dependent on the biodegradability of the HAP; the emission factors presented assume low biorates for all HAPs. Note: It is assumed that all wastes processed in other biological units (ATT1, ATT2, ATI, or QTI) are aqueous wastes; therefore, only aqueous surrogate emission factors apply.

organic surrogate emission factors for each of the model units. The equipment leak emission factors developed for the TSDF RCRA air standards for equipment leaks were used in the computer model.[13] Table 10 summarizes the equipment leak emission factors for each waste management code. [Note: Due to the lack of data regarding the quantity of waste stored in containers and typical storage times for wastes in containers, no emission fractions were developed for container storage. Consequently, emissions are not estimated for container storage.]

A line input for the computer model contains data for one off-site waste stream. For a given waste stream, constituent codes and concentrations for up to 10 HAP and a waste management sequence consisting of up to 10 process codes (refer to Table 7) are input. The computer model calculates the organic HAP emission estimates on a HAP-, emission point type-, waste stream-, and waste management unit-specific basis. There are six different emission point types: 1) non-wastewater treatment tanks; 2) wastewater treatment tanks; 3) containers; 4) land disposal units; 5) process vents; and 6) equipment leaks.

Emissions are calculated for the first waste management unit for each individual HAP constituent for each emission point type. The waste stream HAP concentrations are then adjusted to reflect HAP removal (by treatment or emissions) for that waste management unit before emissions are calculated for the next waste management unit. After emissions are calculated for all of the waste management units in the waste management sequence for that waste stream, data for the next waste stream are input. In this manner, emissions are calculated for every waste stream managed by a given facility. The facility emissions can then be stored in an output file, and the program continues until emissions are calculated for all of the facilities included in the input database.

TABLE 10. EMISSION FRACTIONS FOR EQUIPMENT LEAKS

| Process Code | Emission Fraction (kg HAP emitted/kg HAP in waste) | |
|---|---|---|
| | Org. Surr. 1-3 & Aq. Surr. 1 | Org. Surr. 4-6 & Aq. Surr. 2-6 |
| 1I-11I & M01 | 1.69E-3 | 5.75E-4 |
| 1RF-13RF & M02 | 1.69E-3 | 5.75E-4 |
| 1FB & M03 | 6.60E-5 | 2.24E-5 |
| 1S-7S & M04 | 1.30E-5 | 4.42E-6 |
| 1SR-3SR,8SR & M05 | 9.79E-4 | 3.33E-4 |
| 4SR | 5.76E-4 | 1.96E-4 |
| 5SR-7SR | 6.60E-5 | 2.24E-5 |
| 1MR-10MR & M06 | 6.60E-5 | 2.24E-5 |
| 1WT-26WT,32WT, 34WT-42WT,47WT-51WT, 59WT & M07,M09 | 6.60E-5 | 2.24E-5 |
| 27WT | 3.10E-5 | 1.05E-5 |
| 28WT,29WT | 1.39E-4 | 4.73E-5 |
| 30WT,31WT,33WT, 55WT-57WT,4ST,3D & M08,M12 | 9.00E-6 | 3.06E-6 |
| 43WT-46WT, 52WT-54WT,58WT | 1.30E-5 | 4.42E-6 |
| 60WT[a] | A: 6.60E-5<br>O: 1.30E-5 | A: 2.24E-5<br>O: 4.42E-6 |
| 61WT[a] | A: 6.60E-5<br>O: 3.10E-5 | A: 2.24E-5<br>O: 1.05E-5 |
| 62WT[a] | A: 6.60E-5<br>O: 5.76E-4 | A: 2.24E-5<br>O: 1.96E-4 |
| 63WT[a] | A: 6.60E-5<br>O: 1.01E-3 | A: 2.24E-5<br>O: 3.44E-4 |
| 64WT[a] | A: 6.60E-5<br>O: 9.00E-6 | A: 2.24E-5<br>O: 3.06E-6 |

TABLE 10. EMISSION FRACTIONS FOR EQUIPMENT LEAKS

| | Emission Fraction (kg HAP emitted/kg HAP in waste) | |
|---|---|---|
| 65WT[a] | A: 6.60E-5<br>O: 7.06E-4 | A: 2.24E-5<br>O: 2.40E-4 |
| 66WT[a] | A: 6.60E-5<br>O: 2.83E-3 | A: 2.24E-5<br>O: 9.61E-4 |
| 1TR,2TR,2A,2ST,5ST & M18,M19 | 1.01E-3 | 3.44E-4 |
| 1A,1ST | 2.83E-3 | 9.61E-4 |
| 3ST,1D,2D[a] & M11,M13,M14 | A: 1.30E-5<br>O: 1.69E-3 | A: 4.42E-6<br>O: 5.75E-4 |
| 4D & M15 | 9.00E-5 | 3.06E-5 |
| M10[a] | A: 9.79E-4<br>O: 6.60E-5 | A: 3.33E-4<br>O: 2.24E-5 |

[a]These units have different equipment leak emission fractions for aqueous and organic surrogates. Emission fractions preceded by "A:" apply only to the aqueous surrogate(s) in that column. Emission fractions preceded by "O:" apply only to the organic surrogates in that column.

Figure 1 presents a general flow chart for the computer model to show the calculation methodology algorithm logic.

The computer model maintains HAP-specific emission totals for each emission point type on a facility-wide basis. The computer model also maintains an overall HAP emission total for each emission point type for all facilities (or waste streams) represented by the computer model input data. These overall emission point type HAP emission totals are then used for comparing alternative control options. Note: the HAP emissions totals for non-wastewater treatment tanks and wastewater treatment tanks are summed together to yield the total HAP emissions for the "tanks" emission point type.

B.5 COMPUTER MODEL BASELINE ASSUMPTIONS

For the purposes of evaluating the relative organic emission reduction effectiveness of alternative control options, the EPA defines a "baseline" as a reference point from which each control option can be compared. The baseline represents the estimated level of organic emissions from the source category that would occur in the absence of implementing any of the control options. For the off-site waste operations source category, a baseline was chosen to reflect the level of organic emissions for each emission point type following implementation of air emission controls required by federally enforceable air regulations in effective as of July 1991. The following regulatory baseline assumptions are used for the computer model:

(1) **Existing Controls**. Air emission controls reported in the TSDR Survey to be installed on a unit are assumed to be in operation.

(2) **RCRA Air Standards for TSDF Process Vents (40 CFR 264 subpart AA).**[14] Process vents on processes listed in data base as distillation,

solvent extraction, thin-film evaporation, steam stripping, or air stripping and estimated to have a total organic mass emissions equal to or greater than 3 tons/yr are assumed to be vented to a control device with a 95 percent organic emission control efficiency.

(3) **RCRA Air Standards for TSDF Equipment Leaks (40 CFR 264 subpart BB).**[15] Each waste stream reported in the data base to have a total organic concentration equal or greater than 10 percent is assumed to be controlled by implementing a leak detection and repair (LDAR) program which results in a 70 to 75 percent organic emission reduction depending on the waste materials type.

(4) **RCRA Land Disposal Restrictions (40 CFR part 268).**[16] All surface impoundments reported in the data base to be used for disposal are assumed to be replaced by landfills. Each waste stream disposed in a land treatment unit or landfill is assumed to be treated to meet the LDR treatment standards prior to disposal.

(5) **NESHAP for Benzene Waste Operations (40 CFR 61 subpart FF).**[17] Each waste stream reported in the data base to have a benzene concentration equal to or greater than 10 ppmw uses organic emission controls as follows: (1) affected non-wastewater streams managed in tanks are vented to control devices with a 95 percent organic emission control efficiency; (2) affected wastewater streams are pre-treated by

steam stripping to reduce the benzene concentration to 10 ppmw or to the benzene concentration corresponding to a 99 percent removal of benzene, whichever value is higher; (3) treatment processes handling affected waste streams are vented to control devices with a 95 percent organic emission control efficiency; and (4) transfer of affected waste streams into containers is by submerged fill loading.

## B.6 EMISSION CONTROL EFFICIENCIES FOR BASELINE ASSUMPTIONS

All existing control devices reported to be in place for a given waste management process unit are assumed to be operating effectively. Consequently, an appropriate emission reduction factor (based on the type of emission control device reported for that process unit) is applied to the "uncontrolled" emission fraction for the emission point type affected by the emission control device to calculate the baseline emissions for all waste streams that are managed in that process unit. Thermal control devices, which includes flares and fume/vapor incinerators, were assigned a control efficiency of 98 percent for all surrogate assignments. Internal floating roofs, external floating roofs, condensers, and carbon adsorption units were assigned a control efficiency of 95 percent for all surrogate assignments.

The total organic concentration and the benzene concentration is evaluated for each waste stream to determine if one of the RCRA air standards or the Benzene Waste Operations NESHAP apply for that waste stream. [Note: For the computer model simulation, it is assumed that the action level for identifying the waste streams required to use these additional controls is based on the waste stream characteristics at the point where the waste first enters the TSDF site (i.e., at the facility entrance gate).] If the waste stream concentrations exceed the action levels, an appropriate emission reduction factor is applied to the appropriate emission point type "uncontrolled" emission fraction for the affected units to calculate the baseline emissions.

Control devices assumed to be installed on process vents to comply with the RCRA air rules for process vents are assumed to have a control efficiency of 95 percent. An LDAR program implemented to comply with the RCRA air rules for equipment leaks is assumed to achieve a 70 percent emission reduction for aqueous Surrogate 1; a 75 percent emission reduction for organic Surrogates 1, 2, and 3; and zero reduction for all other surrogate assignments.

All waste streams in the data base are assumed to be affected by the RCRA LDR. Consequently, organic HAP emissions are estimated for waste streams originally managed in land disposal units are reflective of the emission fractions for the waste management model unit configuration sequence expected to be in place due to the LDR (i.e., tanks used to replace storage or treatment impoundments and pretreatment tank sequence preceding land treatment units, disposal impoundments or landfills). Table 11 presents the pre- and post-LDR waste management model unit configuration sequences used for the land disposal model process codes. Note, baseline emissions from evaporation processes are modeled using the emission fractions for disposal impoundments whether the evaporation unit is a surface impoundment or a tank.

Replacing surface impoundments with tanks tends to reduce the organic HAP emissions because tanks are generally have a lower surface area to waste volume ratio and a lower residence time. The emission reduction attributed to replacing a surface impoundment with a tank is dependent on the relative emission fractions of the surface impoundment and the tank sequence used to replace the surface impoundment, and it varies with the volatility (surrogate assignment) of the organic HAP constituents in the waste material.

TABLE 11. MODEL UNIT CONFIGURATIONS FOR PROCESSES AFFECTED BY THE LAND DISPOSAL RESTRICTIONS[18]

| Reported Process Code[a] | Original Model Unit Configuration[b] | Model Unit Configuration after LDR[b] |
|---|---|---|
| 55WT | ATI[c] | ATT2[c] |
| 56WT,M08 | QTI[c] | QOTT[c] |
| 3ST,M11 | WP | Aq=QOST[d]<br>Org=CST[d] |
| 1D,M13 | LF | Treat = PV,TF,2*CST 90% HAP reduction then LF |
| 2D,M14 | LT | Treat = PV,TF,2*CST 90% HAP reduction then LF |
| 3D,M12 | DI | Treat = PV,TF,2*CST 90% HAP reduction then DI |

[a]Process codes as reported in the TSDR survey[19] and GENSUR.[20]

[b]Emission factors for model unit configurations are provided in Table 8. Key to model unit configuration follows:

DI = Disposal impoundment
ATI = Aerated treatment impoundment
ATT2 = Aerated treatment tank with biodegradation
QTI = Quiescent treatment impoundment
QOTT = Quiescent open treatment tank
WP = Waste pile
LF = Landfill (open)
LT = Land treatment unit (with subsurface application)
2*CST = Two covered storage tanks operated in series
PV = Process vent stack
TF = Splash loading of liquid wastes

[c]All waste materials managed in these units are assumed to be aqueous waste streams.

[d]Storage tanks for aqueous wastes (i.e., aqueous surrogates) are assumed to be quiescent and open; storage tanks for organic wastes (surrogates) are assumed to be covered.

The organic removal efficiency of the pretreatment sequence used in the baseline assumptions prior to land disposal is assumed to be 90 percent for all organic HAPs in the waste (i.e., all surrogate assignments). The emissions from pretreatment units are estimated using the model configuration for vented solvent recovery units (Process Codes 1SR through 4SR as indicated in Table 7). The treated waste stream (with one tenth the organic HAP concentration that existed prior to pretreatment)is then disposed of as originally indicated. Consequently, the land disposal unit emissions are reduced by 90 percent for all surrogates, but additional emissions occur from tanks, containers, and process vents during the treatment process. The overall emission reduction achieved by the pretreatment/land disposal unit combination is dependent on the additional emissions that occur from the pretreatment unit (which are, in turn, dependent on the surrogate assignment for the specific HAP), and it may be significantly less than 90 percent.

Control devices assumed to be installed on non-wastewater treatment tanks and process vents used to comply with the Benzene Waste Operations NESHAP are assumed to have a control efficiency of 95 percent for all surrogate assignments. The control efficiency for submerged fill during container waste transfer to comply with the Benzene Waste Operations NESHAP is assumed to be 65 percent for all surrogate assignments.

The required emission control efficiencies for steam strippers used for wastewater treatment to comply with the Benzene Waste Operations NESHAP is dependent on the surrogate assignment and may be limited by the control efficiency required to reduce the benzene concentration to 10 ppmw. The maximum control/removal efficiency for steam stripping for each surrogate class is presented in Table 12. As seen in Table 12, the organic HAP control (or removal) efficiency of a steam stripping unit is dependent on the aqueous volatility of the organic HAP, (i.e., the aqueous surrogate assignment). If the benzene concentration is 1,000 ppmw or more, the control efficiencies in Table 12 are used directly. (Note: Benzene has an aqueous surrogate assignment of 1, so that the benzene removal efficiency of the steam stripper is 99 percent). If the benzene concentration is less than 1,000 ppmw, the control efficiencies presented in Table 12 are adjusted by a correction factor to yield a benzene concentration leaving the steam stripper of 10 ppmw. For example, if the benzene concentration is 100 ppmw, the required steam stripper efficiency for benzene is 90 percent. In this situation, the steam stripper control efficiencies presented in Table 12 are multiplied by 90 percent.

TABLE 12. STEAM STRIPPER FRACTION REMOVED BY SURROGATE CLASS

| Surrogate Number | Henry's Law Constant ($atm\text{-}m^3/mol$) | Steam Stripper Fraction Removed |
|---|---|---|
| 1 | $3.16 \times 10^{-3}$ | 0.99 |
| 2 | $3.16 \times 10^{-4}$ | 0.98 |
| 3 | $3.16 \times 10^{-5}$ | 0.94 |
| 4 | $3.16 \times 10^{-6}$ | 0.63 |
| 5 | $3.16 \times 10^{-7}$ | 0 |
| 6 | $3.16 \times 10^{-8}$ | 0 |

## B.7 EMISSION CONTROL EFFICIENCIES FOR CONTROL OPTIONS

A specific subroutine was written to add additional controls to each waste management unit/emission point type to evaluate the impacts of alternative control options. The impact of additional emission controls can be estimated for any one or any combination of emission controls applied to the six emission point types: 1) non-wastewater treatment tanks; 2) wastewater treatment tanks; 3) containers; 4) land disposal units; 5) process vents; and 6) equipment leaks.

The control efficiency of applying a fixed roof cover to an open tank depends on the surrogate assignment. The control efficiency is calculated as: 1 minus the ratio of the emission fraction for a covered tank to the emission fraction for an open tank for that surrogate assignment. Covers are applied to both non-wastewater treatment tanks and wastewater treatment tanks for waste streams that exceed a selected VOHAP concentration limit, with two exceptions. The first exception is for enhanced biological treatment units (Process Code 52WT). These biological treatment units are assumed to meet specific performance standards and, as such, are not required to apply controls. The second exception is for waste streams that have been treated to remove or destroy the VOHAP in the waste streams to lower the VOHAP concentration to below the selected VOHAP concentration action level.

For enhanced biological treatment units that meet specific performance standards (assumed to be all Process Code 52WT units and only those units), additional credit for biological removal of VOHAP is given. First, the emission fractions used for Process Code 52WT's model unit configuration (i.e., ATT2) are the emission fractions for the aerated treatment tank with high biodegradability (see Table 8). This reduces the emissions from this unit compared to units where the low biodegradability emission factors are used. Second, it is assumed that the overall VOHAP removal efficiency of the unit, including removal by both volatilization and biodegradation, is 90 percent. This assumption reduces the potential for VOHAP emissions in downstream units.

For the purpose of the computer impacts model, it is assumed that covers are not needed for tanks downstream of wastewater steam and air strippers and enhanced biological wastewater treatment units (Process Codes 27WT, 28WT, 29WT, and 52WT). This assumption is based on the typical VOHAP removal efficiencies of these units and the range of VOHAP concentrations in the wastewater streams typically managed in these units. Although there are other treatment units (e.g., incineration, distillation, and thin-film evaporation) that may be as or more efficient in removing or destroying VOHAP, the range of waste stream VOHAP concentrations in these units is much higher than the waste stream VOHAP concentrations in the wastewater treatment units. Consequently, even with 99 percent or more removal or destruction efficiencies, the remaining VOHAP concentrations can still exceed the control option's VOHAP concentration action level. As such, it is assumed that tanks downstream of these other units do require controls if the original VOHAP concentration of the waste stream exceeds the selected VOHAP concentration action level.

Tank control options requiring additional control devices, (e.g., floating roofs, thermal vapor incinerators, condensers, and carbon adsorbers) are applied subsequent to adding covers for open tanks. All of the additional control devices are assumed to reduce covered tank emissions by 95 percent independent of the surrogate assignment.

The control options for containers include installing leak-tight covers during container storage and employing submerged fill pipes for waste transfer between containers. As emissions are not estimated for container storage, the computer model does not estimate the emission reduction achieved by installing leak-tight covers on containers. The control efficiency for submerged fill during container waste transfer is assumed to be 65 percent for all surrogate assignments.

The HAP removal efficiency of the land disposal pretreatment units are based on the removal efficiency needed to reduce the VOHAP concentration to the selected VOHAP concentration action level. All waste streams managed in land disposal units are already assumed to be treated to comply with the RCRA LDR. However, after the VOHAP concentration of the waste stream is revised to account for the pretreatment unit, some waste streams may still exceed different VOHAP concentration action levels. The emission reduction efficiency of the additional pretreatment unit and land disposal unit is assumed to be equivalent to the HAP removal efficiency required to meet the control option action level, but is limited to (i.e., cannot exceed) 95 percent.

An LDAR program equivalent to the requirements of the RCRA Subpart BB standard (except for the waste stream concentration action level) is assumed to achieve a 70 percent emission reduction for aqueous Surrogate 1; a 75 percent emission reduction for organic Surrogates 1, 2, and 3; and zero reduction for all other surrogate assignments. The emission reduction achieved by an LDAR program equivalent to the requirements of the NSPS standard is assumed to be 88 percent for aqueous Surrogate 1 and organic Surrogates 1, 2, and 3, and it is assumed to be zero for all other surrogate assignments. Note, the control efficiencies of LDAR programs are not additive. If a RCRA LDAR program is already assumed to be in place to comply with the RCRA Subpart BB standard (as in the baseline assumption), implementing an LDAR program equivalent to the requirements of the NSPS standard only produces a net emission reduction from baseline of 50 to 60 percent, so that the overall equipment leak emission reduction from an uncontrolled state would be 88 percent.

## B.8 CONCENTRATION ADJUSTMENTS FOR SEQUENTIAL UNITS

The organic HAP concentrations in the waste stream are updated following each model waste management unit configuration according to the HAP emissions from that process. When emission controls are employed with the waste management unit, the controls are classified as either a suppression control or a reduction control. Suppression controls inhibit the volatilization of the organic compounds in the waste and include: submerged fill for container waste transfer; adding a fixed roof or floating roof to a tank; or implementing a leak detection and repair program for equipment leaks. Reduction controls remove or destroy organic compounds in the waste and include: flares; thermal incinerators; condensers; and carbon adsorption systems. For suppression controls, only the amount of HAP emitted from the controlled unit is used to calculate the reduction in HAP concentration. For reduction control, the amount of HAP that would have been emitted from the unit if no controls were in-place is used to calculate the reduction in HAP concentration (i.e., the HAPs are still released from the waste, but they are collected or destroyed rather than released to the atmosphere).

The HAP concentration entering the next waste management unit configuration is also adjusted after processes that would typically destroy or remove organic HAPs from waste stream. Specifically, for thermal incinerators, reuse as fuel processes, and solvent recovery units, it is assumed that 90 percent of the organic HAPs are removed from the waste stream when updating the HAP concentrations for subsequent waste management units.

## B.8 REFERENCES

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17. Code of Federal Regulations. Title 40, Part 261.340. National Emission Standards for Hazardous Air Pollutants for Benzene Waste Operations. U.S. Government Printing Office. Washington, D.C. July 1, 1992.

18. Reference 10.

19. Reference 2.

20. Reference 1.

# APPENDIX C

# OTHER ENVIRONMENTAL AND ENERGY IMPACTS ESTIMATE METHODOLOGY

This appendix provides a description of the methodology used to estimate the environmental impacts other than organic emissions reduction and the energy impacts associated with the control options selected in Chapter 5 of this document for the off-site waste operations source category. Other environmental and energy impacts were estimated for two tank control options (Option T2 and T3) and the land disposal unit control option (Option LD1). As discussed in section 6.1 of this document, the EPA expects that implementation of all of the container control options (Options C1 and C2) and equipment leak control options (Options E1 and E2) will reduce organic emissions with essentially no other environmental or energy impacts. Because all process vents in the computer model data base are assumed at baseline to already be vented to existing control devices for compliance with the RCRA air standards for TSDF process vents, no additional other environmental or energy impacts were estimated for the process vent control option (Option PV1).

## C.1 WASTE QUANTITY ESTIMATES FOR CONTROL OPTIONS

To estimate the other environmental and energy impacts for a given control option, the quantity of off-site waste material that is managed in waste operation units that require controls due to each control option must first be calculated. These quantities are calculated on a waste stream specific basis by the computer model for each waste management model unit when estimating the organic HAP emissions for each control option. Table C-1 presents the annual quantity of waste material that is managed in the different waste management model units that are required to apply a "95 percent control device" for the tank control options (Options T2 and T3) and the annual quantity of waste material that is treated prior to land disposal to comply with the land disposal control option (Option LD1).

Tanks are used for a wide variety of waste management processes. Consequently, the control device appropriate for a given tank is dependent on: 1) the type of tank (storage or treatment; quiescent or aerated); and 2) the form of the waste material itself (aqueous or organic; sludge, solid or liquid). For example, floating roofs can be used for storage tanks, but only external control devices can be used for mixing tanks or waste fixation tanks. Additionally, some applications of carbon adsorption for organic emission control may allow the use of carbon canisters system. A specific combination or "mix" of control devices has been previously assumed in the development of the control cost factors for each type of waste management unit.[1] This same "mix" of control devices, as applied to each type of waste management model unit, is used in the calculation to estimate the other environmental and energy impacts. Table C-2 summarizes the "mix" of control devices (Table C-2a) and pretreatment units (Table C-2b) that are applied for each of the waste management model units listed in Table C-1. As previously discussed, there are no other environmental or energy impacts associated with floating roofs employed to comply with the 95 percent control device requirement.

For the land disposal control option (Option LD1), the other environmental and energy impacts are caused by the operation of the additional treatment unit used treat the waste stream prior to land disposal. The type of treatment unit used to treat this waste stream depends primarily on the

TABLE C-1. QUANTITY OF WASTE MATERIAL MANAGED IN CONTROLLED UNITS

| Emission Source (Model Unit) | Total Annual Waste Throughput in Controlled Units (Mg/yr) | | |
|---|---|---|---|
| | Option T2[a] | Option T3[a] | Option LD1[b] |
| Single storage tanks (QOST/CST) | 70,825 | 90,450 | 0 |
| Series of storage tanks (2*CST) | 1,083,813 | 1,736,067 | 0 |
| Quiescent treatment tank (QOTT & CTT) | 425,951 | 1,234,631 | 0 |
| Aerated treatment tank (ATT1 & ATT2) | 73,126 | 216,773 | 0 |
| Fixation tank (ATT1) | 52,681 | 69,632 | 0 |
| Land disposal unit | 0 | 0 | 168,604 |

(a) Tank control options T2 and T3 require covering tanks and venting to a 95% efficient control device or similar performing control technique (e.g., use of floating roof) if the organic HAP vapor pressure ≥ 0.75 psia and ≥ 0.1 psia, respectively.

(b) Land disposal control option LD1 requires treatment of waste streams to reduce the volatile organic HAP concentration to below 100 ppmw prior to land disposal.

TABLE C-2a. PROPORTIONAL USE OF CONTROL DEVICES FOR TANKS

| Emission Source (Model Unit) | % of Waste Throughput Controlled by Control Device | | | |
|---|---|---|---|---|
| | Floating roof | Fixed-bed carbon adsorber | Carbon canister | Vapor incin-erator |
| Single storage tank (QOST/CST) | 50 | 8.5 | 16.5 | 25 |
| Series of storage tanks (2*CST) | 50 | 16.8 | 8.2 | 25 |
| Quiescent treatment tank (QOTT & CTT) | 50 | 24 | 1.0 | 25 |
| Aerated treatment tank (ATT1 & ATT2) | 0 | 100 | 0 | 0 |
| Fixation tank (ATT1) | 0 | 100 | 0 | 0 |

TABLE C-2b. PROPORTIONAL USE OF PRETREATMENT FOR LAND DISPOSAL

| Emission Source (Model Unit) | % of Waste Throughput Pretreated using Treatment Unit | |
|---|---|---|
| | Thin-film evaporator | Solids incinerator |
| Land disposal pretreatment | 50 | 50 |

characteristics of the waste material, but may be influenced by the types of treatment units that already exist at the facility. For this analysis, it is assumed that 50 percent of the waste material is treated using a thin-film evaporator and 50 percent of the waste material is treated in an incinerator to remove the organic HAP (see Table C-2b).

## C.2 CONTROL DEVICE OPERATION FACTORS

The control device operation factors for the waste management model units and the pretreatment units are summarized in Table C-3. Many of these factors were developed for the RCRA TSDF air rules.[2] Control device operation factors for vapor incineration were developed and documented in a technical report prepared for the EPA.[3]

Multiplying the quantity of waste material managed in controlled units for a given control option (see Table C-1) by the proportional use factors in Table C-2 and the control device operation factors in Table C-3, yields the annual amount of electricity and steam needed to operate the control devices, the annual quantity of vapor incinerated, and annual quantity of spent carbon generated for that control option/waste management model unit combination. These annual control device operation values are then summed for each of the waste management model units for a given control option to yield the total annual control device operation values. Table C-4 provides a summary of the calculation methodology and the intermediate results in calculating the total annual control device operation quantity for tank control Option T3. Table C-5 summarizes the total annual control device operation values for each of the three control options that have appreciable other environmental and energy impacts.

## C.3 IMPACT FACTORS

Other environmental and energy impacts from applying the control options are produced primarily from the generation of electricity and steam required to operate the control devices (i.e., the control device operation values reported in

TABLE C-3. CONTROL DEVICE OPERATION FACTORS

| Emission Source/ Control Strategy | Control Device Operation Factor (unit per Mg of waste material throughput) | | | | |
|---|---|---|---|---|---|
| | Electricity Demand (Kwh) | Steam Demand (kg of steam) | Vapor Incineration ($m^3$ of vapor) | Fixed-Bed Spent Carbon (kg of carbon) | Canister Spent Carbon (kg of carbon) |
| Single storage tank | 0.01 | 10 | 23 | 0.01 | 1.1 |
| Series of storage tanks[a] | 0.02 | 20 | 46 | 0.02 | 2.2 |
| Quiescent treatment tank | 0.14 | 10 | 9 | 0.01 | 0.3 |
| Aerated treatment tank | 0.2 | 10 | 0 | 0.01 | 0 |
| Waste fixation | 2.6 | 11.2 | 0 | 0.1 | 0 |
| Thin-film evaporation | 30 | 307 | 0 | 0 | 0 |
| Incineration | 303 | 0 | 0 | 0 | 0 |

(a) Control device operation factors for series of two covered storage tanks calculated as: 2 x the control device operation factor for single storage tank.

TABLE C-4. CALCULATION METHODOLOGY FOR ANNUAL CONTROL DEVICE OPERATION VALUES

| Emission Source/ Control Strategy | (A) Annual Waste Throughput (Mg/yr) | Annual Electricity Demand[a] (MWh/yr) | Annual Steam Demand[b] (Mg/yr) | Annual Vapor Incineration[c] ($m^3$/yr) | Annual Fixed-Bed Spent Carbon[d] (Mg/yr) | Annual Canister Spent Carbon[e] (Mg/yr) |
|---|---|---|---|---|---|---|
| Single storage tank | 90,450 | 0 | 77 | 520,088 | 0 | 16 |
| Series of storage tanks | 1,736,067 | 17 | 5,816 | 19,964,770 | 6 | 315 |
| Quiescent trtmnt tank | 1,234,631 | 87 | 2,995 | 2,777,920 | 3 | 3 |
| Aerated treatment tank | 216,773 | 43 | 2,168 | 0 | 2 | 0 |
| Waste fixation | 69,632 | 182 | 780 | 0 | 7 | 0 |
| Thin-film evaporation | 0[f] | 0 | 0 | 0 | 0 | 0 |
| Incineration | 0[f] | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 3,347,553 | 329 | 11,834 | 23,232,778 | 18 | 334 |

(a) A × [1 - (%floating roof/100)](Table C-2) × Electricity demand factor(Table C-3) ÷ 1000 (i.e., the electricity demand factor applies to all control devices except floating roofs)
(b) A × [(%fixed-bed + %steam stripping)/100](Table C-2) × Steam demand factor(Table C-3) ÷ 1000
(c) A × [%vapor incineration/100](Table C-2) × Vapor incineration factor(Table C-3)
(d) A × [(%fixed-bed)/100](Table C-2) × Fixed-bed spent carbon demand factor (Table C-3) ÷ 1000
(e) A × [(%carbon canister)/100](Table C-2) × Canister spent carbon demand factor(Table C-3) ÷ 1000
(f) A = Quantity waste material treated prior to land disposal (Table C-1) × 0.5 (Table C-2b)

TABLE C-5.  SUMMARY OF ANNUAL CONTROL DEVICE OPERATION VALUES

| Control Option | Annual Electricity Demand (MWh/yr) | Annual Steam Demand (Mg/yr) | Annual Vapor Incineration ($m^3$/yr) | Annual Fixed-Bed Spent Carbon (Mg/yr) | Annual Canister Spent Carbon (Mg/yr) |
|---|---|---|---|---|---|
| T2 | 193 | 6,045 | 13,829,484 | 11 | 211 |
| T3 | 329 | 11,834 | 23,232,779 | 18 | 334 |
| LD1 | 28,073 | 25,881 | 0 | 0 | 0 |

Table C-5). Certain secondary air pollutant emissions and other environmental and energy impacts that occur from the generation of electricity and steam are greatly affected by: 1) the type of fuel used in the boiler to produce steam (e.g., natural gas versus fuel oil); and 2) the type of power plant generating the electricity supplied to the facility (e.g. coal-fired, nuclear or hydroelectric). Similarly, the method selected by a facility owner or operator to manage spent activated carbon generated by a carbon adsorption emission control device affects the other environmental and energy impacts. Consequently, upper and lower boundary estimates for the other environmental and energy impacts were developed using scenarios of differing fuel sources and spent activated carbon management methods to estimate the potential range of other environmental and energy impacts. The boundary assumptions used for this analysis are presented in Table C-6.

The assumptions summarized in Table C-6 are the same boundary assumptions used to estimate the other environmental and energy impacts for the RCRA air rules; consequently, the other environmental and energy impact factors used for this analysis are the same as those reported in the Hazardous Waste TSDF BID.[4] These other environmental and energy impact factors were developed using fuel property and emission factor values selected from the EPA document AP-42.[5] Table C-7 presents a summary of these other environmental and energy impact factors.

## C.4 OTHER ENVIRONMENTAL AND ENERGY IMPACT ESTIMATES

The other impact environmental and energy impact factors in Table C-7 multiplied by the control device operating values in Table C-4 yield an estimate of the other environmental and energy impacts for each of the control options selected for model analysis that have appreciable other environmental and energy impacts. Table C-8 presents the calculation results for the other environmental and energy impacts using the lower boundary conditions. Table C-9 presents the calculation

TABLE C-6. CONTROL DEVICE OPERATING CONDITIONS USED FOR BOUNDARY ASSUMPTIONS

| Control Device Operating Condition | Lower Boundary Assumption | Upper Boundary Assumption |
|---|---|---|
| Electric utility power plant mix | 50% coal<br>25% natural gas<br>25% noncombustion | 100% coal |
| Steam boiler fuel | 100% natural gas | 100% fuel oil |
| Carbon regeneration yield | 90% yield | 80% yield |
| Spent carbon canister management practice | 100% regenerated | 100% direct landfill disposal |

TABLE C-7. IMPACT FACTORS FOR CONTROL DEVICE OPERATION VALUES

| Control Device Operation Parameter (units) | Boundary Level Estimate | Secondary Air Impact Factors | | | | Energy Impact Factor (MJ) |
|---|---|---|---|---|---|---|
| | | CO Emissions (Mg) | NOx Emissions (Mg) | SOx Emissions (Mg) | Particulate Emissions (Mg) | |
| Electricity Demand (MWh) | Lower | 1.0E-4 | 1.6E-3 | 1.1E-3 | 7.4E-5 | 8.2 |
| | Upper | 1.1E-4 | 2.9E-3 | 2.3E-3 | 1.4E-4 | 11 |
| Steam Demand (Mg) | Lower | 4.4E-5 | 1.8E-4 | 8.0E-7 | 4.0E-6 | 3.0 |
| | Upper | 4.7E-5 | 1.9E-4 | 8.1E-4 | 1.9E-5 | 3.0 |
| Vapor Incineration ($m^3$) | Lower | 0 | 1.5E-5 | 0 | 0 | 0 |
| | Upper | 0 | 3.7E-4 | 0 | 0 | 0.38 |
| Fixed-Bed Spent Carbon (Mg) | Lower | 0 | 0 | 0 | 0 | 0 |
| | Upper | 0 | 0 | 0 | 0 | 0 |
| Canister Spent Carbon (Mg) | Lower | 0 | 0 | 0 | 0 | 0 |
| | Upper | 0 | 0 | 0 | 0 | 0 |

(Continued)

TABLE C-7. (Concluded)

| Control Device Operation Parameter (units) | Boundary Level Estimate | Water Impact Factors | | | Solid Waste Impact Factors | | |
|---|---|---|---|---|---|---|---|
| | | Power Plant Effluent ($10^3$ $m^3$) | Carbon Regen. Effluent ($10^3$ $m^3$) | Incin. Scrubber Effluent ($10^3$ $m^3$) | Flyash & Bottom Ash (Mg) | Scrubber Sludge (Mg) | Spent Carbon (Mg) |
| Electricity Demand (MWh) | Lower | 5.9E-5 | 0 | 0 | 0.022 | 0.035 | 0 |
| | Upper | 1.2E-4 | 0 | 0 | 0.044 | 0.070 | 0 |
| Steam Demand (Mg) | Lower | 0 | 0 | 0 | 0 | 0 | 0 |
| | Upper | 0 | 0 | 0 | 0 | 0 | 0 |
| Vapor Incineration ($m^3$) | Lower | 0 | 0 | 0 | 0 | 0 | 0 |
| | Upper | 0 | 0 | 1.4 | 0 | 0 | 0 |
| Fixed-Bed Spent Carbon (Mg) | Lower | 0 | 1.4E-3 | 0 | 0 | 0 | 0.1 |
| | Upper | 0 | 1.4E-3 | 0 | 0 | 0 | 0.2 |
| Canister Spent Carbon (Mg) | Lower | 0 | 1.4E-3 | 0 | 0 | 0 | 0.1 |
| | Upper | 0 | 0 | 0 | 0 | 0 | 1.0 |

TABLE C-8. CALCULATION RESULTS FOR LOWER BOUNDARY OTHER ENVIRONMENTAL AND ENERGY IMPACTS

| Lower Boundary Impacts | Control Option | | |
|---|---|---|---|
| | T2 | T3 | LD1 |
| Secondary Air Impacts, Mg/yr | | | |
| CO emissions | 0.3 | 0.6 | 4 |
| NOx emissions | 1.6 | 3.0 | 50 |
| SOx emissions | 0.2 | 0.4 | 31 |
| Particulate emissions | 0.0 | 0.0 | 2 |
| Water Impacts, 1,000 $m^3$/yr | | | |
| Power plant effluent | 0 | 0 | 1.7 |
| Carbon regeneration effluent | 0.3 | 0.5 | 0 |
| Incineration scrubber effluent | 0 | 0 | 0 |
| Total Wastewater | 0.3 | 0.5 | 1.7 |
| Solid Waste Impacts, Mg/yr | | | |
| Power plant fly & bottom ash | 4 | 7 | 620 |
| Power plant scrubber sludge | 7 | 12 | 980 |
| Spent Carbon | 22 | 35 | 0 |
| Total Solid Waste | 33 | 54 | 1,600 |
| Energy Impact, 1,000 MJ/yr | | | |
| Total energy consumption | 20 | 38 | 310 |

TABLE C-9. CALCULATION RESULTS FOR UPPER BOUNDARY NATIONWIDE OTHER ENVIRONMENTAL AND ENERGY IMPACTS

| Upper Boundary Impacts | Control Option | | |
|---|---|---|---|
| | T2 | T3 | LD1 |
| Secondary Air Impacts, Mg/yr | | | |
| CO emissions | 0.3 | 0.6 | 4 |
| NOx emissions | 7 | 12 | 86 |
| SOx emissions | 5 | 10 | 83 |
| Particulate emissions | 0.1 | 0.3 | 4 |
| Water Impacts, 1,000 $m^3$/yr | | | |
| Power plant effluent | 0 | 0 | 3.4 |
| Carbon regeneration effluent | 0 | 0 | 0 |
| Incineration scrubber effluent | 19 | 33 | 0 |
| Total Wastewater | 19 | 33 | 3.4 |
| Solid Waste Impacts, Mg/yr | | | |
| Power plant fly & bottom ash | 8 | 14 | 1,240 |
| Power plant scrubber sludge | 14 | 23 | 1,960 |
| Spent Carbon | 213 | 338 | 0 |
| Total Solid Waste | 235 | 375 | 3,200 |
| Energy Impact, 1,000 MJ/yr | | | |
| Total energy consumption | 5,300 | 8,900 | 400 |

results for the other environmental and energy impacts using the upper boundary conditions.

## C.5 REFERENCES


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2. Reference 4.

3. Research Triangle Institute. Vapor Incineration: Cross-Media Environmental and Energy Impact Estimates. Technical Note prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. EPA Contract No. 68-02-4326, July 7, 1988.

4. Reference 4.

5. U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, 4th Edition. AP-42, September 1985.

# APPENDIX D

# CONTROL COST ESTIMATION METHODOLOGY

This appendix provides a description of the methodology used to estimate the costs associated with the control options selected in Chapter 5 of this document for the off-site waste operations source category.

## D.1 AIR EMISSION CONTROL COSTS

A computer model was developed to estimate the emission of organic hazardous air pollutants (organic HAP) from the management of hazardous waste materials at treatment, storage, and disposal facilities (TSDF) nationwide subject to regulation under RCRA subtitle C that receive waste from off-site generators (refer to Appendix B of this document). This computer model also calculates the costs associated with the installation and operation of the organic HAP emission controls required by each emission point type control option. Three different costs parameters are calculated for each control option: 1) total capital investment (TCI); 2) annual operating cost (AOC); and 3) total annual cost (TAC).

The TCI is the total of the costs required to purchase the equipment needed for the control system, costs of labor and materials for installing that equipment, costs for site preparation and buildings, contractor fees, field expenses, start-up and performance test costs, and contingencies. The AOC is the direct and indirect operating costs incurred while operating the control system. Direct operating costs include costs for raw materials, utilities (steam, water, electricity), waste treatment and disposal, maintenance materials, and operating, maintenance and supervisory labor. Indirect operating costs include costs for overhead, administration, property taxes, and insurance. The AOC also includes any recovery credits for materials or energy recovered by the control system which can be sold or reused at the site.

The total annual cost (TAC) is the AOC plus capital recovery costs. The TAC is calculated from the TCI, the AOC, the equipment life (n) and the annual interest rate (i) using the following equation:

$$TAC = AOC + CRF \times TCI \qquad (D.1)$$

where:

$CRF$ = capital recovery factor = $i(1+i)^n/[(1+i)^n-1]$.

All total annual costs are calculated based on a 7 percent interest rate (i = 0.07) to annualize the capital investments.

## D.2 OVERVIEW OF COST ESTIMATION METHODOLOGY

In the computer model, the total capital investment and the annual operating costs for a control device are calculated using control cost factors developed for a specific control option. Actual TCI and AOC for an organic HAP emission control technique were first calculated using the methods outlined in the OAQPS Control Cost Manual[6] for various waste throughput (or equipment size) and different waste characteristics. These costs were then proportioned for the waste throughput (or size) distribution of a waste management model unit to develop control cost factors for each control option.

This methodology has been used previously by the EPA for the development of control cost factors used for the TSDF RCRA air standards project.[7] Control cost factors developed for the TSDF RCRA air standards project were available for the control options for the following emission point types: tanks (both wastewater and non-wastewater tanks); containers;

process vents; and equipment leaks. No control cost factors were available for the land disposal emission point type control option. Section D.3 provides the derivation of the control cost factors used by the computer model to estimate the control costs for pretreating waste material prior to land disposal (following the general methodology used to develop the control cost factors used for the TSDF RCRA air standards project).

## D.3 EXAMPLE COST FACTOR DERIVATION FOR LAND DISPOSAL UNITS

The methodology used to develop cost factors for a given emission point type control option requires: 1) a size distribution of the population for which costs are being estimated; and 2) representative control costs for each size class. One control option considered for land disposal units is the use of a pretreatment process to remove the organic HAP from the waste stream prior to management in open land disposal units. Pretreatment processes potentially applicable to remove volatile organic HAP from off-site waste material include: steam stripping; air stripping; thin-film evaporation; distillation; and incineration. For this control option, "size distribution of the population" is based on the annual quantity of off-site waste material managed in landfills, and the "representative control costs" are based on control costs associated with the installation and operation of a steam stripper. Control costs for steam stripping are used because: 1) control cost equations based on the quantity of waste material processed are available for steam stripping; 2) similar control cost equations are not readily available for other preatreatment processes; 3) the complexity of the different pretreatment process equipment is relatively comparable, and therefore, the equipment and operating costs are assumed to be comparable.

The distribution of facilities that manage off-site waste materials in landfills was determined from data reported in the TSDR Survey.[8] Of 710 facilities that receive waste from offsite, 63 facilities were identified that have landfills, but only 44 facilities were identified that have landfills that specifically manage waste materials received from offsite. The annual quantity of off-site waste material processed by these landfills was used to define four size classes representative of the land disposal units operated at TSDF. The number of facilities that operate landfills that manage offsite waste materials for each of the size class, based on data reported in the TSDR Survey, was used to calculate size class distribution factors. The results of this distribution analysis are summarized in Table D-1.

The control costs for steam stripping pretreatment were calculated for each quantity range based on equations reported in the draft Industrial Wastewater CTG for the total capital investment (TCI) and the total annual cost (TAC) for steam strippers.[9] However, a similar equation for calculating the annual operating cost (AOC) was not reported. The capital recovery factor used in the draft Industrial Wastewater CTG was 0.1315 (i.e., it was based on a 10 percent interest rate and a 15 year equipment life).[10] Therefore, an equation to estimate the annual operating cost (AOC) was developed from the equations reported for total capital developed from the equations reported for total capital investment (TCI) and total annual costs (TAC) as follows:

$$AOC = TAC - 0.1315 \times TCI. \qquad (D.2)$$

The control cost equations provided in the draft Industrial Wastewater CTG were reported in July 1989 dollars. However, all of the other cost factors used in the computer model were developed in January 1986 dollars. Therefore, it was convenient for modeling purposes to adjust the control cost equations reported in the draft Industrial Wastewater CTG to January 1986 dollars. The escalation factor for converting the cost equations reported in July 1989 dollars to January 1986 dollars was calculated using the Chemical Engineering composite plant index values.[11] The composite index value for

TABLE D-1. FACILITY DISTRIBUTION BASED ON THE QUANTITY OF HAZARDOUS WASTE MATERIAL RECEIVED FROM OFF-SITE FOR LAND DISPOSAL IN A LANDFILL[a]

| Distribution Size Class | Wastewater Quantity (Q) Range (tpy) | Representative Q (tpy) | No. of Facilities in Size Class | Distribution Factor |
|---|---|---|---|---|
| Very Small | $0 < Q \leq 10{,}000$ | 10,000 | 21 | 0.477 |
| Small | $10{,}000 < Q \leq 50{,}000$ | 22,000 | 11 | 0.250 |
| Medium | $50{,}000 < Q \leq 200{,}000$ | 100,000 | 9 | 0.205 |
| Large | $Q > 200{,}000$ | 447,000 | 3 | 0.068 |

[a]Facility distribution obtained from data reported in the TSDR Survey.[12]

July 1989 is 356.0; the composite index value for January 1986 is 323.5. Therefore, the cost equations in July 1989 dollars were converted to January 1986 dollars by dividing the July 1989 cost equations by the escalation factor of 1.10 (356/323.5).

Finally, the control cost equations, as reported in the draft Industrial Wastewater CTG, were modified to calculate the control costs as a function of the annual waste quantity, Q, in tons per year (tpy) by assuming the density of the waste material to be 1 kg/liter and that the pretreatment process would run 24 hours/day × 300 days/year or 7,200 hrs/yr (this is the annual operating hours used in developing the control cost equations reported in the draft Industrial Wastewater CTG). The resulting equations used to calculate the control costs for steam stripping follow.

$$AOC(\text{Jan. 1986 \$/yr}) = 37{,}550 + 1.010 \times Q(\text{tpy}) \quad (D.3)$$

$$TCI(\text{Jan. 1986 \$}) = 217{,}860 + 1.601 \times Q(\text{tpy}) \quad (D.4)$$

The control cost equations reported in the draft Industrial Wastewater CTG were developed for continuous steam stripper systems with wastewater flow rates ranging from 10 to 200 gpm (this corresponds to annual waste quantities of 22,000 to 440,000 tpy).[13] However, there were a significant number of facilities (48 percent) that had annual quantities of off-site waste material of less than 10,000 tpy (i.e, more than a factor of 2 less than the low end of the quantity range for which the control cost equations were developed). Efforts were made to develop an alternative methodology to estimate the control cost factors for the lowest waste quantity range listed in Table D-1 (Range 1). For example, batch processing of wastewater in steam strippers, which may be more appropriate these low flow rate systems, was investigated. Unfortunately, the draft Industrial Wastewater CTG only briefly discussed batch steam strippers, and it provided no cost equations for them.[14] Instead, it was assumed that the steam stripper used for lowest waste quantity range was operated 12 hours/day × 5 days/week × 50 weeks/year, or 3,000 hrs/yr. Using this assumption, the steam stripper is basically designed for approximately 2 times the average annual flow rate (7,200 hrs/yr versus 3,000 hrs/yr). Consequently, for waste quantity Range 1, the basic control cost equation for TCI (Equation D.4) was revised based on 3,000 annual operating hours as follows:

$$TCI(\text{Jan. 1986 \$}) = 217{,}860 + 3.842 \times Q(\text{tpy}) \qquad (D.5)$$

A representative annual waste quantity of 10,000 tpy was selected for Range 1 because it was closest to the quantity range for which the control cost equations were developed. Equation D.4 was used to estimate the TCI control costs for waste quantity Ranges 2, 3 and 4; Equation D.5 was used to estimate the TCI control costs for waste quantity Range 1.

Although there are increased operating costs during operation for the larger steam stripper and waste material throughput for Range 1, these costs are offset by the reduced total operating hours. That is, the annual operating costs are expected to remain constant with the average annual throughput. Consequently, Equation D.3 was used to estimate the annual operating costs for all waste quantity ranges.

Tables D-2 and D-3 illustrate the derivation of the overall TCI and AOC cost factors that were developed for steam stripping as a pretreatment control device used to remove volatile organic HAPs from waste materials prior to land disposal. Consistent with the Industrial Wastewater CTG, the equipment life for the steam stripper was assumed to be 15 years.[15]

## D.4 SUMMARY OF COST FACTORS USED FOR MODEL ANALYSIS

Using this methodology, overall control cost factors were developed to estimate the costs of applying controls to the tanks, containers, land disposal units, process vents, and

TABLE D-2. STEAM STRIPPER TOTAL CAPITAL INVESTMENT (TCI) COST FACTORS

| Size Class Number | Rep. Q (Mg/yr) | TCI ($/yr) | $/Mg | Distribution Factor | TCI Cost Factor ($/Mg) |
|---|---|---|---|---|---|
| 1 | 9,090 | 256,300[a] | 28.20 | 0.477 | 13.45 |
| 2 | 20,400 | 253,100[b] | 12.41 | 0.250 | 3.10 |
| 3 | 90,900 | 378,000[b] | 4.16 | 0.205 | 0.85 |
| 4 | 406,000 | 933,500[b] | 2.30 | 0.068 | 0.16 |
| | | | | Overall TCI Cost Factor: | $17.56/Mg |

[a]Calculated using Equation D.5

[b]Calculated using Equation D.4

TABLE D-3. STEAM STRIPPER ANNUAL OPERATING COST (AOC) COST FACTORS

| Size Class Number | Rep. Q (Mg/yr) | AOC ($/yr) | $/Mg | Distribution Factor | AOC Cost Factor ($/Mg) |
|---|---|---|---|---|---|
| 1 | 9,090 | 47,600[a] | 5.24 | 0.477 | 2.50 |
| 2 | 20,400 | 59,800[a] | 2.93 | 0.250 | 0.73 |
| 3 | 90,900 | 138,600[a] | 1.52 | 0.205 | 0.31 |
| 4 | 406,000 | 489,000[a] | 1.20 | 0.068 | 0.08 |
| | | | | Overall AOC Cost Factor: | $3.62/Mg |

[a]Calculated using Equation D.3

equipment leaks emission point types.[16] Different cost factors were developed for each of the different waste management model units used in the computer model (refer to Appendix B for further information regarding the waste management model units) based on the "form" of the waste stream [i.e., 1) VOC-containing solids; 2) aqueous sludges and slurries; 3) dilute aqueous mixtures; 4) organic liquids; 5) organic sludges and solids; and 6) other mixtures (includes 2-phase organic/aqueous mixtures)]. Waste form codes were assigned according to the waste description code reported for the waste stream.[17]

In the previous example for the development of cost factors for control options based on pretreatment using steam stripping, the control costs are largely driven by the amount of steam required to heat the waste material. As the heat capacity of the different waste forms that are typiclly managed in land disposal units are expected to be similar, the cost factors presented in Tables D-2 and D-3 were used for all waste forms. However, some control costs do vary with the form of waste processed in the waste management model unit. Table D-4 presents the overall control cost factors that are used as input to the computer model for each emission point type, waste management model unit control option, and waste form.

## D.5 CALCULATION OF CONTROL COSTS

The control costs are calculated by the computer model at the same time organic HAP emissions are calculated. Therefore, as with the emission calculations, the control costs are calculated on an emission point type, waste stream, and waste management unit-specific basis. At this lowest level, the control costs are escalated to mid-1991 (July 1991) dollars. As all the control cost factors are in January 1986 dollars, a single escalation factor is used to inflate the control costs to mid-1991 dollars. The Chemical Engineering composite plant index value for July 1991 is 362.8; the

TABLE D-4. SUMMARY OF COST FACTORS USED IN MODEL ANALYSIS[a]

| Emission point type - Waste Management Model Unit Control Option[b] | Waste Form[c] | TCI Cost Factor ($/Mg) | AOC Cost Factor ($/Mg) | Equip. Life (yr) |
|---|---|---|---|---|
| Tanks | | | | |
| Fixed-roof for QOST | 2 | 14.66 | 1.07 | 20 |
| Fixed-roof for QOST | 3 | 18.47 | 1.36 | 20 |
| 95% CD for QOST | 2 | 20.98 | 3.98 | 10 |
| 95% CD for QOST | 3 | 27.66 | 10.50 | 10 |
| 95% CD for CST | 1 | 9.74 | 3.29 | 10 |
| 95% CD for CST | 4 | 12.36 | 4.72 | 10 |
| 95% CD for CST | 5 | 11.08 | 5.71 | 10 |
| 95% CD for CST | 6 | 10.74 | 4.78 | 10 |
| 95% CD for 2*CST | 1 | 14.47[d] | 3.50[d] | 10 |
| 95% CD for 2*CST | 2 | 14.47[d] | 3.50[d] | 10 |
| 95% CD for 2*CST | 3 | 19.07[d] | 9.70[d] | 10 |
| 95% CD for 2*CST | 4 | 18.32[d] | 4.98[d] | 10 |
| 95% CD for 2*CST | 5 | 16.02[d] | 5.93[d] | 10 |
| 95% CD for 2*CST | 6 | 15.80[d] | 5.00[d] | 10 |
| 95% CD for CTT | 1 | 0.22 | 0.10 | 10 |
| 95% CD for CTT | 2 | 0.22 | 0.10 | 10 |
| 95% CD for CTT | 3 | 0.82 | 0.37 | 10 |
| 95% CD for CTT | 4 | 0.36 | 0.25 | 10 |
| 95% CD for CTT | 5 | 0.36 | 0.27 | 10 |
| 95% CD for CTT | 6 | 0.80 | 0.36 | 10 |
| Fixed-roof for ATT1 | all | 0.39 | 0.032 | 20 |
| 95% CD for ATT1(non-fixation) | all | 0.42 | 0.30 | 10 |
| 95% CD for ATT1(fixation) | all | 12.03 | 3.72 | 20 |
| Fixed-roof for QOTT | all | 0.39 | 0.032 | 20 |

TABLE D-4. SUMMARY OF COST FACTORS USED IN MODEL ANALYSIS[a]

| Emission point type - Waste Management Model Unit Control Option[b] | Waste Form[c] | TCI Cost Factor ($/Mg) | AOC Cost Factor ($/Mg) | Equip. Life (yr) |
|---|---|---|---|---|
| 95% CD for QOTT | 1 | 0.57 | 0.13 | 10 |
| 95% CD for QOTT | 2 | 0.57 | 0.13 | 10 |
| 95% CD for QOTT | 3 | 1.16 | 0.39 | 10 |
| 95% CD for QOTT | 4 | 0.71 | 0.28 | 10 |
| 95% CD for QOTT | 5 | 0.80 | 0.30 | 10 |
| 95% CD for QOTT | 6 | 1.16 | 0.39 | 10 |
| Containers | | | | |
| Submerged fill | 1 | 0.75 | 0.04 | 15 |
| Submerged fill | 2 | 0.75 | 0.04 | 15 |
| Submerged fill | 3 | 0.92 | 0.05 | 15 |
| Submerged fill | 4 | 0.94 | 0.05 | 15 |
| Submerged fill | 5 | 0.78 | 0.04 | 15 |
| Submerged fill | 6 | 0.79 | 0.04 | 15 |
| Land Disposal | | | | |
| Pretreatment[e] | all | 17.56 | 3.62 | 15 |
| Process Vents | | | | |
| 95% CD for process vents | all | 25.90 | 9.38 | 10 |
| Equipment Leaks[f] | | | | |
| LDAR program for QOST | all | 1.28 | 0.34 | 10 |
| LDAR program for CST | all | 1.28 | 0.34 | 10 |
| LDAR program for 2*CST | all | 2.56[g] | 0.67[g] | 10 |
| LDAR program for CTT | all | 0.083 | 0.022 | 10 |
| LDAR program for ATT1(fix) | all | 0.016 | 0.004 | 10 |
| LDAR program for QOTT | all | 0.083 | 0.022 | 10 |
| LDAR program for ATT1&2 | all | 0.016 | 0.004 | 10 |

TABLE D-4. SUMMARY OF COST FACTORS USED IN MODEL ANALYSIS[a]

| Emission point type - Waste Management Model Unit Control Option[b] | Waste Form[c] | TCI Cost Factor ($/Mg) | AOC Cost Factor ($/Mg) | Equip. Life (yr) |
|---|---|---|---|---|
| LDAR program for SI | all | 0.011 | 0.003 | 10 |
| LDAR program for containers | all | 3.57 | 0.94 | 10 |

NOTES:

[a] All cost factors are in January 1986 dollars.

[b] Legend for waste management model unit control options:

QOST = quiescent open storage tank
CST = covered storage tank
2*CST = series of two covered storage tanks
CTT = covered treatment tank
ATT1(fix) = waste fixation "aerated" treatment tank
LDAR = leak detection and repair
QOTT = quiescent open treatment tank
ATT1&2 = aerated treatment tank (with or without biodegradation)
SI = surface impoundment (storage or treatment)

[c] Key for waste forms:

1 = VOC-containing solids
2 = Aqueous sludge/slurry
3 = Dilute aqueous
4 = Organic liquid
5 = Organic sludge/slurry
6 = Other (2-phase)

[d] Control costs for 2*CST model tanks were calculated as the control costs for a single CST plus the cost of venting a second CST to an existing control device.

TABLE D-4. SUMMARY OF COST FACTORS USED IN MODEL ANALYSIS

NOTES (Continued):

[e] Land disposal pretreatment techniques are expected to vary widely. Assumed total capital investment and annual operating costs of purchasing and operating a pretreatment process are similar to the capital investment and operting cost associated with steam stripping. Therefore, used cost factors developed for steam stripping for all pretreatment processes.

[f] Due to the nature of control costs for equipment leaks, a facility implementing a LDAR program will incur certain costs which are not a function of the quantity of waste (e.g., include a one time purchase of a portable VO meter). Consequently, a facility that has to implement a LDAR program, a fixed TCI of $6,318 is added (one time) to the TCI calculated using the TCI equipment leak cost factor. Additionally, a fixed AOC of $918/yr is added (one time) to the AOC calculated using the AOC equipment leak cost factor.

[g] Control costs for equipment leaks for 2*CST model units were estimated to be twice the equipment leak control costs for a single CST.

composite index value for January 1986 is 323.5.[18] Therefore, the escalation factor of 1.1215 (362.8/323.5). Once the waste stream/waste management unit TCI and AOC are converted to mid-1991 dollars, the TAC is calculated using Equation D.1 using a 7 percent interest rate.

The control costs (TCI, AOC, and TAC) for a given emission point type, waste stream, and process unit is calculated by multiplying the appropriate control cost factor for a given waste management model unit (from Table D-4) times the waste stream quantity and the escalation factor (1.1215). The control costs for that waste stream/process unit are calculated by totalling the individual emission point type control costs. The total control costs for the waste stream is calculated as the sum of the waste stream/process unit control costs for all the waste management model units in which that waste material is managed. The facility control costs are calculated by summing the waste stream control costs for all of the waste streams managed by a given facility. Finally, the facility control costs are totalled for all facilities included in the database to calculate the total control costs used for comparing alternative control options.

The control costs are accounted for in two different ways: 1) by emission point type for direct evaluation of control options; and 2) by process or "service" type for subsequent evaluation of economic impacts. Control costs by emission point type are calculated for six different types: 1) non-wastewater treatment tanks; 2) wastewater treatment tanks; 3) containers; 4) land disposal units; 5) process vents; and 6) equipment leaks. The emission point type control costs are calculated at the emission point type/waste stream/process unit level. Control costs by process type are calculated for 12 different process types (refer to Table D-5). The process type control costs are calculated at the waste stream/process unit level.

TABLE D-5. WASTE MANAGEMENT PROCESS TYPE ASSIGNMENTS

| Process Type | Waste Management Process | Process Code[a] |
|---|---|---|
| 1 | Incineration | 1I-11I,M01 |
| 2 | Reuse as fuel | 1RF-13RF,M02 |
| 3 | Fuel blending | 1FB,M03 |
| 4 | Waste fixation | 1S-7S,M04 |
| 5 | Solvent recovery | 1SR-8SR,M05 |
| 6 | Metals recovery | 1MR-10MR,M06 |
| 7 | Wastewater treatment | 1WT-66WT,M07-M09 |
| 8 | Land disposal | 3ST-5ST,1D-3D,M11-M14 |
| 9 | Underground Injection | 4D,M15 |
| 10 | Other treatment | 1TR,2TR,M10 |
| 11 | Storage/unknown | 1A,2A,1ST,2ST,M18,M19 |
| 12 | Discharge only | M16,M17 |

[a]Process codes as defined and used in the survey database.[19]

## D.6 REFERENCES


6. U.S. Environmental Protection Agency. OAQPS Control Cost Manual, 4th Edition, EPA 450/3-90-006. January 1990.

7. U.S. Environmental Protection Agency. Hazardous Waste TSDF - Background for Proposed RCRA Air Emission Standards. Publication No. EPA-450/3-89-023c. Office of Air Quality Planning and Standards, Research Triangle Park, NC. June 1991. pp. K-1 through K-15.

8. U.S. Environmental Protection Agency. National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities. OMB No. 2050-0070. June 1988. Questions H21c and H21d.

9. U.S. Environmental Protection Agency. Control of Volatile Organic Compound Emissions from Industrial Wastewater, September 1992. pp. 5-11 and 5-15.

10. Reference 5. p. 5-13.

11. Vatavuk, William M., "Cost Escalation." Technical paper prepared for the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. March 1993.

12. Reference 3. Questions H21c and H21d.

13. Reference 5. p. 5-8.

14. Reference 5. p. 4-4.

15. Reference 5. p. 5-13.

16. Reference 2. pp. K-1 through K-15.

17. U.S. Environmental Protection Agency. National Survey of Hazardous Waste Generators. OMB No. 2050-0075. November 1989. Question GB2.

18. Reference 7. pp. 12 and 13.

19. U.S. Environmental Protection Agency. National Survey of Hazardous Waste Generators - Instructions. OMB No. 2050-0075. November 1989. Appendix A, pp. A-2 and A-3.

# APPENDIX E

# COST ESTIMATION METHODOLOGY FOR MONITORING, INSPECTIONS, RECORDKEEPING AND REPORTING

The purpose of this appendix is to document the methodology used to estimate the costs associated with monitoring, inspections, recordkeeping, and reporting (MIRR) for the control options selected for consideration for the off-site waste operations source category. The MIRR costs are estimated only for the hazardous waste TSDF included in the computer model data base (i.e., refer to Appendix B of this document).

## E.1 OVERVIEW OF COST METHODOLOGY

For the off-site waste operations source category control options, the costs of the associated with the MIRR requirements are driven by the labor required to perform the MIRR. The man-hours needed to perform MIRR for a single emission source and control option combination are estimated. Data obtained from the National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities[1] (hereon referred to as the "TSDR Survey") are used to characterize the number of emission sources within each emission point type defined for the off-site waste operations source category that would be required to apply controls for that control option. Annual MIRR costs are then calculated based on the number of man-hours per emission source times the number of emission sources times the labor costs associated with the MIRR requirements for that emission source and control option combination.

The labor costs used to calculate the annual MIRR costs are derived from the operating and supervisory labor costs reported in the OAQPS Control Cost Manual.[2] The operating labor cost, as reported in the OAQPS Control Cost Manual in "1988 dollars," is $12.96/hr.[3] As recommended in the OAQPS Control Cost Manual, the supervisory labor costs are estimated to be 15 percent of the operating labor costs,[4] and an overhead rate of 60 percent was used on the operating and supervisory costs[5] to calculate an overall labor cost per hour (in 1988 dollars) as follows: [$12.96 + (0.15 × $12.96)] × 1.60 = $23.85/hr. Since all of the control costs are in July 1991 dollars, the labor costs are escalated to July 1991 dollars, using the Chemical Engineering (CE) Plant Index values. The average CE Plant Index value for 1988 is 342.5; the CE Plan Index value for July 1991 is 362.8.[6] Therefore, the escalation factor is 362.8/342.5 or 1.059, and the overall labor rate used in estimating MIRR costs is $23.85 × 1.059 = $25.26/hr (in July 1991 dollars). This labor rate is used for estimating the MIRR costs for each emission point type and control option combination.

## E.2 MIRR COSTS FOR TANK CONTROL OPTIONS

Based on the information collected in the TSDR Survey, there are 8,510 tanks at the 710 facilities that manage hazardous wastes received from off-site. Almost 80 percent of these tanks already have some type of cover according to the data obtained from the TSDR Survey.

Tank control Option T1 requires use of a fixed-roof cover for tanks managing wastes with volatile organic HAP concentrations equal to or greater than 100 ppmw. From the baseline emission estimates, 83 percent of the facilities that accept off-site waste materials have organic HAP emissions from tanks. Although not every tank at these facilities are expected to manage waste materials that contain organic HAP, it was assumed that 83 percent of the tanks (7,063 tanks) would be required to have fixed-roofs for the purpose of estimating MIRR costs.

It was assumed that the monitoring and inspections would be performed semi-annually and that these monitoring and inspections would take 15 minutes per tank. Semi-annual recordkeeping for the monitoring and inspections was assumed to require 5 minutes per tank, and that annual reporting would require 15 minutes per tank. Therefore, just under 1 labor hour [(15/60 × 2) + (15/60 × 1) + (5/60 × 2) = 0.92] is required annually per tank for all MIRR activities, resulting in an annual cost of $23.24 per tank (0.92 hours/tank/yr × $25.26/hr) and a nationwide annual cost of $164,000 (7,063 tanks × $23.24/tank/yr). Table 1 summarizes these assumptions and the calculation methodology. This basic calculation methodology is used for estimating the monitoring costs for each control option.

Tank control Options T2 and T3 require that a 95 percent efficient emission control device in addition to fixed-roof covers for tanks managing certain waste streams. The number of tanks requiring additional controls under control Options T2 and T3 could not be directly evaluated, but the total number of facilities that were required to apply additional controls on tanks could be evaluated from the computer model used to estimate the emissions from the hazardous waste TSDF. For tank control Option T2, 70 percent of the facilities were required to have apply additional controls on at least one tank. For tank control Option T3, 80 percent of the facilities were required to have apply additional controls on at least one tank. As stated previously, not every tank at these facilities are expected to require additional organic emission controls. However, for the purpose of estimating MIRR costs, the proportion of facilities requiring additional controls was used to estimate the number of tanks that would be required to apply additional controls. Consequently, 5,960 tanks were assumed to require

TABLE 1. MONITORING, INSPECTIONS, RECORDKEEPING, AND REPORTING COSTS FOR TANK CONTROL OPTION T1

| Item | (A) Labor Required (time/occurrence) | (B) Frequency (occurrences/yr) | (C = A × B) Annual Labor (hrs/yr) |
|---|---|---|---|
| 1) QAPP[a] | 0 | 0 | 0 |
| 2) Performance Test | 0 | 0 | 0 |
| 3) Inspections | 15 min. | 2 | 0.50 |
| 4) Monitoring | (included in A3) | (included in B3) | (included in C3) |
| 5) Reporting | 15 min. | 1 | 0.25 |
| 6) Recordkeeping | 5 min. | 2 | 0.17 |
| 7) Annual labor hours per emission source (∑ C1 through C6) | | | 0.92 |
| 8) Annual cost per emission source ($25.26 × C7) | | | $23.24 |
| 9) Total number of emission sources | | | 7,063 |
| 10) Total annual MIRR cost (C8 × C9) | | | $164,000 |

[a]QAPP = quality assurance program plan

additional controls for tank control Option T2, and 6,810 tanks were assumed to require additional controls for tank control Option T3. These assumptions are expected to be an upper bound for the tank control options' annual MIRR cost estimates.

TSDF owners and operators can choose to use floating roofs instead of external control devices to comply with tank control Options T2 and T3. The cost factors used to estimate the control costs for these options assumed that 50 percent of the tanks would employ an external control device and 50 percent of the tanks would employ a floating roof. Consequently, separate (subtotal) monitoring costs are estimated for each of the different approaches used to comply with the rule. Table 2 presents the assumptions used to estimate time requirements and per tank monitoring costs for both floating roofs and external control devices. Table 3 completes the calculation methodology and presents the total monitoring costs for both tank control Options T2 and T3.

## E.3 MIRR COSTS FOR CONTAINER CONTROL OPTIONS

According to the data in the TSDR Survey for the 710 hazardous waste TSDF, a total of 626 facilities used containers for the accumulation and/or storage of hazardous materials. As data are no available on the total number of containers used for storing or transferring off-site waste material at the hazardous waste TSDF, the MIRR costs are based on the estimated number of container storage areas. Assuming that each facility has, on average, two areas designated for container storage/accumulation, inspections (monitoring) will be required at approximately 1,250 container storage areas. For both container control Option C1 and C2, every container storage area is assumed to be inspected on a monthly basis, and that the time needed to perform the inspections is the same for both container control options. Based on a monthly inspection frequency, the annual MIRR costs for the container control options (Options C1 and C2) are presented in Table 4.

TABLE 2. MONITORING, INSPECTIONS, RECORDKEEPING AND REPORTING COSTS FACTORS FOR ADDITIONAL CONTROL DEVICES USED FOR TANKS

| Control Device/ Item | (A) Labor Required (time/occurrence) | (B) Frequency (occurrences/yr) | (C = A × B) Annual Labor (hrs/yr) |
|---|---|---|---|
| Tank with floating roof (FR) | | | |
| 1) QAPP[a] | 2 hr | 0.5[b] | 1 |
| 2) Performance Test[c] | 4 hr | 0.5[b] | 2 |
| 3) Inspections | 15 min. | 2 | 0.50 |
| 4) Monitoring | 0 | 0 | 0 |
| 5) Reporting | 15 min. | 1 | 0.25 |
| 6) Recordkeeping | 5 min. | 2 | 0.17 |
| 7) Annual labor hours per tank w/FR (∑ C1 through C6) | | | 3.92 |
| 8) Annual cost per tank w/FR ($25.26 × C7) | | | $99 |
| Tank with external control device (Ext. CD)[d] | | | |
| 9) QAPP[a] | 2 | 0.5[b] | 1 |
| 10) Performance Test | 6 | 0.5[b] | 3 |
| 11) Inspections | 30 min. | 4 | 2 |
| 12) Monitoring | 1 min. | 365 | 6.1 |
| 13) Reporting | 30 min. | 1 | 0.5 |
| 14) Recordkeeping | 1 min. | 365 | 6.1 |
| 15) Annual labor hours per tank w/Ext. CD (∑ C1 thru C6) | | | 18.7 |
| 16) Annual cost per tank w/Ext. CD ($25.26 × C7) | | | $472 |

[a]QAPP = Quality assurance project plan.

[b]An occurrence of 0.5/yr is used for tests that would be conducted on a one time only basis or less frequently than once per year.

[c]Performance test for floating roofs are gap measurements.

[d]Estimates assume two tanks are controlled per control device on average.

TABLE 3. MONITORING, INSPECTIONS, RECORDKEEPING AND REPORTING COSTS FOR TANK OPTIONS T2 AND T3

| Control Option/Control Technique | No. Tanks | Cost/Tank | Annual Cost |
|---|---|---|---|
| Tank Control Option T2 | | | |
| 1) Fixed-roof covers only | 1,103 | $23 | $25,000 |
| 2) Floating roof | 2,980 | $99 | $295,000 |
| 3) External control device | 2,980 | $472 | $1,410,000 |
| 4) Total annual MIRR cost | | | $1,730,000 |
| Tank Control Option T3 | | | |
| 5) Fixed-roof covers only | 253 | $23 | $6,000 |
| 6) Floating roof | 3,405 | $99 | $337,000 |
| 7) External control device | 3,405 | $472 | $1,607,000 |
| 8) Total annual MIRR cost | | | $1,950,000 |

TABLE 4. MONITORING, INSPECTIONS, RECORDKEEPING AND REPORTING COSTS FOR CONTAINER CONTROL OPTIONS C1 AND C2

| Item | (A) Labor Required (time/occurrence) | (B) Frequency (occurrences/yr) | (C = A × B) Annual Labor (hrs/yr) |
|---|---|---|---|
| 1) QAPP[a] | 0 | 0 | 0 |
| 2) Performance Test | 0 | 0 | 0 |
| 3) Inspections | 30 min. | 12 | 6 |
| 4) Monitoring | 0 | 0 | 0 |
| 5) Reporting | 30 min. | 1 | 0.5 |
| 6) Recordkeeping | 15 min. | 12 | 3 |
| 7) Annual labor hours per storage area (∑ C1 through C6) | | | 9.5 |
| 8) Annual cost per storage area ($25.26 × C7) | | | $510.50 |
| 9) Total number of storage areas for Option C1 or C2 | | | 1,250 |
| 10) Annual MIRR cost for Option C1 or C2 (C8 × C9) | | | $638,100 |

[a]QAPP = Quality assurance project plan.

## E.4 MIRR COSTS FOR LAND DISPOSAL UNIT CONTROL OPTIONS

Annual MIRR costs for land disposal units are estimated from the MIRR requirements of the pretreatment units used prior to land disposal. From the TSDR Survey, a total of 64 facilities (out of 710) operate one or more land disposal units. Therefore, it is assumed that there are 64 pre-treatment processes requiring MIRR. The MIRR requirements for land disposal pretreatment include an initial performance test and continuous monitoring of important operating parameters. Table 5 presents the assumptions and the annual MIRR costs for the land disposal control option (Options LD1).

## E.5 MIRR COSTS FOR PROCESS VENT CONTROL OPTIONS

The total number of process vents at the 710 TSDF was estimated from the number of vented solvent recovery units, the number of steam and air strippers, and the number of facilities that are assumed to pretreat wastes prior to land disposal. A total of 407 process vents were counted. The number of process vents requiring controls was then estimated from the ratio of the number of facilities that had emission controls on at least one process vent to the total number of facilities that had process vents. Using the computer model emission estimates, 80 percent of the facilities needed some process vent emission control for the process vent control option (Option PV1). Consequently, a total of 326 vents were assumed to require emission controls for calculating the MIRR costs. The annual MIRR costs for the process vent control option (Option PV1) are presented in Table 6.

## E.6 MIRR COSTS FOR EQUIPMENT LEAK CONTROL OPTIONS

The total number of equipment leak emission sources was estimated from the number of waste management units that have associated equipment leaks (as modeled in the computer impacts model). The number of equipment leak emission sources per waste management unit was estimated using the equipment leak counts for the model unit configurations used to develop the equipment leak emission factors (see Memorandum from Coy,

TABLE 5. MONITORING, INSPECTIONS, RECORDKEEPING AND REPORTING COSTS FOR LAND DISPOSAL CONTROL OPTION LD1

| Item | (A) Labor Required (time/occurrence) | (B) Frequency (occurrences/yr) | (C = A × B) Annual Labor (hrs/yr) |
|---|---|---|---|
| 1) QAPP | 16 hr | 0.5 | 8 |
| 2) Performance Test | 16 hr | 0.5 | 8 |
| 3) Inspections | 1 hr | 12 | 12 |
| 4) Monitoring | 5 min. | 365 | 30.5 |
| 5) Reporting | 2 hr | 4 | 8 |
| 6) Recordkeeping | 5 min. | 365 | 30.5 |
| 7) Annual labor hours per emission source (∑ C1 through C6) | | | 97 |
| 8) Annual cost per emission source ($25.26 × C7) | | | $2,450 |
| 9) Total number of emission sources | | | 64 |
| 10) Total annual MIRR cost (C8 × C9) | | | $157,000 |

[a]QAPP = Quality assurance project plan.

[b]An occurrence of 0.5/yr is used for tests that would be conducted on a one time only basis or less frequently than once per year.

TABLE 6. MONITORING, INSPECTIONS, RECORDKEEPING AND REPORTING COSTS FOR PROCESS VENT CONTROL OPTION PV1

| Item | (A) Labor Required[a] (time/occurrence) | (B) Frequency (occurrences/yr) | (C = A × B) Annual Labor (hrs/yr) |
|---|---|---|---|
| 1) QAPP[b] | 2 hr | 0.5[c] | 1 |
| 2) Performance Test | 6 hr | 0.5[c] | 3 |
| 3) Inspections | 30 min. | 4 | 2 |
| 4) Monitoring | 3 min. | 365 | 18.2 |
| 5) Reporting | 30 min. | 4 | 2 |
| 6) Recordkeeping | 2 min. | 365 | 12.2 |
| 7) Annual labor hours per emission source (∑ C1 through C6) | | | 38.4 |
| 8) Annual cost per emission source ($25.26 × C7) | | | $970 |
| 9) Total number of emission sources | | | 326 |
| 10) Total annual MIRR cost (C8 × C9) | | | $316,000 |

[a]Estimates assume two vents are controlled per control device on average.

[b]QAPP = Quality assurance project plan.

[c]An occurrence of 0.5/yr is used for tests that would be conducted on a one time only basis or less frequently than once per year.

D. W., and Robert Zerbonia to Hustvedt, K. C., "Revisions to the Model Units, Weighted Average Throughputs, and Partition Fractions for Equipment Leak Emission Sources Used in the Source Assessment Model," September 30, 1988). As the equipment leak emission control options affect only waste streams that have 10 percent organic HAP content or more, equipment leak counts for metals recovery units, wastewater treatment units, and underground injection wells were not included in the overall equipment leak count. Table 7 summarizes the assumptions used to develop a total number of potential equipment leak emission sources. From the computer impacts model, approximately 80 percent of the facilities will need to implement a leak detection and repair (LDAR) program for both equipment leak control options (Options EL1 and EL2 both apply to equipment handling waste streams containing 10 percent organic HAP content or more). The LDAR control costs include costs associated with inspections and leak monitoring. Furthermore, it is expected that most waste streams that contain 10 percent or more organic HAP are currently managed as hazardous waste. Consequently, as monitoring for these equipment leak emission sources is already required under RCRA Subpart BB rules, it is anticipated that little additional reporting and recordkeeping costs will be associated with equipment leak control options. Nevertheless, to provide an estimate of potential, additional MIRR costs, it is assumed that an additional quarterly report is filed to document compliance with the equipment leak control option MIRR requirements. The annual MIRR costs for equipment leak control options (Options EL1 and EL2) are summarized in Table 8.

TABLE 7. ESTIMATED NUMBER OF EQUIPMENT LEAK EMISSION SOURCES

| Waste Management Unit | No. Units[a] | Sources per Unit[b] | Total No. Sources |
|---|---|---|---|
| 1) Incineration | 66 | 226 | 14,916 |
| 2) Reuse as Fuel | 122 | 226 | 27,572 |
| 3) Fuel Blending | 83 | 45 | 3,735 |
| 4) Fixation | 15.[c] | 45 | 675 |
| 5) Solvent Recovery | 328 | 136 | 44,608 |
| 7) Land disposal pretreatment | 64 | 136 | 8,704 |
| 8) Total number of potential emission sources (∑ C1 thru C7) | | | 100,210 |
| 9) Number of emission sources @ 10% TOHAP (0.80 × C8) | | | 80,170 |

[a]Counts from TSDR Survey individual process questionnaires.

[b]From model process units used to develop equipment leak emission factors.

[c]Assumed one-fourth of the fixation units would manage waste that have organic HAP concentrations anywhere near 5 percent or more.

TABLE 8. MONITORING, INSPECTIONS, RECORDKEEPING AND REPORTING COSTS FOR EQUIPMENT LEAK CONTROL OPTIONS EL1 AND EL2

| Item | (A) Labor Required (time/occurrence) | (B) Frequency (occurrences/yr) | (C = A × B) Annual Labor (hrs/yr) |
|---|---|---|---|
| 1) QAPP[a] | 0 | 0 | 0 |
| 2) Performance Test | 0 | 0 | 0 |
| 3) Inspections | 0 | 0[b] | 0 |
| 4) Monitoring | 0 | 0[b] | 0 |
| 5) Reporting | 1 min. | 4 | 0.067 |
| 6) Recordkeeping | 0 | 0[b] | 0 |
| 7) Annual labor hours per emission source (∑ C1 through C6) | | | 0.067 |
| 8) Annual cost per emission source ($25.26 × C7) | | | $1.69 |
| 9) Number of emission sources for Options EL1 or EL2 | | | 80,170 |
| 10) Annual MIRR cost for Option EL1 or EL2 (C8 × C9) | | | $135,000 |

[a]QAPP = Quality assurance project plan.

[b]The monitoring, inspections, recordkeeping and reporting (MIRR) costs associated with an LDAR program are included in the control costs; only minimal additional reporting costs are anticipated.

## E.7 REFERENCES

1. U.S. Environmental Protection Agency. National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities. OMB No. 2050-0070. June 1988.

2. U.S. Environmental Protection Agency. OAQPS Control Cost Manual, 4th Edition, EPA 450/3-90-006. January 1990.

3. Reference 2. p. 3-54.

4. Reference 2. p. 2-25.

5. Reference 2. p. 2-29.

6. Vatavuk, William M., "Cost Escalation." Technical paper prepared for the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. March 1993.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT

Off-site waste and recovery operations are facilities that treat, store, recycle, and/or dispose of wastes received from outside the boundaries of the facility. Under the authority of the Clean Air Act, a national emission standard for hazardous air pollutants (NESHAP) is proposed to control organic hazardous air pollutant (HAP) emissions from off-site waste and recovery operations. This document provides background information on emission sources at off-site waste and recovery operations, HAP emissions, applicable emission control technologies, and the costs and environmental impacts of implementing these control technologies.

17. KEY WORDS AND DOCUMENT ANALYSIS

| a. DESCRIPTORS | b. IDENTIFIERS/OPEN ENDED TERMS | c. COSATI Field/Group |
|---|---|---|
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