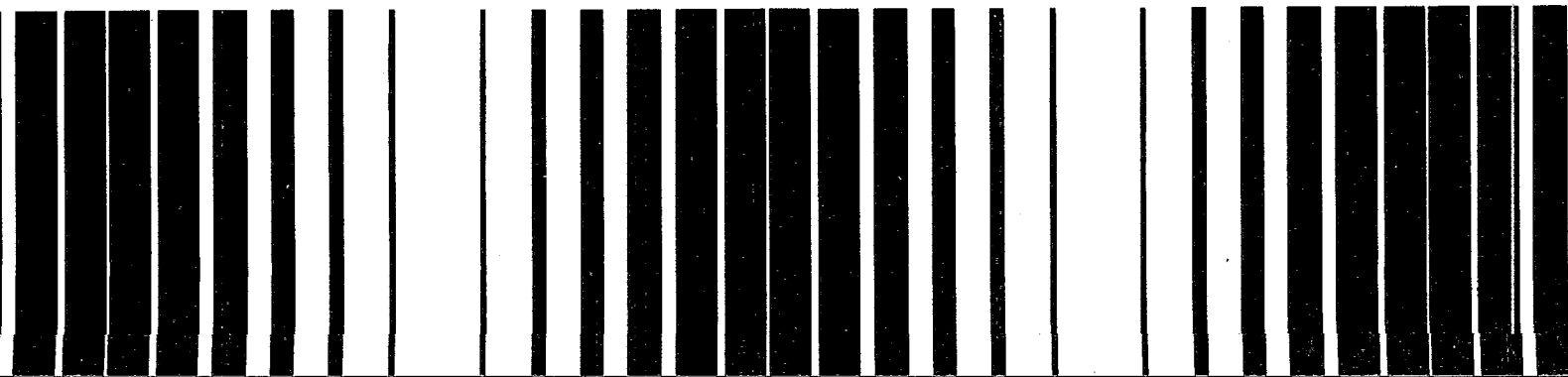
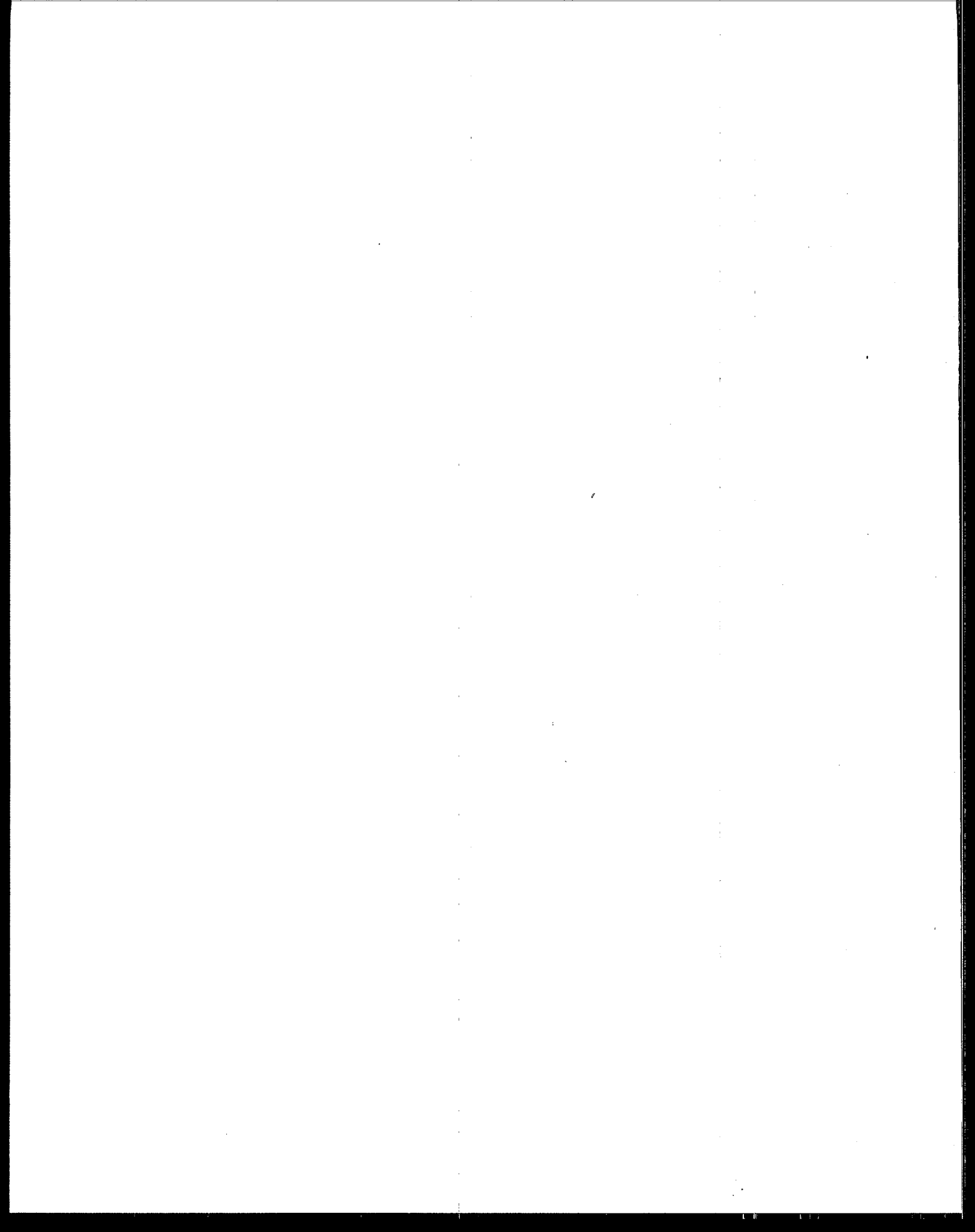




Seminar Publication

Organic Air Emissions from Waste Management Facilities





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Organic Air Emissions from Waste Management Facilities

Center for Environmental Research Information
Office of Research and Development
Office of Air Quality Planning and Standards
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268



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Acknowledgments

This seminar publication was prepared by Research Triangle Institute (RTI) under contract to the Office of Air Quality Planning and Standards (OAQPS). It contains the presentations of the speakers at the seminar series conducted from August 1990 to March 1991. The seminars were sponsored jointly by OAQPS and the Office of Research and Development (ORD). Many persons were involved in the development of these seminars and the presentations. They include:

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Justice A. Manning, the Center for Environmental Research Information, ORD, coordinated the workshops with assistance from PEER Consultants, P.C. Peer review was provided by several persons at RTI and OAQPS. Special appreciation is expressed to Bob Zerbonia who worked tirelessly with CERI in bringing this document to completion. Bob Zerbonia and Bob Lucas provided a final review.

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Introduction

The organic chemicals contained in wastes processed during waste management operations can volatilize into the atmosphere and cause toxic or carcinogenic effects or contribute to ozone formation. Because air emissions from waste management operations pose a threat to human health and the environment, regulations were developed to control organic air emissions from these operations. In June of 1990, the Environmental Protection Agency (EPA) promulgated standards under the authority of Section 3004 of the Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA). The standards limit organic air emissions as a class from process vents and equipment leaks at hazardous waste treatment, storage, and disposal facilities requiring a permit under Subtitle C of RCRA. Additional RCRA standards are under development. On July 22, 1991, EPA proposed, under RCRA authority, organic air emission standards for tanks, surface impoundments, and containers at hazardous waste treatment, storage, and disposal facilities (56 FR 33491). In March of 1990, the EPA promulgated standards under the authority of Section 112 of the Clean Air Act (CAA) that limit emissions of benzene from benzene waste operations.

To improve the understanding of the recently proposed and promulgated air rules that apply to waste management operations and to ensure that EPA, state, and local permit writers and enforcement personnel and the regulated community receive consistent guidance related to implementation, compliance, and enforcement activities, EPA conducted a series of workshops focusing on these rules. Presentations and case studies focus on waste management sources of air emissions, control technologies, and the RCRA and CAA regulations. This workshop was sponsored jointly by EPA's Office of Air Quality Planning and Standards and the Office of Research and Development, with support from the Office of Solid Waste and Emergency Response. Technical support for the workshops was provided by Research Triangle Institute; logistical support for the workshops was provided by PEER Consultants, P.C.

At the end of each chapter is a select list of questions either submitted by the attendees or asked of the speakers at the conclusion of their presentations. Answers based on the best information available at the time were given onsite and summarized here.

Workshop Schedule

Boston, MA	August 28-30, 1990
Elizabeth, NJ	September 11-13, 1990
Chicago, IL	October 23-25, 1990
Atlanta GA	November 13-15, 1990
Dallas, TX	December 11-13, 1990
Sacramento, CA	January 15-17, 1991
Seattle, WA	January 22-24, 1991
Kansas City, MO	February 12-14, 1991
Philadelphia, PA	February 26-28, 1991
Denver, CO	March 26-28, 1991

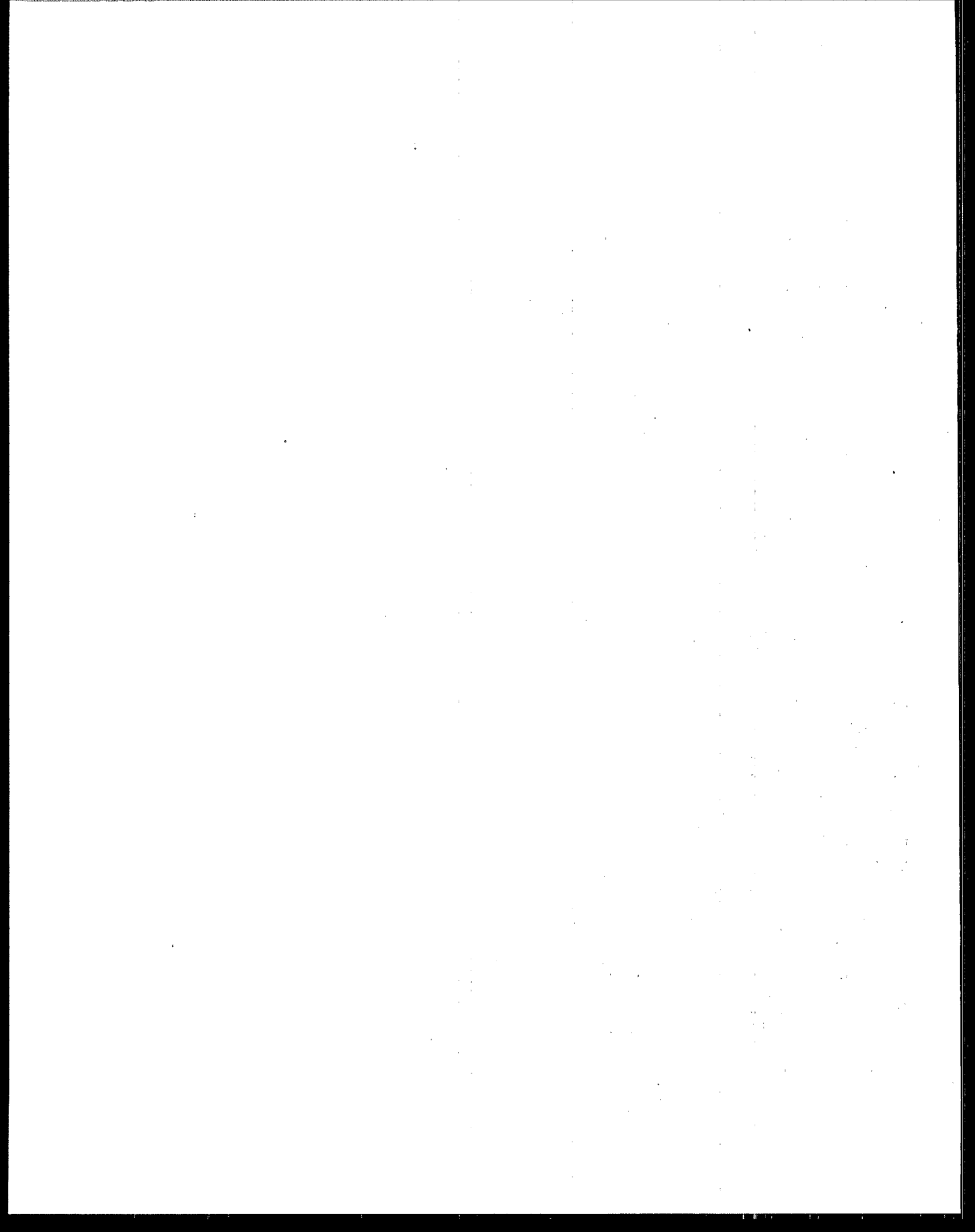
Since the regulatory scene is dynamic, some statements in this publication may be dated. As can be seen from the above dates, these workshops were completed over a year ago. Information was accurate then. If questions arise concerning TSDFs from reading material in this publication, the reader should contact:

Air Questions

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Chapter 1

Air Pollution Overview

Abstract

A broad overview of the need to control organic air emissions is provided in this introductory chapter. Human health and environmental problems caused by organic air emissions or problems to which organic air emissions contribute are discussed. Major problems discussed are those resulting from tropospheric ozone formation and exposure to air toxics. Other problems discussed include stratospheric ozone depletion, global climate change, and acid rain. The statutory mechanisms under which organic air emissions are regulated are discussed, with emphasis on the Clean Air Act and the Resource Conservation and Recovery Act (RCRA). The specific rules that apply to waste management operations and that are the focus of the workshop are introduced. These are the rules developed by the U.S. Environmental Protection Agency (EPA) under RCRA Section 3004(n) that apply to RCRA-permitted hazardous waste treatment, storage, and disposal facilities (TSDFs) and the rule promulgated under Section 112 of the Clean Air Act that limits emissions from benzene waste operations.

Overview

Organic gaseous emissions are the focus of this chapter because the air emissions standards that are the subject of this workshop are those being developed by the Office of Air Quality Planning and Standards (OAQPS) to address organic emissions from several waste management sources. However, other types of emissions also occur from waste management sources, such as inorganic gaseous emissions (e.g., metals) and particulate emissions, that are subject to regulation through other programs. For example, the Office of Solid Waste (OSW) has proposed standards for emissions from industrial boilers and furnaces that include requirements for metals. General requirements exist that limit blowing dust (particulates) from landfills and waste piles at hazardous waste treatment, storage, and disposal facilities (TSDFs). The EPA also has developed a *Hazardous Waste TSDF - Fugitive Particulate Matter Air Emissions Guidance Document* (EPA-450/3-89-019) that deals with controlling these emissions.

Why are we concerned about organic gaseous emissions? Two major concerns are ozone and air toxics.

Ozone

Ozone in the atmosphere is illustrated in Figure 1-1. Ozone is both a blessing and a curse, in relation to human health and environmental effects. It exists naturally in the upper atmosphere (the stratosphere) and in the lower atmosphere (the troposphere). Ozone is a blessing in the stratosphere; it protects us from the sun's radiation. However, in the lower atmosphere, exposure to ozone results in negative health effects on humans and other adverse environmental impacts.

The way ozone is formed in the lower atmosphere is depicted very simplistically in Figure 1-2. The primary ingredients are nitrogen oxides, organic compounds, and solar radiation. Emission of nitrogen oxides come primarily from combustion sources. Major stationary sources of NO_x are coal-fired power plants. Transportation sources (automobiles, trucks, buses) are also big NO_x sources. Organic compounds come from a variety of sources, including waste management operations.

In the presence of sunlight, nitrogen oxide and organic compounds go through a series of complex chemical reactions, and two principal by-products are formed. One is ozone, identified by the symbol O_3 , and the other is an aerosol that,

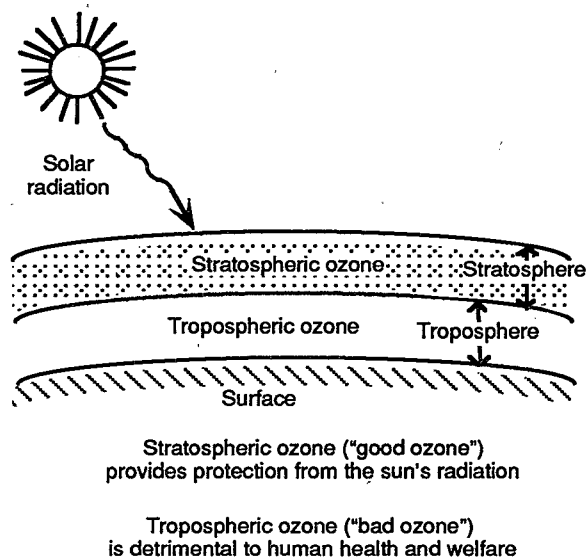


Figure 1-1. Ozone in the atmosphere.

among other things, restricts visibility. The combination of these is referred to as photochemical smog. Human exposure to ozone can affect the respiratory system. Impacts include inflammation of the lungs, impaired breathing, reduced breathing capacity, coughing, chest pain, nausea, and general irritation of the respiratory passages. The results of long-term ozone exposure can include increased susceptibility to respiratory infections, permanent damage to lung tissues, and severe restrictions on breathing capacity. Certain subpopulation groups, such as the very young, the elderly, and those with preexisting respiratory conditions, are more sensitive to exposure to ozone than the normal, healthy, adult population. However, healthy, young individuals can also be subject to negative health impacts if exposed to ozone during exercise.

Studies have been conducted to determine the existence and extent of the human health impacts of ozone. For example, in a study in 1988 of several hundred deceased persons in Los Angeles, all believed to be accident victims and otherwise healthy, about half were found to have lesions in their lungs, characteristic of the early stages of lung disease (Figure 1-3).

Welfare effects are associated with ozone exposure. Material damage due to oxidation may occur. Synthetic and rubber compounds, for example, have a much shorter useful life in an ozone-laden environment. Reduction in crop fields, lower forest growth rate, and premature leaf droppage also may occur. EPA recently estimated that between \$2 billion and \$3 billion worth of annual damage to commercial crops

and forests was due to zone exposure. Visibility impairment can also be considered a welfare impact of photochemical smog.

EPA is charged under the Clean Air Act (CAA) to establish national ambient air quality standards for pollutants including ozone. One measure of how extensive the ozone problem is in the United States is to compare air quality monitoring data with the health-based ambient air quality standard. The national ambient air quality standard (NAAQS) for ozone was set at 0.12 ppm (an hourly average not to be exceeded more than once annually). Historical monitoring data indicate that the national ambient air quality standard has been exceeded routinely in more than 60 areas nationwide. Over 100 million people live in these areas. Recent data indicate some improvement from these figures, but the ambient air quality standard for ozone is still being exceeded in many areas that contain a significant portion of the total population of the United States. Furthermore, some areas may not attain the ambient air quality standard for many years. The CAA amendments of 1990 contain provisions that address "nonattainment" areas; that is, areas not attaining the ambient air quality standards for several "criteria" pollutants, including ozone. Under this new law, areas with extreme ozone nonattainment problems have 20 years to attain the ozone ambient air quality standard.

More stringent standards for ozone have been called for—particularly with regard to sensitive populations for whom 0.12 ppm may not be low enough.

A map of the United States highlighting areas exceeding the ambient ozone standard, based on data collected in 1986 and 1988, is shown in Figure 1-4. Although the largest urban areas, such as the Los Angeles area, Chicago, Houston, and the northeast corridor, are the "hot spots" for ozone, many other areas across the United States also have an ozone problem. In addition, due to the transport of ozone precursors, the ozone NAAQS is exceeded in areas of the country far

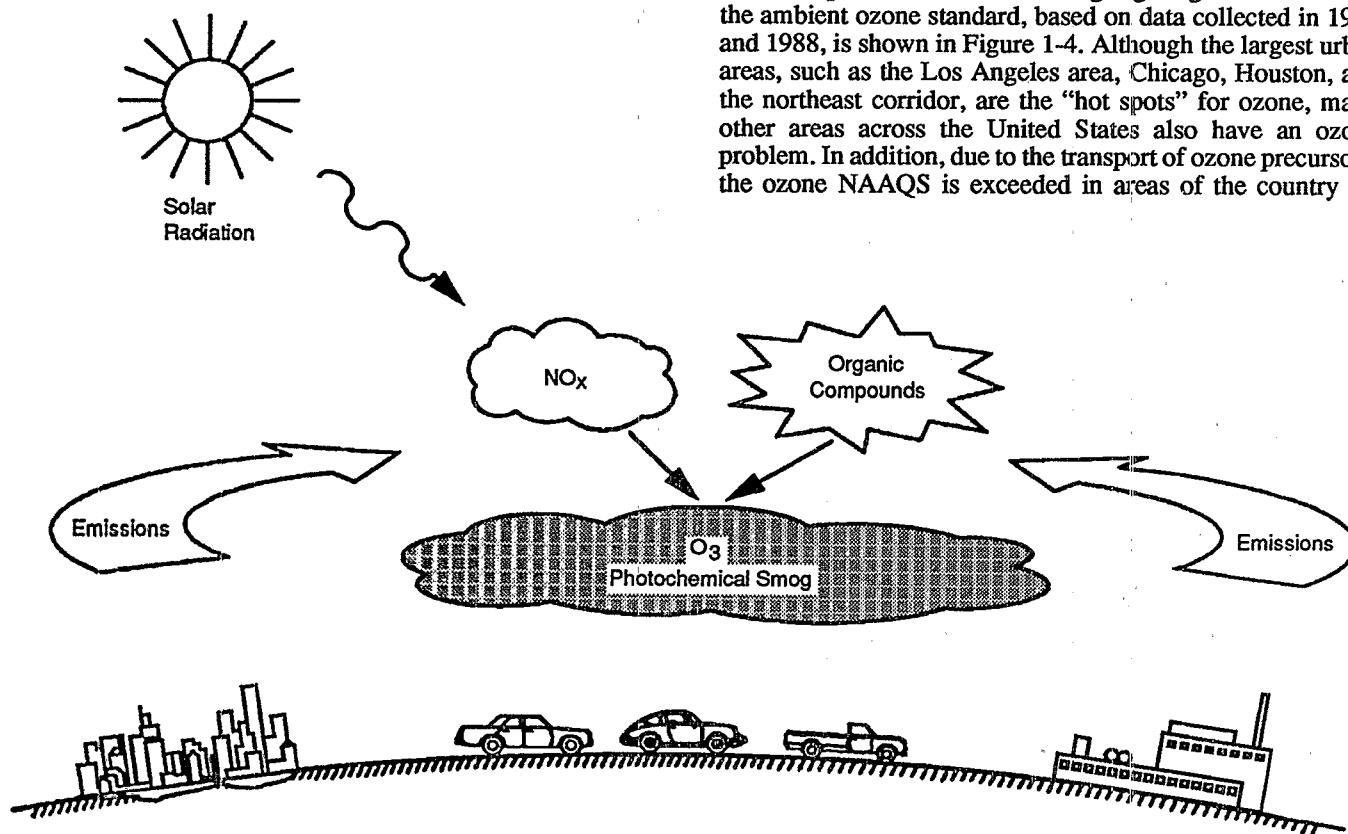


Figure 1-2. Tropospheric ozone formation.

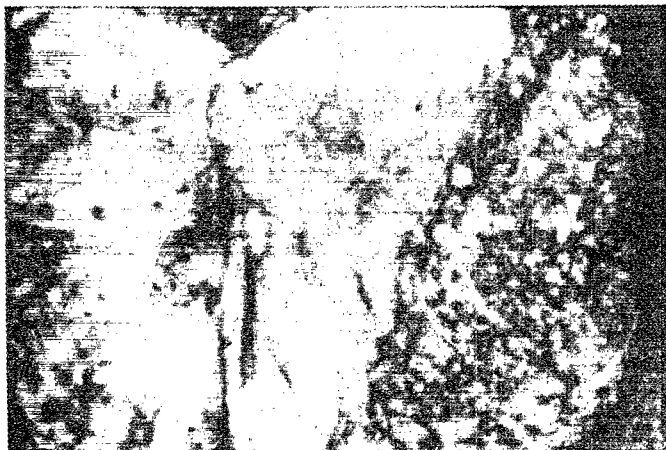


Figure 1-3. Photograph of lung from 19-year-old accident victim in Los Angeles showing lung damage possibly due to ozone exposure.

removed from urban centers. Some of the national parks, for example, have been observed to exceed the ozone ambient air quality standard occasionally.

The relative contribution of various source categories to total nationwide emissions of volatile organic compounds (VOCs) is shown in Figure 1-5. In EPA terminology, a VOC is an organic compound that is believed to participate in ozone formation. As shown, hazardous waste TSDFs are a significant source, contributing an estimated 8 percent of total VOC emissions.

Air Toxics

In general, air toxics are air pollutants that cause cancer or other human health effects. One hundred ninety compounds are specifically identified in the CAA amendments of 1990 as air toxics that EPA must investigate and potentially regulate. A significant number of those 190 are organic compounds.

Many point and area sources of air toxic emissions exist. These include large point sources such as chemical plants, petroleum refineries, and power plants. Smaller and more widespread sources, such as dry cleaners, can also be sources of air toxic emissions. Waste management sources also contribute to air toxics and are widespread. A recent count of TSDFs by the EPA OSW indicated about 2,600 to 3,000 potentially permitted TSDFs.

Each air pollutant produces characteristic health effects, which can occur due to acute (short-term) exposure or chronic (long-term) exposure. Exposure to air toxics affect neurologi-

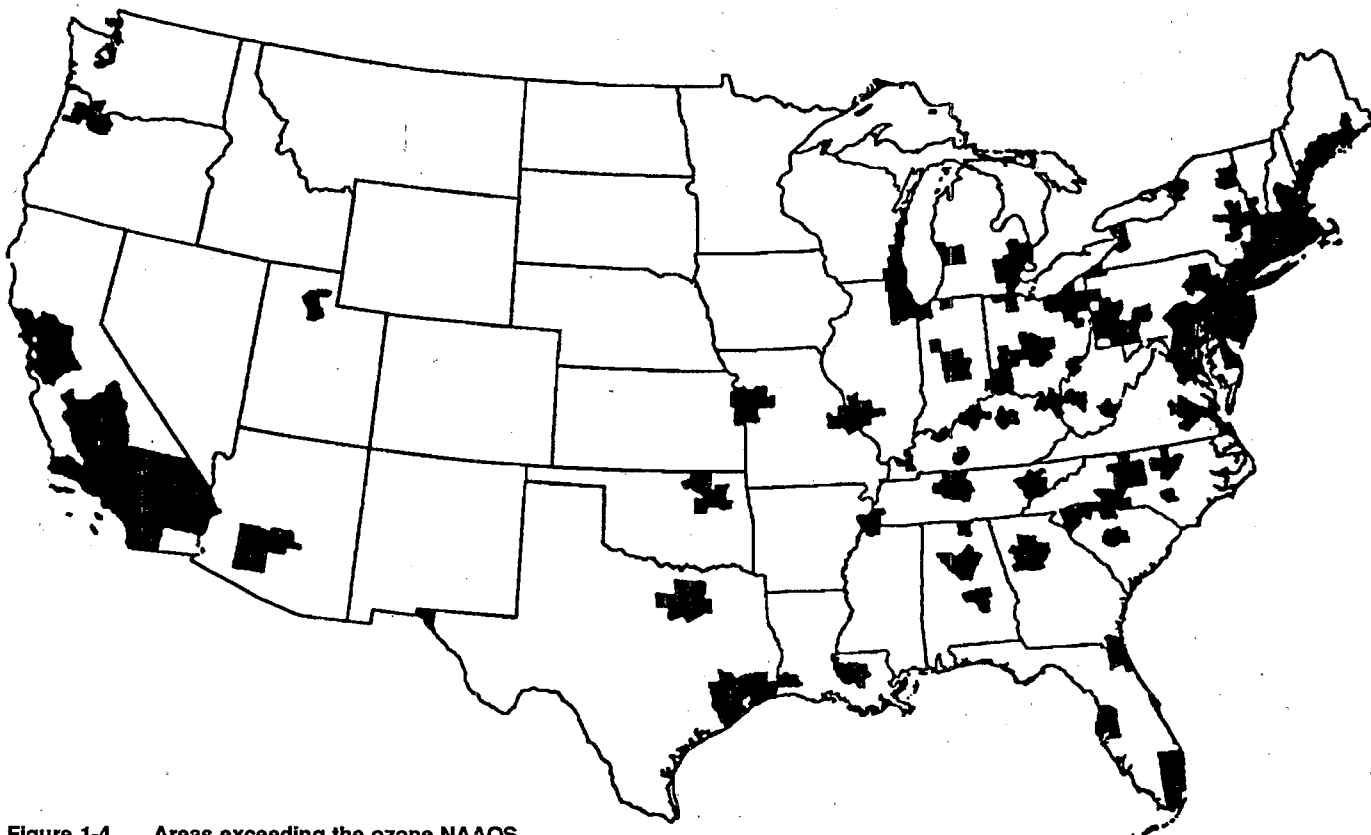


Figure 1-4. Areas exceeding the ozone NAAQS.

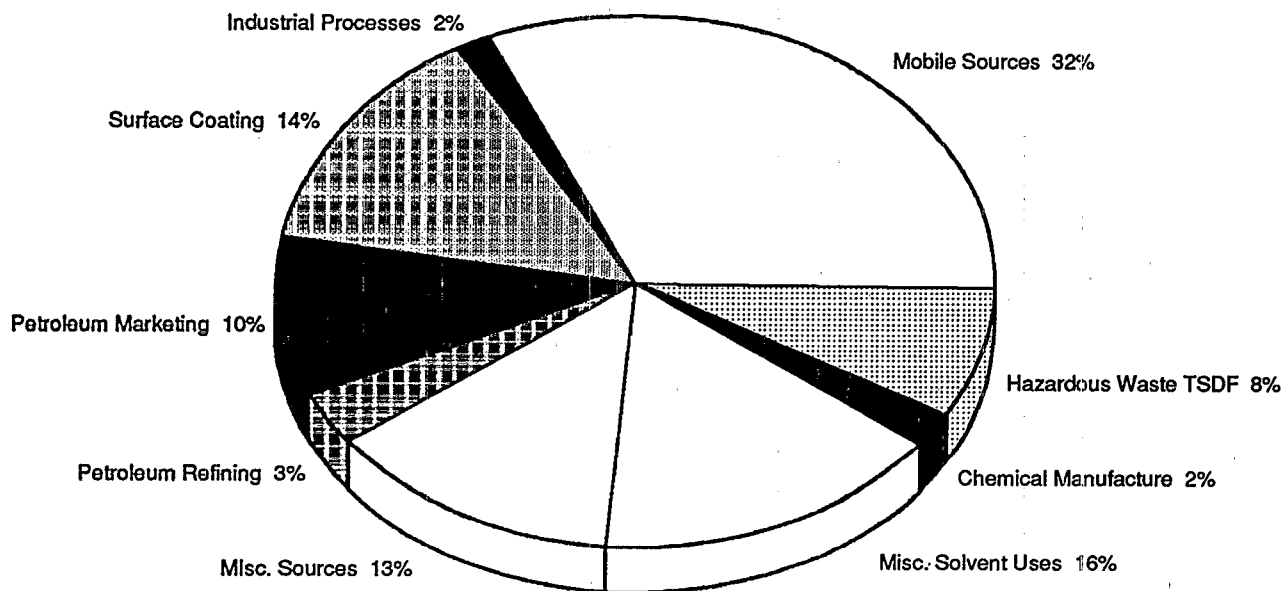


Figure 1-5. Sources of nationwide VOC emissions.

cal, respiratory, and reproductive systems. Some air toxics, such as benzene, also may cause cancer. Two EPA measures of health effects are used to identify or quantify the impacts of carcinogenic air toxics. One is individual risk, expressed as a statistical probability, that indicates an individual's increased risk of contracting cancer when exposed to a particular concentration of a pollutant over a 70-year lifetime. The other measure is an indication of population risk expressed as the number of cancer incidences per year expected nationwide due to exposure to that pollutant.

Recently, major U.S. industries began reporting the amount of toxic chemicals released to the air, land, and water as required by the Superfund Amendments and Reauthorization Act (SARA), Section 313. Industry reported that in 1987 about 2.4 billion pounds of toxic pollutants were emitted to the air. Air toxics are estimated by EPA to account for between 1,600 and 3,000 cancer deaths per year, and the *average* urban individual lifetime risk of contracting cancer due to exposure to air toxics is estimated to be as high as 1 in 1,000.

For treatment, storage, and disposal facilities, a preliminary estimate indicates a national population risk of about 140 cancer incidences per year and a maximum individual risk of 2 in 100 possibly caused by air toxic emissions from these facilities.

The top 14 VOCs and air toxics (also referred to as "hazardous air pollutants" (HAPs)) on a mass emission basis are shown in Figure 1-6. Mass of emissions alone, however, does not indicate the relative severity of the problems associated with air toxics. The toxicity of each compound and the degree of exposure that occurs (e.g., time and concentration) are equally important and must be considered. Toluene, for

example, is the most emitted compound but is less toxic than benzene, a carcinogen linked to leukemia.

Laws That Address Organic Air Emissions

Several major environmental laws address organic air emissions. These include the CAA, which is specifically designed to address major air pollution problems in the United States; the RCRA, as amended by the Hazardous and Solid Waste Amendments; and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by SARA.

Most of the new air standards described in this workshop are being developed under RCRA. Section 3004(n) directs the EPA Administrator to establish standards for the monitoring and control of air emissions from treatment, storage, and disposal facilities, as necessary, to protect public health and welfare. The standards developed under RCRA 3004(n) are to be implemented through the RCRA permit system established for hazardous waste management units.

Table 1-1. Standards Development Under Section 3004(n)

Phase I	<ul style="list-style-type: none"> Total organics Process vents and equipment leaks Promulgated 6/21/90 (55 FR 25454)
Phase II	<ul style="list-style-type: none"> Total organics Tanks, surface impoundments, containers and miscellaneous units Proposal package in OMB
Phase III	<ul style="list-style-type: none"> Individual constituent standards, as needed, to supplement Phase I and Phase II standards Early Work Group stage

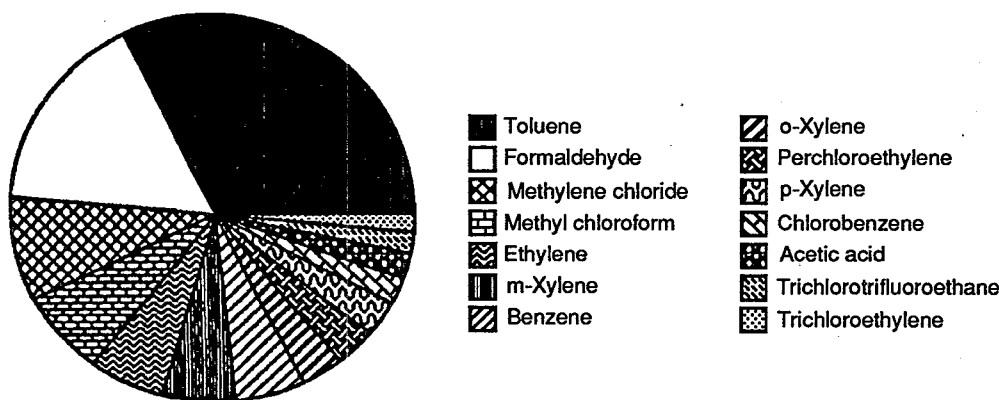


Figure 1-6. Top fourteen VOC/HAP chemicals.

As illustrated in Table 1-1, the EPA is developing the RCRA 3004(n) air standards in three phases. Organic emissions from process vents associated with specific noncombustion waste treatment processes (e.g., stream stripping and thin-film evaporation units) as well as equipment leaks from pumps, valves, and pipe fittings are addressed in Phase I. Final standards for these sources were promulgated June 21, 1990 (refer to Subparts AA and BB in the Code of Federal Regulations (CFR), Title 40, Parts 264 and 265 (40 CFR 264 and 265)). Organic emissions from tanks, surface impoundments, containers, and miscellaneous units are addressed in Phase II. Standards for these sources were proposed in July 1991 as a new Subpart CC in 40 CFR Parts 264 and 265. Current analyses indicate that a potential residual risk problem may remain after implementation of the Phase I and Phase II standards for organics. Therefore, emissions of individual chemical constituents as necessary to bring the residual maximum individual risk to within an acceptable range under RCRA (10^{-4} to 10^{-6}) will be addressed in Phase III. Proposal of standards, as needed, under Phase III is planned to be concurrent with promulgation of the Phase II standards.

The Corrective Action Program is also under RCRA. Under the Corrective Action Program, solid waste management units have to go through a site-specific facility evaluation. Site-specific evaluation and risk assessment also include consideration of air emissions. In addition, the land disposal restrictions (LDR) promulgated under RCRA affect air emissions. The LDR prohibit the depositing of hazardous waste on or into land disposal sources such as landfills, surface impoundments, and waste piles unless certain treatment requirements are met. Treatment of wastes to meet the LDR can result in air emissions if the treatment process is not properly controlled, and the RCRA 3004(n) air standards work in concert with the LDR to prevent this potential cross-media pollution.

Other programs under RCRA, such as one that establishes location standards for the siting of new facilities, also require consideration of air emissions.

An overview of hazardous waste management is shown in Figure 1-7. Once a hazardous waste is generated, it may go through a series of different processes and waste management

units before disposal. Waste may be stored or treated, for example, in tanks and containers. Containers include 55-gallon drums, dumpsters, tank trucks, and railcars. Waste treatment to meet the requirements of the LDR may take place early in the waste management process, or just prior to disposal. Further, the management of hazardous waste may take place at the generator site (onsite) or at a commercial TSDF (offsite). If a waste is managed offsite, it may also be handled at a storage and transfer station before being transported to another location for final treatment and disposal.

In Figure 1-8, coverage of the Phase I and Phase II RCRA air standards is overlaid onto the hazardous waste management units illustrated in Figure 1-7. In the Phase I standards, process vent organic air emissions from treatment units specifically identified in the standards are limited, and equipment leak emissions from other waste management units are limited also.

Coverage of the RCRA air standards would be expanded by the Phase II standards to address organic air emissions from tanks, surface impoundments, and containers. As is discussed in more detail in later workshop chapters, the Phase II standards are designed to contain (or suppress) potential organic emissions from escaping prior to treatment. According to the standards, operators would be required, for example, to cover open tanks unless the concentration of organic waste contained in a tank could be demonstrated to be below a specified value. Because control requirements are triggered by the organic content of the waste, these standards are "waste-based" rules. Waste treatment is not required, according to the Phase II RCRA air standards, but is required by the LDR. The benzene waste national emissions standards for hazardous air pollutants (NESHAP), also discussed in this workshop, requires containment-type controls prior to treatment similar to the Phase II RCRA air standards. Unlike the Phase II standards, however, treatment requirements for benzene-containing wastes are included in the benzene waste NESHAP.

Clean Air Act

Major regulatory programs established under the CAA that are used to address organic air emissions, including ozone precursors and air toxics, are shown in Table 1-2.

As referenced earlier, NAAQS are established by EPA for "criteria" pollutants, and the states then set standards to attain and maintain them. Ozone is a criteria pollutant, and

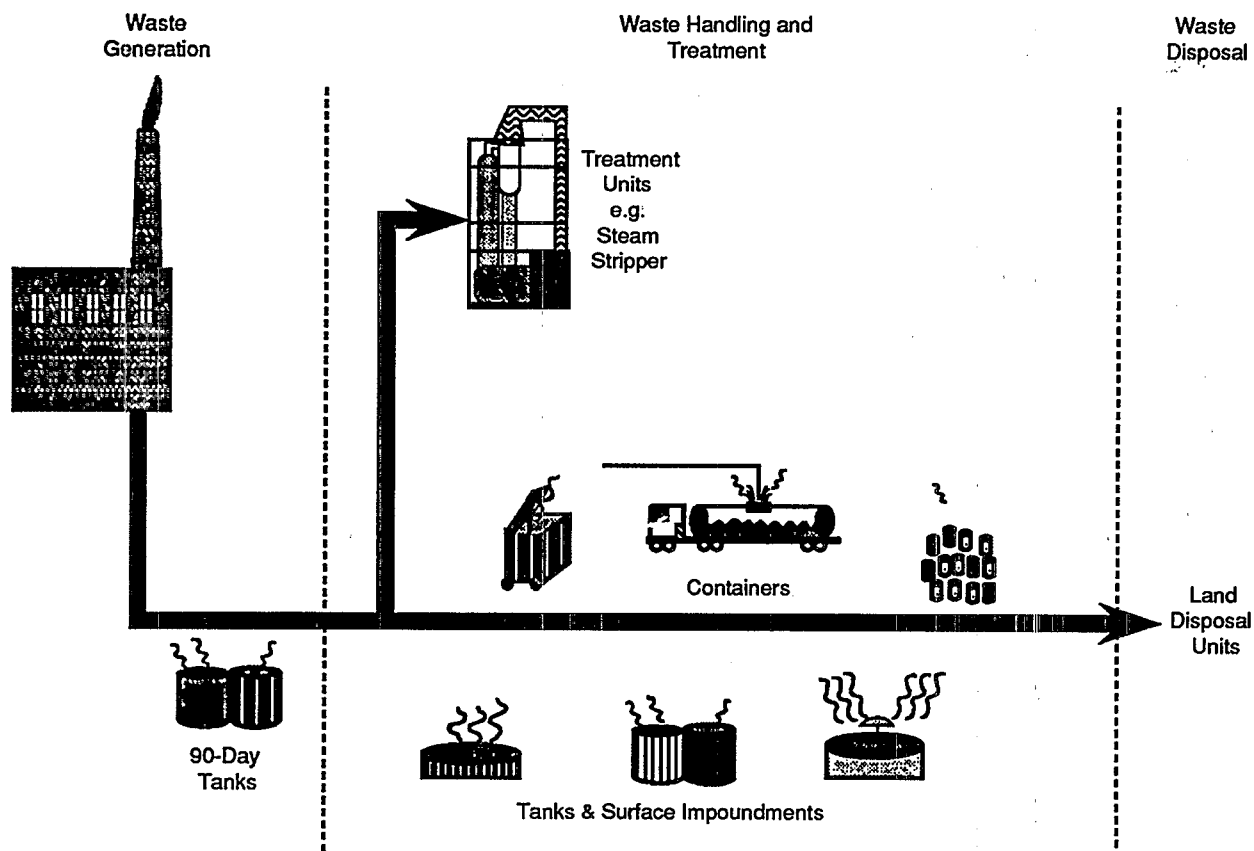


Figure 1-7. Hazardous waste management.

volatile organic compounds are regulated by the states as ozone precursors on a source-by-source basis. The new source performance standards (NSPS), set under Section 111 of the CAA, are designed to address emissions of the criteria pollutants from new, modified, or reconstructed stationary sources. "Designated pollutants" may also be addressed by NSPS. A designated pollutant is a noncriteria pollutant that is identified by EPA for regulation under Section 111(d), based on health or welfare impacts. Examples of designated pollutants are total reduced sulfur (TRS) and sulfuric acid mist. NESHAP are set under Section 112 of the Clean Air Act to limit emissions of pollutants identified as hazardous from both existing and new stationary sources. Section 112 was changed substantially by the 1990 CAA amendments. The "old" Sec-

tion 112 required EPA first to list a pollutant as hazardous and then to establish standards to protect public health "with an ample margin of safety." In the new Section 112, EPA must establish technology-based standards for sources of 190 hazardous pollutants listed in the new law. At a later time, more stringent standards are required if risk assessments indicate that the technology-based standards are not adequately protective.

A NESHAP for benzene waste operations was completed recently and is the last NESHAP set under the "old" Section 112. It was promulgated in March 1990 and is codified in 40 CFR 61, Subpart FF. It applies to chemical plants, petroleum refineries, coke by-product recovery facilities, and certain treatment, storage, and disposal facilities. The compliance deadline for existing facilities to install the controls that are required by this standard is March 7, 1992. The benzene waste NESHAP is described more fully in later chapters.

Table 1-2. Clean Air Act

- National Ambient Air Quality Standards (NAAQS)
 - Criteria pollutants
 - PM, SO₂, CO, NO_x, O₃, Pb
- New Source Performance Standards (NSPS)
 - Criteria pollutants
 - Designated pollutants (e.g., TRS)
- National Emission Standards for Hazardous Air Pollutants (NESHAP)

CERCLA (Superfund)

The cleanup of inactive contaminated sites is mandated in CERCLA. As shown in Table 1-3, several aspects of CERCLA are important in the control of organic air emissions. A site-specific risk analysis must be conducted prior to a removal and remediation action under Superfund, and this site-specific analysis must include a consideration of air emissions that may result from the cleanup. For example, ground-water

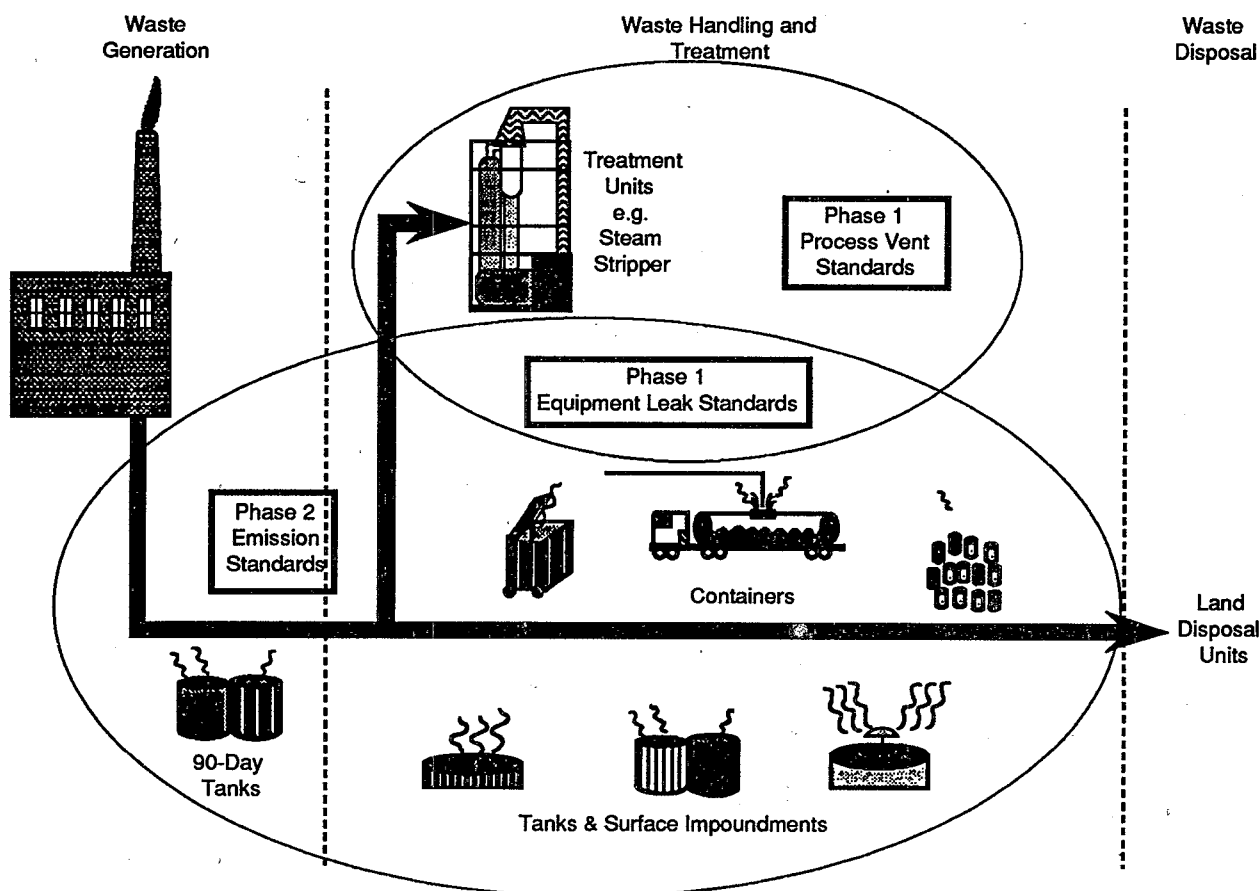


Figure 1-8. Phases I and II RCRA air standards overlaid onto hazardous waste management.

stripping to remove an organic contaminant could result in a potential cross-media problem if air emissions created by the treatment process were not controlled. In addition, removal and remediation actions must comply with those existing laws that are applicable or relevant and appropriate requirements (ARARs). As will be discussed later, the Phase I RCRA air standards may be ARARs for some cleanup operations under Superfund.

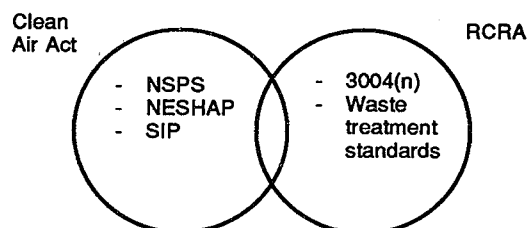
Finally, the toxic release inventory required by SARA Title 313 is also an important tool for addressing air toxics. In a very broad sense, this inventory is helping to improve EPA's knowledge of the sources of toxic air pollutants. SARA Title 313 was one of the databases that EPA reviewed recently in

trying to identify sources of the 190 toxic air pollutants listed under the CAA of 1990.

Some overlap exists in statutory coverage of air emission sources by the various laws as shown in Figure 1-9. In some situations, this overlapping coverage will result in the same source being subject to regulations with different control requirements. When this occurs, it likely will be because the applicable regulations were developed under laws with different mandates. For example, NSPS under the CAA are technol-

Table 1-3. CERCLA/SARA (Superfund)

- Site-specific risk analysis required for removal and remediation actions
- Removal and remediation actions must comply with federal and state laws that are applicable or relevant and appropriate (ARARS)
- Toxic release inventory required by SARA Title 313



- Control requirements consistent and complimentary to the extent possible
- Compliance must be demonstrated with all applicable rules

Figure 1-9. Overlap of statutory coverage for air emission sources.

ogy-based standards, and the RCRA 3004(n) air standards are risk-based. Where different standards apply, compliance must be demonstrated with all applicable rules. However, when possible, EPA will make the control requirements of rules that apply to the same sources consistent and complementary.

An example of this overlapping coverage related to waste management is storage tanks. As illustrated in Figure 1-10, storage tanks may be covered by three separate rules. Tanks in which benzene-containing waste is stored at chemical plants, petroleum refineries, coke by-product plants, and certain TSDF are covered by the benzene waste NESHAP (40 CFR Part 61, Subpart FF). New, modified, or reconstructed tanks containing volatile organic liquids (VOLs) and those above certain size limits are covered by the NSPS for VOL storage (40 CFR Part 60, Subpart Kb). Finally, the RCRA Phase II air standards will apply to tanks in which organic hazardous waste is managed. Depending on the particular physical characteristics of the tank, the waste being stored, and the age of the tank, the same tank could be covered by the benzene waste NESHAP, the VOL storage NSPS, and the RCRA Phase II air standards. The ramifications of this overlap for owner/operators are minimal, however, because, if an owner/operator is complying with the control requirements of any one of the standards, he or she will be in compliance with the control requirements of all three.

Conclusions

Organic air emissions contribute to major air pollution problems, including ozone formation in the lower atmosphere and air toxics. Waste management operations are a significant source of organic air emissions and are being regulated under several federal laws. The applicability and specific requirements of the various regulations issued and under development will be discussed in subsequent chapters of this course.

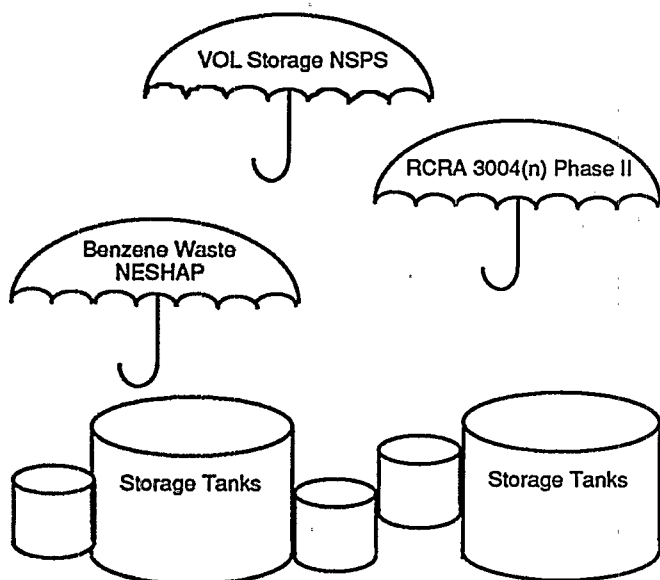


Figure 1-10. Storage tanks under several "regulatory umbrellas."

Questions and Answers

Question—Regarding the location of ozone problems in the lower atmosphere, where do the problems occur in terms of emission sources or locations? Is the transport of VOC a factor?

Answer—This oxidizing type of pollution is generally found in urban areas. It results from chemical reaction of NO_x and HC in sunlight and produces O_3 , PAN, and other complex compounds. The pollution is expressed as ozone and referred to as photochemical oxidants. Because it is a secondary pollutant, transport is a concern. Ozone is a regional problem with impacts occurring up to 250 km from the source.

Question—If ozone is depleted in the upper atmosphere, why is it not depleted in the lower atmosphere?

Answer—Ozone is short-lived in the lower atmosphere. The concentration follows a daily cycle with peaks around noon decreasing to near zero levels after midnight, as the intensity of solar radiation diminishes. Ozone in the upper atmosphere (~ 30 km) is formed by photodissociation of oxygen.

Question—Regarding the ozone NAAQS, does a link exist between the concentration of 0.12 ppm and when health effects take place?

Answer—The ozone NAAQS is a health-based standard, but debate exists on the level that provides an adequate margin of safety.

Question—Is a copy of the hazardous pollutant list available? Do standards exist for these compounds; existing limits on emission rates from facilities?

Answer—No standards exist on emission rates; some emission measurements are available.

Question—Why are we concentrating on benzene from among the entire list of 190 hazardous air pollutants?

Answer—A court order has been issued on the benzene regulations.

Question—Can you summarize when RCRA and when CAA has jurisdiction? How do the new CAA amendments overlap with the RCRA process vent rules?

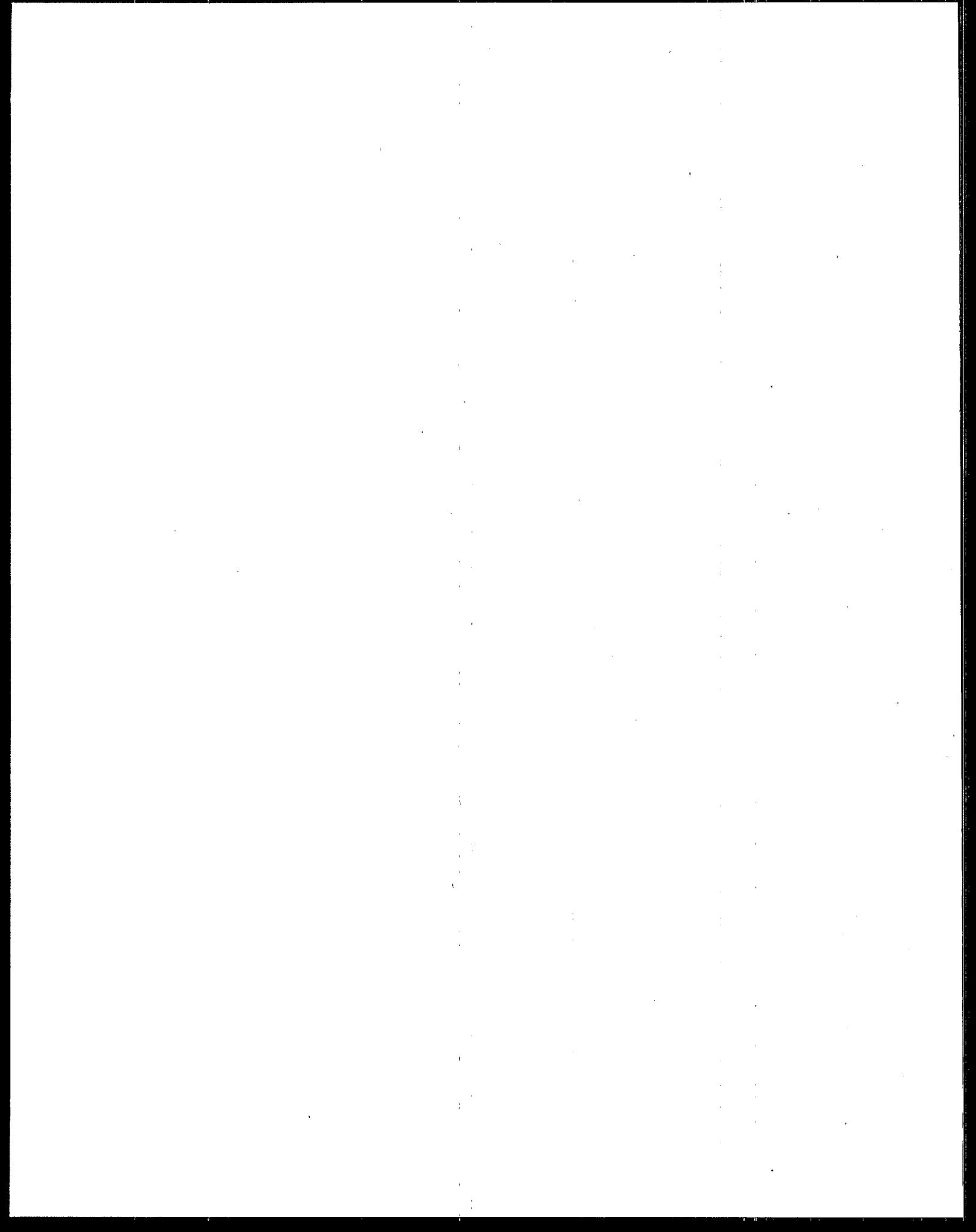
Answer—Both say protect and the CAA says "be consistent" with RCRA rules. Guidance for VOC control is being issued in the process vent alternative control technology; RCRA-exempt WWTS maximum achievable control technology (MACT) standards (technology based for HAPs) will be developed. Title 5 permits still may be needed for RCRA vents.

Question—Could you be more specific as to what impacts organic air emissions have on global climate change and acid rain, and the specific organics that cause these impacts? What are the “greenhouse gases”?

Answer—The greenhouse gases are CO₂, H₂O, CH₄, NO₂, and CFCs; concentrations are increasing.

Question—Regarding maximum individual cancer risk, is it onsite, offsite, 24-hour exposure, lifetime, or nationwide? Is the risk for TSDF sources evaluated separately from the risk from production processes?

Answer—The risk is evaluated at the fenceline. It represents the nationwide maximum individual cancer risk resulting from lifetime exposure.



Chapter 2

Emission Sources and Controls

Abstract

The major sources of air emissions at waste management facilities, how these emissions occur, and their control are the focus of this chapter. The major sources that are discussed in detail include surface impoundments, the very broad and diverse category of tanks and ancillary equipment, containers, and other major land disposal sources. As each source is described, controls that are inherent to that source or commonly found on that particular source are presented. In addition, details are provided on the basic mechanisms by which emissions occur and the major factors that affect the emissions.

After the discussion of sources and their inherent controls, air pollution control devices that may be generally applicable to any enclosed or vented source (i.e., add-on controls) are described. The discussion of control devices focuses on their applicability, control performance, and the major factors affecting performance. Organic removal (i.e., pretreatment) and destruction processes are also discussed as a means of controlling air emissions and reducing or eliminating the emission potential. This discussion describes processes that remove or destroy the organics in the waste, which may eliminate the need to control subsequent waste processing steps.

Emission Sources and Controls

The types of sources found at waste management facilities, inherent controls that are typically part of the construction and operation of the sources, and emission mechanisms are covered in this chapter. As each source is discussed, covers and enclosures that are specifically applicable to the source are described, as well as simple work practices that reduce emissions. Other emission controls that are broadly applicable to many of the individual sources are discussed collectively in the second part of this chapter. These controls include traditional air pollution control devices, processes that remove the organics before the waste is placed in units with a high emission potential, and waste incineration.

Sources of Air Emissions

The discussion of emission sources is divided into four categories: surface impoundments, the very broad and diverse group of tanks and ancillary equipment, containers, and land disposal sources that are expected to be most affected by the

land disposal restrictions (LDR). The major focus is on the first three categories because they are the most directly impacted by the air emission regulations covered in this workshop.

Surface Impoundments

A surface impoundment is "a natural topographical depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials) which is designed to hold an accumulation of liquid wastes or wastes containing free liquids and which is not an injection well. Examples of surface impoundments are holding, storage, settling, and aeration pits, ponds, and lagoons."

Impoundments are simply ponds and lagoons that are used primarily for managing aqueous wastes and sludges. They are certainly land disposal sources, but they are discussed separately because of continued use after LDR is in place, and because they may continue to be major sources of air emissions. For example, surface impoundments that are dredged annually may be exempted from LDR.

A surface impoundment is below grade, usually has berms with sloping sides to contain wastes, and has a liquid surface that is exposed to the atmosphere. It may be operated as a flowthrough system with liquid flowing in at one point and out at the same time at another point, or the liquid may be pumped out or evaporated, leaving behind a sludge. Surface impoundments are commonly part of wastewater treatment processes and are used for storage, equalization of different waste streams, neutralization, biodegradation, or other processes.

Surface impoundments have a very high emission potential for volatile organics for several reasons. These impoundments have large exposed surface areas that range in size up to several acres. In addition, the residence time of the waste in the impoundment is on the order of days, weeks, or months, which results in the loss of most of the volatiles.

Several of the factors that affect emissions from impoundments are listed in Table 2-1. These same factors are applicable to emissions from open tanks. The constituent's volatility has a direct effect on emissions from impoundments and other sources with exposed liquid surfaces. Highly volatile compounds such as benzene are readily emitted from open

Table 2-1. Major Factors Affecting Emissions

•	Constituent volatility
•	Residence time
•	Surface area
•	Turbulence (aeration, agitation)
•	Windspeed and temperature
•	Extent of competing mechanisms (such as biodegradation)

sources, whereas relatively nonvolatile compounds such as phenol tend to stay in the water.

The residence time in the impoundment has an obvious effect on emissions: longer residence times result in higher emissions. If the waste is in the impoundment long enough, even relatively nonvolatile compounds are evaporated. For impoundments with relatively short residence times, a higher percentage of the organic may be removed with the effluent and emitted later in other units in the treatment sequence.

Many impoundments and tanks are agitated for mixing, air stripping, or biodegradation. Agitation and aeration increase emissions by creating turbulent zones and increase contact between the waste and air. A highly turbulent area and water spray around the agitators used in mechanically aerated units exists. Essentially all of the highly volatile compounds can be emitted when the impoundment is mechanically agitated. Approximately half of the impoundments used to treat hazardous waste are aerated or agitated.

As is illustrated in Figure 2-1, emissions from impoundments occur from wind blowing across the exposed surface of the waste. Organics can also be removed by biodegradation, adsorption onto sludge, or removed with the effluent. Emission models have been developed to estimate the extent of each of these different removal mechanisms.

The models developed for open liquid surfaces are applicable to both impoundments and open tanks. These models can account for relatively calm surfaces or the emissions from the turbulence created by aeration or agitation. The emissions are modeled as two mass transfer steps in series: (1) diffusion through the liquid, and (2) mass transfer from the surface of the liquid to the air. The approach can account for removal in flowthrough systems and removal in units designed for dis-

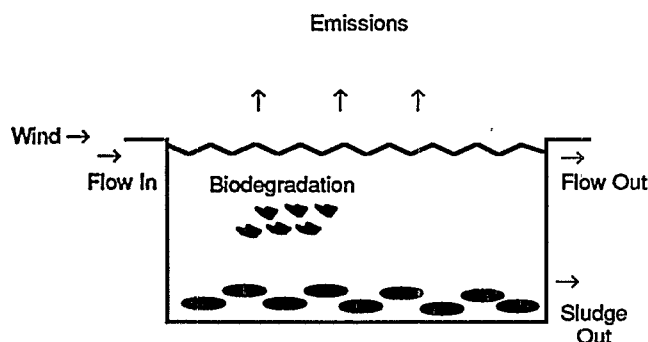


Figure 2-1. Fate of organics: emissions, effluent, biodegradation, sludge.

posal or evaporation. The extent of biodegradation, if any, can also be estimated.

One of the controls demonstrated for impoundments is an air-supported structure, which uses fans to maintain a positive pressure to inflate the structure. For effective control, the air vented from the structure must be sent to a control device, such as a carbon adsorber. Air-supported structures have been used as enclosures for conveyors, open top tanks, and storage piles, as well as impoundments.

An air-supported structure and control device has been installed on a 1-acre aerated lagoon that is used for biodegradation at a pharmaceutical manufacturing facility. The cover material is a PVC-coated polyester with a Tedlar backing. Agitators are used inside the structure to provide oxygen and to keep carbon and biomass suspended. In this application, the exhaust from the structure is vented to a carbon adsorber. Very few leaks were found around the structure; consequently, the control efficiency is determined primarily by how well the control device works. This plant's experience with the air-supported structure has found that corrosion can be accelerated inside the structure and that special worker safety precautions are needed.

Floating membrane covers are another control option and have been demonstrated on various types of impoundments, including water reservoirs in the western parts of the United States. For proper operation as a control technique for organic compounds, the membrane must provide a seal at the edge of the impoundment and provisions made to remove rainwater. If gas is generated under the cover, vents and a control device may be needed. In addition, if sludge accumulates, some means for periodic sludge removal may be required, such as a sludge pump.

Emission control depends primarily on the type of membrane, its thickness, and the individual organic compounds in the waste. Theoretical estimates based on diffusion through the membrane indicate worst-case control efficiencies of 50 to over 95 percent. Laboratory studies indicate that the cover is an efficient control for some organic compounds, and, for specific compounds that permeate the membrane, the control efficiency is lower.

The floating membrane cover has been demonstrated on an impoundment that is used as an anaerobic digester. The impoundment is about 7 acres in size with a depth of approximately 14 feet. The membrane material is 100-mil high-density polyethylene. The cover is anchored over a concrete ring wall that extends above grade level around the perimeter of the impoundment. The membrane extends over the concrete wall and is covered with backfill to anchor and seal it. Punctures or tears in the membrane can be patched. This installation has been in operation for 4 years, and the company supplying the membrane offered a 20-year warranty on the life of the material.

Tanks

The most diverse group of sources falls into the category of tanks, which is broadly defined. If the unit is not a land disposal source, it is probably a tank. A tank is defined as "a stationary device, designed to contain an accumulation of

hazardous waste which is constructed primarily of nonearthen materials (e.g., wood, concrete, steel, plastic) which provide structural support." A tank system is defined as a tank and its ancillary equipment, and ancillary equipment includes such devices as piping, fittings, flanges, pumps, and valves.

The category of tanks and tank systems includes a discussion of those units that are easily identified as tanks, such as fixed-roof storage tanks. It also includes wastewater treatment tanks that are typically open; units that perform separation processes, such as columns used for distillation, absorption, and solvent extraction; units used for dewatering; and devices used for waste fixation. The discussion of tanks is divided into four groups: (1) those used primarily for managing organic liquids, (2) those used for aqueous wastes, (3) those used for sludges, and (4) the miscellaneous equipment items associated with tanks.

Organic Liquids

Organic liquids are usually managed in covered or enclosed tanks, including those with fixed roofs, those with floating roofs, and pressure tanks. Fixed-roof tanks are the most common type of storage tank found at hazardous waste facilities. Emissions occur through the tank's vent, which may be open to the atmosphere, equipped with a pressure-vacuum relief valve, or vented to a pollution control device.

The fixed roof may have several openings in addition to the vent, such as a manhole for tank entry, a hatch used for measuring the liquid level, or an overflow pipe (Figure 2-2). The pressure-vacuum relief valve is also called a conservation vent, which permits small changes in the liquid level without pushing out the tank's vapors. If the tank has a conservation vent or is vented to a control device, the other openings on the tank must be kept closed and sealed for the emission controls to be effective.

Emissions from fixed-roof tanks occur primarily by working losses and, to a lesser extent, by breathing losses. The quantity emitted is most directly affected by the rate at which vapors are pushed from the tank and the volatility of the tank's contents. These emissions are increased by heating or aeration. Working losses occur when waste is pumped into the

tank and vapors are pushed out by the rising level of liquid (Figure 2-3). Breathing losses occur when the volume of vapor in the tank is increased because of changes in temperature or pressure (Figure 2-4).

Equations developed by the American Petroleum Institute (API) are used to estimate emissions for organic liquids. The basic form of the equation, which can be used for other types of wastes, estimates the volume of vapor pushed out from the amount of liquid pumped in. The concentration of organics in the vapor can be measured or estimated. One error in using the API tank equations for aqueous wastes is to estimate the concentration in the vapor from the mole fraction of the compound in the liquid, which significantly underestimates concentration. Henry's law constant should be used for dilute aqueous wastes. Breathing losses are usually very low compared to working losses and can often be neglected. Note that if the tank is operated at a constant liquid level, as some separators and collection tanks are, very little vapor is displaced and working losses are small.

As an emission control option, fixed-roof tanks can be retrofitted to open tanks, or a fixed-roof tank can be used to replace an open tank or impoundment. Compared to an open tank, a fixed-roof tank can provide additional control of 86 to 99 percent, depending on the waste volatility and the operating characteristics of the open tank. If the fixed-roof tank is constructed to withstand pressures of 2.5 psig, an additional control of 20 to 45 percent can be obtained. (Most tanks are not designed and constructed to withstand this pressure.)

Floating roof tanks are common at petroleum refineries and gasoline marketing facilities for the storage of volatile liquids. The floating roof can be installed internally in a fixed-roof tank or externally without a fixed roof. The roof floats on the liquid and moves with changes in the liquid level, thus controlling working losses. Emissions from a properly maintained floating roof are very low and occur from standing losses and withdrawal losses.

The equipment associated with an external floating roof tank is shown in Figure 2-5. Standing losses occur at the deck seals and at openings for fittings in the floating roof. With-

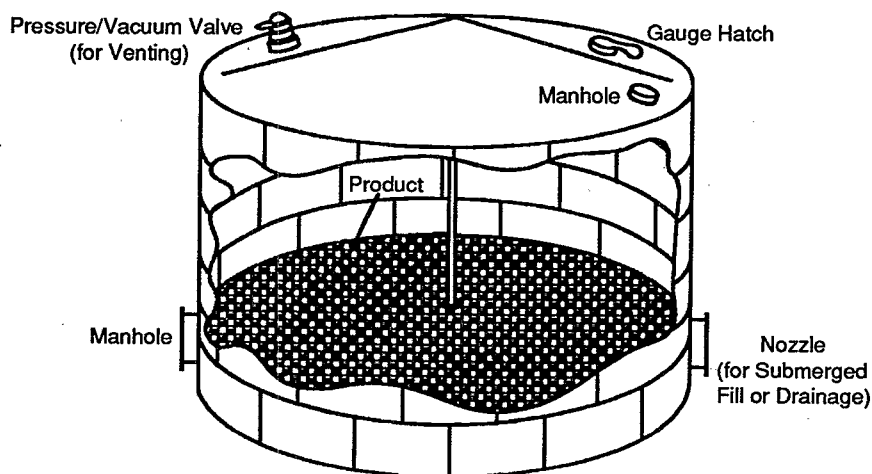


Figure 2-2. Typical fixed-roof tank.

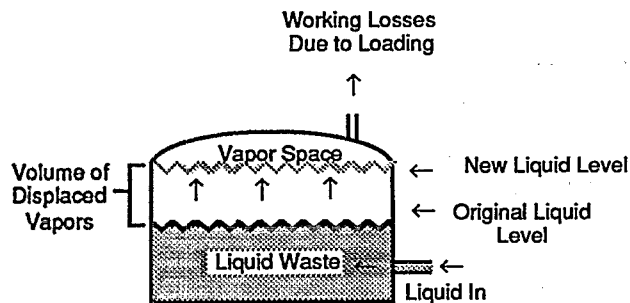


Figure 2-3. Covered tanks (working losses).

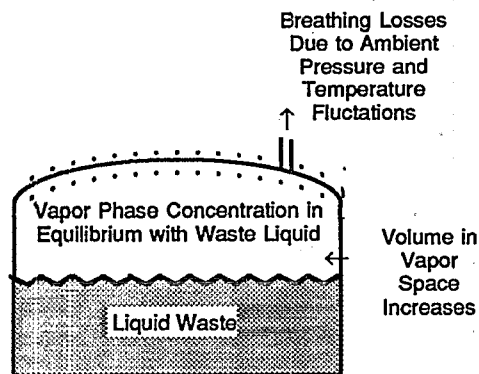


Figure 2-4. Covered tanks (breathing losses).

drawal losses occur from the evaporation of volatiles on the wetted wall as liquid is removed from the tank and the roof descends.

If retrofitted to a hazardous waste tank, the floating roof materials must be compatible with the waste, and floating roofs cannot be used in hazardous waste treatment tanks with surface mixers or aeration equipment. The emission reductions achieved by a floating roof relative to a fixed roof have been evaluated for volatile organic liquids by using empirical models. Depending on the type of deck and seal system selected, emission reductions of 93 to 97 percent can be obtained. For the smaller size tanks and varieties of wastes found at hazardous waste facilities, reductions of 74 to 82 percent can be obtained relative to a fixed roof. Converting an open top tank to a floating roof tank is estimated to reduce emissions by 96 to 99 percent.

Pressure tanks are designed to operate safely at internal pressures above atmospheric pressure. Consequently, these tanks can often be operated as closed systems and do not emit organics at normal storage conditions or during routine loading and withdrawal. Pressure-relief valves on the tanks open only in the event of improper operation or an emergency to relieve excess pressure. They are most common for the storage of gases; however, they can also be used to store liquids.

Another type of tank is that used for the *distillation* of organic liquids, which is common at solvent recyclers. In distillation, the more volatile components are separated from the waste by heating and transferring them to the vapor phase, which is removed through the overhead system. Distillation can be performed in a simple heated pot as a batch operation or in a column as a continuous operation. The device may be operated at atmospheric pressure, under vacuum, or under pressure. Emissions occur from the condenser/decanter vent, vents on collection tanks, and the vacuum system if vacuum is used (Figure 2-6).

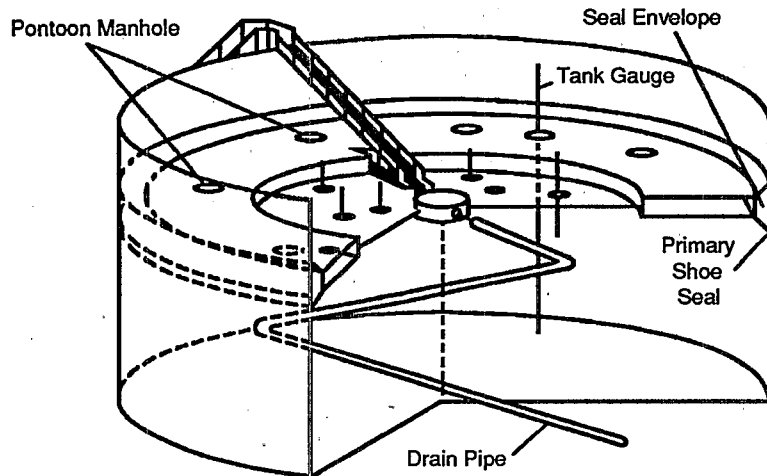


Figure 2-5. External floating roof tank.

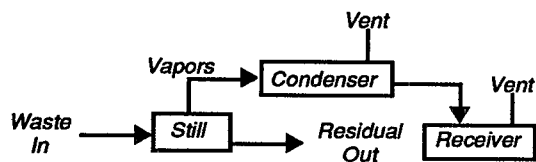


Figure 2-6. Emission sources for distillation.

In a batch still, the waste material is heated and volatiles are removed to some predetermined cutoff point, such as the concentration of organics in the condensate or the concentration remaining in the waste.

Emission models for distillation columns or other separation devices are not available because the emissions depend on the types of wastes, the specific organic compounds, and the design and operating details. However, the emissions from distillation and other separation devices are usually vented from a point source and can be measured. In addition, the operator should have the basic design and performance calculations that can provide insight into emission potential, or material balance calculations that indicate the fate of volatile compounds.

Solvent extraction is another type of separation process that has been used for organic liquids. It involves dissolving the volatile organics in a solvent. The solvent is physically separated from the waste and then recovered for recycle by distilling off the volatiles. This process has also been demonstrated for removing benzene from petroleum refinery sludge.

Although 80 to 100 percent of the target organics can be removed from the waste by the solvent, the overall control efficiency is probably less. Major emission points associated with solvent extraction are those involved in the distillation process used to recover the solvent (Figure 2-7). As discussed earlier, these emission points include the vent on the condenser/decanter and any collection tanks associated with the unit.

Aqueous Wastes (Wastewater)

Wastewater collection systems are of interest because some are affected by the NESHAP for benzene waste operations. The collection system includes individual drains, sewers, and junction boxes. Emissions occur when the wastewater is in direct contact with the air or from air sweeping through the collection system from a chimney effect. Our modeling efforts indicate that 20 to 40 percent of the benzene that is

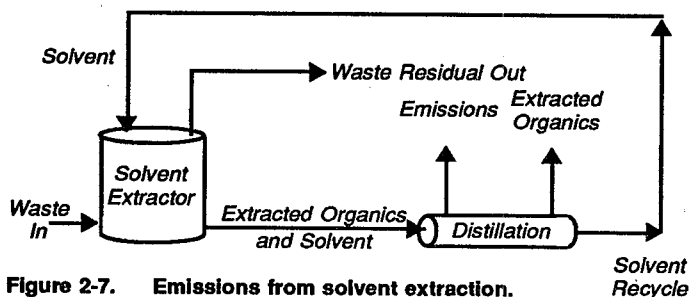


Figure 2-7. Emissions from solvent extraction.

present in the wastewater when it is first generated is emitted in the collection system.

Some of the different ways that the wastewater is drained from a specific process into the sewer line are shown in Figure 2-8. The open, unsealed *drain* is the greatest source of emissions from the free fall of the wastewater and vapors from the sewer. The closed drain essentially eliminates these emissions.

Individual sewer lines from different processes flow through *junction boxes* before entering the trunk or main sewer lines that handle combined flows from different process areas. The purpose of the junction box is to combine flows, to permit ready access to the sewer line for cleaning and inspection, and to isolate vapors from the different individual sewer lines. A typical junction box that is fitted with a gas-tight cover and a vent is shown in Figure 2-9. The device also has a water seal to prevent the flow of air through lines that may be partially filled with water. This device is operated at a constant liquid level; consequently, emissions from working losses should be relatively low.

Oil-water separators at petroleum refineries are also part of collection systems that may require control under the benzene waste NESHAP. These devices separate oil, water, and sludge from the wastewater (Figure 2-10).

The most common type of oil-water separator at petroleum refineries is the API separator. The separator is a large rectangular tank with an oil skimmer and the main bay, which provides a zone for separation. The separator relies on the different densities of oil, water, and solids: oil and solids lighter than water float on top of the aqueous phase and heavier sludges sink to the bottom. Oil is skimmed from the surface, and heavy sludge is periodically removed from the bottom of the separator.

Another type of separator in use at refineries is the corrugated-plate interceptor (CPI). This unit consists of 12 to 48 parallel corrugated plates mounted at an angle. Wastewater flows downward between the plates with the lighter oil droplets coalescing and floating to the surface. The oil droplets move up the plates to form a floating layer that is skimmed from the surface of the tank. These oil-water separators can be controlled by covering or by covering and venting emissions to a control device.

Wastewater is usually treated in large *open tanks*, and the emission mechanisms are similar to those described for surface impoundments. Generally, these tanks have smaller exposed surface areas and much shorter residence times than impoundments. This results in somewhat lower emissions from a single tank compared to a single impoundment; however, usually several of these tanks in series provide multiple opportunities for volatiles to be emitted.

Examples of wastewater treatment tanks include large open tanks used for equalization of wastewater streams from different processes and tanks that are often aerated or agitated to provide mixing, to suspend biomass, or to provide oxygen. Many wastewater treatment processes are performed in open tanks, such as equalization, neutralization, solids settling, and biodegradation.

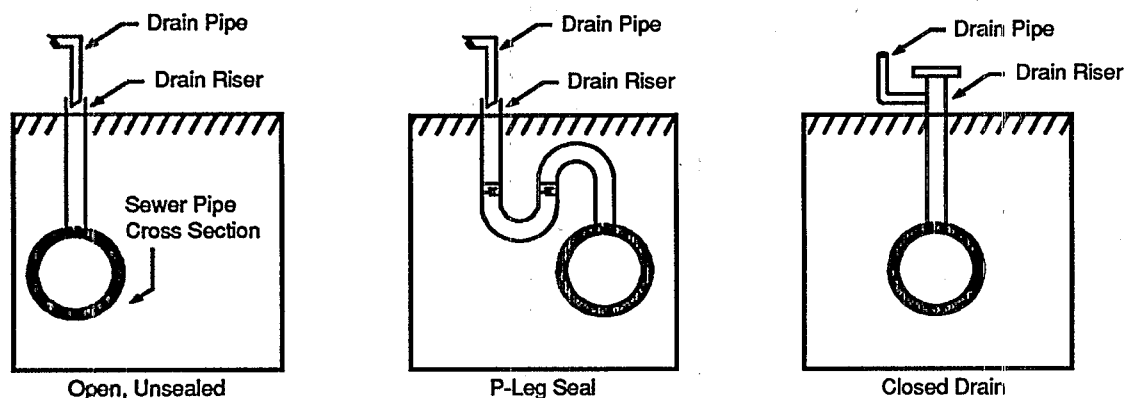


Figure 2-8. Individual drains.

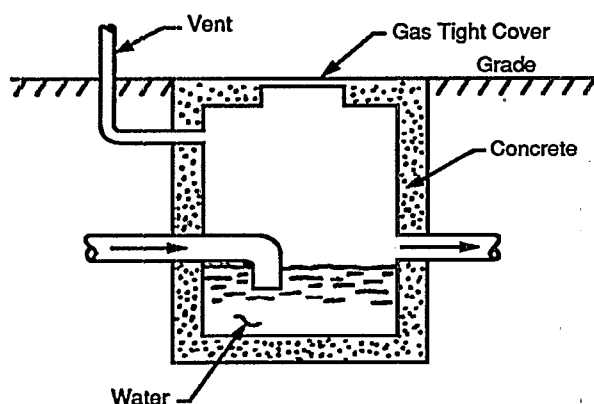


Figure 2-9. Typical junction box.

Another type of tank used to treat aqueous wastes is an *air stripper* (Figure 2-11), which may be a spray tower, packed column, or simply an aerated tank. It is most commonly used to remove parts per million or lower levels of volatiles from dilute aqueous wastes. Many air strippers with lower emissions simply are vented directly to the atmosphere, while others are controlled by carbon adsorption or incineration if organic concentrations warrant. Condensers on air strippers are generally ineffective because of low vapor phase concentrations and high volumetric flow rates.

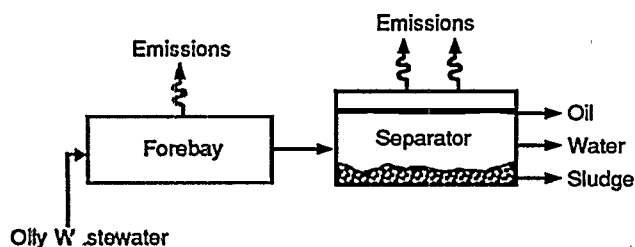


Figure 2-10. Oil-water separator.

Steam stripping also is used to treat aqueous wastes with concentrations on the order of hundreds of parts per million or higher. Steam is injected directly into the wastewater, the overhead vapors are condensed, organics are separated from the condensed water, and the decanted water is returned to the feed stream. Emissions occur from the vent on the condenser/decanter and from collection tank vents.

A schematic of an actual steam stripping system is shown in Figure 2-12 and illustrates the use of a heat exchanger to preheat the feed (to recover energy) and to cool the bottoms stream from the stripper before additional wastewater treatment. This particular system has a high level of organic recovery because both a primary and much colder secondary condenser are used. Emission control should be excellent because noncondensibles are vented to a vapor incinerator.

For continuous steam strippers, pretreatment (Figure 2-13) may sometimes be required to adjust pH or to remove solids, which can foul the column packing or trays and cause plugging problems. Any separate organic phase that can be decanted from the wastewater is removed prior to stripping.

Sludges

Fixation is another process that is often performed in tanks to solidify or stabilize sludges. The basic steps include mixing in a fixative agent, such as lime or fly ash, curing to allow solidification, and disposal. Mixing occurs most often in tanks, containers, or pug mills, which are relatively easy to enclose to control emissions. About half of the hazardous waste that is solidified is cured in tanks or containers, and the other half is cured in large open sources such as trenches or landfills.

Most of the volatiles are emitted during mixing when agitation is provided while adding the fixative agent. Exothermic reactions produce heat and increase volatilization, as in the addition of quick lime or calcium oxide to aqueous sludges. These emissions can be controlled by installing covers or enclosures that are vented to a control device.

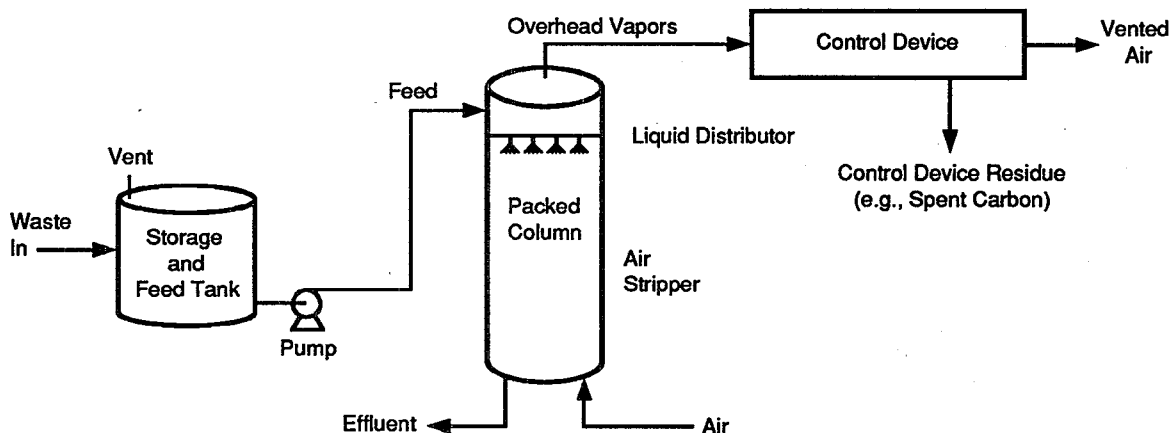


Figure 2-11. Schematic diagram of an air stripping system.

Another common process used for managing sludges is *dewatering*, which is performed by various types of filter presses, rotary vacuum filters, and centrifugal filters. A plate-and-frame press is an assembly of alternate solid plates, which are grooved or perforated to permit drainage, and hollow frames, in which the dewatered sludge collects during filtration. A filter medium, usually a fabric, covers both faces of each plate. As the slurry passes through the filter fabric to the plates, a cake of solids slowly builds up. The filtration continues until the pressure drop across the filter reaches a preset limit. The plates are then separated and the cake drops from the filter press into a collection bin under the press.

The belt filter press (Figure 2-14) squeezes the sludge between two systems of belts. Sludge is fed onto the lower belt, and, as the belt moves into the press, the upper belt meets it and squeezes the sludge. The filtrate squeezed from the sludge is usually collected in a sump under the filter and removed for further treatment or discharge. Solids are scraped off the belts as they separate and collect in a bin or are taken by conveyor to a storage or disposal area. As the belts continue their rotation, they are usually cleaned by being

passed through a belt washing system of high-pressure spray nozzles.

Other types of dewatering units are rotary in nature and use a vacuum, gravity, or centrifugal force to remove water from the sludge. For larger scale operations, sludge is scraped from the unit continuously and discharged through a chute to a container or conveyor belt.

These dewatering devices are not usually enclosed systems and provide several opportunities for volatile organics to be emitted. For the plate-and-frame press, emissions occur when the press is opened to remove and transport the accumulated sludge. During filtration, a small amount of liquid may leak from the press and accumulate in the drip pan underneath. The belt press provides a moving exposed surface area that facilitates drying and evaporation of volatiles. The filtrate drains freely and is often collected in an open sump. Both the filtrate and sludge are sources of emissions. Similarly, the sludge and filtrate handling systems for rotary vacuum and centrifugal filters are emission sources for any volatiles that are present in the original slurry. In addition, the vacuum pump may discharge volatiles. Emissions from dewatering devices can be controlled by building an enclosure around the unit and venting it to a control device.

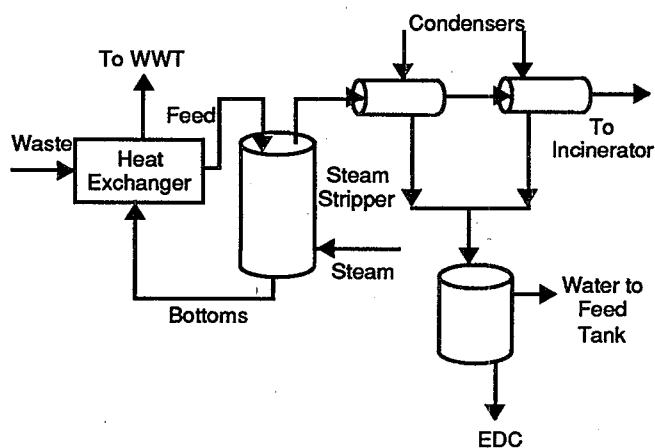


Figure 2-12. Steam stripper for ethylene dichloride/vinyl chloride.

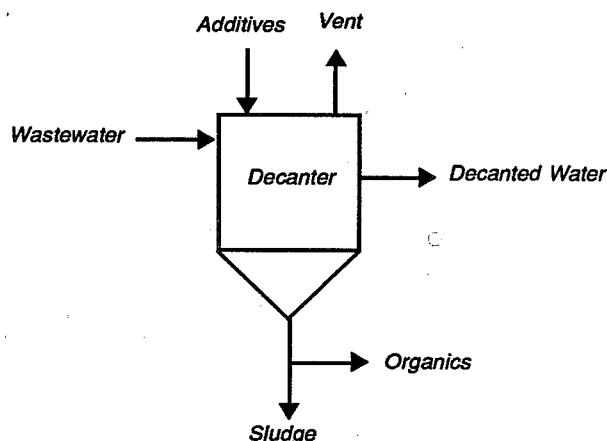


Figure 2-13. Preliminary treatment prior to stripping.

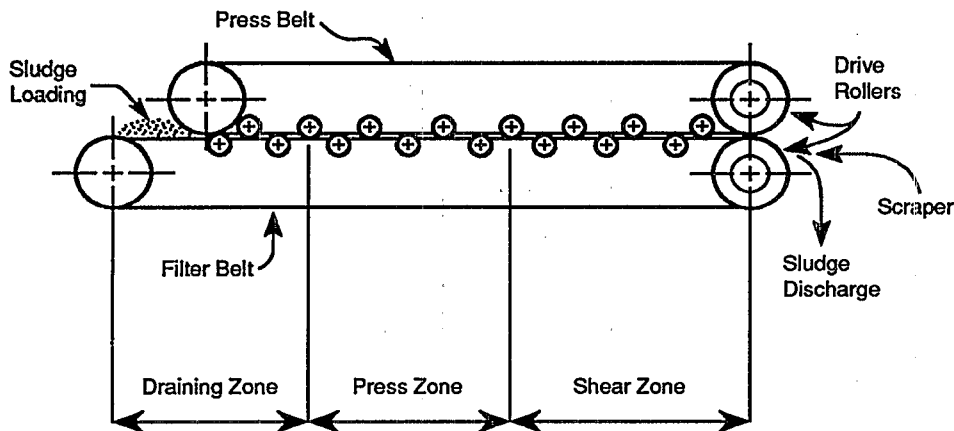


Figure 2-14. Belt filter press.

Thin-film evaporators (TFEs) (Figure 2-15) are also used to treat sludges. The primary advantage of this treatment technique is that it can remove volatiles from viscous sludges and slurries. A thin layer of waste is spread over a moving or wiped surface that is heated to volatilize organics. Emissions

occur from vents on condensers, decanters, and collection tanks, or from the vacuum system if one is used.

The vertical thin-film evaporator looks like a distillation column. In the TFE, the vapors with volatile organics are removed overhead to a condenser, and the treated waste is discharged from the bottom.

Ancillary Equipment

The ancillary equipment associated with tank systems includes pumps, valves, pressure-relief devices, compressors, sampling connections, and open-ended lines, which can become emission sources when they leak. Controls include dual mechanical seals with a barrier fluid (for pumps and compressors), sealless pumps, diaphragm or sealed-bellows valves, rupture disks for pressure-relief devices, closed-loop sampling, and caps for open-ended lines. In addition to the equipment controls for these types of sources, emissions can be controlled by establishing a leak detection and repair (LDAR) program. This program includes surveying these components for leaks, using a portable organic vapor detector to locate leaks, and making repairs, adjustments, or replacements as needed.

Containers

Containers are defined as any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled. Examples of typical containers are drums, dumpsters or roll-off bins, and tank trucks. Emissions occur from loading these containers, from uncovered containers during storage or transport, and from spills.

Drums can be sources of emissions from the evaporation of leaks and spills, and poor housekeeping practices can make spill detection and cleanup difficult. If the drums are well maintained on a diked pad, emissions from spills or ruptures can be identified by routine inspection procedures and promptly cleaned up. Dumpsters or roll-off bins can be a source of emissions if they are left uncovered with the surface of the waste exposed to the atmosphere.

Emissions from containers (Figure 2-16) occur when they are loaded, and emissions are greatest when splash filling is

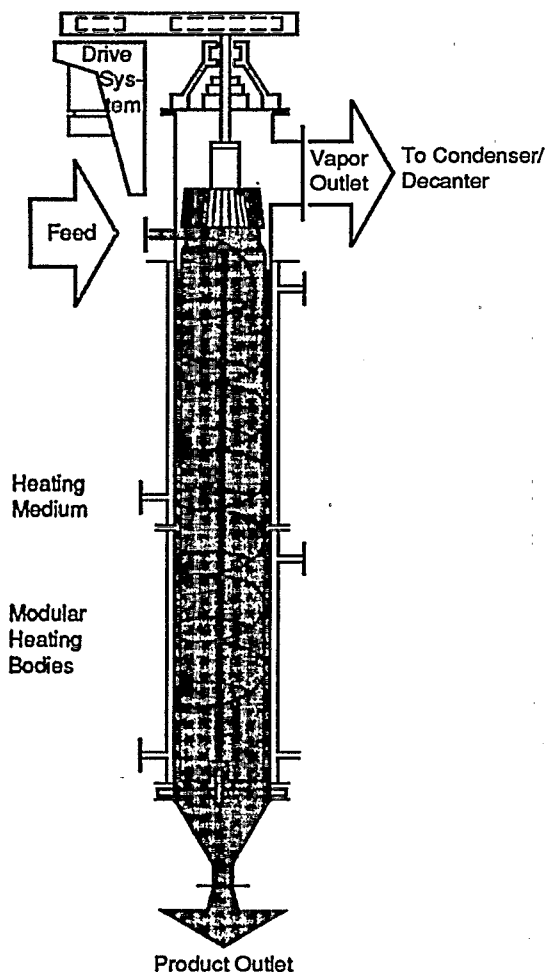


Figure 2-15. Flow path of thin-film evaporator.

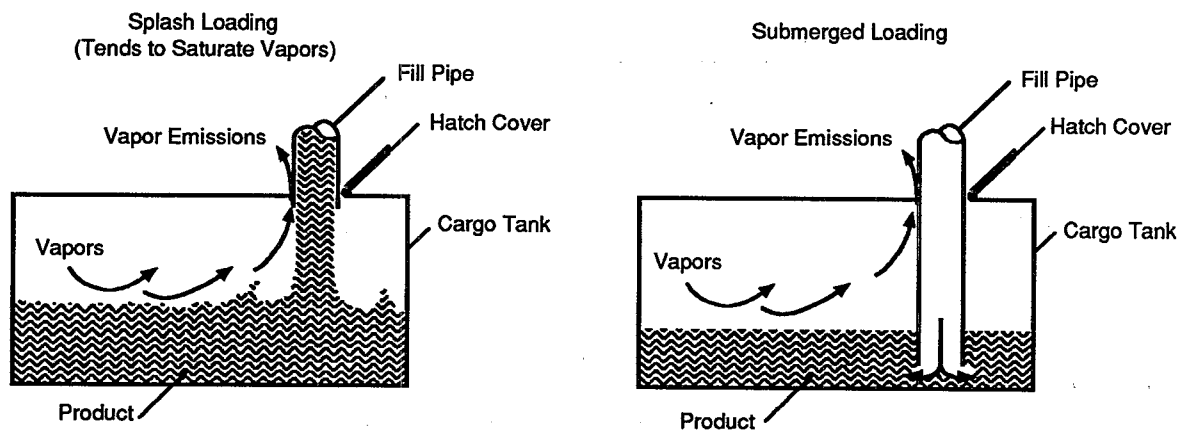


Figure 2-16. Splash loading vs. submerged loading.

used. When splash filling, the vapors displaced from the container by loading can quickly become saturated with volatiles from the splashing. Submerged fill uses an influent pipe that is below the surface, which reduces splashing and the degree of saturation of the displaced vapors. A study of submerged filling of tank trucks indicated that emissions were reduced by 65 percent relative to splash filling. Other basic controls for containers include using simple covers during storage or transport and routine housekeeping practices with daily inspections and prompt cleanup of spills.

Land Disposal Sources

Landfills, wastepiles, and land treatment are the sources expected to be most directly affected by the LDR. These are open area sources from which the volatile organic compounds are emitted fairly quickly, and the emissions can be controlled by covers and enclosures. However, the technologies described under LDR will likely take care of the volatile organics, and in the end they should not be significant sources of emissions.

A *land treatment* facility is defined as a facility at which hazardous waste is applied onto or incorporated into the soil surface; such facilities are disposal facilities if the waste will remain after closure. Land treatment is also known as land farming, land application, land spreading, and soil incorporation. Volatiles are rapidly emitted from the surface of land-treated waste (Figure 2-17). Over time, volatiles diffuse through the waste to the surface, where they are swept away by the wind.

In land treatment, the waste can be applied to the soil and mixed by tilling, or the wastes may be sprayed directly onto the soil and subsequently mixed with the soil by tilling. Volatiles are rapidly removed from the waste during spraying.

Landfills are composed of active and covered cells. Wastes are often segregated based on waste compatibility and compaction requirements. The wastes are then covered with a layer of soil and compacted, and another layer of waste is added or a new cell is started. If any volatiles are left in the waste when it finally reaches the landfill, they are rapidly emitted from the surface of exposed waste in active cells.

After covering and compacting, emissions occur by diffusion, barometric pumping, and gas venting (Figure 2-18).

Wastepiles are defined as noncontainerized accumulations of solid, nonflowing hazardous waste used for treatment or storage. The emission mechanisms for wastepiles are similar to those for land treatment: rapid volatilization from the exposed surface followed by mass transfer through the waste.

Models have been developed for exposed soil surfaces such as land treatment and wastepiles and for covered landfills. In the model for exposed soil surfaces that contain organics, volatiles in the oil and water are assumed to be in equilibrium with air in the void spaces. Some organics may be adsorbed onto the soil particles, and, in some cases, biodegradation may destroy the organics. Emissions occur by diffusion to the surface, where organics are removed by the wind. For the covered portion of landfills, the modeling includes diffusion through the cap and losses from barometric pumping, which is caused by changes in ambient pressure.

These land disposal sources can be controlled by installing a flexible membrane cover, enclosing the source in a rigid structure, or using an air-supported structure as discussed earlier for surface impoundments. A better emission control is not to place wastes containing volatiles in these sources (for example, treat the wastes to remove the organics before disposal).

Emission Controls

Several air pollution control devices can be applied to many of the sources that have been discussed once they are covered or enclosed and vented. The traditional ones that are discussed briefly here are carbon adsorption, condensation, absorption, and vapor combustion.

Carbon Adsorption

In adsorption, organics are selectively collected on the surface of a porous solid. Activated carbon is a common adsorbent because of its high internal surface area: 1 gram of carbon can have a surface area equal to that of a football field and can typically adsorb up to half its weight in organics. The adsorber will remove essentially all of the target volatiles

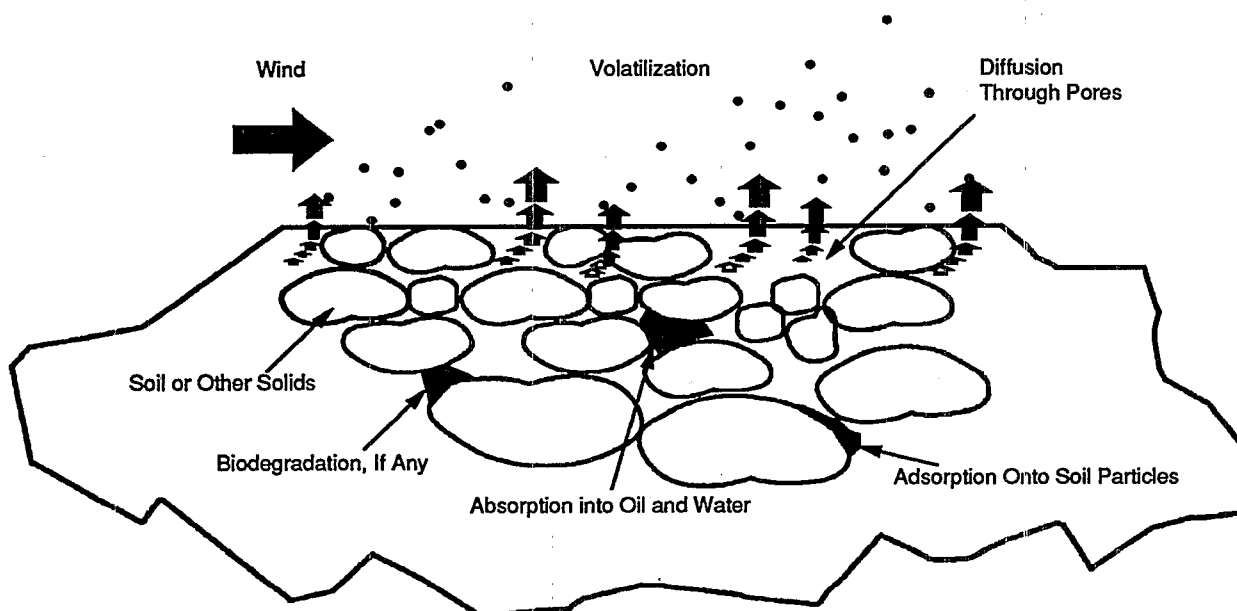


Figure 2-17. Land treatment emission mechanisms.

from the vented vapors until breakthrough, which is when the volatiles are first detected in the cleaned vapor leaving the bed. Carbon adsorbers can achieve control efficiencies of at least 95 percent, and control levels of 97 to 99 percent have been demonstrated in many applications. The two common types of adsorbers are carbon canisters and regenerable fixed beds.

Carbon canisters (Figure 2-19) are used for low vent flows, usually less than 100 ft³/min, and are not regenerated onsite. They are usually discarded or returned to the supplier. The canisters are fairly compact units and can easily be removed and fresh canisters installed. Fixed-bed carbon adsorbers that can be regenerated (Figure 2-20) are used for controlling continuous vent streams with flows exceeding 100,000 ft³/min and can handle a wide range of organic

concentrations. A common procedure is to have dual beds with one desorbing while the other is adsorbing.

The carbon capacity for organics is affected by the concentration of organics in the vapor. Carbon manufacturers generally have equilibrium data for specific compounds and their specific carbons. The bed design is important and must be deep enough to prevent rapid breakthrough, yet not so deep as to cause excessive pressure drop. The flow rate is important in the bed design and in determining carbon capacity requirements. Humidity has an adverse effect when water occupies some of the adsorption sites. For a relative humidity of 50 percent or more, dehumidification or dilution may be neces-

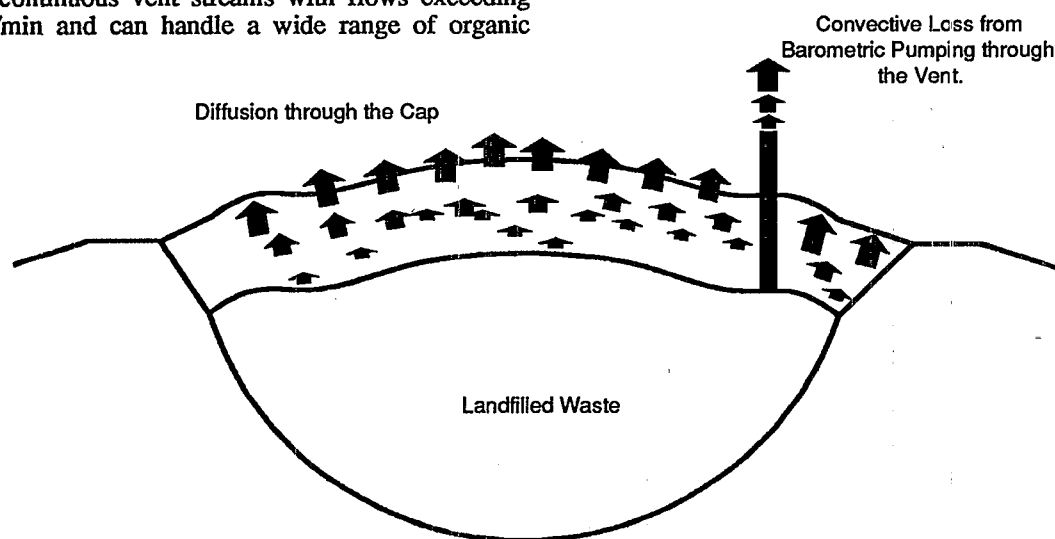


Figure 2-18. Emissions from a closed landfill.

- For Vent Flows Less Than 100 CFM
- Cannot Be Regenerated in Canister

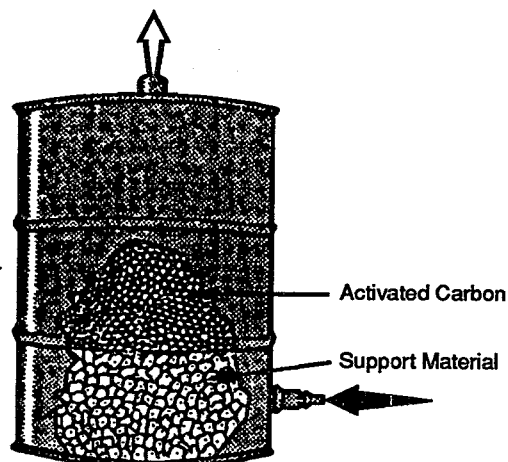


Figure 2-19. Carbon canisters.

sary to lower the relative humidity. The bed's operating temperature affects capacity, and some compounds such as aldehydes and ketones may generate heat in adsorbers. For these special cases, some means of removing the excess heat may be necessary.

For effective emission control by adsorption, one of two actions is necessary: either to monitor for breakthrough or to replace the carbon periodically before breakthrough occurs. In addition, any emissions from the disposal or regeneration of the carbon should be controlled. Controlling emissions from a vent stream is of little value if the collected organics are emitted later in the wastewater treatment associated with regeneration.

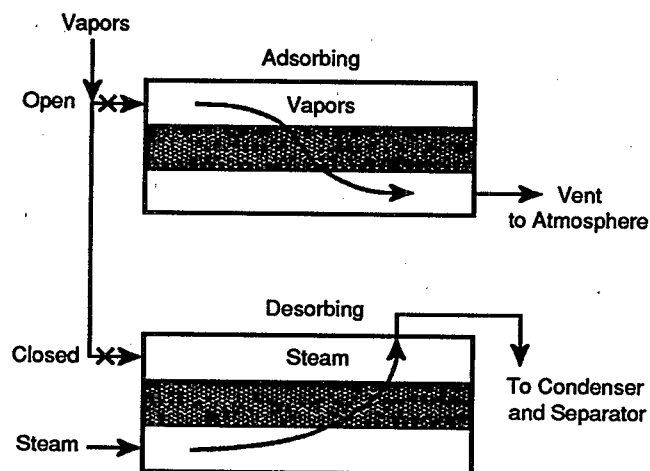


Figure 2-20. Two-stage adsorption system.

Condensation

Condensers work by cooling the vented vapors to the dew point and removing the organics as a liquid. The efficiency of a condenser is determined by the vapor phase concentration of the specific organics and the condenser temperature. Two common types of condensers are contact condensers and surface condensers.

The contact condenser (Figure 2-21) is cheap and efficient. However, the cooling liquid that directly contacts the vented vapors can present a disposal problem. For example, if the coolant is water that is sent to wastewater treatment, the volatiles may be emitted in open tanks. The shell and tube condenser (Figure 2-22) does not allow contact between the vented vapors and the cooling medium. In this type of condenser, a concentrated organic liquid can be recovered for recycle or other use.

Absorption

In absorption, the organics in the vent gas are dissolved in a liquid (Figure 2-23). The contact between the absorbing

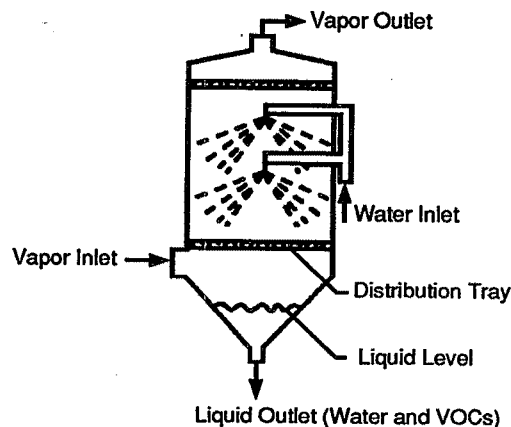


Figure 2-21. Schematic diagram of a contact condenser.

liquid and the vent gas is accomplished in spray towers, scrubbers, or packed or plate columns. Some common solvents that may be useful for volatile organics include water, mineral oils, or other nonvolatile petroleum oils. Absorption efficiencies of 60 to 96 percent have been reported for organics. For example, methylene chloride removal from vented vapors has been measured at 87 percent using water as the absorbing liquid.

The material removed from the absorber may present a disposal or separation problem. For example, organics must be removed from the water or nonvolatile oil without losing them as emissions during the solvent recovery or treatment process.

Vapor Combustion

Vapor combustion is another control technique for vented vapors. The destruction of organics can be accomplished in flares, thermal oxidizers, such as incinerators, boilers, or process heaters, and in catalytic oxidizers.

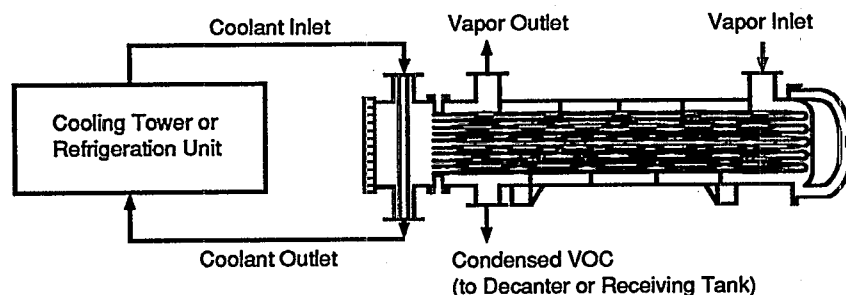


Figure 2-22. Schematic diagram of a shell-and-tube surface condenser.

Flares are an open combustion process in which the oxygen is supplied by the air surrounding the flame. Flares are operated either at ground level (usually with enclosed multiple burner heads) or they are elevated. Elevated flares often use steam injection to improve combustion by increasing mixing or turbulence and pulling in additional combustion air. Properly operated flares can achieve destruction efficiencies of at least 98 percent. Figure 2-24 is a schematic of the basic components of a flare system. The EPA has developed regulations for the design and operation of flares that include tip exit velocities for different types of flares and different gas stream heating values.

Thermal vapor incinerators can also achieve destruction efficiencies of at least 98 percent if the conditions of an adequately high temperature, good mixing, sufficient oxygen, and an adequate residence time are met. These vapor incinera-

tors can be designed to handle vent rates of 200 to 500,000 cfm. An auxiliary fuel may be required to maintain the combustion conditions if the vent gas has less than 50 Btu/scf. Figure 2-25 shows the components of a vapor incinerator. A heat recovery unit, such as a steam generator, may be used to recover some of the energy from a thermal incinerator.

Catalytic incinerators provide oxidation at temperatures lower than those required by thermal incinerators. Design considerations are important because the catalyst may be adversely affected by high temperatures, high concentrations of organics, fouling from particulate matter or polymers, and deactivation by halogens or certain metals. The basic components of a catalytic oxidizer (Figure 2-26) are similar to those of a thermal unit except that a catalyst bed is used. The energy requirements of a catalytic oxidizer are lower than those of a thermal unit because of the lower operating temperatures.

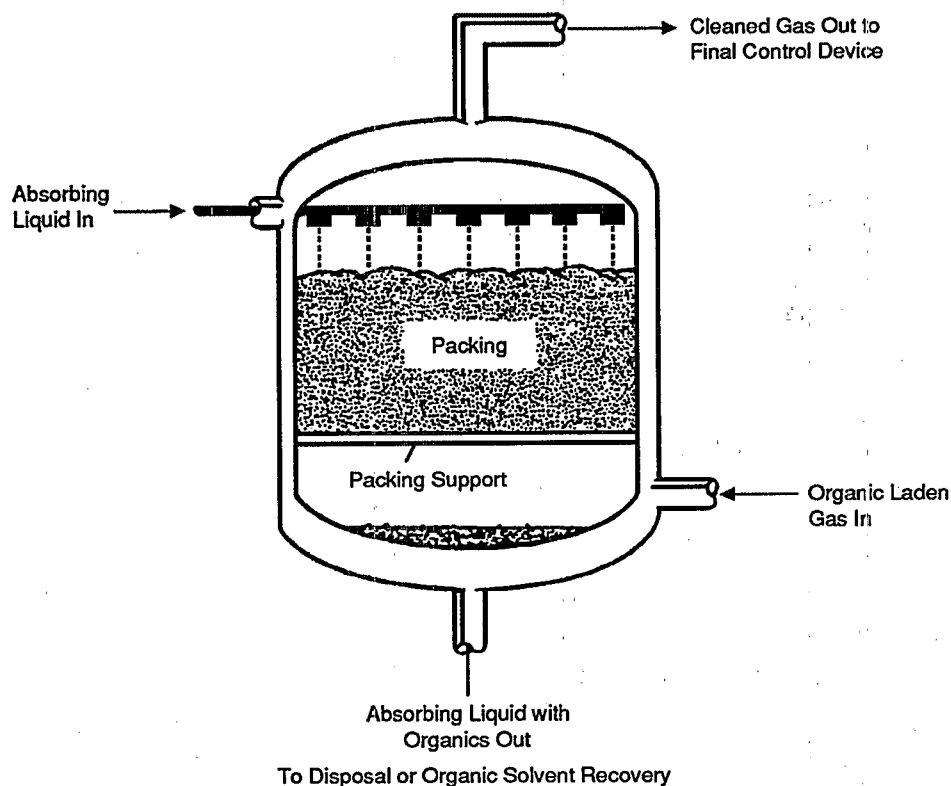


Figure 2-23. Packed tower for gas absorption.

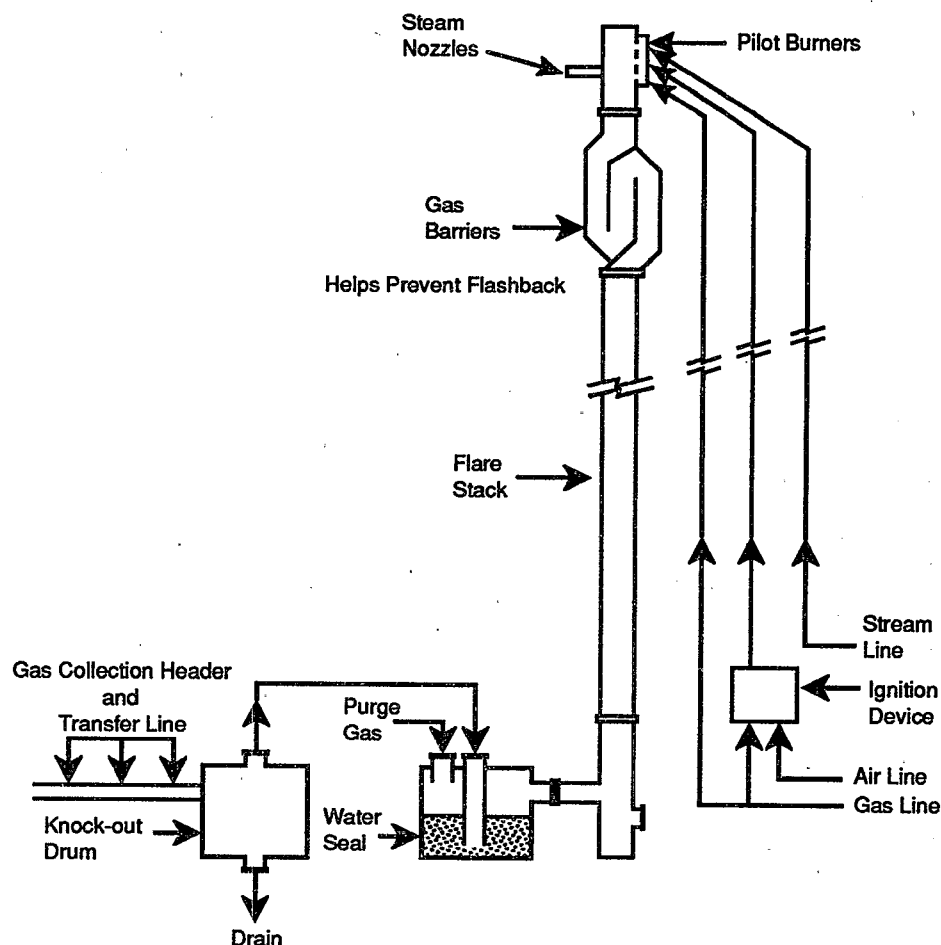


Figure 2-24. Steam-assisted elevated flare system.

The organics in vented vapors can also be destroyed with a high level of efficiency in boilers or process heaters. In these devices, vapors with halogens or sulfur are avoided because of potential corrosion problems. These devices recover the heating value of the vent stream, and they offer the advantage of using existing equipment to control emissions.

Organic Removal

Organic removal or pretreatment is a control option that is applicable to a variety of waste types. These processes include steam or air stripping, thin-film evaporation, solvent extraction, and distillation. These processes are capable of removing essentially all of the highly volatile compounds from the waste. The removal of the volatiles near the point of generation can avoid the need to install controls on subsequent process units and may facilitate recycling the recovered organics back to the process.

The control efficiency that can be obtained by organic removal depends on many factors, such as the percent removed from the waste, the emissions from the removal system, and the uncontrolled emissions from treatment units before the removal device was installed. Generally, overall control efficiencies of 98 to over 99 percent can be achieved.

Waste Incineration

Waste incineration is also an emission control option that can be used instead of processing the waste in units with a high emission potential. This technology has been identified as an alternative to land disposal in the development of the land disposal restrictions for certain wastes. Destruction efficiencies of 99.99 percent or higher have been demonstrated in properly operated waste incinerators.

Summary

In summary, tanks and surface impoundments are the major sources of organic air emissions at hazardous waste treatment, storage, and disposal facilities. Based on work performed in the development of the benzene waste NESHP, wastewater systems are a major source of benzene emissions from wastes that contain benzene.

Emissions occur from the surface of open area sources, and high percentages of the volatiles are lost as emissions in these sources. For enclosed sources, the displacement of vapor containing volatiles from the enclosed vapor space is the emission mechanism. For both types of sources, heating or

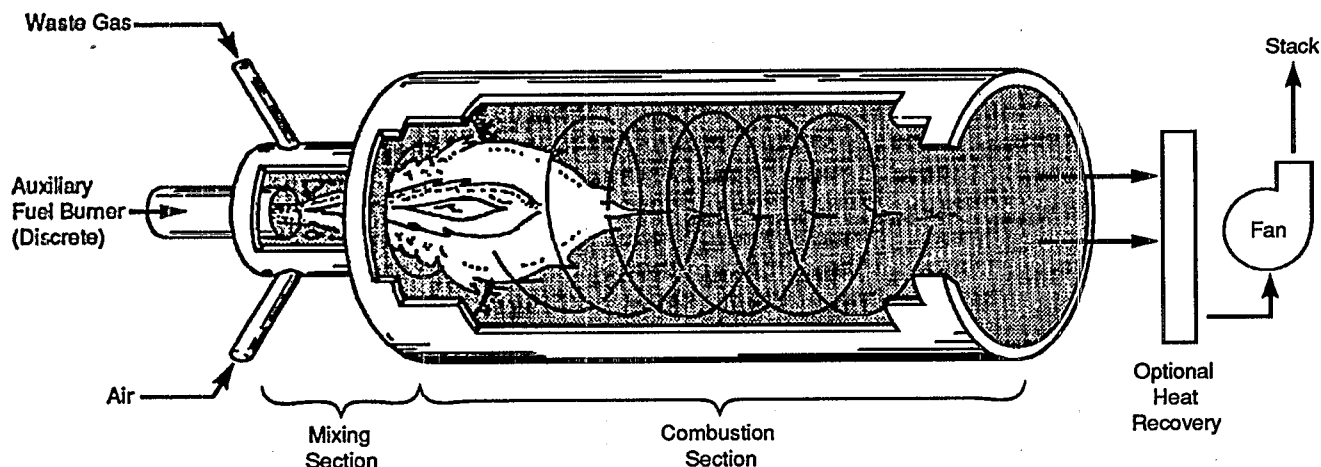


Figure 2-25. Thermal Incinerator.

aeration increases emissions. Emissions also occur from the evaporation of leaks and spills.

Emission models have been developed for open area sources, including both the liquid surface of impoundments and tanks and the solid surfaces associated with land treatment and landfills. Both types of models can account for the biodegradation of specific compounds, and the effect of turbulence from agitation can be included for liquid surfaces. For enclosed sources, models are available to estimate the vapor displacement rate and the concentration of volatiles in the vapor.

For emission control, open area sources and containers can be covered or enclosed. Control devices can be installed to collect and remove organics from vented vapors, which is especially important if the sources are heated or aerated. Organic removal by pretreatment and waste incineration are also emission control options, and their use may preclude the need to apply covers or control devices to subsequent treatment units. Simple work practices, such as leak detection and repair or inspections and cleanup of spills, help to control emissions from equipment leaks and spills. Pumps and valves that are designed not to leak offer another potential control option for these sources.

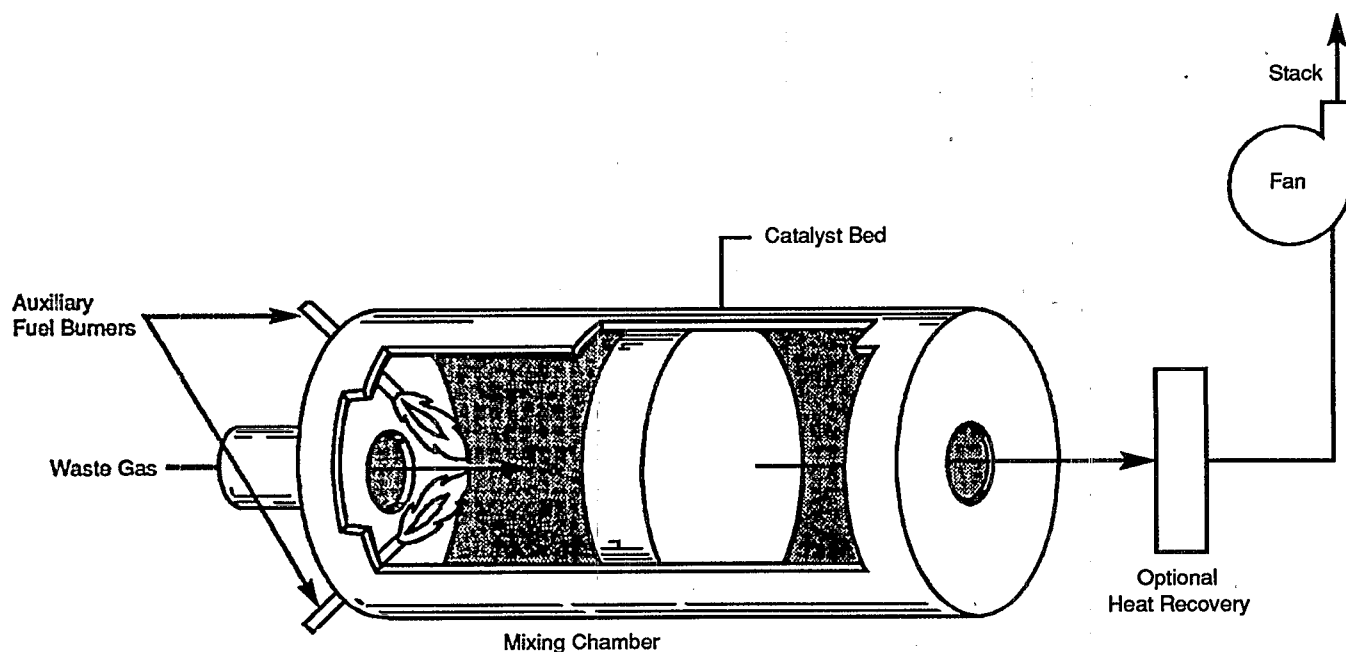


Figure 2-26. Catalytic oxidizer.

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Questions and Answers

Question—What is the difference in the combustion of gaseous emissions at 95 to 98 percent efficiency versus the combustion of hazardous waste at 99.99 percent efficiency?

Answer—Vapor incinerators are often used on vapor streams that have relatively low concentrations. EPA studies indicate that destruction efficiencies on the order of 98 percent or higher can be achieved on these vapor streams. For vapor streams with very low concentrations, the destruction

efficiency may be limited by a minimum outlet concentration of 20 ppm.

The destruction and removal efficiency (DRE) for hazardous waste combustion is based on the principal organic hazardous constituents. These compounds are present in relatively high concentrations, and the measured DRE is often limited by detection limits in the exhaust.

Question—How significant are equipment leaks as sources of emissions?

Answer—The uncontrolled emissions can be as significant as those from open area sources, especially when the facility has a large number of equipment items (such as pumps, valves, and flanges) that handle volatile organic emissions.

Question—Are emissions from landfills, land treatment, and wastepiles significant, and will these sources be regulated for organic emissions?

Answer—Currently, no plans to regulate these sources under Section 3004(n) of RCRA exist. Our available data and consideration of the effects of the land disposal restrictions suggest that these operations are not significant sources of organic emissions.

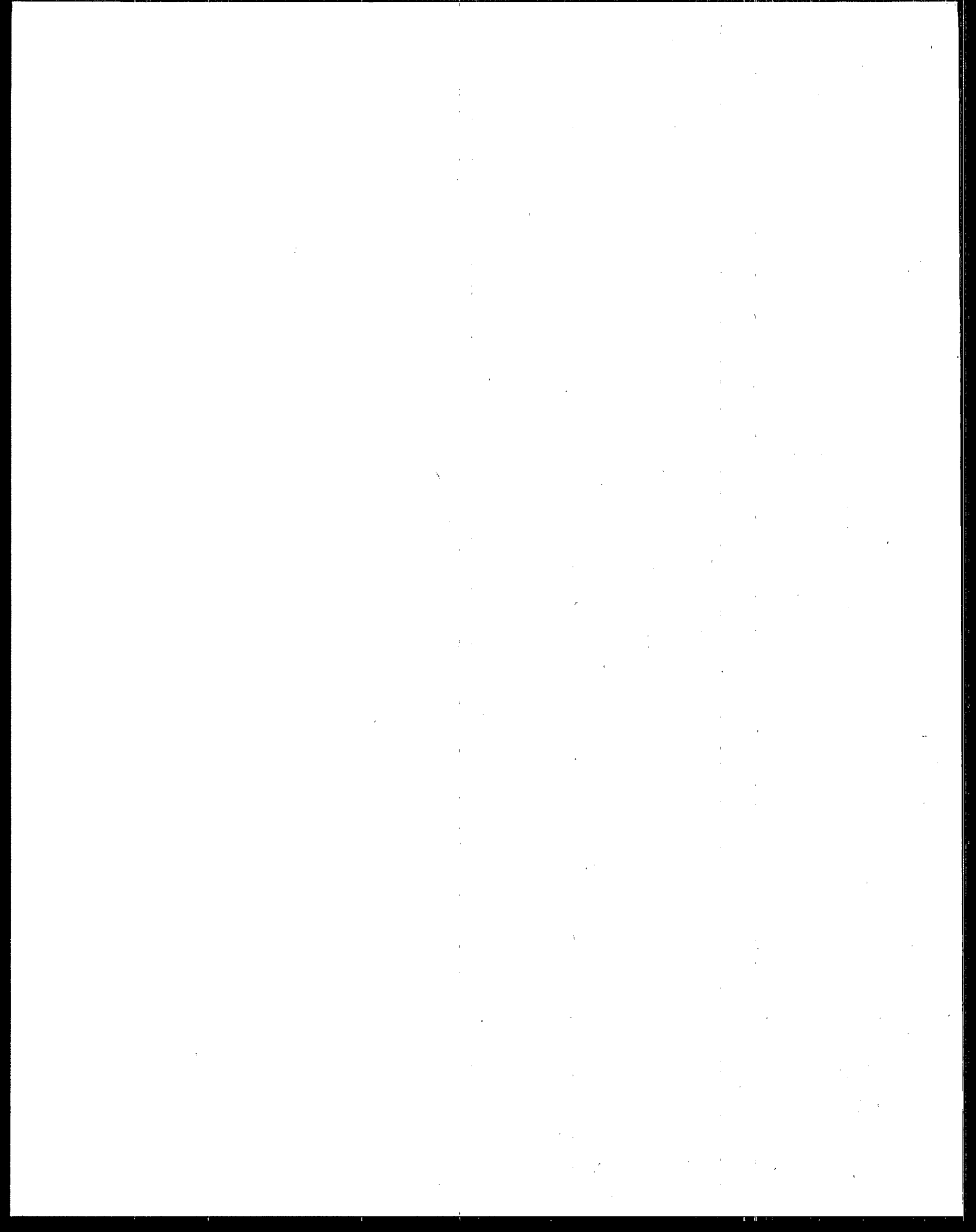
Question—When carbon is used for emission control, what happens to the organics that are removed when the carbon is regenerated?

Answer—The fate of the organics depends on the regeneration process. If the regeneration is performed in a furnace, the organics in the gases and vapors removed from the carbon usually are destroyed by thermal oxidation. If steam is used for regeneration, the organics are either recovered by condensation, emitted through the condenser vent, or emitted from the wastewater (condensed steam from regeneration) when it is treated.

Question—Are primary condensers part of the production unit or are they control devices? Condensers are efficient from primary control, but often do not get high efficiencies as an emission control. Is EPA promoting their use?

Answer—Primary condensers are part of the production unit and are not considered as a control device to meet the standards. For example, in many recovery operations, volatile components are separated in the vapor phase and then recovered by condensation in the primary condenser.

The EPA is not promoting the use of condensers; most of the rules require that the condenser be designed and operated to achieve a control efficiency of at least 95 percent. Consequently, condensers may not be acceptable controls in many applications, such as the control of vapor streams with very low concentrations or streams that would require unreasonably low temperatures to achieve 95 percent control.



Chapter 3

Process Vents Standards

Subpart AA

Abstract

The objective of this presentation on the RCRA process vent rules is to provide a basic understanding of the new RCRA air emission standards for process vents so that those persons required to comply with, implement, or enforce the rules can do so effectively and in a timely manner. The presentation clearly explains the process vent rule applicability criteria, which include facility authorization under RCRA, hazardous waste management unit type, and waste organic concentration. Technical requirements for emission controls and the facility "bubble" concept for emission rate limits are explained. Record-keeping and reporting requirements are discussed also.

The process vent standards in 40 CFR 264 and 265, Subpart AA, limit organic air emissions at hazardous waste treatment, storage, and disposal facilities (TSDF) requiring a permit under Subtitle C of the Resource Conservation and Recovery Act (RCRA). The standards were promulgated on June 21, 1990 (55 FR 25454), under the authority of Section 3004(n) of the Hazardous and Solid Waste Amendments (HSWA) to the RCRA. The Subpart AA standards are applicable to process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, and air and steam stripping operations that manage hazardous wastes with 10 parts per million by weight (ppmw) or greater total organic concentration. The RCRA air rules for process vents require that owners/operators of TSDFs subject to the provisions of Subpart AA: (1) reduce total organic emissions from all affected process vents at the facility to below 1.4 kg/h (3 lb/h) and 2.8 Mg/yr (3.1 ton/yr), or (2) install and operate a control device(s) that reduces total organic emissions from all affected process vents at the facility by 95 weight percent. The process vent rules do not require use of any specific types of equipment or add-on control devices. Condensers, carbon adsorbers, incinerators, and flares are demonstrated emission control technologies for the regulated processes, although the choice of control is not limited to these. To ensure that control devices perform according to their design, the rules for process vents require that specific control device operating parameters be monitored continuously and the monitoring information be recorded in the facility operating record.

Process Vents

This chapter covers the organic air emission standards for process vents. These rules were promulgated on June 21, 1990. The purpose of the chapter is to answer some of the most common questions the U.S. Environmental Protection Agency (EPA) has received on the rules.

This chapter should answer the following questions (Table 3-1): "Who is affected by the rule, why did EPA develop the rule, and how many facilities are subject to the rule?" In addition, details of the regulation including types of regulated units, the effective date, control device requirements, recordkeeping, and reporting will be discussed.

Table 3-1. Questions on Details

What units are regulated?
How does the regulation work?
When do the regulations become effective?
What are the requirements for control devices?
What records must be maintained?
What reports must be filed?

Who is affected? On the broadest level, anyone who has a facility subject to Part 270 of the Resource, Conservation, and Recovery Act (RCRA). That covers anyone with a Subtitle C facility, whether the facility has a final permit or is still in interim status. In promulgating this rule, EPA modified Section 261.6 of the RCRA regulations and brought in previously exempt recycling units at RCRA-permitted facilities. If you have a RCRA permit and you have a recycling unit that up to this point has not been subject to any RCRA rules, it may now be subject to the RCRA air rules, Subparts AA and BB.

Six types of unit operations are covered by the rule (Table 3-2): steam strippers, distillation, fractionation, thin-film evaporation, solvent extraction, and air strippers. Unless the unit involves one of these six types of unit operations, it is not regulated by Subpart AA.

Other than recycling, all RCRA exemptions remain in effect. Production units are not regulated by RCRA and are not affected by this rule (40 CFR 261.4(c)). The wastewater treatment exemption applies to units that are regulated under

Table 3-2. Units Affected

- Steam strippers
- Distillation
- Fractionation
- Thin-film evaporation
- Solvent extraction
- Air strippers

the Clean Water Act (CWA) (40 CFR 264.1(g)(6), 265.1(c)(10), and 270.1(c)(2)(v)). Subtitle D or municipal waste units are not covered under these rules. Units handling domestic sewage are exempted from the rules because sewage is not considered a solid waste (40 CFR 261.4(a)(1)). Closed-loop reclamation refers to another exclusion from the solid waste definition that is presented in 40 CFR 261.4(a)(8) of the RCRA rules. Secondary materials that are being reclaimed in accordance with the RCRA rule are not considered solid waste and therefore are not subject to RCRA. Section 261.4 is specific as to what is considered a closed-loop reclamation: the reclamation process must be connected directly by piping to the production process, only tank storage is allowed, the materials have to be reclaimed within 12 months, and reclamation cannot involve combustion processes. A process that qualifies for this closed-loop reclamation exclusion is not regulated by the Subpart AA rules discussed here.

The applicability discussion started at the facility level, moved to the process level, and is now at the vent level. Subpart AA is a waste-based rule, and the waste must contain 10 ppm or greater total organics by weight before an individual unit must be controlled under this rule. The 10 ppmw must be determined on a time-weighted annual average basis, which means that, at some point in the year, greater than 10 ppmw waste could be managed in the unit and still the unit would not be affected by the rule if the waste managed in the unit had an organic concentration of less than 10 ppmw on a time-weighted annual average basis. In addition, emissions do not have to be vented from the affected unit. If the emissions are vented through a tank that is associated with the unit, the emissions are still covered by this rule. Typical associated tanks with affected process vents include condensers, hot wells, and distillate receivers.

Example 1 (Figure 3-1), air stripping, is one of the six unit operations covered by the rule. If the waste going into this air stripper is greater than 10 ppmw in organic concentration on a time-weighted annual average basis, then the overhead vapors from this air stripper would be covered by the rule. The tank that sits in front of the air stripper, the feed tank, is not regulated by the process vent rule. The emissions from this tank are a result of the breathing and working losses.

Example 2, steam stripping, is another one of the six unit operations covered by the rule (Figure 3-2). In this case, the emissions pass through a condenser and are vented through a distillate receiver. This distillate receiver is considered a tank associated with the steam stripper and therefore the emissions are regulated under the rule. The other three tanks, the accumulator tank, the effluent storage tank, and the feed tank, are similar to the feed tank in the first example. Emissions from these three tanks are not regulated by the process vent rule. If you need to get a better understanding of which vents are

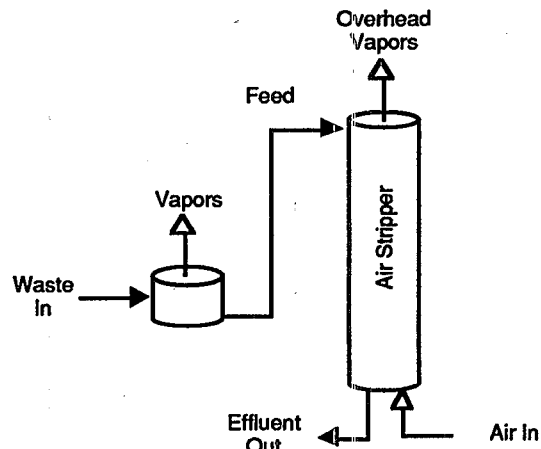


Figure 3-1. Example 1—air stripping.

covered under the rules, the process vent case study is very helpful.

Subpart AA was developed to protect human health and the environment. In addition, as mentioned previously, EPA developed this rule in recognition of the fact that the Office of Solid Waste (OSW) was also developing rules on land disposal restrictions and that air emissions would need to be controlled from some of the technologies used to comply with the land disposal restrictions rule.

The number of units in the United States is shown in Figure 3-3. These data were collected by the OSW in 1987. Batch distillation is the most common, with 185 units, and the numbers decrease to only 10 air strippers shown as *regulated under RCRA* in 1986. Again, the rule covers recycling units that are located at facilities with a RCRA permit so these numbers from 1986 will increase as previously unregulated units are brought into the RCRA system. The annual emissions for three different size model plants is presented in Figure 3-4. In the development of the rule, EPA looked at three different size facilities based on annual operating hours

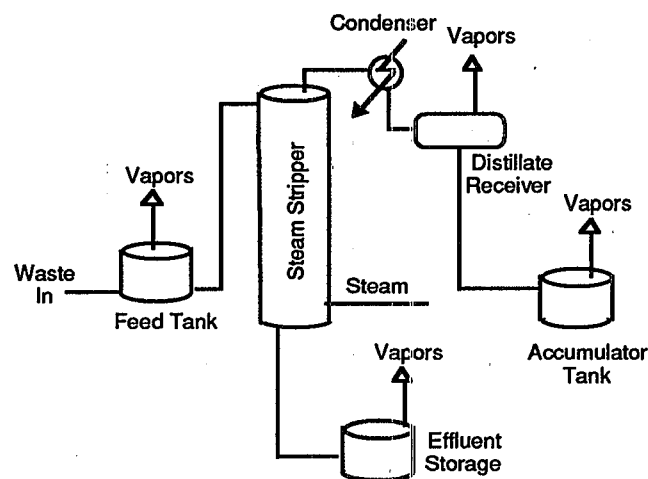
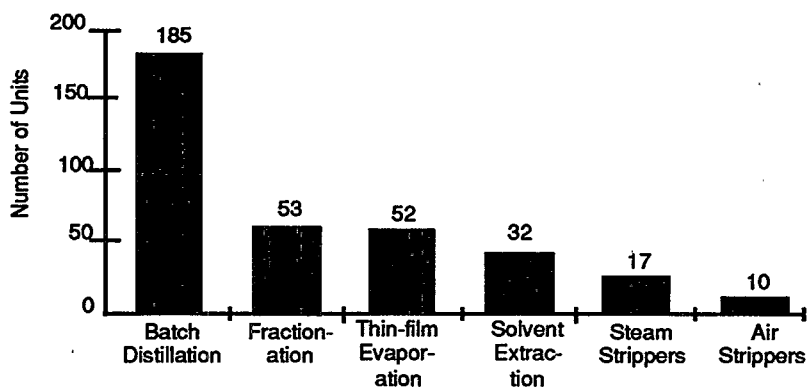


Figure 3-2. Example 2—steam stripping.



Source: 1987 TSDR Survey

Figure 3-3. Number of units.

and the size of the units. With six different operations covered by the rule, quite a range of emissions exists. For a large facility, emissions range from about 1 ton per year up to slightly more than 20 tons per year. Medium facilities range from around 1/2 ton per year up to 5-1/2 tons per year. Small facilities, which are primarily batch distillation units, all have less than 1 ton per year of emissions.

The five steps involved in how the regulation works at a single facility are listed in Table 3-3.

The first step is to identify all the units that fall under the rule. Six types of unit operations are covered, and the units must be treating a hazardous waste with an organic concentration of 10 ppmw or greater on a time-weighted annual basis. Once a unit is identified as falling under the rule, the owner/operator must determine the maximum hourly and annual emission rates from the vents. The rule specifies methods that can be used for direct measurement, such as Method 18 for organic concentration and Method 2 for velocity and volumetric flow rate. In addition, the rule has provisions for use of "knowledge" to determine emission rates. If you have previously tested the stack on the process vent and can certify that the operation and the waste have not changed, then the previous test results would be acceptable. In some cases, the manufacturer may be able to certify emission rates on certain units.

Once a maximum hourly and annual emission rate for each vent has been determined, the individual rates must be summed to get a facility rate. The total facility process vent emissions rate must be compared to the limits of 3 lb/h and 3.1 ton/yr. If the facility is over either limit, the owner/operator must either reduce emissions down to the limit or reduce total facility process vent emissions by 95 percent. The rule specifies that the reduction must be obtained by using a control device.

In Example 3, shown in Figures 3-5, 3-6, and 3-7, three process vents have been identified; the facility emission rate is obtained by summing the individual emission rates. In this case, the three emission rates are 10, 1, and 55, for a total of 66 ton/yr. To reach compliance with the rule, the facility must either bring emissions below the emission rate limit or reduce the total by 95 percent. In this case, a 95 percent reduction works out to be 3.3 ton/yr, which is slightly greater than the 3.1-ton/yr emission rate limit. The facility can reach compliance by achieving 95 percent control on each of the three vents. The facility could use three different control devices, or it could tie all three into a single control device that would achieve 95 percent. A second option shown here involves the facility providing 88 percent control on Process Vent #1, leaving the second vent uncontrolled, and achieving an emission reduction of 98 percent on the largest emitting vent, #3.

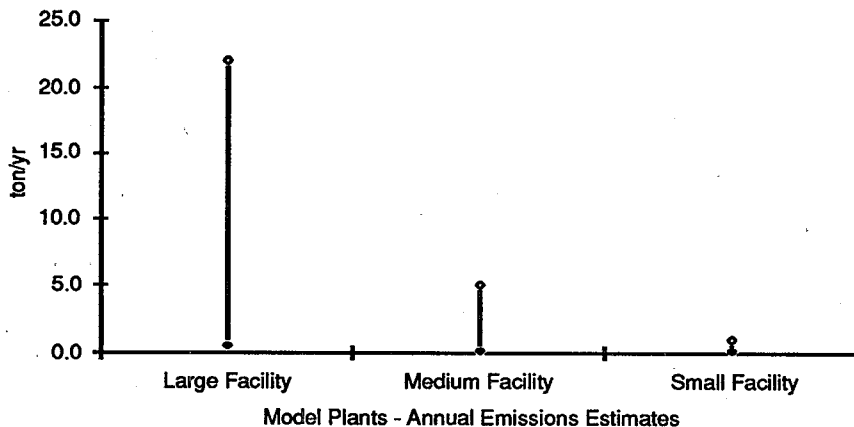


Figure 3-4. Annual emissions from a typical facility.

Table 3-3. How the Regulations Work

- **Identify** affected process vents
- **Determine** emission rates
- **Sum** individual rates
- **Compare** to emission rate limits
- **Reduce** emissions below limits or 95%

One additional point: certain control devices have the performance standards in the rules. The performance standard for combustion devices is 95 percent destruction efficiency. A facility using a combustion device on Vent #1 would not be in compliance with a control efficiency of 88 percent.

The rules became effective December 21, 1990. However, the compliance date depends on the classification of the facility. Interim status facilities have up to 18 months after the effective date to install control equipment. The 18 months is not a blanket extension; facilities will need to submit an implementation schedule to the permit writer for approval.

Facilities that already have a final permit are shielded from the Phase I air standards; this means that they do not have to comply with the standards until their permit is reissued. The different situations that occur under the RCRA permitting program are discussed in the RCRA implementation chapters of this workshop.

The rule does not specify the use of a specific control device. However, there are individual performance requirements for certain devices. In addition, there is a provision that equipment must be properly designed, operated, and maintained and continuously monitored. The regulation specifies what parameters must be monitored for particular control devices. As an example, if you are using a vapor incinerator, you have to monitor the temperature in the combustion chamber downstream of the combustion zone. If you are using a catalytic incinerator, you have to monitor temperature both at the inlet and the outlet of the catalyst bed. In addition, the

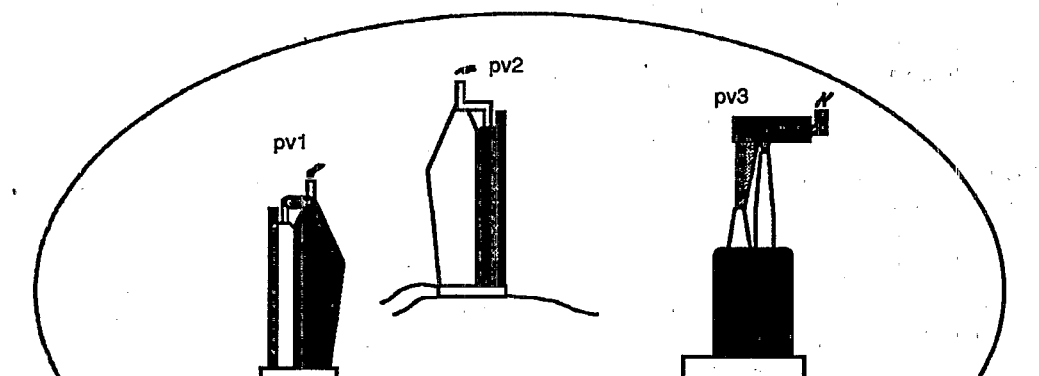
owner/operator is required to do a daily check of the control device to ensure proper operation.

Vapor recovery systems include condensers and carbon adsorbers, and the rule specifies that each device has to achieve at least 95 weight percent recovery efficiency. The primary condenser on a distillation column is considered a primary recovery device rather than a control device and does not count toward the 95 weight percent reduction. For combustion devices such as incinerators, process heaters, and boilers, the rule requires a destruction efficiency of 95 weight percent or greater or the use of a combustion device that has a minimum residence time of half a second at a minimum temperature of 760°C. In addition, EPA's work on vapor incinerators determined that, for air streams with low concentrations of organics, 95 percent reduction is not always possible. For those situations, the rule includes an alternative provision by which you can demonstrate that the incinerator exhaust concentration has been reduced to 20 ppm by volume total organics and be in compliance with the process vent rules.

Flares are another option as a control device. The performance requirements for flares specify that they can have no visible emissions as demonstrated by using Method 22. A flame must be present at all times, and a heat-sensing monitoring device with continuous recorder to indicate the continuous ignition of the pilot flame must be used. In addition, the flare requirements have specifications for net heating value on the gas being combusted and the permissible exit velocity.

The owner/operator must inspect readings from each monitoring device daily, and, if there is a problem, the rules require that the owner/operator immediately implement corrective measures to get the control device operating correctly again.

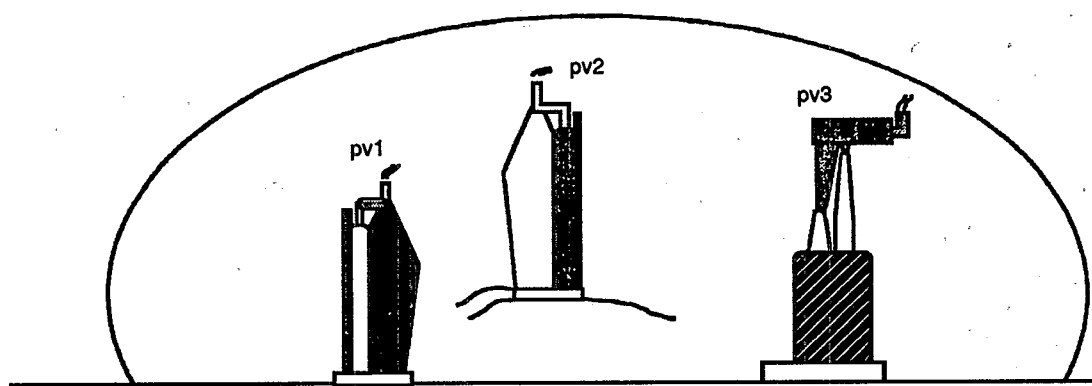
The equipment that connects the process vent to the control device is called the closed-vent system (Figure 3-8). The next chapter on equipment leaks will cover leak monitor-



$$ER_{\text{Facility}} = \sum_{i=1}^n ER_{pvi}$$

$$ER_{\text{Facility}} = ER_{pv1} + ER_{pv2} + ER_{pv3}$$

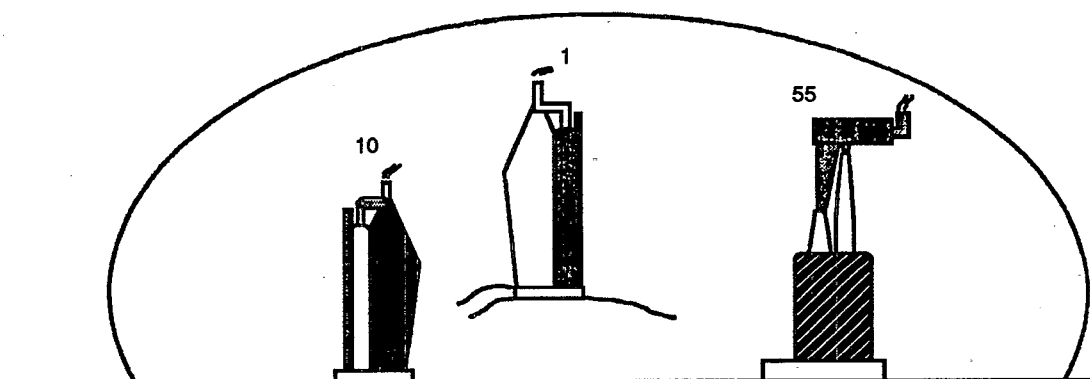
Figure 3-5. Facility bubble for emission rate (ER).



$$ER_{\text{Facility}} = ER_{\text{pv1}} + ER_{\text{pv2}} + ER_{\text{pv3}}$$

$$ER_{\text{Facility}} = 10 + 1 + 55 = 66$$

Figure 3-6. Example 3—control options for a facility.



$$ER_{\text{Facility}} = 66$$

$$66 (1-.95) = 3.3$$

$$3.3 \text{ Mg/yr vs. } 3.1 \text{ Mg/yr}$$

Option 1 - 95% Control on All Three Vents

Option 2 - 88% Control on pv1 and 98% Control on pv3

Figure 3-7. Example 3 (continued)—control options for a facility.

ing required of closed-vent systems. In this figure, emissions from this process vent pass through the closed vent system to the control device.

Records must be maintained to demonstrate compliance. The records must be kept onsite at the facility and consist of two main types: facility compliance documents and control device records. For facility compliance documents, records must be kept of the waste stream determinations, which are particularly important if you are claiming that a unit is exempt from controls because it receives waste with an average concentration less than 10 ppmw. Emission rate determinations, the second type of records, are the stack tests and other materials that document emissions from a particular unit and also total emissions from the facility.

Facilities that are installing a control device must keep the implementation schedule in the operating record. In addition, design and operational information must be maintained in the operating record. Control device exceedance records must also be maintained. The rules specify the conditions that define an exceedance (i.e., when the control device is not operating correctly). As an example, an incinerator designed to operate at 760°C is exceeding the rules when it is operating at $<760^{\circ}\text{C}$. Any time the owner/operator finds an exceedance, the owner/operator must record that exceedance and keep it as part of the records. In addition, facilities that elect to use alternative controls must keep additional information regarding the control device onsite.

Facilities with a final permit that incorporates these rules are required to submit semi-annual reports if any exceedances

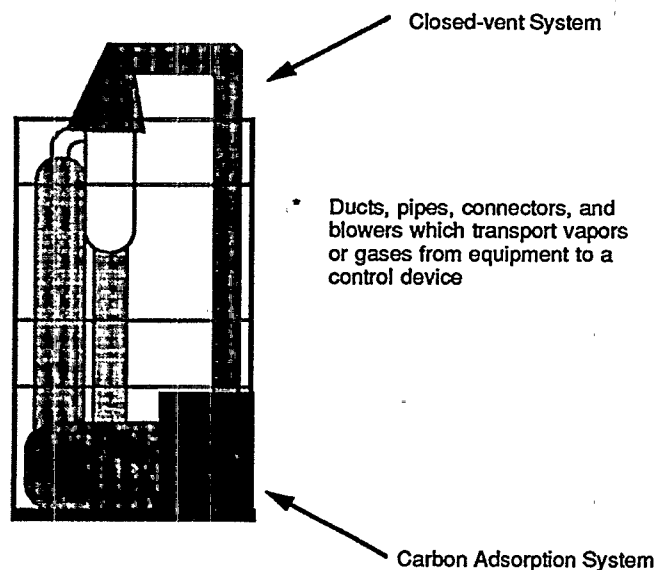


Figure 3-8. Closed-vent system.

last longer than 24 hours. Note that all exceedances must be recorded in the operating record. However, only exceedances that go uncorrected for more than 24 hours must be reported. A facility with no exceedances during a 6-month period does not file any report. Interim status facilities are not required to report.

The rule with an applicability decision tree is summarized in Figure 3-9. The first decision point is a determination of whether the facility is subject to Subtitle C of RCRA. If so, are any units affected, i.e., any of the six specific unit operations that are regulated under rules of RCRA? If so, do these units treat hazardous waste with greater than 10 ppmw in the total organics on a time-weighted annual basis? Finally, are any of these units exempt under the rules of RCRA? If they are not exempt units, the rule applies, and the facility must meet the emission rate limits. The limits require that all organic emissions from affected process vents be reduced to below 3 lb/h and 3.1 ton/yr. As an alternative, the facility can reduce the total organic emissions from all affected process vents by 95 percent after the primary recovery.

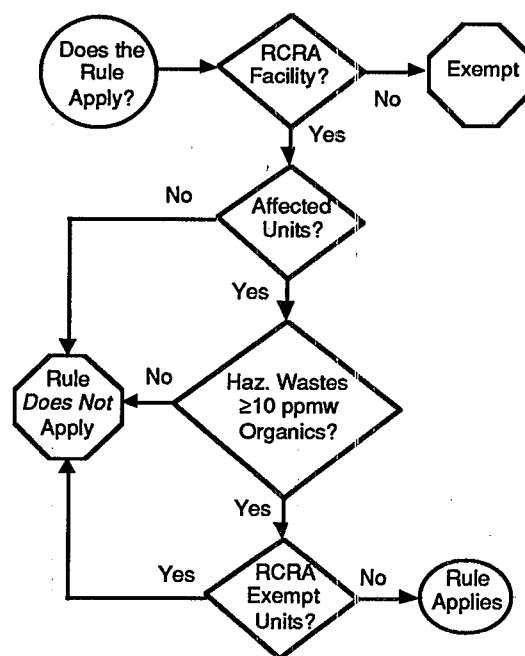


Figure 3-9. Summary—applicability decision tree.

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Questions and Answers

Question—Can a vapor recovery system be operated at less than 95 percent efficiency if the emission rate limits are met?

Answer—Yes. The performance requirements for control devices must be met only when the facility exceeds the emission rate limits and is required to reduce total process vent emissions by 95 percent.

Question—What is a primary recovery?

Answer—Vapor recovery or collection devices that are inherently part of the process, e.g., a primary condenser on a solvent distillation unit. Primary recovery devices are not considered control devices under the Subpart AA rules.

Question—By semiannual reporting of exceedances, does this mean an exceedance is a total of 24 hours in 6 months or must an exceedance last more than 24 hours to be reported? If an exceedance must last longer than 24 hours, then could not a facility have a 4-hour or more exceedance every day? What is the relation of an exceedance to the annual emissions limit?

Answer—An exceedance must last more than 24 hours to be reported. Exceedances of shorter duration must be recorded and may be the basis for enforcement action upon a RCRA inspection. Exceedances provide an indication that the control equipment is not properly operated and maintained as required under the rules. Exceedances and the annual emission rate limit are different provisions; the emission rate limit is an emission cap that is not to be exceeded. Exceedances indicate that the control device is operating outside design limits.

Question—Do the Subpart AA requirements apply to incinerators?

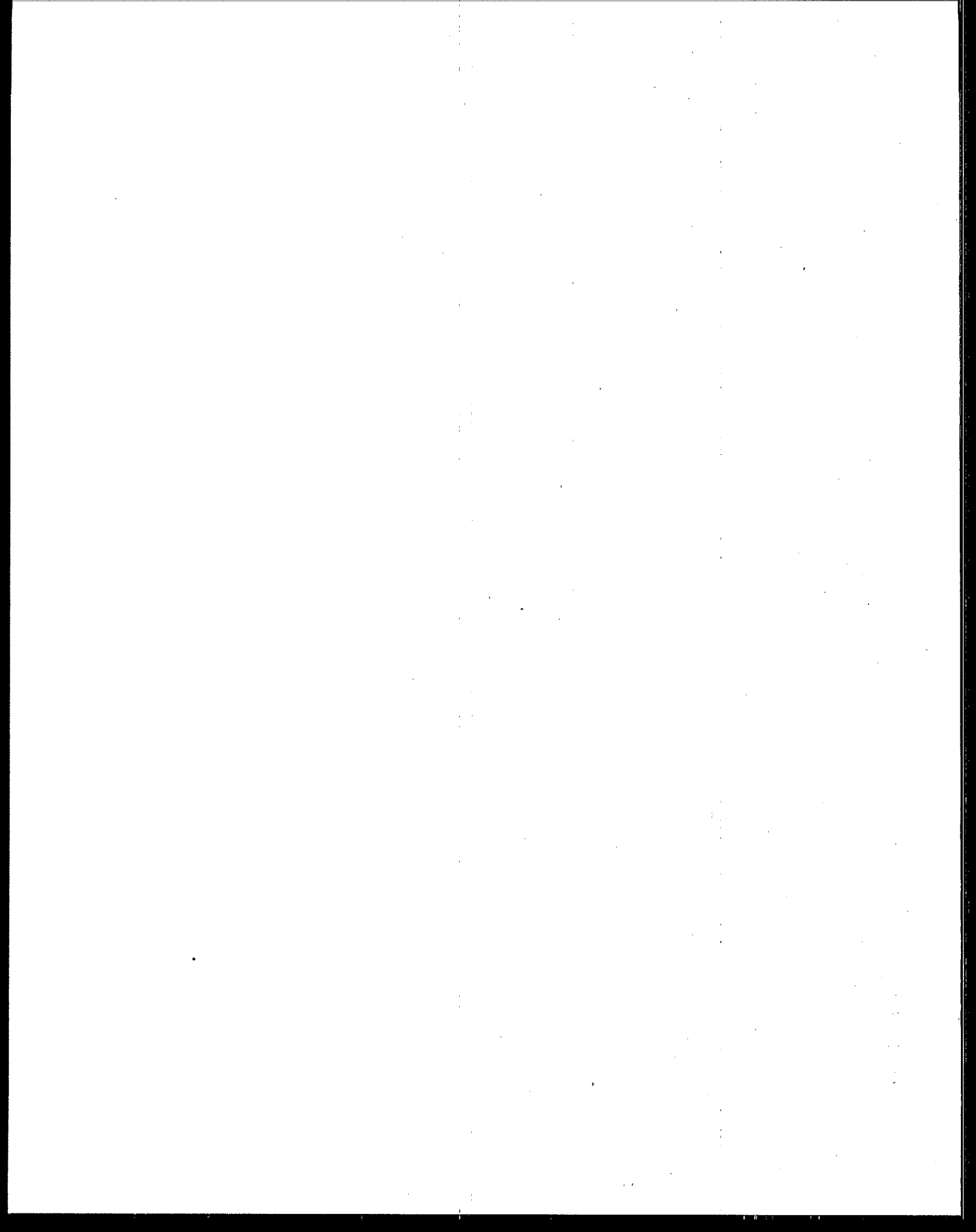
Answer—No. Incineration is not one of the unit operations specified in the rule.

Question—Would soil venting units and air strippers at gasoline cleanup sites be brought under the rules by the toxicity characteristic leaching procedure (TCLP) rule for benzene?

Answer—If the site requires a RCRA permit and the air stripper is managing a hazardous waste with 10 ppmw or greater organics, then the air stripper would be covered. Soil venting units are not covered by the rule because they are not one of the unit operations specified in the rules.

Question—The process vent rules require control for sources exceeding the emission rate limits at 95 percent control efficiency. Are there any requirements under the RCRA rules for capture efficiency, since overall control efficiency is the product of capture and removal/destruction efficiency of the control device? Are there any test methods to determine capture efficiency?

Answer—The closed vent system requirements in the Subpart AA rules result in 100 percent capture efficiency. Method 21 leak detection monitoring must be conducted on the closed vent system.



Chapter 4

Equipment Leak Standards

Subpart BB

The organic air emission standards for equipment leaks at hazardous waste treatment, storage, and disposal facilities (TSDFs) codified in Subpart BB of 40 CFR 264 and 265 are covered in this chapter. The session is designed to provide a basic understanding of the equipment leak rules to aid Resource Conservation and Recovery Act (RCRA) permit writers and enforcement personnel in determining compliance and to aid facility owners and operators in achieving compliance.

A review of the background of the equipment leak rules is presented first, followed by a detailed presentation of the applicability of the rules. The control requirements are briefly summarized with references to the standards for details. Waste stream determinations for the purposes of applicability are covered in detail and the recordkeeping and reporting requirements are summarized with references to the standard for details of the recordkeeping requirements.

Subpart BB—Equipment Leak Rules

Resource Conservation and Recovery Act (RCRA) organic air emission standards for equipment leaks were promulgated to protect human health and the environment through reduction of equipment leak emissions at hazardous waste treatment, storage, and disposal facilities (TSDF). These rules were promulgated as Subpart BB of Parts 264 and 265 of the *Code of Federal Regulations* (CFR). The purpose of this chapter is to provide a basic understanding of Subpart BB equipment leak rules, which were promulgated under authority of Section 3004(n) of RCRA.

The highlights of this chapter are presented in Table 4-1: First, these standards affect equipment that comes into contact with hazardous organic waste. Second, hazardous waste treatment, storage, and disposal facilities may have hundreds or even thousands of potential sources or equipment components such as pumps, valves, and flanges to which the rules could apply. Third, the standards include requirements for leak detection and repair for certain equipment; for other potential emission sources specified equipment is required to reduce leak emissions. The last point, which is related to recordkeeping, is that compliance with these rules is demonstrated through

the maintenance of records. Therefore, the recordkeeping aspects of these rules are very important.

The chapter is organized into seven sections as shown in Table 4-2.

Background

These rules were promulgated June 21, 1990. The effective date was December 21, 1990 (i.e., 6 months following promulgation). Facility owners and operators should have completed the first leak detection and repair work by the effective date, if they have equipment that is subject to these rules.

These standards were adopted in large part from Clean Air Act (CAA) standards that were promulgated for equipment leaks in other industries, such as the synthetic organic chemical manufacturing industry, the petroleum refining industry, and the coke by-product industry. For example, Clean

Table 4-1. Highlights

•	Standards generally affect equipment contacting organic wastes
•	Facilities may have hundreds of these potential sources
•	Standards include leak detection and repair (LDAR) and specified equipment
•	Compliance is demonstrated through the maintenance of records

Table 4-2. Topics

•	Background
•	Applicability
•	Waste stream determination
•	Control requirements
•	Recordkeeping requirements
•	Reporting requirements
•	Summary

Air Act standards were promulgated as 40 CFR 60, Subpart VV, for NSPS and 40 CFR 61, Subpart V, for NESHAP. In general, the language of these standards was revised to make them apply to waste management facilities and to format them according to RCRA specifications. For example, the words "process operations" were changed to "waste management units," and the words "process fluids" were changed to "waste." In addition to these word changes, requirements were added for inspection and monitoring that would make the rules self-implementing under the RCRA program. The Parts 264 and 265 rules for equipment leaks are identical except that reporting is not required for those facilities covered by the Part 265 rules (i.e., interim status facilities).

Applicability

An applicability decision tree for the rule is shown in the workshop manual (Figure 4-1). In the first block at the top of the diagram is the question, "Is this a RCRA facility?" That is, is it a new or existing hazardous waste treatment, storage, and disposal facility that requires a subtitle C permit? If it is, proceed to the next question, which is, "Are certain types of 'equipment' present at the facility?" The equipment covered

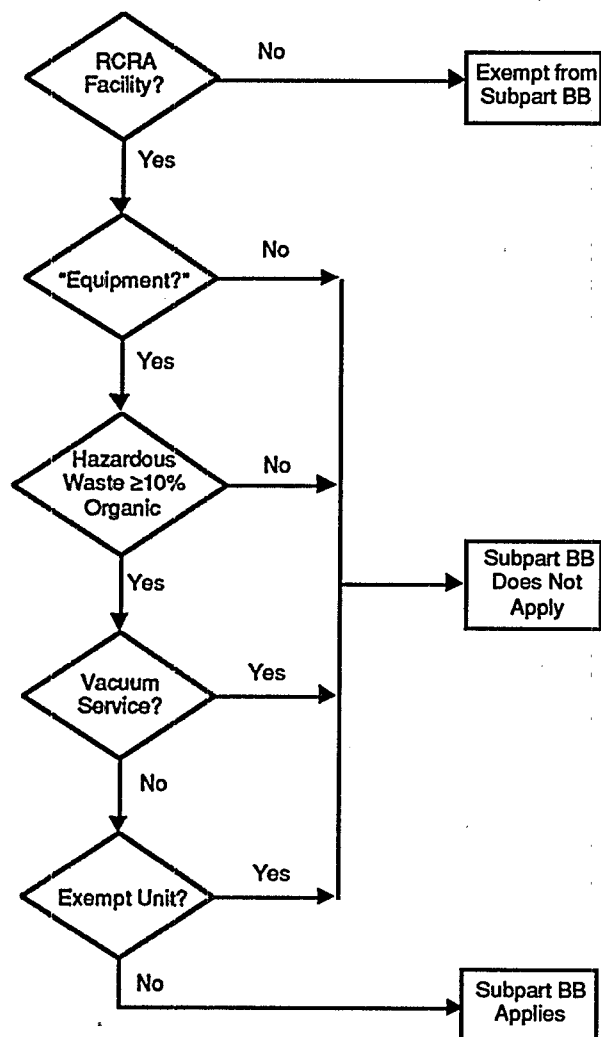


Figure 4-1. Applicability.

by this rule is shown in Table 4-3. If "equipment" is present in the facility, "Is the waste material at the facility hazardous waste that contains at least 10% organics by weight?" If the answer is yes, proceed to the next question regarding the type of service in which the equipment is used. "Is the equipment operated under vacuum?" If it is operated under vacuum, then it is exempt; the Subpart BB rules do not apply. If it is operated at atmospheric conditions or positive pressure, go to the final question, "Is the unit an exempt unit?" In the workshop presentation on process vents, RCRA exempt units are identified; that same list of units is exempt from the Subpart BB rules. If the facility, wastes, and equipment meet all the criteria shown in the applicability diagram, then Subpart BB does apply to the equipment in the facility.

A list of the types of equipment affected by the rules—pumps, valves, compressors, sampling connections, open-ended lines, pressure-relief devices, and flanges—is presented in Table 4-3. The following figures are diagrams that help to show why these equipment pieces are potential sources of emissions for which these rules apply. The first is a schematic diagram of a centrifugal pump (Figure 4-2). The impeller that moves the fluid through the pump is at one end of the pump. Penetrating that impeller housing is a shaft that provides the motive power for the impeller. A seal or packing along the shaft prevents leakage to the outside of the wastes that are in the pump impeller section. When that seal breaks down or does not operate properly, the fluids from inside the pump can move along the pump shaft and become exposed to the atmosphere at the point where a potential leak area is indicated in the figure.

Compressors (Figure 4-3) are similar to pumps. The difference is that the fluid on which they operate generally is a gas. The gaseous fluid is on the inside. Pressure is exerted inside the compressor, which tends to force waste materials along the shaft and through the seal area. Once the gas is exposed to the atmosphere, it becomes a leak.

A diagram of a gate valve is shown in Figure 4-4. The waste fluid passes through the valve when the gate is open. The fluid can leak along the valve shaft; once it penetrates the packing gland area and becomes exposed to the atmosphere, a leak or air emission exists.

A flow control valve shaft moves constantly to change the flow rate through the valve. This shaft movement up and down creates constant wear on the seal, and the area where the shaft becomes exposed to the atmosphere is a potential leak site. Flow control valves, as a result, have a higher potential for leakage than manual on/off valves.

Table 4-3. Equipment Covered by Subpart BB

- | | |
|---|------------------------------|
| • | Pumps |
| • | Valves |
| • | Compressors |
| • | Sampling connections systems |
| • | Open-ended valves or lines |
| • | Pressure-relief devices |
| • | Flanges and other connectors |

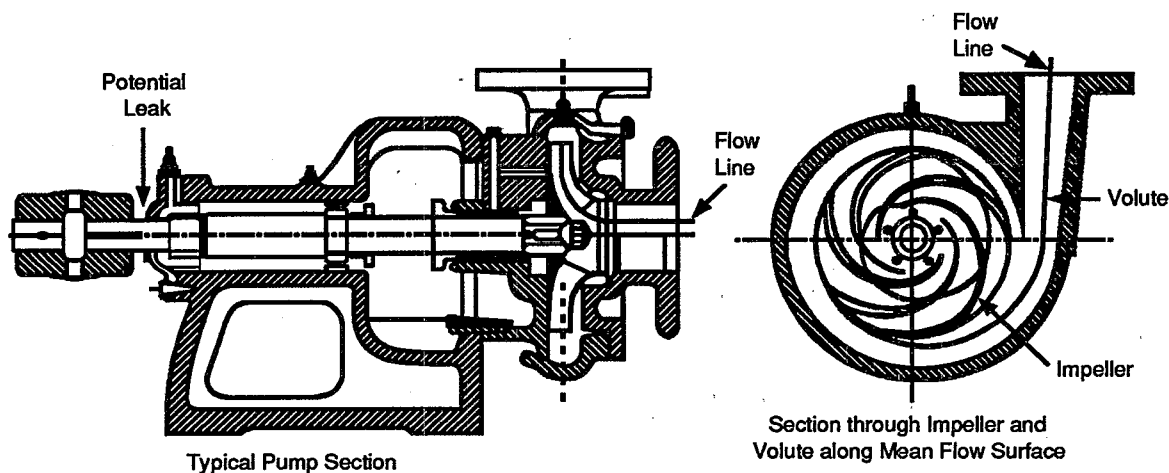


Figure 4-2. Centrifugal pump construction.

A diagram of a pressure relief valve is shown in Figure 4-5. The pressure relief is provided for a process that is located upstream of the device; the pressure is produced by the fluid inside the process or waste management unit. In this case, the pressure is exerted upward and may cause the sealing disc to move and potentially produce a leak if the disc is not reseated properly.

For flanges, leaks can occur at the area where two pieces of pipe interface (Figure 4-6). Leaks tend to develop at the gasket because of vibration, bad assembly, or damage to the gaskets at the time they were installed when the pipe was put in place.

The most common site for equipment covered by Subpart BB at a TSDF is in the waste destruction, recycling, and recovery operations. Example operations include: incineration, distillation, solvent extraction, steam stripping, and storage tanks for reclaimed organics. But these are not the only places that the types of equipment subject to these rules can be found. If concentrated organic wastes are in tanks or containers, the auxiliary/ancillary equipment related to that tank or container management may also be affected by these rules.

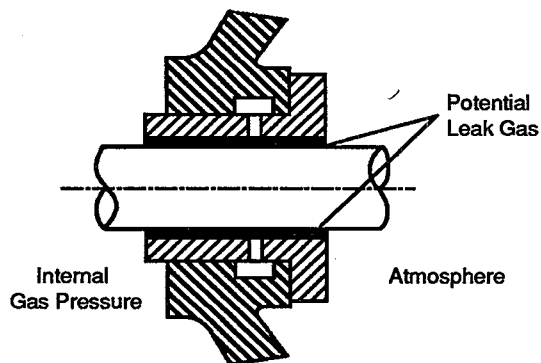


Figure 4-3. Labyrinth shaft seal for compressors.

Steam strippers (Figure 4-7) commonly are used on relatively dilute aqueous wastes. So a question might be, "Why is this a type of device where you would find equipment affected by these rules?" When the waste materials are stripped, the organic vapor phase passes overhead into an accumulator tank. When the organic material comes out of the accumulator tank and passes through the pumps and valves, the stripping system at these points may be contacting waste materials with high enough organic content to be subject to these rules.

Waste Stream Determinations

The waste stream determination is that portion of the applicability diagram that helps you decide whether the waste materials that contact the equipment are of sufficient organic content to make the equipment subject to the rules. The organic content of the hazardous waste must be at least 10 percent by weight. This is not an average organic concentra-

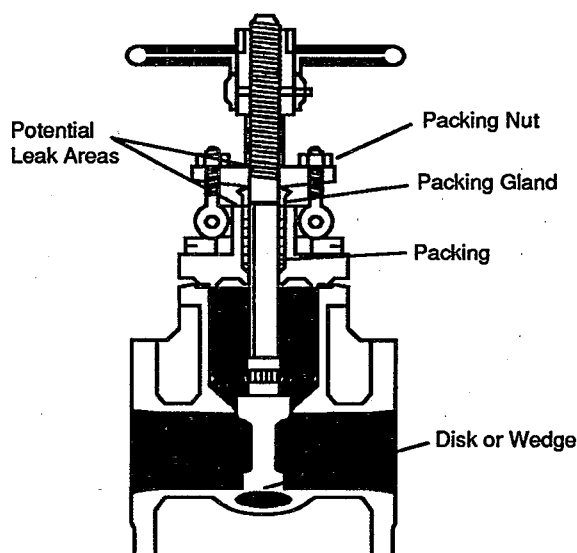
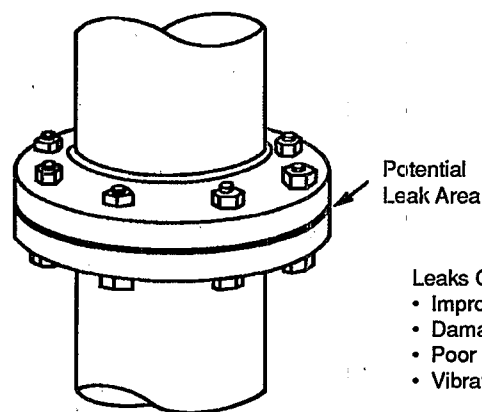
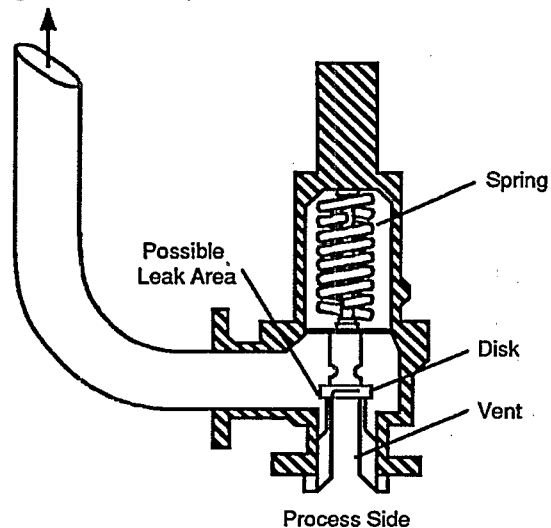


Figure 4-4. Rising stem gate valve.

Emissions
(Simmering, Improper
Reseating, Pressure Relief)



Leaks Caused by

- Improperly Chosen Gaskets
- Damaged Gaskets
- Poor Assembly
- Vibrations

Figure 4-6. Leak area in flanged joint.

Figure 4-5. Spring-loaded relief valve.

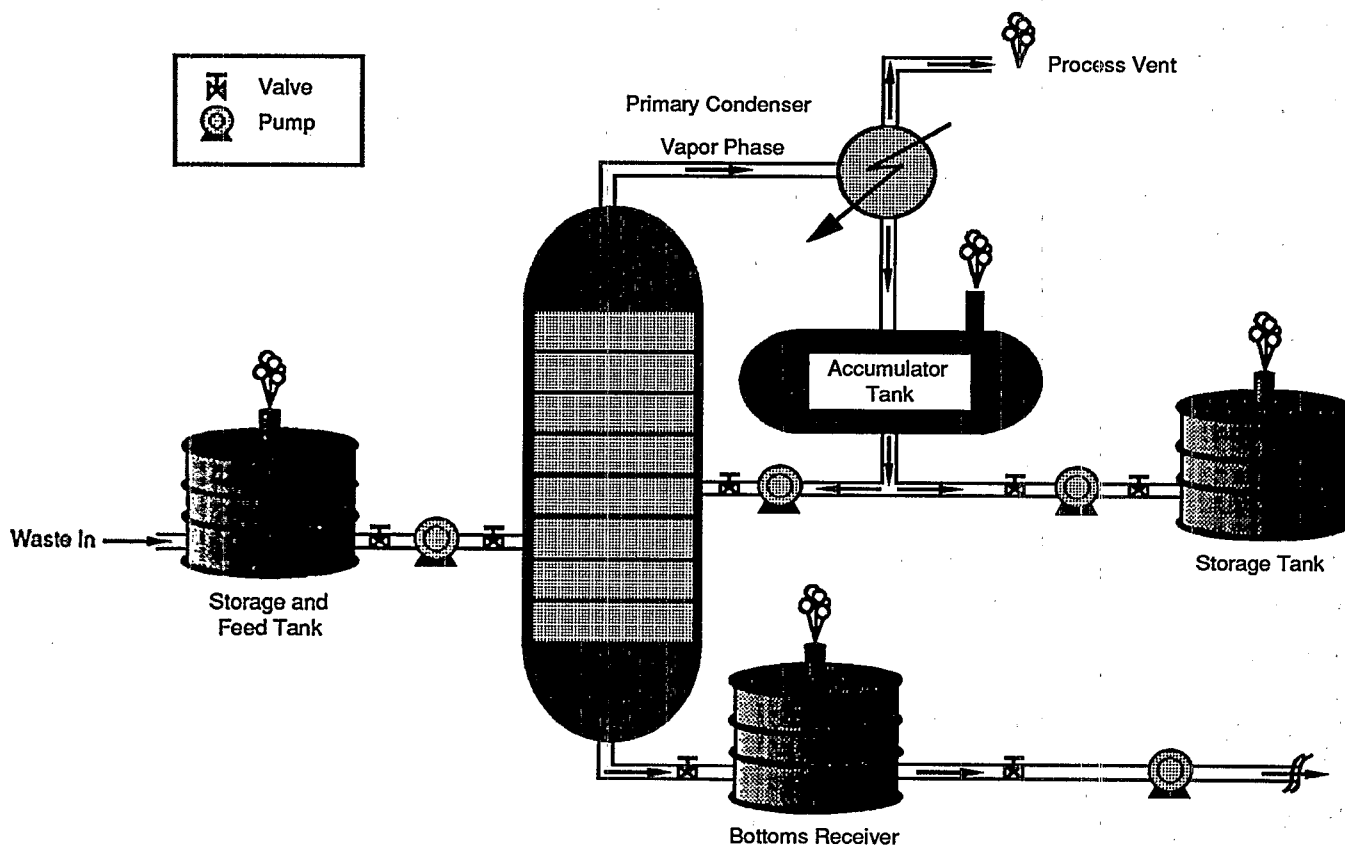


Figure 4-7. Steam stripper.

tion. If at any time the equipment is expected to contain or come into contact with a hazardous waste that could have 10 percent or greater organic content, that equipment is subject to the equipment leak rules if it meets the other applicability criteria.

The second aspect of waste stream determinations is the type of "service" in which the equipment is used. Is it a gas or a liquid at the operating conditions, and, if it is a liquid, is it a light or heavy liquid?

The waste organic content determinations can be based on prior knowledge that the waste is lower than the 10 percent limit or by direct measurement or chemical analysis.

Examples of types of acceptable knowledge are: (1) documentation that no organics are used in the process, (2) information from an identical process if the waste materials that are handled in the process for which you are making the certification are the same, (3) analyses done previously on the waste managed in the unit when no changes to the waste materials have been made since that analysis was done. If questions exist about whether the level of knowledge is adequate, the Regional Administrator can require a direct measurement to demonstrate that the waste is less than 10 percent organic.

Some analytical methods that can be used to make an organic concentration determination are listed in Table 4-4. First, representative samples must be taken; guidance on how to do that is available in the EPA document SW846, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods*. An analytical technique that is appropriate for the types of waste being managed must be chosen. Some alternative ways of making those determinations are found in the table.

If a gas chromatographic method is selected, the appropriate detector for the types of compounds that are expected to be in the waste must be selected (Table 4-5). Some detectors are more appropriate than others. For instance, if you are

Table 4-5. Applicability of Organic Analytical Detectors

Method	Compounds Most Applicable
Flame ionization	All
Photoionization	Aromatics
Hall electrolytic conductivity device	Halogenated
Nondispersive infrared	Any compound with C-H bond
Mass spectrometer	All

working with halogenated solvents, the Cl, F, I, Br, and carbon content of the material must be measured because the halogens also count toward the total organic compound concentration determination. Therefore, you must add both the carbon and halogen portions of the waste compounds.

The next question to be answered in determining the applicability of the equipment leak standards is, "In what type of service is the equipment used?" At this point, the waste exceeds 10 percent organic content by weight. The next question is, "Is the fluid a gas at operating conditions?" An example of a gas service situation is an overhead stream from a distillation unit prior to the condenser. If the waste stream is not a gas at operating conditions, a determination must be made as to whether it is a light liquid or a heavy liquid.

The light liquid determination is made in several steps (Table 4-6). First, if the waste stream is a liquid at the operating temperature, the next step is to determine whether compounds are present in the waste that have vapor pressures greater than 0.3 kilopascals at 20°C. If compounds of that type are in the waste, the concentration of those compounds with vapor pressures exceeding 0.3 kilopascals must be determined. If the total concentration of those compounds with vapor pressures greater than 0.3 kilopascals is 20 percent or more, then the waste stream is a light liquid. If it does not meet these criteria, then the liquid is a heavy liquid. Any liquid that is more volatile than kerosene would probably be a light liquid. An example of a heavy liquid is No. 6 fuel oil.

Control Requirements

In this segment, control requirements and the standards used to achieve control of the equipment leak emissions are described and discussed.

Table 4-4. Applicability of Organic Content Analytical Methods

Method	Compounds Most Applicable
ASTM E 260-85 (General GC analysis)	Multiple compounds
ASTM D 2267-88 (Aromatics by GC)	Benzene, toluene, C8, and heavier aromatics
Method 9060 (SW-846) (Total organic carbon [TOC])	Organic carbon greater than 1 mg/L
Method 8240 (SW-846) (Volatiles by gas chromatograph/mass spectrometer [GC/MS])	Generally used to measure Appendix VIII compounds in wastewaters, sludges and soils
ASTM E 168-88 (Infrared [IR] analysis)	Single- or double-component systems
ASTM E 169-87 (Ultraviolet [UV] analysis)	Single- or double-component systems

Table 4-6. Light/Heavy Liquid Determination

<ul style="list-style-type: none"> A light liquid: <ul style="list-style-type: none"> Is a liquid at operating temperatures Contains compound(s) with vapor pressure >0.3 kPa (0.04 psia) at 20°C (68°F) Total concentration of pure components with vapor pressure >0.3 kPa at 20°C is greater than 20% All liquids not light liquids are heavy liquids.

The first type or format of standards to be discussed is based on work practices. Work practices are based on leak detection and repair (LDAR) programs. Depending on the source type, an LDAR program requires leak detection monitoring and/or inspection by use of an instrument or by visual means or by sense of smell. Once a leak has been detected, repair must be initiated and completed within a specific time frame. A flame ionization analyzer can be used to monitor for leaks or a soap bubble solution can be used on nonmoving equipment or equipment that is not at elevated temperatures that would cause the liquid to evaporate. The formation of bubbles is an indication that the valve leaks and needs repair.

Usually, leak detection monitoring by Method 21 (Table 4-7) requires the use of a total organic analyzer to locate leaks from valves, flanges, and pumps. For purposes of this standard, leaks are defined as measuring a concentration of 10,000 ppm or greater based on a reference compound. The Subpart BB rule specifies that the reference compounds for this standard are methane or n-hexane. In leak detection monitoring,

Table 4-7. Leak Detection Monitoring with Method 21

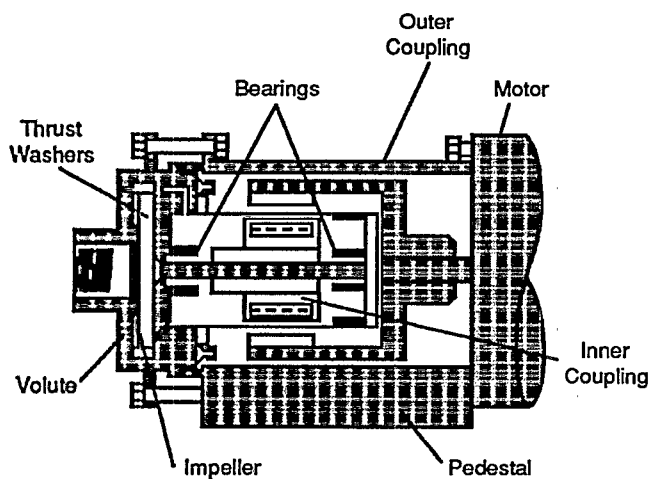
- Portable total organic analyzer is used to locate leaks from valves, flanges, and pumps
- A leak is defined as 10,000 ppm, based on a reference compound
- The Subpart BB reference compound is methane or n-hexane
- A response factor must be determined for each compound to be measured

the response factor of the instrument to each of the compounds that may be leaking from that equipment must be determined. A certification or demonstration must be made for EPA that the leak detection equipment (analyzer) used is capable of responding to all the organic compounds that could be leaking from the equipment. For additional information, review the chapter on Method 21 in this workbook.

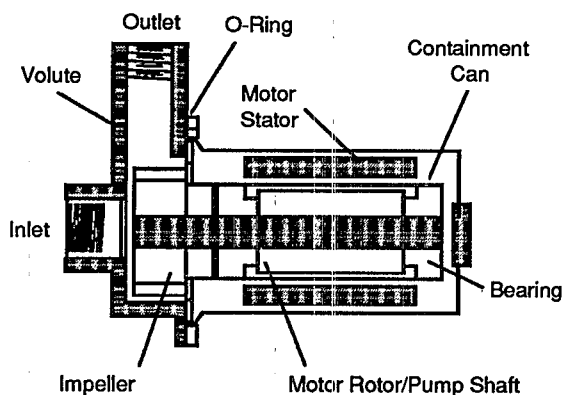
Once a leak has been detected, repair to the equipment must be started within 5 calendar days. Repairs must be completed within 15 days of detecting the leak.

The second type or format of standard that applies to some of the emission sources regulated under Subpart BB is an emission limit standard. This standard is based on use of equipment that has been designed not to leak. No waste must contact the equipment's external activating mechanisms. For instance, in a pump, the drive shaft must be isolated from the waste for it to qualify for compliance with the emission limit standard. Compliance is based on demonstrating that no detectable emissions (i.e., >500 ppm) are present, which is done with a leak-detection monitoring device using Method 21. Compliance must be demonstrated at least annually and more often if the Regional Administrator believes a problem exists.

Two types of pumps that would qualify under the emission limit rules are a magnetically coupled pump and a canned motor pump (Figure 4-8). The canned motor pump is designed so that a containment can is located around the pump impeller shaft. A magnetic field is induced on the outside of the containment can. The field causes the impeller shaft to rotate without any direct contact between the waste and the drive shaft for the pump. A schematic diagrams of two additional leakless pumps is shown in Figure 4-9.

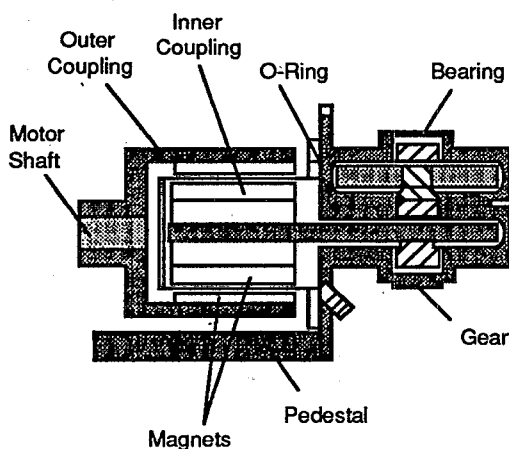


a. Magnetically Coupled Centrifugal Pump

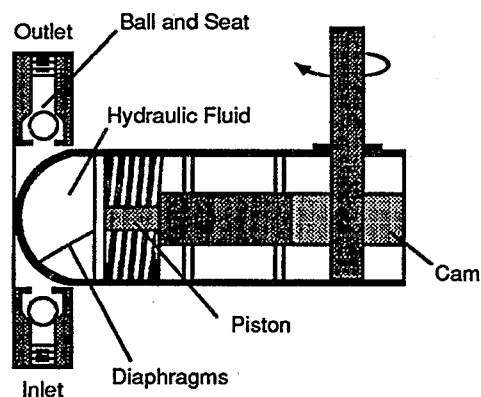


b. Canned Motor Centrifugal Pump

Figure 4-8. Sealless pumps can be designated for no detectable emissions.



c. Magnetically Coupled Gear Pump



d. Hydraulically Backed Diaphragm Metering Pump

Figure 4-9. Schematic diagram of two leakless pumps.

The third type of standard that may apply to emissions sources affected by this rule is an equipment standard. The equipment standard specifies the type of equipment that must be used to comply with the rules, for example, dual mechanical seals on pumps, the use of a closed-vent system and control device, or, in the case of sampling connections, closed-loop sampling. Visual inspections must be made of equipment that is subject to the equipment standard provisions, and if equipment is vented to a control device, no emissions must be detectable from the vent system to the control device. Any leaks detected must be repaired within 15 days.

The control requirements under the Subpart BB equipment leak rules for various types of equipment are summarized in Table 4-8. The left-most column in Table 4-8 lists the type of source. The second column gives the type of service in which that source is used (i.e., light liquid, heavy liquid, or gas). The next three columns list types of standards that could apply for certain types of equipment. Because alternatives are available for certain types of equipment, the primary control method is indicated in the figure by a box. You may also comply with the standard for pumps in light liquid service by using either of the alternative types of controls. The asterisk (*) in the box indicates that leak detection monitoring is required for those sources; for example, for pumps in heavy liquid service, leak monitoring is required if evidence of a leak is found. So a visual inspection must be made and, if liquids are seen leaking from the pump, monitoring for leaks must be done.

Information for pressure-relief devices and flanges and other connectors is also summarized in Table 4-8. To demonstrate compliance with the standard for pressure-relief devices in gaseous service, the emission limit is no detectable emissions.

For compressors, sampling connection systems, and open-ended lines, equipment standards constitute the primary means of complying. Notice that for sampling connections systems, the use of certain types of equipment is the only means of complying.

The following figures demonstrate various equipment controls. A pump shaft with dual mechanical seals is shown in Figure 4-10. Two sets of seals are on the pump shaft; a barrier fluid is circulated from a reservoir between those two pump seals and is discharged at the opposite end. The rules specify requirements for managing this liquid. It can be sent to a control device or vented into a degassing reservoir connected to a control device. An alarm must be on the system to indicate when organic fluids have penetrated into this circulating barrier fluid.

A type of valve that could be used to comply with the no-detectable emissions limit is shown in Figure 4-11. A diaphragm-type material lines the inside of the valve and prevents any possibility of waste materials moving along the stem and escaping the valve at the point at which the stem is exposed to the atmosphere.

Figure 4-12 is a schematic of a sealed-bellows valve. The bellows prevents contact between the waste material and the valve stem.

For pressure-relief purposes, rupture discs (Figure 4-13) are placed over the potential leak source. Rupture discs are designed to rupture at certain pressures. The discs must be replaced after a pressure-relief event has occurred so that the valve can be returned to the condition of no detectable emissions.

Closed-loop sampling systems (Figure 4-14) must be designed so that no possibility exists for the purged waste material stream to become exposed to the atmosphere and produce organic emissions. The purged material must be returned to the process line or waste management unit or disposed of by incineration or some other method that eliminates the possibility of organic emissions.

For open-ended lines (Figure 4-15), a cap or plug must be put on the opening to prevent leaks from the open end.

Table 4-8. Control Requirements, Subpart BB Equipment Leak Rules, Summary

Source	Service	Emission Limit		Equipment Specification		Work Practice
Pump	Light liquid	No detectable emissions	(or)	Dual seals, closed vent	(or)	Monthly monitoring (and) weekly inspection
	Heavy liquid	_____		_____		_____
Valve	Gas & light liquid	No detectable emissions	(or)	_____		Monthly monitoring
	Heavy liquid	_____		_____		_____
Pressure-relief device	Gas	No detectable emissions		Closed vent		_____
	Light & heavy liquids	_____		_____		_____
Flange/connector	Gas & light & heavy liquids	_____		_____		_____
Compressor	Gas	No detectable emissions	(or)	Seal system with barrier fluid or closed vent		_____
Sampling connection	Gas & light & heavy liquids	_____		Closed-purge system or closed vent		_____
Open-ended line	Gas & light & heavy liquids	_____		Cap, plug, flange, or second valve		_____

* Monitoring is required if evidence of a leak is found.

_____ Indicates the primary control method

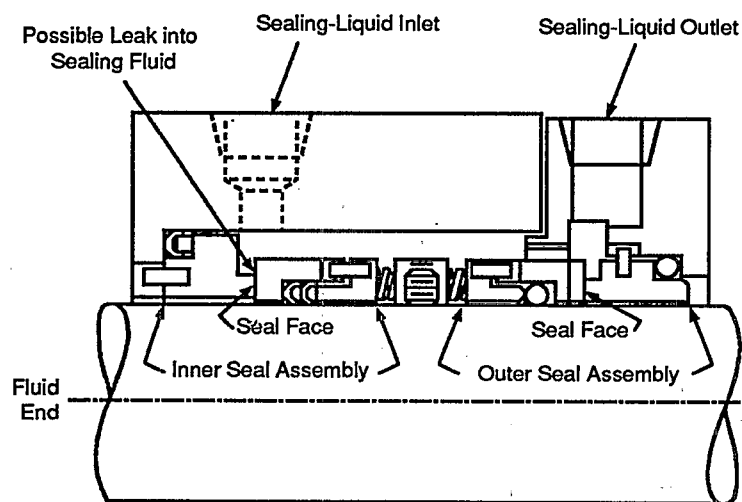


Figure 4-10. Double mechanical seal with barrier fluid controls emissions.

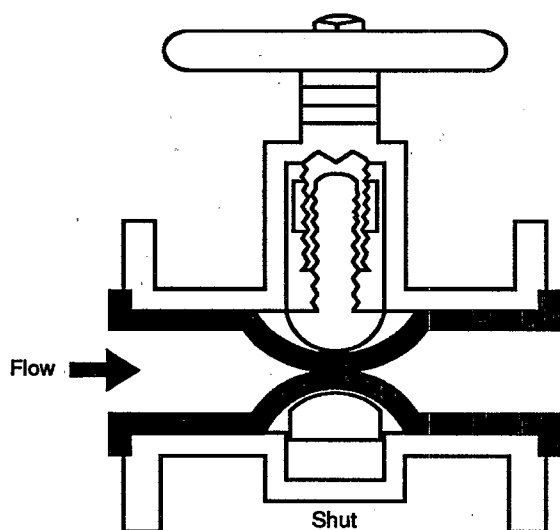


Figure 4-11. Handwheel-operated pinch valve.

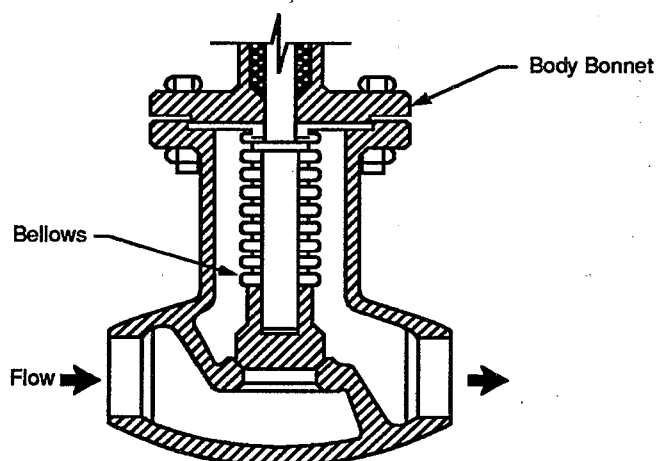


Figure 4-12. A bolted-bonnet bellows seal globe valve.

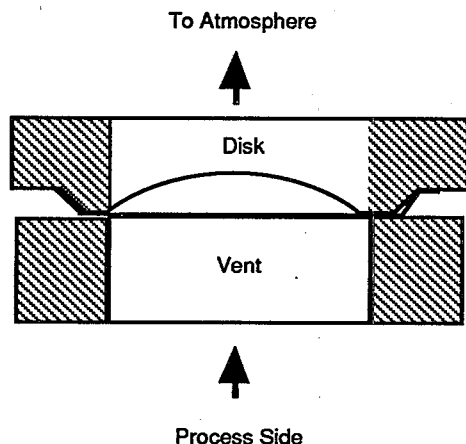


Figure 4-13. Rupture disk.

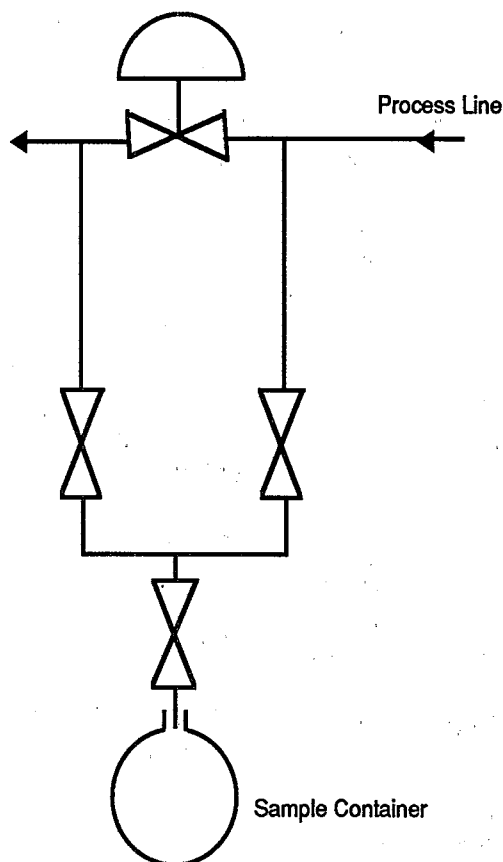


Figure 4-14. Closed-loop sampling system (to avoid losses from sampling).

To estimate equipment leak impacts for the background information document, model units were developed. The model unit parameters, A, B, and C, that were used to estimate national impacts for equipment leaks during development of the standards are listed in Table 4-9. Model Unit A, the largest model facility, is characteristic of the numbers of equipment components that would be found in a large recycling facility; B represents a small recycling facility or waste incinerator; and C represents a small tank farm.

The national impact estimates listed by model unit and the nationwide estimates are given in Table 4-10. The national emissions from equipment leaks from these types of facilities were estimated to be about 26,000 metric tons or megagrams per year. The rules were estimated to be able to achieve an emission reduction of about 73 percent at an annual cost of nearly \$33 million. One of the components of this cost is the salary of the persons who do the leak-detection work, but annual cost also includes the cost of materials for repairing the leaking pumps and valves and for the leak detection work necessary for compliance with the standards.

Recordkeeping Requirements

Compliance with the Subpart BB rules is demonstrated through the maintenance of records; thus recordkeeping is a very important aspect of the rules.

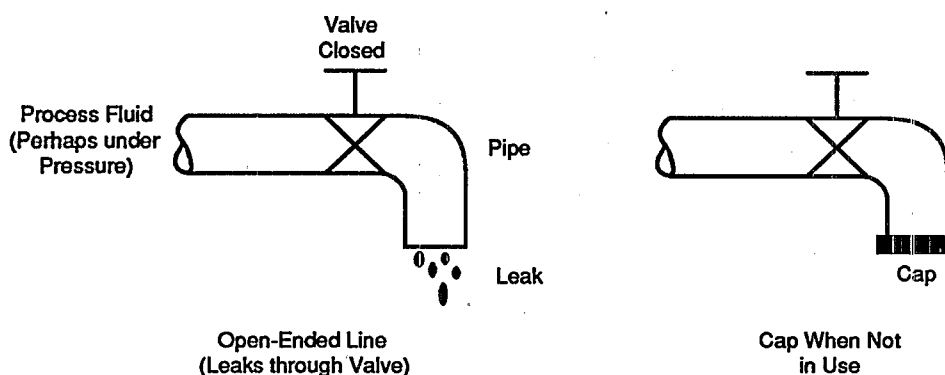


Figure 4-15. Open-ended lines.

The sections of the regulation that describe the details of recordkeeping requirements are listed in Table 4-11. Note that the last one, Information for Determining Exemptions, is critical. If a claim is made that the equipment in a facility is not subject to the rules, that information must be retained. Records must be retained for different periods of time under the rules. Some records must be retained for only 3 years: the results of monthly leak monitoring, repair, detectable emission monitoring work that is done, and any closed-vent control device operating data that have to be available to show that those devices have complied with the operating requirements. Other records must be maintained for the life of the facility. An example is the design basis for a control device that demonstrates that the device is able to meet a 95 percent control efficiency. The design basis must be kept on record for

the life of the facility to indicate how that determination was made.

Reporting Requirements

The reporting requirements for these rules (i.e., Subpart BB) are similar to those for Subpart AA.

A record of control device exceedances must be kept; situations that go uncorrected for greater than 24 hours must be reported (Table 4-12). For pumps, valves, and compressors in light liquid service, and valves in gaseous and light liquid service, repairs that have not been completed within 15 days as required by the standards must be reported as an exceedance. If no exceedances have occurred, filing a report is not necessary. Facilities subject to the interim status provisions of Part 265 are not required to report; however, they must maintain the exceedance records in the facility operating records.

Summary

To summarize, the equipment leak rules apply to equipment at new or existing hazardous waste treatment, storage, and disposal facilities that require a Subtitle C permit (Table 4-13). Some recycling units at hazardous waste facilities were previously exempt but are now covered. Equipment coming into contact with a hazardous waste that contains at least 10

Table 4-9. Equipment Leak Model Units

Model Unit	Pumps	Valves	Sampling Connections	Open-ended Lines	Pressure-relief Devices
A	15	364	26	105	9
B	5	121	9	35	3
C	3	72	5	21	2

Table 4-10. Equipment Leak Impacts

Model Unit	Emissions (Mg/yr)	Emission Reductions		Capital Costs* (\$)	Annual Costs* (\$)
		(Mg/yr)	%		
A	41.1	30.4	74	68,300	31,000
B	13.7	10.2	74	27,000	11,900
C	8.3	6.2	74	18,700	8,100
Nation-wide	26,200	19,000	72.5	127 million	32.9 million

* Costs are in 1986 dollars.

Table 4-11. General Records Required

- Equipment-specific identification information (Section 264.1064[b])
- Closed-vent system and control device information (Section 264.1064[e])
- Information on equipment not subject to monthly LDAR (Section 264.1064[g])
- Marking of leaking equipment (Section 264.1064[c])
- Information on leaking equipment (Section 264.1064[d])
- Barrier fluid system sensor information (Section 264.1064[j])
- Information for determining exemptions (Section 264.1064[k])

Table 4-12. Information Required in Semiannual Reports (264.1065)

- Control device exceedances uncorrected for >24 hours—dates, duration, cause, corrective measures
- Pumps in LL service, valves in G/LL service, compressors not repaired in 15 days
- No report required if no exceedances
- Facilities subject to interim status provisions, Part 265, are not required to report

Table 4-13. Equipment Leak Rules

- Equipment at new or existing TSDF requiring RCRA Subtitle C permit
- Equipment containing or contacting wastes with at least 10% organic
- Control requirements vary by type of service—gas, light liquid, heavy liquid
- Recordkeeping requirements to demonstrate compliance
- Semiannual reporting of exceedances

percent organic by weight is affected by this rule. The control requirements vary by the type of service in which the equipment is used: gas, light liquid, or heavy liquid. Recordkeeping is the means by which the operators can demonstrate compliance; semiannual reports of exceedances are required if exceedances have occurred within the 6-month period preceding that reporting time.

The types of standards that are available for complying with Subpart BB for each source are summarized in Table 4-14. As shown in the table, alternative compliance methods are available for pumps, valves, compressors, and pressure-relief devices. For sampling connection systems, flanges, and other connectors, only one means of compliance is appropriate.

Table 4-14. Types of Equipment Leak Standards

Sources	Equipment	Work Practice	Emission Limit
Pumps	• (or)	• (or)	•
Valves		• (or)	•
Compressors	• (or)		•
Sampling connection systems	•		
Open-ended valves or lines	•		
Pressure-relief devices		•	•
Flanges and other connectors		•	

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Questions and Answers

Question—Is the process vent applicability criterion a waste concentration of 10 ppm versus the 10 percent organics concentration for equipment leaks? Why the difference?

Answer—The criteria are correct as stated in the question and the reason is related to the emission potential of the wastes in the two situations. Fluids in which the organic concentration was less than 10 percent were not found to have as significant an emission potential in leaks from the types of equipment covered by the Subpart BB rules as discharges from vents on processes where wastes with lower organic concentrations were managed. The rules are described as waste-based, meaning applicability is conditional upon the organic content of the wastes and their emission potential from the sources regulated.

Question—What is the difference between leak definitions of 10,000 ppm and 500 ppm in the equipment leak rules? What must happen between 10,000 and 500 ppm?

Answer—For certain types of equipment in certain types of service (gas/light liquid/heavy liquid), leak detection monitoring with an instrument that meets the criteria of EPA Reference Method 21 is required. When a concentration of 10,000 ppm or greater is found at a source, a leak is determined to be present. The presence of a leak requires the facility operator to attempt to complete a repair of the leak within a certain period of time after identifying the leak. Detection of the leak is not a violation of the rules, but failure to repair or attempt to repair within a certain time period would be a violation.

For other equipment, controls are applied to meet the rules that are designed to achieve a condition of "no detectable emissions." The demonstration of no detectable emissions present is a compliance test using a leak detection instrument that indicates no concentrations greater than 500 ppm above background concentrations near the equipment. The compliance test must be repeated at least annually to show that the controls continue to have no detectable emissions. The rules have been violated if concentrations more than 500 ppm above background are measured.

Question—Are flanges on a valve considered part of the valve or are they separate sources? Should monitoring be done with the valve in an open or closed position?

Answer—Each flange on the valve is considered a separate source under the Subpart BB rules. So three total sources are associated with the valve, a flange on each end of the fluid flow path and the valve stem area where the stem exits the body of the valve. Monitoring of the valve sources should be done during normal operations (either open or closed).

Question—Is the pressure/vacuum (P/V) vent on a storage tank considered a "pressure relief device" for purposes of the Subpart BB rules, and, if so, does the operator need to monitor the P/V vent after each time organic liquid is loaded into the tank?

Answer—No, the pressure/vacuum vent on a storage tank is not considered a pressure-relief device and, therefore, does not require monitoring.

Question—Is equipment that is used for the management of recycled (product) materials subject to the Subpart BB equipment leak rules?

Answer—If the material is a recycled "product" as opposed to waste, then the equipment it comes into contact with is not subject to the Parts 264 and 265, Subpart BB equipment leak rules. Depending on the facility in which the "product" is handled, the equipment could be subject to equipment leak rules issued under the authority of the Clean Air Act, however. Some examples of facility types where this could happen include petroleum refineries, coke by-product plants, and synthetic organic chemical manufacturing plants. The point at which a waste becomes a recycled "product" may not be clear. Such distinctions may have to be made on a case-by-case basis.

Question—What provisions are stipulated for inaccessible equipment? Can elevated pipes with flanges be ignored until replacement or until evidence of a leak is seen?

Answer—Elevated pipe flanges cannot be ignored. The Subpart BB rules require that flanges be monitored by Method 21 within 5 days of finding evidence of a potential leak via visual, audible, or olfactory means, or by any other detection method. First attempt at repair is required within 5 days if a leak is found and repairs must be completed within 15 days. Difficult-to-monitor valves and unsafe-to-monitor valves may be monitored less frequently than others depending on the circumstances. Difficult-to-monitor valves must be monitored at least once a year, but valves placed in operation after June 21, 1990, are not granted this relief. Unsafe-to-monitor valves must be monitored as frequently as practicable during safe-to-monitor times.

Question—Are any changes anticipated in the leak definition concentration of 10,000 ppm based on the planned proposal of a 500-ppm value for process leaks under the Hazardous Organic NESHAP (HON) (at refineries, synthetic organic chemical manufacturing plants)?

Answer—The 500-ppm leak definition is one of many new requirements in the HON regulatory negotiation package. The package has not yet been proposed or promulgated but will be an action under the 1990 Clean Air Act Amendments. No plans have been made at this time to revise the Subpart BB rules.

Chapter 5

RCRA Phase II Air Regulations

Abstract

Under the Resource Conservation and Recovery Act (RCRA) Phase II rulemaking, the U.S. EPA is developing new standards and amendments that would control more treatment, storage, and disposal facility (TSDF) waste management units and add new requirements and implementation changes to the existing RCRA air emission standards under Subpart AA (TSDF treatment unit process vents) and Subpart BB (TSDF equipment leaks). A new Subpart CC would be added to 40 CFR 264 and 265 requiring that organic emission controls be applied to TSDF tanks, surface impoundments, containers, and certain miscellaneous units based on the volatile organic concentration of the waste managed in the unit. In addition, compliance with the air emission control requirements relevant to tanks and containers under Subparts AA, BB, and CC would be included as a condition to maintain a permit exemption for 90-day accumulation tanks and containers. Also, the U.S. EPA would amend 40 CFR 270.4 to require the owner or operator of an existing permitted TSDF to comply with the RCRA air emission standards for interim status facilities (40 CFR 265 Subparts AA, BB, and CC) until the facility's permit is modified or renewed. Finally, to be consistent with Subpart CC, the U.S. EPA would add to Subparts AA and BB requirements for managing spent carbon removed from carbon adsorbers.

RCRA Phase II Air Regulations

Under authority of Resource Conservation and Recovery Act (RCRA) Section 3004(n), EPA is developing nationwide standards to control air emissions from hazardous waste treatment, storage, and disposal facilities (TSDF). These standards are being developed in a series of phases. For the first phase of this RCRA regulatory program, EPA promulgated in 40 CFR 264 and 265 air emission standards for TSDF process vents (Subpart AA) and TSDF equipment leaks (Subpart BB). For the second phase, EPA proposed on July 22, 1991 (56 FR 33490), rules that would (1) create a new Subpart CC to control air emissions from more TSDF waste management units; (2) create two new EPA test methods for implementing the Subpart CC standards; (3) extend the relevant air emission control requirements specified in Subparts AA, BB, and CC to 90-day accumulation tanks and containers; and (4) add new requirements and implementation changes to the existing Subparts AA and BB standards. The purpose of this chapter is

to summarize the regulatory actions EPA proposed for the RCRA Phase II air rules.

Organic emissions from TSDF contribute to ambient ozone formation, affect public health (e.g., increase cancer risk to humans), and contribute to stratospheric ozone depletion. Like the Subparts AA and BB standards, the Phase II rulemaking is intended to control total organic emissions from TSDF. This rulemaking would significantly reduce TSDF organic emissions beyond the levels controlled by the Subparts AA and BB standards (Figure 5-1).

The Subpart CC standards would establish air emission control requirements for additional categories of waste management units at TSDF subject to permitting requirements under RCRA Subtitle C. Applying the same implementation approach used for the Subparts AA and BB rules, a new Subpart CC would be added to Part 264, and a new Subpart CC would also be added to Part 265. Part 264 applies to permitted TSDF, and Part 265 applies to interim status TSDF. The specific Subpart CC requirements in Parts 264 and 265 are identical with one exception; no reporting requirements exist in Subpart CC for interim status TSDF.

The Subpart CC standards would be applicable to three broad categories of waste management units at TSDF subject to RCRA Subtitle C permitting requirements: tanks, surface impoundments, and containers. In addition, the Phase II rulemaking would require TSDF waste management units that are not specifically defined under the RCRA regulations (referred to as "miscellaneous units") to comply with the appropriate emission control requirements specified in Subpart CC as well as Subparts AA and BB.

The Subpart CC standards are based on a control strategy that reduces air emissions from those TSDF hazardous waste streams identified to have a significant organic emission potential as determined by the amount of volatile organics in a given waste stream. Organic emission controls are then applied on each unit managing these waste streams from the point where the waste is generated through treatment to remove or destroy the organics in the waste stream in accordance with other RCRA rules (e.g., incinerator standards in Part 264, Subpart O, or the land disposal restriction treatment standards in Part 268).

The TSDF owner or operator could demonstrate compliance of an affected TSDF waste management unit with the Subpart CC standards in one of three ways: (1) install and

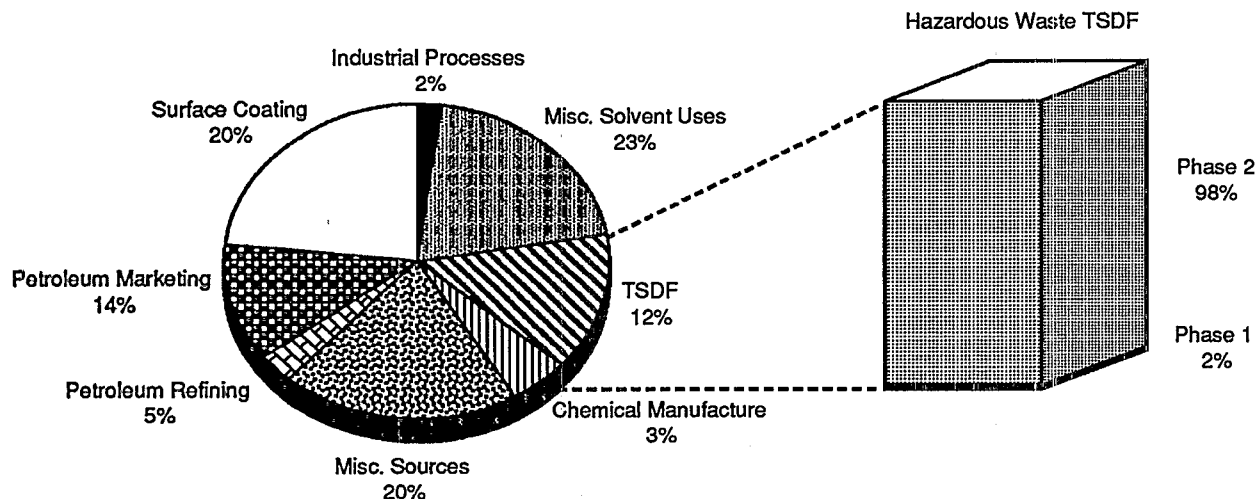


Figure 5-1. National VOC emissions—stationary sources.

operate on the unit the organic emission controls specified in the rule; (2) determine that the waste managed in the unit at all times has a volatile organic concentration less than 500 parts per million by weight (ppmw); or (3) certify that the waste managed in the unit complies with organic-specific land disposal restriction treatment standards in Part 268. The specific control requirements for those affected units managing waste with a volatile organic concentration of 500 ppmw or more depend on the type of unit.

For tanks, the basic control requirement would be to cover the tank and vent it through a closed-vent system to a control device that removes or destroys the organics in the vent stream by 95 percent. As an alternative to using the control device, a floating roof could be used. Also, a control device would not be required for certain tanks that contain wastes having organic vapor pressures below specified limits and manage the wastes in a "quiescent" manner (i.e., a waste is not aerated, agitated, or mechanically mixed).

The control requirements for surface impoundments would be to cover the unit and vent it through a closed-vent system to a control device that removes or destroys the organics in the vent stream by 95 percent. As with tanks, if the waste in the surface impoundment is managed in a "quiescent" manner, a control device would not be required and a floating membrane cover could be used.

Containers would need to be tightly covered except when waste is being added to or removed from the container. Pumpable waste would need to be added by submerged fill. If the container is used for certain treatment processes, such as waste fixation, then the container would need to be placed in an enclosure that is vented to a control device during the periods when the container is open.

Under existing RCRA regulations in Part 264, Subpart X, miscellaneous units are permitted on a case-by-case basis. Each permit contains terms and provisions to protect public health and the environment based on the similarity of the unit to the other types of waste management unit categories regulated under RCRA. The Phase II rulemaking would amend

Subpart X to require that the permit conditions for a miscellaneous unit include compliance with appropriate emission control requirements specified in Subparts AA, BB, and CC. This means, for example, if a miscellaneous unit is determined to resemble a surface impoundment, the control requirements for surface impoundments apply to the unit.

As part of the Phase II rulemaking, EPA is proposing two new test methods for use in implementing and enforcing the Subpart CC standards. These methods would be used to determine which waste streams have a significant organic emission potential, and therefore need to be controlled. Both methods are based on relatively simple and easy-to-use protocols that do not require measuring specific organic compounds. Also, both methods would be added to two sets of EPA test method references: Appendix A to the New Source Performance Standards in 40 CFR 60 and "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (SW-846).

The first test method could be used by a TSD owner or operator to determine if a waste stream has a volatile organic concentration less than the 500-ppmw action level specified in the Subpart CC standards. This method, Reference Method 25D in Appendix A or Test Method 5100 in SW-846, involves collecting representative samples, heating the sample and purging it with nitrogen, measuring the carbon and chloride content, and then using a formula to calculate the volatile organic concentration value for comparison to 500 ppmw.

The second test method could be used by an owner or operator to determine if the organic vapor pressure of a waste is below the vapor pressure limit specified in the Subpart CC standards so that a control device would not be required for a tank. This method, Reference Method 25E in Appendix A or Test Method 5110 in SW-846, involves collecting representative samples, analyzing the headspace vapor for propane, and then using a formula to calculate the organic vapor pressure.

Three amendments to existing RCRA air rules would be added by the Phase II rulemaking. One amendment would

affect hazardous waste generators accumulating waste in 90-day tanks and containers. A second amendment would change the implementation practice for RCRA air rules under Subparts AA, BB, and CC. The third amendment would add new requirements for managing spent activated carbon removed from carbon adsorber control devices used to comply with Subparts AA and BB.

Under current RCRA regulations, tanks and containers accumulating waste for 90 days or less at the site where the waste is generated do not need a RCRA permit provided the waste generator complies with certain conditions specified in 40 CFR 262. As part of the Phase II rulemaking, EPA would amend the RCRA rules to add an additional condition that a hazardous waste generator must meet in order for 90-day accumulator tanks and containers to remain exempt from needing a RCRA permit. This condition would require compliance with the emission control requirements relevant to tanks and containers specified in Subparts CC, AA, and BB. To maintain a permit exemption for a 90-day accumulation tank, for example, the waste generator would need to install the controls as specified in Subpart CC if the waste in the tank has a volatile organic concentration of 500 ppmw or more. Also, specific requirements under Subparts AA and BB may apply depending on the particular circumstances.

Implementation of RCRA air rules would be changed by the Phase II rulemaking. Current EPA practice is to require that interim status TSDF comply with a new RCRA rule by the rule's effective date, but allow a permitted TSDF to comply with the new rule when the facility's permit is modified or renewed. The Phase II rulemaking would amend the RCRA rules to require compliance with Subparts AA, BB, and CC by the rule's effective date regardless of the TSDF permit status. This means a TSDF with a permit issued before the effective date would comply with the Part 265 standards until the facility's permit is modified or reissued. A TSDF with a permit issued or renewed after the effective date would comply with the Part 264 standards.

Requirements for management of spent carbon removed from carbon adsorber control devices would be added to Subparts AA and BB by the Phase II rulemaking. For carbon adsorbers to remain effective control devices, the activated carbon eventually needs to be replaced with fresh carbon. Because the spent carbon is saturated with organics, the benefits of controlling the emissions from the waste management unit would be lost if the organics adsorbed on the spent carbon are released to the atmosphere when the carbon is regenerated or disposed of. The Subpart CC standards include specific requirements for managing spent carbon removed from carbon adsorbers used to comply with the rule. For consistency, Subparts AA and BB would be amended to include the same requirements. These requirements specify that the TSDF owner or operator certify that the spent carbon removed from the carbon adsorber is either (1) regenerated or reactivated by a process that uses organic emission controls or (2) destroyed in a hazardous waste incinerator.

Summarizing the Phase II rulemaking as proposed, air emission standards would be established for TSDF tanks, surface impoundments, containers, and miscellaneous units. Specific organic emission controls would be required on those units managing wastes with a volatile organic concentration of 500 ppmw or more. To implement these standards, EPA is proposing two new test methods. Also, existing RCRA air rules would be amended. To maintain a RCRA permit exemption for a 90-day accumulation tank or container, relevant air emission controls specified in Subparts AA, BB, and CC would need to be used. Control requirements under Subparts AA, BB, and CC in Part 265 would need to be implemented at permitted TSDF until the facility's permit is modified or renewed. Subparts AA and BB would be amended to include the same spent activated carbon management requirements specified in Subpart CC.

Questions and Answers

Question—Would the proposed Subpart CC standards require testing of every waste managed at a TSDF in a tank, surface impoundment, or container?

Answer—No. Waste determinations would be required only when an owner or operator chooses to demonstrate that controls are not needed on a unit because the waste managed in the unit has a volatile organic concentration less than 500 ppmw, or the owner or operator chooses to place a waste with an organic vapor pressure below the specified limits in a tank not using a control device. Furthermore, the owner or operator would be allowed to perform the waste determinations using either direct measurement or knowledge of the waste. Direct measurement of the waste volatile organic concentration or organic vapor pressure would be performed using the EPA test methods included in the RCRA Phase II rulemaking. Knowledge of the waste would need to be supported by documentation that shows that the waste volatile organic concentration or organic vapor pressure is below the specified limit under all conditions.

Question—Is the 500-ppmw action level specified in the proposed Subpart CC standards for determining the need to apply emission controls to a unit an average value?

Answer—No. The 500-ppmw action level is a maximum volatile organic concentration not to be exceeded at any time. EPA intends that only those units be exempted from using emission controls for which the owner or operator is reasonably certain that the volatile organic concentration of the waste managed in the unit consistently remains below 500 ppmw. If the owner or operator cannot determine confidently that the volatile organic concentration of the waste placed in a unit will remain below 500 ppmw at all times, then the owner or operator should install the required emission controls.

Question—For the purpose of determining if the volatile organic concentration of a waste is below the 500-ppmw action level, who is responsible for performing the waste determination—the hazardous waste generator or the TSDF operator?

Answer—The proposed Subpart CC standards would require that the waste determination be based on the waste composition before the waste is exposed to the ambient air. When a waste generator is also the TSDF owner or operator (e.g., the TSDF is located at the waste generation site), performing a waste determination before the waste is exposed to the ambient air can be readily accomplished since the TSDF owner or operator has custody of the waste from the point of generation. However, for the situations where the waste generator is not the TSDF owner or operator (e.g., the waste is generated at one site and shipped to a commercial TSDF), the TSDF owner or operator would not have custody of the waste until it is delivered to the TSDF. In this case, the TSDF owner or operator may not have access to the waste before it is exposed to the ambient air. Consequently, the hazardous waste generator must perform the waste determination if waste is to be placed in TSDF units not equipped with the specified emission controls.

Question—Would pollution prevention techniques be allowed under the proposed Subpart CC standards?

Answer—Yes. The proposed Subpart CC standards would allow a TSDF owner or operator to reduce the volatile organic concentration for a specific waste to a level less than 500 ppmw through pollution prevention and other engineering techniques. For example, if a waste is treated using a means other than by dilution or evaporation into the atmosphere so that the volatile organic concentration of the waste is less than 500 ppmw, then emission controls would not be required on the subsequent downstream tanks, surface impoundments, containers, and miscellaneous units that manage this waste. However, the unit used to treat the

waste would still be required to use controls in accordance with the appropriate requirements of the Subpart CC standards.

Question—How long a period would TSDF owners and operators have to comply with the requirements as proposed for the Subpart CC standards?

Answer—The TSDF owners and operators would be required to be in compliance with the Subpart CC standards by the rule's effective date, which would be 6 months after the promulgation date of the final rule. Facilities required to install control equipment would be allowed up to an additional 18 months beyond the effective date to complete the design and installation of the equipment provided the owner or operator has prepared an implementation schedule by the effective date showing when these controls will be installed.

Question—How would the proposed amendment requiring compliance with RCRA air rules by the rule's effective date regardless of a TSDF's permit status (i.e., removal of "permit-as-a-shield" policy for RCRA air rules) affect the implementation of the Subpart AA and BB rules at existing permitted TSDF?

Answer—Currently, a TSDF that has been issued a final permit prior to the promulgation date of the Subpart AA and BB standards is not subject to the Subpart AA and BB standards under either Part 264 or 265 rules until the facility's permit is modified or reissued. Upon promulgation of the RCRA Phase II air rules, owners and operators of these permitted TSDFs would be required to be in compliance with the Subpart AA and BB rules under Part 265 within 6 months. Facilities that would be required to install control equipment would be allowed up to an additional 18 months to complete the design and installation of the equipment. This is the same period of time now allowed for owners and operators of interim status TSDF to comply with the Subpart AA and BB rules.

Chapter 6

RCRA Overview

Abstract

General information and background on the structure and operations of the solid and hazardous waste management programs are provided in this chapter. Its objectives are to

- Introduce/summarize the Resource Conservation and Recovery Act (RCRA);
- Discuss the RCRA Subtitle C hazardous waste program and its regulations; and
- Discuss the relationship of the air standards to other rules.

RCRA Overview

Federal regulations and standards dealing with the ongoing management of solid and hazardous wastes are founded in the Resource Conservation and Recovery Act (RCRA) passed in 1976. The goals of the legislation are to

- Protect human health and the environment,
- Reduce waste and conserve energy and natural resources, and
- Reduce or eliminate the generation of hazardous waste as expeditiously as possible.

The RCRA program is continually evolving as new regulations and standards are developed and promulgated. For example, the Hazardous and Solid Waste Amendments (HSWA) of 1984 further refined hazardous waste regulations (e.g., introducing the land disposal restrictions). Regulations regarding the management of hazardous wastes associated with abandoned disposal sites are found in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—commonly known as Superfund—and the Superfund Amendments and Reauthorization Act (SARA).

There are four major programs within RCRA: Solid Waste Management under Subtitle D; Hazardous Waste under Subtitle C; Underground Storage under Subtitle I; and Medical Waste—a 2-year demonstration program under Subtitle J.

The improper management of hazardous waste is probably one of the most serious environmental problems in the United States. In 1979, EPA estimated that only 10 percent of

all hazardous waste was managed in an environmentally sound manner.

The remainder was transported, treated, stored, or disposed of in a way that potentially threatens human health and the environment. Since that time, the amount of hazardous waste produced has risen steadily.

The Subtitle C program developed under RCRA (Sections 3001-3019 of the act) is designed to ensure that the mismanagement of hazardous wastes does not continue.

This is done by creating a federal “cradle-to-grave” system to manage hazardous waste (including provisions for cleaning up releases) and to set forth statutory and regulatory requirements for

- Identifying hazardous waste;
- Generating hazardous waste;
- Transporting hazardous waste;
- Owners and operators of facilities that treat, store, or dispose of hazardous wastes;
- Issuing operating permits to owners or operators of treatment, storage, and disposal facilities (TSDFs) and providing for corrective action for hazardous waste releases;
- Enforcing the Subtitle C program; and
- Transferring the responsibilities of the Subtitle C program from the federal government to the states.

The Subtitle C regulations are grouped under Title 40, Chapter I, of the *Code of Federal Regulations* (CFR). Chapter I is divided into numerous parts.

Each part is further divided into subparts. Parts of 40 CFR are identified by the word “Part” followed by a number in Arabic numerals, for example, the TSDF air standards fall under 40 CFR Part 264 (often written as 40 CFR 264, without “Part” included), Subparts AA, BB, and CC. The parts in Chapter I of Title 40 that deal with hazardous waste are listed in Table 6-1.

Waste Definitions

Materials that are solid wastes and the subset of these that are defined as hazardous wastes are identified in 40 CFR 261. Specific exclusions to the definitions of solid and hazardous

waste also are identified in Part 261. For example, domestic sewage is a solid waste but is excluded from the definition of a hazardous waste.

The hazardous waste definition is divided into four categories:

- Characteristic wastes—described as wastes that exhibit hazardous properties such as ignitability, corrosivity, reactivity, or toxicity;
- Listed wastes—such as wastes from specific and nonspecific generation sources, and discarded and off-specification commercial chemical products;
- Mixture rule wastes—(1) a mixture of nonhazardous waste and a characteristic hazardous waste unless the mixture no longer exhibits any hazardous characteristic, or (2) a mixture of a nonhazardous waste and one or more listed hazardous waste; and
- Derived from rule wastes—any solid wastes generated from the treatment, storage, or disposal of a hazardous waste, including any sludge, spill residue, ash, emission control dust, or leachate (but not including precipitation runoff). Air emissions are *not* defined as hazardous waste because they do not meet the definition of a solid waste (i.e., solid, liquid, or containerized gas).

The criteria for identifying characteristics of hazardous wastes and for listing hazardous waste are described in Part 261. The first criterion is that the characteristic be capable of being defined in terms of physical, chemical, or other properties that cause the waste to meet the definition of hazardous

waste in RCRA. The second criterion is that the properties defining the characteristic be measurable by standardized and available testing protocols.

Characteristic hazardous wastes exhibit one or more of the following: ignitability, reactivity, corrosivity, and toxicity, which are portrayed in Figure 6-1. The definition of each property ties into test results of waste properties and/or constituents. The toxicity test was amended this year to reflect specific concentrations of some 40 organic and inorganic waste constituents in a waste extract derived using the Toxicity Characteristic Leaching Procedures (TCLP), which became effective September 29, 1990.

Listed hazardous wastes are divided into four groups:

- Nonspecific industry sources such as degreasing operations and electroplating;
- Hazardous wastes generated from specific sources such as petroleum refining;
- Wastes representing discarded and/or off-specification commercial chemical products and manufacturing chemical intermediates (whether usable or off-specification); and
- Wastes from spill residues, contaminated soils, and cleanup materials.

Wastes are also characterized into RCRA waste codes. "Characteristic wastes" are labeled as D codes which are shown on Figure 6-1. "Listed wastes" encompass four groups of alphanumeric code published in 40 CFR 261, Subpart D. Hazardous wastes generated from nonspecific industry sources such as degreasing operations and electroplating are listed as codes beginning with the letter "F," e.g., F001, spent halogenated degreasing solvents.

Hazardous wastes from specific generation sources such as petroleum refining are assigned codes beginning with the letter "K," e.g., K04g, oil emulsion solids from petroleum refining. Waste codes beginning with "P" or "U" represent waste commercial chemical products and manufacturing chemical intermediates (whether usable or off-specification), e.g., P037, container residue-dieldrin and U196 spill residue-pyridine.

Generators

Title 40 CFR Part 262 defines a hazardous waste generator as any

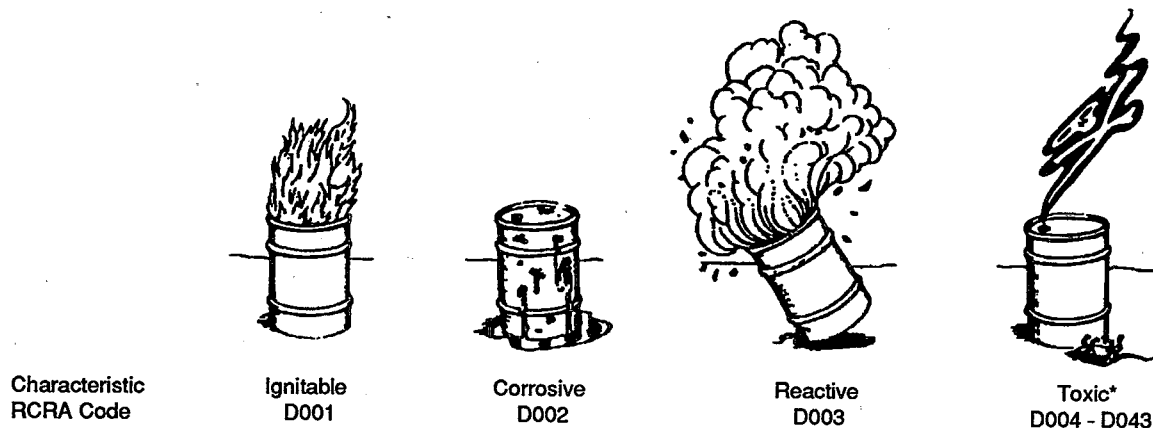
- Facility owner or operator or person who first creates a hazardous waste;
- Person who first makes the waste subject to Subtitle C regulations, e.g., mixes hazardous wastes of different Department of Transportation (DOT) shipping descriptions by placing them into a single container.

The regulations require all solid waste generators to determine whether any of their waste is hazardous. Once determined hazardous, the generator may fall into one of three categories depending on the volume of waste generated:

- Large-quantity generator—generates >1,000 kg/mo of hazardous waste;

Table 6-1. RCRA Hazardous Waste Program—Title 40, Code of Federal Regulations

40 CFR Part	Title
260	Hazardous waste management system: general
261	Identification and listing of hazardous waste
262	Standards applicable to generation of hazardous waste
263	Standards applicable to transporters of hazardous waste
264	Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities
265	Interim status standards for owners and operators of hazardous waste treatment, storage, and disposal facilities
266	Standards for the management of specific hazardous wastes and specific types of hazardous waste land disposal facilities
267	Interim status standards for owners and operators of new hazardous waste land disposal facilities
268	Land disposal restrictions
270	EPA-administered permit programs: the hazardous waste permit program
271	Requirements for authorization of state hazardous waste programs
124	Procedures for decisionmaking



*Toxicity Characteristic Leaching Procedure (effective 9/29/90).

Figure 6-1. Hazardous waste characteristics.

- Small-quantity generator—generates >100 kg/mo and <1,000 kg/mo of hazardous waste; and
- Conditionally exempt small-quantity generator—generates <100 kg/mo of hazardous waste (or 1 kg of acutely hazardous waste).

Generators must comply with specific regulations including obtaining an EPA identification number specific for hazardous waste generators, pretransport requirements (e.g., container storage, labeling, inspection), manifest requirements for shipping (part of the waste tracking system), biennial reporting and recordkeeping requirements, and conditions for which accumulation is required without the need for a RCRA hazardous waste management facility permit. The length of time waste may be accumulated without requiring a storage permit is

- 90 days for large-quantity generators;
- 180 - 270 days for small-quantity generators depending on transportation circumstances; and
- No limit for conditionally exempt small-quantity generators.

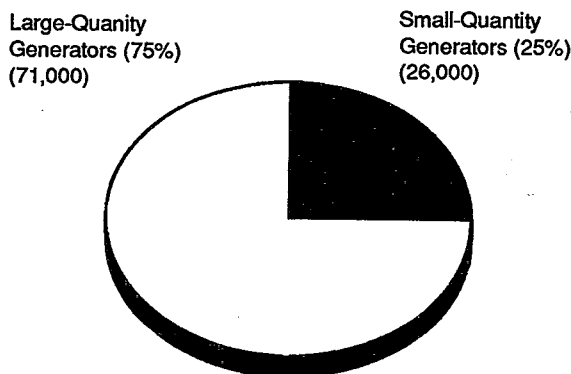
The overwhelming majority of hazardous wastes are produced by large-quantity generators, i.e., those firms that generate more than 1,000 kg/mo of hazardous wastes. It has been estimated that there are about 71,000 large-quantity generators of hazardous waste in the United States (Figure 6-2). These generators accounted for more than 99 percent of the 275 million Mg/yr of hazardous waste produced and managed under RCRA in 1985.

Although small-quantity generators (those that generate >100 kg/mo and <1,000 kg/mo of hazardous waste) represent a large proportion of the number of hazardous waste generators nationally (more than 26,000), they account for only a very small fraction of the hazardous wastes generated as shown in Figure 6-3. About 25 percent of the country's hazardous waste generators are small-quantity generators; but these generators contribute less than one-half of the 1 percent

of the total hazardous waste generated. The majority of the small-quantity generators are automotive repair firms, construction firms, dry cleaners, photographic processors, and laboratories.

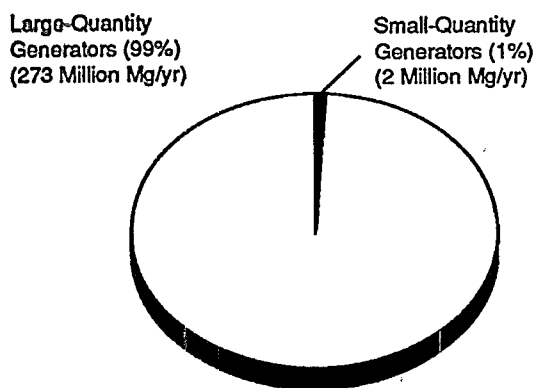
Transporters

EPA and the DOT jointly developed regulations governing the transportation of hazardous waste. The regulations in Part 263 incorporate, by reference, pertinent parts of DOT's rules on labeling, marking, packaging, placarding, and other requirements for reporting hazardous waste discharges or spills during transportation. In summary, Part 263 requires that transporters be subject to regulations on obtaining an EPA identification number, complying with the manifest system, and handling hazardous waste discharges. It should be



Source: EPA Office of Solid Waste, April 1984 and June 1986.

Figure 6-2. Hazardous waste generator statistics—number of generators by generator size.



Source: EPA OSWER, The Hazardous Waste System, June 1987.

Figure 6-3. Hazardous waste generator statistics—waste quantity by generator size.

noted that any transporter holding hazardous waste for more than 10 days is required to obtain a RCRA storage permit.

Permitting and Interim Status Standards

TSDFs are the last link in the cradle-to-grave hazardous waste management system. Subtitle C requires all TSDFs that handle hazardous waste to obtain an operating permit and comply with the treatment, storage, and disposal regulations of Part 265 before fully permitted and Part 264 once permitted.

RCRA permits are required for any facility that treats, stores, or disposes of hazardous waste. Parties are exempt from permitting if

- They generate the waste and accumulate it for a limited amount of time (e.g., for less than 90 days if large-quantity generators);
- The waste is being managed in an emergency situation; or
- An imminent and substantial danger exists that requires immediate waste management.

Interim status facilities are those that have not yet been permitted. To qualify, the TSDF must be in existence when the permit regulations become effective. The TSDF owner/operator must notify the authorized agency of its existence and submit a Part A permit application describing (1) the waste types managed and their annual quantities, and (2) the waste management process(es) in use at the TSDF.

It should be emphasized that interim status is only temporary. It is available only until a TSDF is granted a final permit decision.

Interim status TSDFs are regulated under 40 CFR Part 265. These are self-implementing regulations that contain both administrative and technical standards. The administrative standards include rules for developing and implementing

- Waste analysis plans;
- Personnel training programs;
- Contingency plans;
- Manifest systems for waste shipped or received from offsite;
- Closure and post-closure plans (if a land disposal unit); and
- Financial responsibility for closure, post-closure, and liability.

Technical standards for interim status facilities address specific types of hazardous waste management units. These include containers, tanks, surface impoundments, wastepiles, landfills, land treatment units, incinerators, thermal treatment units, and chemical, physical, and biological treatment units.

As with interim status standards, the components of the RCRA permit for TSDF fall into two areas: General Facility Standards and Technical Standards for specific waste management unit types.

The RCRA permit requires compliance with general standards on facility security, inspection, personnel training, and other programs. Other permit requirements common to all TSDFs address waste analysis, contingency procedures, training, closure, etc.

Depending upon the type of hazardous waste management processes proposed for the facility, the permit will specify technical requirements for containers, tanks, and other waste management units. Unit-specific standards exist for containers, tanks, surface impoundments, wastepiles, landfills, land treatment, incinerators, and miscellaneous units.

To obtain a RCRA permit, the following steps must be taken: First, the TSDF owner/operator submits a detailed RCRA Part B permit application. EPA then

- Reviews the application for completeness and technical adequacy;
- Prepares a draft permit;
- Issues a public notice to local newspapers and radio stations
 - notifying the public that a draft permit has been prepared; or
 - notifying the public that the permit has been denied.
- Allows 45 days for receipt of public comment on the decision;
- Holds a public hearing if requested; and
- Issues a final permit decision and responds to comments received.

The public or any interested party has the opportunity to appeal a permit decision before the permit becomes effective.

Interim status facilities regulated in Part 265 have or will be submitting Part B permit applications to obtain RCRA operating permits. HSWA established a schedule for final permitting decisions for interim status facilities. The HSWA schedule for submitting Part B permit applications and for the Agency to reach a permit decision is shown in Table 6-2.

Table 6-2. HSWA Schedule for Submitting Part B Permit Applications

Waste Management Process	Application Due	Agency Decision
Land disposal facilities	November 1985	November 1988
Facilities with incinerators	November 1986	November 1989
Other—storage/treatment and miscellaneous units (Subpart X)	November 1988	November 1992

Land Disposal Restrictions

HSWA mandated a phased approach to prohibit the land disposal of all untreated hazardous wastes by 1990. In Part 268, EPA has promulgated treatment standards for each hazardous waste code which must be complied with to allow land disposal of the waste treatment residue. Otherwise,

- A TSDF owner/operator must have an approved petition that demonstrates that there will be no migration of hazardous constituents from the disposal unit as long as the waste remains hazardous (a case-by-case decision);
- A TSDF owner/operator must have an approved petition that demonstrates that a specific waste cannot be treated to the RCRA-specified level or by the specified method;
- EPA must determine that the national treatment capacity is inadequate; or
- The TSDF owner/operator's disposal unit is a surface impoundment that will be dredged annually.

The restrictions were divided into the following phases: solvents and dioxins, California list, first scheduled wastes, second scheduled wastes, and third scheduled wastes. The third and final scheduled waste restrictions became effective May 8, 1990. Any newly listed waste (i.e., after 1984) must have a land disposal restriction determination performed within 6 months of the listing.

State Authority

Part 271 provides the procedures that state hazardous waste management agencies must follow in order to receive authority to administer a hazardous waste program in place of the federal RCRA program administered by EPA. To receive authority, state hazardous waste programs must be substantively equivalent and equally or more stringent than the federal program.

Standards Under Development

EPA chose to develop this portion of its TSDF rulemaking first to prevent uncontrolled air emissions from land disposal restriction (LDR) treatment technologies since these technologies were likely to have increased use. In addition, EPA already had control technology information to support these regulations, and thus earlier development of these rules was possible. This is principally because effective controls now in place under the Clean Air Act (CAA) to control emissions from the same types of emission points in chemical production facilities and petroleum refineries can be applied to reduce the health risk posed by air emissions from uncontrolled distillation, fractionation, thin-film evaporation, solvent extraction, and stripping processes and equipment leaks at TSDFs.

The EPA has limited the applicability of today's final standards to those types of process vents for which control techniques are well developed, i.e., those associated with processes designed to drive the organics from the waste, such as distillation, fractionation, thin-film evaporation, solvent extraction, and stripping operations.

The LDRs are already in place, so there is a need to begin some level of emission control as soon as possible. The restrictions will reduce emissions from land disposal units in most cases, since the designated best demonstrated available technology (BDAT) has the same goal of reducing organics in waste. However, BDAT units, other than incineration, will have process vents and equipment leaks that will remain air emission sources. The technologies used in lieu of land disposal include the distillation/separation processes subject to the Phase I rules.

Publication of the June 21, 1990, final rules for air emissions from hazardous waste management unit process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, and air and steam stripping processes and from leaks in equipment and piping containing or contacting hazardous waste marked the completion of this first phase.

Phase II standards address organic emissions from TSDF tanks, surface impoundments, and containers. These standards would substantially reduce emissions of ozone precursors as well as toxic constituents. The regulation of total organics as a class is relatively straightforward because it can be accomplished by a single standard, whereas the control of individual toxic constituents will require multiple standards. Implementation of the Phase II standards would achieve substantial organic emission reductions while EPA analyzes the residual emissions as part of the third phase of the program.

A third phase would involve analyses of individual toxic constituents that compose the TSDF organic emissions. The EPA has initiated an effort to improve the database used for the Phase II TSDF impact analyses. If additional controls are needed to reduce specific toxic constituent emissions, the number of constituents requiring the development of standards is expected to be significantly fewer than if a constituent-by-constituent approach were used as the only means of regulating TSDF air emissions. The EPA believes that the control of organics as a class followed by controls for indi-

vidual toxic constituents, if necessary, will result in comprehensive standards that are protective of human health and the environment.

Relationship of Air Standards to Other Rules

Three regulatory programs may have an effect on the Phase I rules or be affected by the Phase I rules. These are RCRA's hazardous waste toxicity characteristic, LDRs, and corrective action along with CERCLA.

Hazardous Waste Toxicity Characteristic

One of the procedures by which EPA defines wastes as hazardous is through hazardous waste characteristics (ignitable, corrosive, reactive, and toxic). This procedure involves identifying properties or characteristics of wastes, which, if exhibited by a waste, indicate that the waste will pose hazards to human health and the environment if its management is not controlled.

Final rules became effective on September 29, 1990, to modify and significantly expand the existing characteristic of toxicity. Sections 40 CFR 264.24 and 40 CFR Part 261, Appendix II, were amended by adding 25 organic constituents to the Toxicity Characteristic list of constituents and replacing the Extraction Procedure (EP) with the TCLP. These changes identify large quantities of currently nonhazardous wastewater and additional quantities of sludges and solids as hazardous waste. Consequently, additional waste types and quantities would be subject to the control requirements of the TSDF air standards.

Land Disposal Restrictions Under Section 3004(m)

The LDRs, developed under Section 3004(m) of the HSWA, require that hazardous waste be treated to reduce concentrations of specific chemicals or hazardous properties to certain levels or be treated using technologies before the waste may be disposed on land. Affected land disposal units include surface impoundments, wastepiles, landfills, and land treatment units. The EPA anticipates that LDR will substantially reduce the potential for air emissions from these land disposal sources. The first set of restrictions, for certain dioxins and solvent-containing hazardous wastes, was promulgated on November 7, 1986 (40 CFR 268.30-268.31); the second set of restrictions, the California list, was promulgated on July 8, 1987 (40 CFR 268.32). Standards were developed for wastes having RCRA waste codes in three phases, hence the name "Thirds." The "First Third" was promulgated on August 7, 1988 (40 CFR 268.33); the "Second Third" on June 23, 1989 (40 CFR 268.34); and the "Third Third" on May 8, 1990.

The treatment technologies evaluated under the LDRs for nonwastewater spent solvents include distillation and other separation processes subject to the requirements of the Phase I rules. The proposed Phase II TSDF air standards are designed to protect human health and the environment by reducing air emissions from technologies expected to be used to treat wastes prior to land disposal.

The basis for the proposed Phase II standards is to implement control measures that would keep the organics in the

hazardous waste stream until the waste is treated or disposed of in such a manner that the organics are destroyed, removed, or otherwise prevented from being released to the atmosphere. Because all hazardous waste must ultimately be disposed of, air emission standards are needed that control the release of organic emissions to the atmosphere during the management of the waste from the point of generation through the various treatment processes to the point of disposal. Thus, the LDRs in combination with air emission standards provide an integrated approach to air pollution control at TSDFs.

Corrective Action Under Section 3004(u)

Under the authority of RCRA Section 3004(u), EPA is developing regulations to address releases of hazardous waste or hazardous constituents from solid waste management units (SWMU) that pose a threat to human health and the environment. Because this authority applies to contamination of soil, water, and air media, organic air emissions from SWMU at some TSDFs would be addressed by the corrective action program. The regulations under development would establish health-based media-specific trigger levels measured at the TSDF boundary for determining whether further remedial studies are required. Health-based cleanup standards would then be set for air emission or contamination levels that exceed acceptable health-based levels. When such contamination or exposure is determined either through monitoring or modeling techniques, corrective action would be required to reduce such emissions. Corrective actions and standards are handled on a site-specific basis. There are no uniform standards. Any corrective action using one of the six treatment/separation technologies would be required to comply with Phase I rules, Subpart AA and/or Subpart BB. Likewise, any wastes removed from the site as part of a corrective action containing wastes >10 ppmw organics and managed in one of the six technologies would also be subject to the Phase I rules.

CERCLA

The Comprehensive Emergency Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601 et seq., authorizes EPA to undertake removal and remedial actions to clean up hazardous substance releases. Removal actions typically are short-term or temporary measures taken to minimize exposure or danger to humans and the environment from the release of a hazardous substance. Remedial actions are longer term activities that are consistent with a permanent remedy for a release. Remedial actions are required by CERCLA Section 121(d)(2) to comply with the requirements of federal and more stringent state public health and environmental laws that are applicable or relevant and appropriate requirements (ARAR) to the specific CERCLA site. The National Contingency Plan (NCP) provides that CERCLA removal actions should comply with the federal ARAR "to the greatest extent practicable considering the exigencies of the circumstances" (40 CFR 300.65(f)). The equipment leak standards may be considered ARAR for certain onsite remedial and removal actions.

A requirement under a federal or state environmental law may either be "applicable" or "relevant and appropriate," but not both, to a remedial or removal action conducted at a CERCLA site. "Applicable requirements," as defined in 40

CFR 300.6, are those federal requirements that would be legally applicable either directly or as incorporated by a federally authorized state program to a particular activity if the activity was not undertaken as a remedial or removal action pursuant to CERCLA. "Relevant and appropriate requirements" are those federal requirements that, while not applicable, are designed to apply to an environmental problem similar to one encountered at a particular CERCLA site and, therefore, it is appropriate to apply these requirements to a remedial or removal action performed at the CERCLA site.

Some waste management activities used for remedial and removal actions to clean up hazardous organic substances require use of the distillation/separation operations regulated under 40 CFR 264, Subpart AA. For example, hazardous organic liquid wastes and ground and surface waters contaminated with hazardous wastes may be treated onsite using air stripping processes. Therefore, the organic emission control requirements of the Subpart AA rules may be "applicable" for onsite remedial and removal action activities that use distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations that treat substances identified or listed under RCRA as hazardous wastes and that have a total organic concentration of 10 ppmw or greater. In addition, offsite storage, treatment, and disposal of all wastes classified under RCRA as hazardous waste must be performed at a TSDF permitted under RCRA Subtitle C. Thus, CERCLA wastes that are defined as hazardous under RCRA that contain more than 10 ppmw of total organics and that are shipped offsite for management in distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping operations would be subject to the final standards as would any similar RCRA hazardous waste.

The new Subpart AA control requirements for process vents may also be "relevant and appropriate" to onsite CERCLA removal and remedial actions that use distillation, fractionation, thin-film evaporation, solvent extraction, and air or steam stripping operations to manage substances that contain organics not covered by this rule (e.g., organics less than 10 ppmw or organics from nonhazardous wastes).

The final rules do not include control requirements for process vents on operations not associated with organics distillation/separation but typically associated with CERCLA remedial or removal actions such as soil excavation, in situ soil vapor extraction, in situ steam stripping of soil, soil washing, stabilization, bioremediation (in situ or otherwise), dechlorination, and low-temperature thermal desorption.

The organic emission control requirements of Subpart BB for TSDF equipment leaks may also be considered as an ARAR for the equipment components (e.g., pumps and valves) installed at CERCLA cleanup sites that contain or contact substances containing 10 percent by weight or more total organics.

Although the final standards would not be ARAR for all types of remedial and removal actions that are potential sources of organic air emissions, other existing RCRA or CAA regulations may qualify as ARAR for many of these activities. For example, Subpart O of 40 CFR 264 establishes standards of performance limiting organic emissions from

thermal destruction processes (i.e., hazardous waste incinerators).

Other Existing RCRA Air Standards

In addition to the promulgation of Phase I air emission standards, the EPA has promulgated several standards under RCRA that reduce air emissions from TSDFs. These include standards for particulate emissions from land disposal units, particulates, metals, chloride, and carbon monoxide emissions from incinerators and boilers and industrial furnaces, general air protection standards for miscellaneous waste management units, unspecified emissions from interim status thermal treatment units, and the 1990 emission standards for process vents and equipment leaks at TSDFs. Nonparticulate air emissions from waste management units such as tanks, containers, and impoundments are currently not regulated. Thus, it is EPA's charge under Section 3004(n) of HSWA to develop such standards as determined necessary.

Land Disposal Units—Particulates

Several existing provisions in 40 CFR 264 (40 CFR 264.251[f], 264.301[i], and 264.273[f]) require the implementation of general design and operating practices at permitted wastepiles, landfills, and land treatment operations to limit the release of particulate air emissions. The EPA has prepared a technical guidance document to aid in the implementation of these particulate rules; the document (*Hazardous Waste TSDF—Fugitive Particulate Matter Air Emissions Guidance Document*, EPA-450/3-89-019) provides information on the sources of and control technology for particulate air emissions at TSDFs.

Miscellaneous Units

40 CFR 264, Subpart X, contains provisions that require prevention of air releases that may have adverse effects on human health and the environment at miscellaneous hazardous waste management units. Miscellaneous units are those units that are not containers, tanks, surface impoundments, wastepiles, land treatment units, landfills, incinerators, boilers, industrial furnaces, underground injection wells, or units eligible for a research, development, and demonstration permit. Miscellaneous units would include detonation units and salt domes.

Incinerators

Air standards also have been promulgated for the control of air emissions from permitted hazardous waste incinerators (40 CFR 264, Subpart O). These standards require that incinerators be operated to achieve a destruction and removal efficiency (DRE) of at least 99.99 percent for those principal organic hazardous constituents listed in the facility permit. Higher efficiencies are required when the incinerator is burning certain specified waste types, e.g., polychlorinated biphenyls. These standards also limit air emission of organics, hydrochloric acid, and particulates from incinerator stacks.

EPA proposed revised standards in April 1990 that also require risk-based emission limits on metal chloride species and products of incomplete combustion using carbon monoxide as an indicator.

Thermal Treatment

Interim status standards for thermal treatment units other than incinerators (such as wet air oxidation) are found in 40 CFR 265, Subpart P. These standards apply to facilities that thermally treat hazardous waste in devices other than enclosed devices using controlled flame combustion. The standards require monitoring of visible emissions and operating conditions of the combustion devices and prohibit open burning except for open burning and detonation of waste explosives.

Boilers and Industrial Furnaces

The EPA also has promulgated standards covering the burning of hazardous waste in boilers and industrial furnaces (December 31, 1990; published in the *Federal Register*). These standards would require such burning to achieve a DRE of 99.99 percent for each principal organic hazardous constituent identified in the facility permit. The proposed standards also have provisions for exempting the burning of low-risk wastes when the risk posed to the most exposed individual is less than 1 in 100,000. For noncarcinogenic compounds, exemptions may be allowed if the resulting air concentrations do not exceed the reference concentration (RfC) of individual hazardous compounds. The proposed standards would also limit emissions of carbon monoxide, metals, and hydrochloric acid from boilers and furnaces burning hazardous wastes.

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Chapter 7

Implementation of RCRA Air Regulations

The Treatment, Storage, and Disposal Facility (TSDF) Air Emissions Standards, Subparts AA (Process Vents) and BB (Equipment Leaks) are self implementing. The rules became effective 6 months after the promulgation date, or December 21, 1990. Some facilities will have up to an additional 18 months to install control devices. The actual effective date for specific facilities depends on the type of facility with regard to its permit status. Phase II, currently undergoing Office of Management and Budget (OMB) review, will also have an impact on the implementation of Phase I.

The self-implementing nature of the regulations minimizes the need for interaction between the permitting agency and the permit applicant or permittee. The need for interaction is reduced because the regulations are very specific. The regulations have specific requirements that a facility must meet in order to be in compliance. First, facilities must make applicability determinations, and the regulations include specific procedures for determining whether a facility is affected by the regulations. If the rules are applicable to a facility, the regulations specify how to estimate emissions.

Whether control devices are needed to control air emissions is determined by the facility emissions. If the facility exceeds the facility emission rate limits of 3.0 lb/h or 3.1 ton/yr, then control devices are required to control the emissions. If control devices are required, performance and operations standards for those control devices would apply. Therefore, meeting the requirements that have been specified in the regulations would ensure compliance with the regulation as a whole. Because of these specific requirements, the need for engineering or professional judgment in interpreting the regulations and in applying them to a specific facility is reduced. To further ease the implementation of the Resource, Recovery, and Conservation Act (RCRA) air rules, the requirements for interim status facilities under Part 265 and for permitted facilities under Part 264 are essentially the same, with the exception that no reporting requirements for interim status facilities are required.

The air rules have been passed pursuant to 3004(n) of the Hazardous and Solid Waste Amendments of 1984 (HSWA), are therefore considered HSWA rules, and will follow an HSWA implementation schedule. This means that the rules become effective immediately in all states and that the U.S. EPA would implement and enforce these rules in all states. The EPA would continue to do so in nonauthorized states, but at such a time as HSWA-authorized states have revised their

programs to reflect the new air emissions standards and these changes have been approved by EPA, then the authority for implementation and for enforcement would be delegated to that state.

HSWA-authorized states are required to adopt the HSWA provisions or the TSDF air standards to maintain their authorization status. Authorized states had a statutory deadline to adopt the Phase I air regulations by July 1, 1990, to maintain their authorization status. If a statutory change is required to reflect the new Phase I air standards, an additional year is available and July 1, 1991, became the deadline. In some cases the schedule can be extended for up to 6 months for extenuating circumstances. The states may have or adopt the equivalent standards as a matter of state law and administer and enforce these as state law prior to approval of the HSWA modification authorization.

Delays in the permitting process are likely because of the inclusion of these air standard requirements into the permits, an additional layer of complexity in the permitting process. Delays were likely for those permits scheduled for issuance in early 1991. This can occur for three major reasons: (1) if the detailed module approach is used, some delays may occur in developing permit language that specifically and adequately addresses the Phase I air standards; (2) if information or data received from the applicant are either incomplete or of poor quality and insufficient for permitting decision; and (3) procedural delays, if the permit has gone through public notice without the inclusion of the air standards. For these facilities, an additional public notice covering only the Phase I air standards is required. The whole permit does not need to be opened, only that portion covering the Phase I standards. The best way to minimize delays in the permitting process is to first set up a dialogue between the applicant and the permitting agency to determine what information is required for the permit and what is the quality of that information, and to call for any Part B information as early as possible in the process. To further minimize delays, language associated with the Phase I air standards should be incorporated into the draft permit as soon as possible.

When to expect facilities to develop and submit information depends upon when the rules become effective for specific facilities. The effective date of the Phase I air standards is December 21, 1990. The actual effective date for a specific facility may be as early as December 21, 1990, or may be later depending upon its permitting status. Information can be

expected as early as December 21, 1990, for facilities immediately affected by the regulation. The effective date of the regulations for specific facilities depends upon the permit status classification of that facility.

For the purposes of discussing the classification of the effective date for a specific facility, facilities have been divided into five categories: (1) interim status facilities, (2) permitted facilities, (3) facilities or units that become newly subject to the RCRA rules (either through a newly listed or newly identified waste), (4) a newly constructed facility or unit, and (5) a unit that becomes newly subject to the Phase I air standards (where a change has been made in the waste stream concentrations so that they now exceed the waste classification limits).

Interim status facilities became subject to the air rules on the effective date, December 21, 1990. Any part of the permit applications that has been submitted before December 21, 1990, or those submitted subsequent to this date must be modified to include the Phase I air standards. Facilities are required to install emission control devices, if needed, by the effective date, December 21, 1990. If they are not able to install those control devices, an extension period of up to 18 months from that effective date is available. The 18-month extension period is not a blanket extension and any delays must be justified. All control devices must be installed as early as possible, and all must be installed by June 21, 1992.

Permitted facilities—those that have received their final permits before the effective date of the regulations (December 21, 1990)—are effectively shielded from the Phase I air standards through the permit-as-a-shield policy. This means that the rules do not apply to these facilities, and they do not have to comply with the requirements. The standards can be applied and added to the permit when the permit is reissued, modified, or reviewed under the land disposal review. The Phase I rules provide cause for the agency to modify any permits under the permit modification procedures outlined in Part 270.41.

If the Agency initiates a permit modification, headquarters policy is that the Phase I air standards can be applied to the facility as a whole. However, if an owner/operator- or facility-initiated permit modification is requested, the Phase I air standards would apply only to those units subject to that permit modification. The rules should not be applied to that facility as a whole. However, the rules may be applied to the facility as a whole if the permit modification procedures outlined in Part 270.41 are followed.

For those facilities that become newly subject to RCRA—through a newly listed or newly identified waste—the air rules would apply 6 months after the listing of that waste, or the effective date of the test by which the waste was identified. These facilities would then become interim status facilities and follow the interim status rules under Part 265. They would therefore have up to an additional 18 months from the listing date of that waste to install control devices. If control devices are not installed by the effective date of that regulation for that facility, the operating record must contain either an implementation schedule that describes when installation control devices will occur or documentation that the emission rate

limit of 3.0 lb/h or 3.1 ton/yr has not been exceeded and control devices are not needed. This must be in the operating record at the time of the effective date for that facility.

For newly constructed facilities, the law requires that permits issued after December 21, 1990, must include the Phase I air emission standards in the permit. The law also requires that any facility must receive final permit prior to the initiation of construction. Any applications submitted prior to December 21, 1990, must be modified and resubmitted. In all cases, controls must be in place and operating upon startup. No extension is allowed for the installation of controls.

For new units at existing facilities, if the unit is at a permitted facility, a permit modification is required to address the air emission standards. The air standards would apply to that unit on the date that the permit modification is approved. For new units at interim status facilities, a revised Part A application is required to justify the need for an additional unit, and the air standards would apply on the date that the revised Part A is approved. In all cases, controls must be installed and operating upon startup of new units. For newly constructed facilities and new units at existing facilities, no extensions are allowed for the installation of controls. They must all be installed and operating on the startup of that facility or unit.

The waste stream of a facility may change, so that the concentration of the waste now exceeds the waste classification limit, 10 ppm by weight for the Subpart AA process vent standards or 10 percent for the equipment leak Subpart BB standards. The air rules would apply on the date that the facility begins to exceed the waste classification limits. In all cases, all vents associated with wastes 10 ppm or greater by weight are considered affected regardless of whether facility emissions are above or below the emission rate limit. If control devices are needed, they must be installed and operating on the effective date, the date that the facility begins to exceed the limit. No extensions are permitted for the installation of control devices allowed for these facilities. Therefore, if facility owners/operators believe that change has occurred in the waste stream, they should be conservative in making their determinations. If a facility begins to exceed the waste classification limit, and controls to comply with the regulations have not been installed, they would be considered out of compliance. The waste classification limit for Subpart AA, 10 ppmw is an annual average, not an instantaneous concentration limit. Therefore, the facility owners/operators must determine whether or not they foresee a chance of the facility's exceeding the waste classification, in order to have sufficient time to install control devices. By contrast, the Subpart BB equipment leak standards are instantaneous concentration limits. The instant that equipment comes in contact with wastes exceeding 10 ppm, they are considered to be affected by the regulation; controls, if needed, must be installed and operating and a leak detection and repair (LDAR) program must be in place.

To demonstrate compliance with the regulations, facility owners/operators must first determine that they are affected by the regulations, that theirs is a Subtitle C facility (either having or needing a RCRA permit), that they manage waste in one of the six technologies designated in the standards for

process vents (Subpart AA), and/or that they exceed the waste classification limits. The determination of applicability must be made by the effective date for facilities immediately affected by the regulations (December 21, 1990). They must document these determinations in the operating record by the effective date. Information that must be in the operating record at the effective date includes the waste determinations of organic concentrations of all waste streams; whether or not they exceed the waste classification limits of 10 ppmw for Subpart AA or 10 percent for Subpart BB; and, for process vents, any emissions estimates either from actual measurement or monitoring data or from engineering calculations. The facility must also make a determination as to whether or not control devices are needed at their facility, i.e., if the facility exceeds the emission rate limit of 3 lb/h or 3.1 ton/yr. If either emission rate is exceeded, control devices are needed, and documentation must exist stating that control device efficiency will be met—by existing operating records, data associated with existing control devices, or any documentation or engineering calculations that indicate devices to be installed will achieve 95 percent control efficiency or reduce emissions to below the facility emission rate limits. Certain requirements and data associated with equipment leaks must be in the operating record by the effective date (as early as December 21, 1990). In addition to the applicability determinations, any Method 21 monitoring results and any leak detection repair records associated with the equipment leak rules must be documented.

On the effective date, facilities can be considered to be in one of three states:

1. They can be in full compliance, having made their applicability determination of what facility or the units at their facility are affected by the regulations, made emissions estimates to determine whether control devices are needed, and, if needed, have these control devices installed by the time of the effective date, December 21, 1990.
2. If emission control devices are required and have not been installed by the effective date, the facility must have an implementation schedule in their operating record. This will be covered in greater detail later in this chapter.
3. A facility owner/operator can document that the emission rate limit is not exceeded, i.e., that the total facility emissions from the affected process vents do not exceed the 3 lb/h or 3.1 ton/yr, and, therefore, control devices are not required. In all cases these requirements must be met by a facility at the time of the effective date in order for it to remain in compliance. No extension period is allowed for these requirements.

If installation of control equipment has not been completed by the effective date, an extension is possible if included in the implementation schedule is the statement that these control devices will be installed within 18 months from the effective date, as early as June 21, 1990. Further extensions are not possible beyond this date.

The Phase I air standards require information for Part B permit applications above that already required for a normal RCRA permit. This information would reflect the Phase I air standards. The information required for Part B applications

follows that described above for facility documentation of compliance. The facility must include any documentation associated with applicability determinations. Affected facilities are, for the equipment leak standards, those managing wastes greater than 10 percent, and, for the process vents standards, those using one of the six designated technologies and also handling wastes greater than 10 ppmw. Once affected by the process vent rules, determination that the process vent emission rate limit is or will be met must also be included. If the facility emissions from affected process vents are below 3 lb/h and 3.1 ton/yr, control devices are not needed. If control devices are needed (emissions above 3.0 lb/h or 3.1 ton/yr), controls would reduce emissions below the 3-lb/h, 3.1-ton/yr limit or, if the limit cannot be met, achieve 95 percent control efficiency.

For the Subpart BB rules, each piece of equipment must have a designation of service. Equipment designation is important because the actual requirements or standards of Subpart BB depend upon and vary according to the classification of that piece of equipment, be it in gaseous, light liquid, or heavy liquid service. Additionally, for equipment leak rules, records and reports associated with a leak detection and repair program must be submitted.

Determining emission rates and control device design can be done in several ways; a verification must be made that acceptable methods to calculate emissions and control device designs have been followed. The regulations define appropriate test methods and are described in the rules. Further, if test methods are not used, proper engineering design or judgment should be used. Finally, if controls have not been installed at the time of the effective date, an implementation schedule must be submitted with the Part B application and must include an explanation as to why the units were not installed by the effective date and the dates by which each unit will be up and operating.

If control devices have not been installed by the time of the effective date, procedures must be followed so that the facility remains in compliance. An extension period of up to 18 months is possible. This extension period is available only to interim status facilities and newly regulated facilities. The extensions do not apply to either new facilities or facilities that become newly subject to the standards due to waste stream changes resulting in exceedance of the waste classification limit. This 18-month period is not a blanket or automatic extension. The rules specify that the equipment must be installed by the time of the effective date, as early as December 21, 1990. If the control devices have not been installed, an explanation of why they were not installed by the effective date must be included. The rules allow for an extension if documentation exists stating that the installation of these control devices could not reasonably have been expected to have been completed earlier.

Two reasons are acceptable for not having installed control devices by the effective date. They are

1. vendor constraints, or documentation that vendors could not deliver and install control devices at any date earlier, and

2. delay of installation until normal scheduled routine shutdown of a unit.

Delaying installation until normal routine shutdown is acceptable only if documentation exists stating that doing so would actually reduce the overall emissions from that unit. This would apply to those many control devices, units, or technologies for which the greatest emission potential occurs during shutdown and startup of the unit. An unscheduled shutdown may increase the emission potential from the unit so much that waiting until normal shutdown would actually reduce emissions and would justify a delay. Economic constraints are not considered to be a legitimate reason for delay of installation of controls, though this may be negotiated on a case-by-case basis.

An implementation schedule is required to be in the operating record by the effective date. This schedule shows the dates by which the design and construction for each unit will be completed. The dates and schedule must be specific for each unit at the facility. The 18-month extension period is not a blanket extension; delays for each unit must be justified and documented.

In all cases, the implementation schedule should show that the installation of all control devices should be completed within 18 months of the effective date, by June 21, 1992, for those immediately affected. No further extensions are allowed for the installation of controls beyond this date.

The rules allow for changes in the extension period if documentation exists stating that a schedule change could not reasonably be avoided because of vendor constraints (e.g., delivery was not able to be completed by such time). This exception should be supported and documented with vendor information (e.g., purchase orders). Extensions for this or any reason are not allowed beyond the 18-month period.

In all cases the implementation schedule must be in the facility operating record by the effective date, as early as December 21, 1990, for those immediately affected by the regulations. No extension is allowed for the presence of the implementation schedule in the operating record.

Measures exist in Phase II that will have an impact on the implementation of the Phase I air standards. The implementation of the Phase II rules will be essentially the same as that discussed under Phase I. Provisions included in Phase II that would have an impact on the implementation of Phase I include the elimination of the permit as a shield and the inclusion of accumulation tanks and containers into the Subpart AA and BB standards. The removal of the permit as a shield is being allowed primarily because the rules are self implementing; that is, they are very specific for facilities making applicability determinations and determinations of the need for control devices. If control devices are needed, standards for design and operation are included in the rule. Standards for interim status and permitted facilities are essentially the same. The Office of Air Quality Planning and Standards (OAQPS) has had success in taking this approach with other regulations and has that experience to draw from. Also, human health and environmental benefits are associated with the reduced emissions that would occur as a result of the Phase I air standards. Given that many TSDFs are estimated to con-

tribute about 10 percent of the total organics from stationary sources nationwide, if they were allowed to continue to operate without having to comply with the Phase I rules, these emissions would continue to occur, and delayed health and environmental benefits associated with those reduced emissions would occur. Also, Congress clearly intended to have these regulations implemented as early as possible and uniformly, as stated in the preamble language.

Accumulation is the first step in the hazardous waste management process and occurs prior to any air emission control. Air emission potential is probably the highest during accumulation. The possibility exists of losing most, if not all, of the volatiles before any controls or standards can be applied to that waste stream, which reduces the regulatory benefits of the Phase I rules.

The changes that have been proposed under Phase I will become effective 6 months after the promulgation of Phase II, which is anticipated to occur by mid-1992.

What does the removal of a permit as a shield mean? Those facilities that had their original operating permit before December 21, 1990, were effectively shielded from the regulations and did not have to comply. By removing the permit as a shield, those facilities that were originally exempt from the Phase I rules would become subject to the interim status rules under Part 265. Because they are going to be following the interim status rules, they will have up to an additional 18 months to install control devices. The interim status rules would apply directly to that facility until a permit is either modified or reissued. In essence, the facility would be operating under dual status. The permit rules under Part 264 would apply to all other units, while the interim status Part 265 rules would apply directly to those units at that facility that are affected by the Phase I regulations.

Phase II would also change the rules governing accumulation tanks and containers. The requirements have been changed so that Subparts I and J regulations would require compliance with the Subpart AA process vent standards, Subpart BB equipment leak standards, and the new Subpart CC tanks and containers requirements under Phase II in order for them to maintain their permit exempt status. Phase II is not going to affect either small-quantity generators or satellite accumulation exemptions.

In summary, the rules are self implementing, with specific requirements and procedures for facilities to follow to determine the applicability of the rules to their facilities and, if they are applicable, how to make estimates of emissions to determine the need for control devices and whether a facility exceeds the waste emission rate limit. Specific design and operating standards for control devices are available, if they are needed. For the equipment leak rules, specific procedures and leak detection and repair (LDAR) programs must be instituted to comply with the Subpart BB standards. The self-implementing nature of the rules minimizes the need for interaction between the permitting agency and the permit applicant. The Phase I rules became effective on December 21, 1990, but the effective date for individual facilities depends upon the classification of the facility with regard to its permit status. Interim status facilities are immediately af-

ected by the regulations. Other facilities, such as new units or newly regulated facilities, would become subject on later dates, and permitted facilities are initially exempt from the regulations.

The Phase I rules are considered to be HSWA rules, passed pursuant to 3004(n) of HSWA and therefore will follow an HSWA implementation schedule. The rules are effective immediately in all states, implemented and enforced by EPA. When HSWA-authorized states modify their programs to address the Phase I air standards and these modifications are approved by EPA, enforcement and implementation authority will be delegated to those authorized states. EPA will continue to enforce and implement the rules in nonauthorized states. Finally, provisions in Phase II will have an impact on the implementation of the Phase I rules. This includes the removal of permit as a shield for those facilities that are originally exempt by having their final operating permit issued prior to December 21, 1990. After Phase II they will become subject to the interim status facility for those units. To maintain their permit exempt status, accumulation tanks and containers will also be required to comply with the Subpart AA and BB standards along with the new CC standards proposed under Phase II.

Questions and Answers

Question—Must the applicant submit determinations of process vents and equipment not subject to control requirements?

Answer—The determination must be in the operating record; it is not submitted with the permit application.

Question—Are only the regions authorized to implement the air regulations? If so, does the state permit writer have omnibus authority with respect to air emissions?

Answer—Only EPA is currently authorized to implement the air regulations; however, once authorized state adoption of regulations is approved, they can implement. Omnibus is left to the states as policy. The support role depends on the state and its relationship with the region.

Question—If a manufacturing facility has both final and interim status units, does the rule apply?

Answer—The rule applies to interim status units; final permit units are shielded.

Question—If the permit is opened for an unrelated purpose, does the facility come under the rules?

Answer—Office of Solid Waste-Headquarters says the rules would apply only to those units affected by the permit reopening if the owner/operator initiated the permit modification. If EPA initiated the opening of the permit, the rules may be applied to all units.

Question—What will trigger the reopening of a permit for these rules?

Answer—Any opening of the permit (administrative, technical) would open the units subject to the rules associated with the permit change. On the basis of excessive residual risk, omnibus can be used to open a permit under 270.41.

Question—In the process vent presentation, the statement was made that permitted facilities are shielded from Phase I air standards. Does this shielding of permitted facilities apply to both the process vent requirements and to the equipment leak requirements?

Answer—Yes, until the permit is reissued, modified, or Phase II is promulgated.

Question—Do states automatically get authorization for Phase I if the state is previously authorized?

Answer—No. The state must adopt changes/new regulations and have the modification approved.

Question—Would the proposed Subpart CC standards require testing of every waste managed at a TSDF in a tank, surface impoundment, or containers?

Answer—No. Waste determinations would only be required when an owner or operator chooses to demonstrate that controls are not needed on a unit because the waste managed in the unit has a volatile organic concentration less than 500 ppmw, or the owner or operator chooses to place a waste with an organic vapor pressure below the specified limits in a tank not using a control device. Furthermore, the owner or operator would be allowed to perform the waste determinations using either direct measurement or knowledge of the waste. Direct measurement of the waste volatile organic concentration or organic vapor pressure would be performed using the EPA test methods included in the RCRA Phase II rulemaking. Knowledge of the waste would need to be supported by documentation that shows that the waste volatile organic concentration or organic vapor pressure is below the specified limit under all conditions.

Question—Is the 500 ppmw action level specified in the proposed Subpart CC standards for determining the need to apply emission controls to a unit an average value?

Answer—No. The 500 ppmw action level is a maximum volatile organic concentration not to be exceeded at any time. EPA staff intends that only those units be exempted from using emission controls for which the owner or operator is reasonably certain that the volatile organic concentration of the waste managed in the unit consistently remains below 500 ppmw. If the owner or operator cannot determine confidently that the volatile organic concentration of the waste placed in a unit will remain below 500 ppmw at all times, then the owner or operator should install the required emission controls.

Question—For the purpose of determining if the volatile organic concentration of a waste is below the 500 ppmw action level, who is responsible for performing the waste determination—the hazardous waste generator or the TSDF operator?

Answer—The proposed Subpart CC standards would require that the waste determination must be based on the waste composition before the waste is exposed to the ambient air. When a waste generator is also the TSDF owner or operator (e.g., the TSDF is located at the waste generation site), performing a waste determination before the waste is exposed to the ambient air can be readily accomplished since the TSDF owner or operator has custody of the waste from the point of generation. However, for the situations where the waste generator is not the TSDF owner or operator (e.g., the waste is generated at one site and shipped to a commercial TSDF), the TSDF owner or operator would not have custody of the waste until it is delivered to the TSDF. In this case, the TSDF owner or operator may not have access to the waste before it is exposed to the ambient air. Consequently, the hazardous waste generator must perform the waste determination if waste is to be placed in TSDF units not equipped with the specified emission controls.

Question—Would pollution prevention techniques be allowed under the proposed Subpart CC standards?

Answer—Yes. The proposed Subpart CC standards would allow a TSDF owner or operator to reduce the volatile organic concentration for a specific waste to a level less than 500 ppmw through pollution prevention and other engineering techniques. For example, if a waste is treated using a means other than by dilution or evaporation into the atmosphere so that the volatile organic concentration of the waste is less than 500 ppmw, emission controls would not be required on the subsequent downstream tanks, surface impoundments, containers, and miscellaneous units that manage this waste. However, the unit used to treat the

waste would still be required to use controls in accordance with the appropriate requirements of the Subpart CC standards.

Question—How long a period would TSDF owners and operators have to comply with the requirements as proposed for the Subpart CC standards?

Answer—The TSDF owners and operators would be required to be in compliance with the Subpart CC standards by the rule's effective date which would be 6 months after the promulgation date of the final rule. Facilities required to install control equipment would be allowed up to an additional 18 months beyond the effective date to complete the design and installation of the equipment provided the owner or operator has prepared an implementation schedule by the effective date showing when these controls will be installed.

Question—How would the proposed amendment requiring compliance with RCRA air rules by the rule's effective date regardless of a TSDF's permit status (i.e., removal of "permit-as-a-shield" policy for RCRA air rules) affect the implementation of the Subpart AA and BB rules at existing permitted TSDF?

Answer—Presently, a TSDF that has been issued a final permit prior to the promulgation date of the Subpart AA and BB standards is not subject to the Subpart AA and BB standards under either Part 264 or 265 rules until the facility's permit is modified or reissued. Upon promulgation of the RCRA Phase II air rules, owners and operators of these permitted TSDFs would be required to be in compliance with the Subpart AA and BB rules under Part 265 within 6 months. Facilities that would be required to install control equipment would be allowed up to an additional 18 months to complete the design and installation of the equipment. This is the same period of time now allowed for owners and operators of interim status TSDF to comply with the Subpart AA and BB rules.

Chapter 8

Case Study:

Measuring and Estimating Emissions

This chapter is provided primarily as information that may be of interest and not as guidance for implementing the rules that are the topic of the workshop. None of the rules covered in the workshop require that the owner/operator of an affected source measure or estimate emissions. Under the Phase II rule for process vents (Subpart AA), the owner/operator of the source has the option of measuring emissions from process vents.

If the source has not been constructed, emissions must be estimated either by using emission models or by analogy to an existing source where emission measurements have been made. For enclosed vented sources, emission measurements are the preferred choice because they can be determined with a high degree of accuracy. On the other hand, open area sources are very difficult to measure and may be candidates for emission modeling. Some of the techniques to be discussed for open area sources may be very inaccurate. In such cases, emission models may provide estimates that are equally or more accurate than attempts to measure the emissions.

Emission models may also be useful, and much less expensive than measurements, when only an upper bound estimate of emissions is needed. For cases where significant variability exists in the way a unit is operated or the quantity and composition of the waste, emission models can be used to account for the variability and the effect on emissions. Attempts to measure emissions from highly variable sources could require numerous measurements and significant costs, often for results that are highly uncertain. Consequently, cost and available time are often important considerations in deciding whether to measure or estimate emissions.

Emission Measurements

The discussion of emission measurements is divided into direct measurements of mass emission rates, indirect measurements that involve a back calculation, and engineering calculations, which involve the use of mass balances.

Direct Measurements

Two types of direct measurement techniques are vent sampling and the isolation flux chamber. Vent sampling requires that the volumetric flow rate of vapors in the vent be measured along with the vapor phase concentration of the

organic of interest. Concentration can be analyzed on site with a gas chromatograph, or samples can be collected in Tedlar bags, stainless steel canisters, or glass for transport to a laboratory for analysis. If the concentration is too low for analysis, the sample can be concentrated by collection on an adsorbent, such as Tenax or activated carbon, and then desorbed for analysis. The basic items for vent sampling are shown in Figure 8-1. A sample is taken from the vent through a sampling probe and a filter to remove particulate matter, then routed to a sample container or online analyzer.

If the process varies over time or if it is a batch operation, representative samples must be obtained over the cycle or during the variations in processing. For steady-state continuous operations, vent sampling can provide very accurate measurements of emissions. Even with process variations or cyclic operation, vent sampling can provide accurate results if care is taken to obtain measurements of flow and concentration that are representative of the operation over time.

Vent sampling has been used for various types of waste management units, such as vented landfills, vented treatment systems, vented buildings, storage tanks, etc. Obviously vent sampling can be used for any source in which the unit is vented through an enclosed pipe, and the accuracy of the results depends primarily on the accuracy of the measurement of flow and concentration.

The isolation flux chamber shown in Figure 8-2 was developed to measure the flux rate of organics from open area sources such as surface impoundments and land treatment facilities. The device is placed over a portion of the open source. A clean, dry sweep of inert gas is introduced into the Plexiglas chamber at a metered rate and is mixed with the vapor in the chamber, either by an impeller or by the design (e.g., multiple outlets for the sweep gas). The mixture of sweep gas and vapors is withdrawn from the chamber and analyzed for organics, either onsite or at an offsite laboratory if samples are collected in containers. For large area sources, multiple samples are taken at multiple locations to characterize emissions from the entire source.

During its operation, the pressure inside the chamber must be kept at zero. If a positive pressure exists from the sweep gas, emissions may be suppressed; if a negative pres-

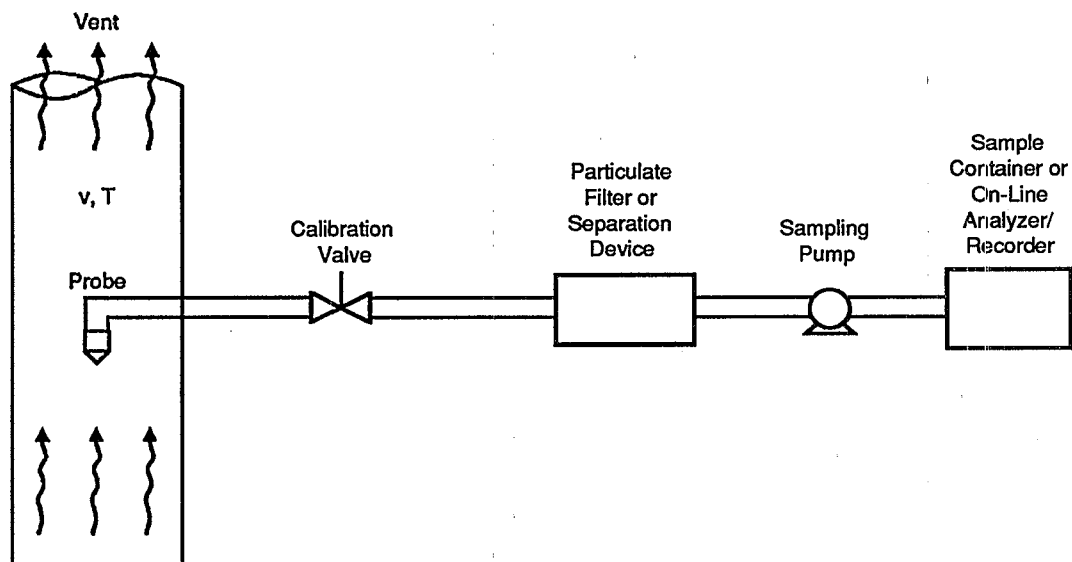


Figure 8-1 Vent sampling.

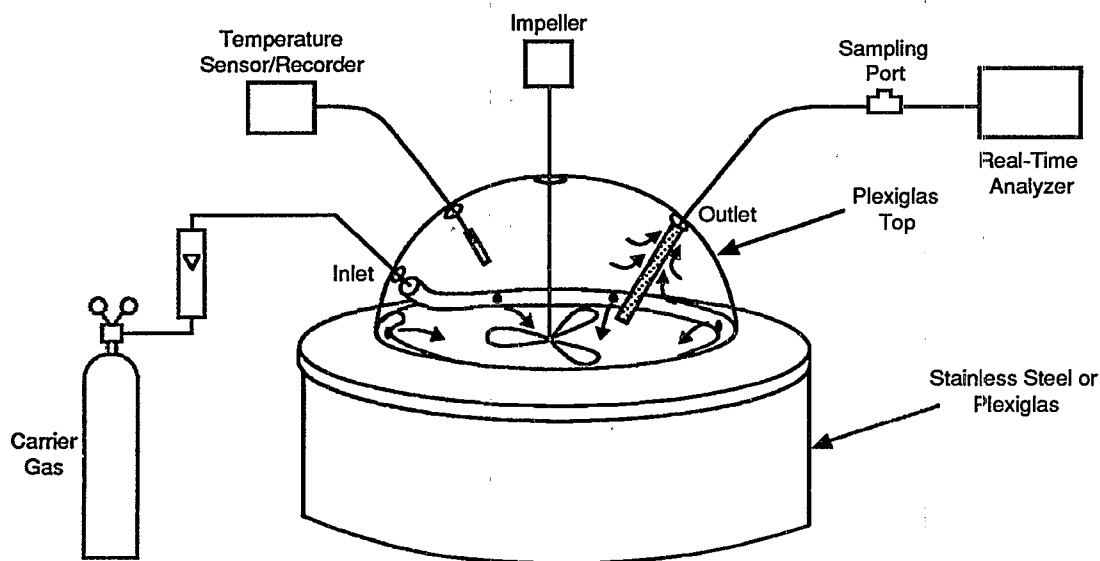


Figure 8-2 Isolation flux chamber and supporting equipment.

sure exists, emissions may be increased by the removal of more organics from the surface. Another factor to consider is the sampling of sufficient locations, especially for sources where the emission rate may vary because of differences in concentration in the waste as a function of location.

The flux chamber has been evaluated on several different types of sources, such as active landfills, land treatment, impoundments, and vents. Its utility for vents is limited to the case where a very low (almost immeasurably low) flow rate from the vent exists. In this case, the flux chamber may be a

reasonable approach to measure the emissions that are occurring primarily by diffusion. If the source is heterogeneous with variation in composition with respect to location, many samples may be required. Some individuals have commented that the flux chamber has some shortcomings for measuring emissions from area sources. For example, when the flux chamber is placed over a source outdoors, the chamber alters the emission mechanisms that existed before the chamber was installed. For impoundments, the chamber disrupts the wind that was blowing across the exposed surface and creating the emissions.

Indirect Measurements

Indirect measurements involve measuring concentrations of specific organics in the ambient air, and then back-calculating what the emission rate from the source would be to give the measured air concentration. One such technique is called the concentration profile technology. The sampling device shown in Figure 8-3 consists of six sampling probes that are mounted vertically and placed at logarithmically spaced intervals. A single mast 4 m in height is placed downwind of the source in the plume centerline. The concentration, wind speed, and temperature are measured at each of the probe heights to generate profiles for each. These profiles are used to calculate the vertical flux rate from the source.

The sampling equipment can be placed on a trailer or on a boat for measurements on impoundments. The concentration profile technique has been used to make measurements on both surface impoundments and land treatment facilities. The technique does not work (it is not applicable) when quiescent or unstable wind conditions exist, such as shifting of direction. The site must be relatively homogeneous; the technique will not work well if emissions or waste composition vary with respect to location.

The transect technology illustrated in Figure 8-4 is also known as plume mapping. This device uses both a vertical and horizontal array of sampling probes that are placed downwind of the source in the plume centerline. The probes are used to measure the ambient air concentration in a cross section of the plume. Four probes are mounted on 1.5-m masts and three on the 3.5-m center mast. Background measurements are made

upwind of the source to correct for the contribution from other sources. The device also has instruments to measure wind speed, wind direction, and temperature. The measured concentrations are spatially integrated and a Gaussian dispersion model is used to back-calculate the emission rate from the source that would be needed to give the measured concentration.

The transect technique has been used on several types of area sources, such as active landfills, surface impoundments, land treatment facilities, and drum storage areas. As with the concentration profile technology, this technique does not work when calm wind conditions exist or when the wind conditions are unstable. It is less susceptible to changing meteorological conditions than the concentration profile technique, and it is more suitable to heterogeneous sites provided sufficient sampling stations are used across the plume.

Mass Balance

The mass balance approach shown schematically in Figure 8-5 focuses on measuring what enters and leaves a unit, and then calculating what is emitted by difference. For example, the flow and concentration can be measured for the waste that enters an open tank and for the treated waste as it leaves. Potential air emissions (in the simplest application of this approach) are calculated from the difference between what enters and what leaves. If no competing removal mechanisms are in the unit, this approach can provide accurate results. Even if competing mechanisms exist, the approach can be used to place an upper bound on the emissions.

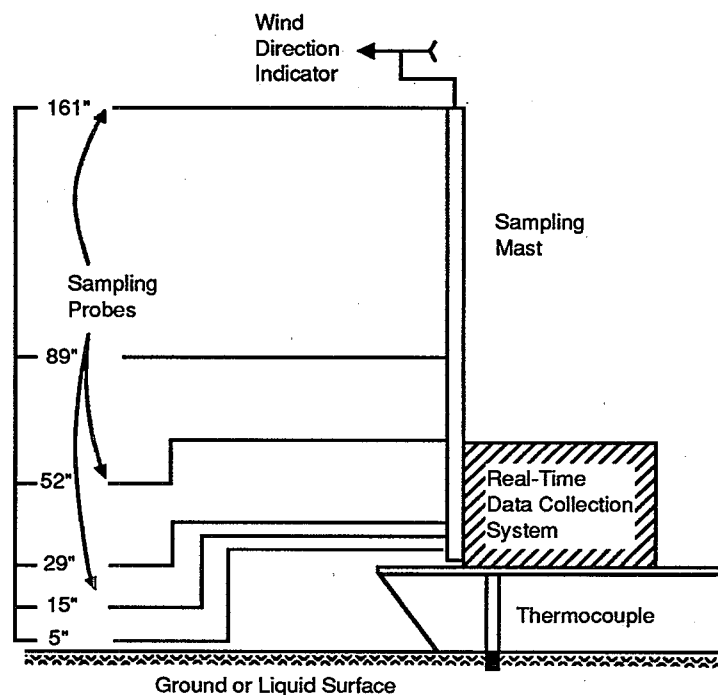


Figure 8-3 Concentration-profile technology.

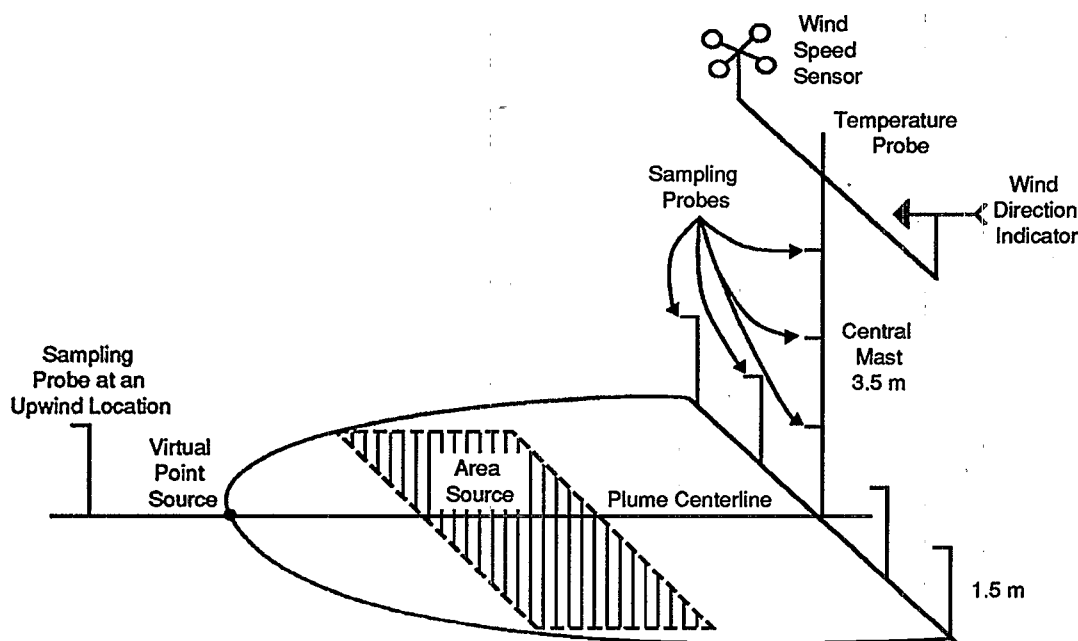


Figure 8-4 Transect technology.

If biodegradation or adsorption are occurring in the unit, attempts should be made to quantify the fraction of the organic that is removed by these mechanisms. This removal can then be used to correct the mass balance to obtain a more accurate estimate of emissions. The mass balance approach works best on sources that are operated at steady-state conditions with little variation in flow rate or composition. However, unsteady-state operations can also be evaluated with this technique if a sufficient number of samples are taken.

The mass balance approach has been evaluated on several types of waste management units, such as wastewater treatment tanks, solvent recovery processes, and surface impoundments. The accuracy of this approach depends on the accuracy of the individual measurements of flow rate and concentration, and on the size of the differences between what enters

the unit and what leaves by the various mechanisms. If biodegradation or other competing mechanisms are significant for a specific organic constituent, this approach may, at best, provide an upper bound estimate of emissions.

Summary

In summary, advantages and disadvantages exist for performing the emission measurements. The measurements provide a feel for site-specific results from the facility or unit of interest, the methods have been evaluated and standardized, and they can provide reasonable precision. On the other hand, the results can be very inaccurate, and they are affected by the site conditions (such as wind speed) and the way the unit is operated. Consequently, the measurements provide results for only one point in time, and the emissions over the long term may be different from the short-term results. The measurements can also be very costly and often require a significant amount of time to get usable results. The sensitivity varies, and often detection limit problems arise for the measurement of concentration in the air. Therefore, emission models in many cases can provide equally satisfactory (or better) results at a fraction of the cost.

Estimating Emissions

The discussion of the mathematical models used for estimating emissions is divided into an overview to provide background information, models that are used for open liquid surfaces, and models used for wastes applied to soil or other porous solids.

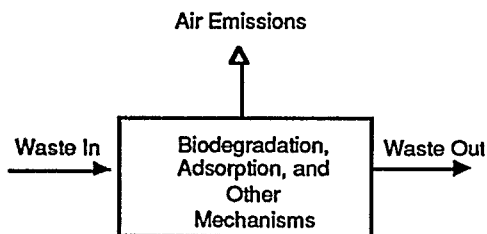


Figure 8-5 Mass balance approach.

Overview

Models have proven to be useful in estimating emissions in many applications. For example, models have been used to evaluate emission estimates or measurements that others have made and are also helpful in assessing the emission potential of sources that are to be constructed. In cases of large open area sources, measurements are often impractical and modeling is the most practical option to estimate emissions. Emission modeling has other uses, such as understanding what factors affect emissions and to what extent. For example, sensitivity analyses using the models can provide insight into the major operating parameters, how the variability in these parameters affects emissions, and how to place reasonable bounds on the estimates. These models have also been used to perform one of the several steps (the emission estimates) in an environmental and health impacts analysis.

Although the models are quite versatile, limitations exist in the use of the models. The typical system that is being modeled is always more complex than the relatively simple models that we use to describe it. There are invariably some questions about the uncertainties associated with the use of the model for a specific site and their effect on accuracy. For example, are all of the assumptions that are used in the model applicable for the specific case for which the model is being used? If not, are the model results still close enough? Another limitation in using the models is the availability of the input parameters needed to run the model.

The models are relatively simple and require only a few inputs; however, if these basic inputs are not available, the models will not provide accurate emission estimates.

Perhaps the most important concept in understanding emissions from wastes is that of volatility, which is the concentration in the vapor divided by the concentration in the waste at equilibrium. For example, if we have a dilute aqueous waste containing benzene and place it in a half-filled, tightly capped vial, roughly 20 percent of the benzene will be in the vapor phase above the waste and 80 percent will remain in the waste. If the waste contains phenol instead of benzene, less than 0.002 percent of the phenol appears in the vapor space. Consequently, benzene in water is highly volatile, whereas phenol in water is relatively nonvolatile. In contrast, some volatiles in mixtures of similar compounds exhibit a lower volatility than when they are present in water. If the sample in the vial contained benzene in oil at the same concentration as benzene in water from the previous example, the amount of benzene in the vapor space is over 100 times less.

We do not have equilibrium data for the wide variety of compounds and types of wastes; consequently, theoretical relationships are used in the emission models. For aqueous wastes, volatility is assessed by Henry's law constant, which is estimated from the pure component vapor pressure divided by its solubility in water. For organic liquids, the volatility used in the emission models is usually estimated from the pure component vapor pressure and the mole fraction in the waste.

To aid in the discussion of emissions and modeling, the term "emission potential" is often used and is most easily pictured for open area sources in which most of the volatiles

are emitted. The potential emissions are bounded on the upper end by the quantity of waste and the concentration of volatiles in the waste. The emission models give us a feel for the fraction of a particular volatile compound that is likely to be emitted, and the product of waste quantity, concentration, and fraction emitted provides an estimate of emissions. *A critical point to remember in assessing emission potential or in using the models is that the concentration that is needed is the concentration entering the source* (for example, at the point of generation before exposure to the atmosphere). Measuring the concentration in the impoundment or open tank after most of the volatiles have been emitted is of little value.

Models for Open Liquid Surfaces

The emissions from open liquid surfaces that are characteristic of surface impoundments and open wastewater treatment tanks are modeled as two mass transfer steps that occur in series (Figure 8-6). The first step involves the transfer of the organic through the liquid phase to the surface, followed by the transfer of the organic from the surface to the air. These steps are referred to as liquid-phase and gas-phase mass transfer, respectively. For highly volatile compounds, the rate of transfer to the air is very rapid relative to the rate of mass transfer through the liquid; for these compounds, the rate of volatilization is controlled by the liquid phase rate. Other compounds such as phenol are not very volatile and the rate of mass transfer is controlled by the gas-phase rate.

As shown in Figure 8-7, volatility has an important effect on the tendency of a compound to be emitted. The graph shows that the fraction of organic compounds emitted increases with volatility up to a point. In the example, the fraction emitted eventually levels off as a function of volatility; at this point, the rate of emissions of the more volatile compounds is controlled by the liquid-phase rate and is not affected by the volatility. The residence time also has an important effect on emissions as illustrated in Figure 8-8. As the residence time increases to several weeks, even the relatively nonvolatile compounds such as phenol will be emitted.

The rate of mass transfer through the liquid phase is affected by the specific compound's diffusivity in the liquid (usually water), by the wind speed, and by the ratio of fetch/depth. (Fetch is the distance across the exposed surface of the source in the direction that the wind is blowing.) The gas-phase mass transfer is affected by the constituent's volatility, its diffusivity in air, the wind speed, and the diameter of the source. If the surface is highly turbulent from mechanical

- Two mechanisms in series
 - Through liquid to surface
 - From surface to air
- Rate-controlling step
 - Liquid phase
 - Gas phase
- Other removal mechanisms
 - With effluent
 - Biodegradation
 - Sludge

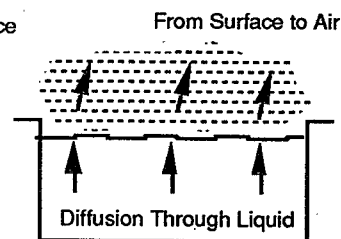


Figure 8-6 Open liquid surfaces—modeling approach.

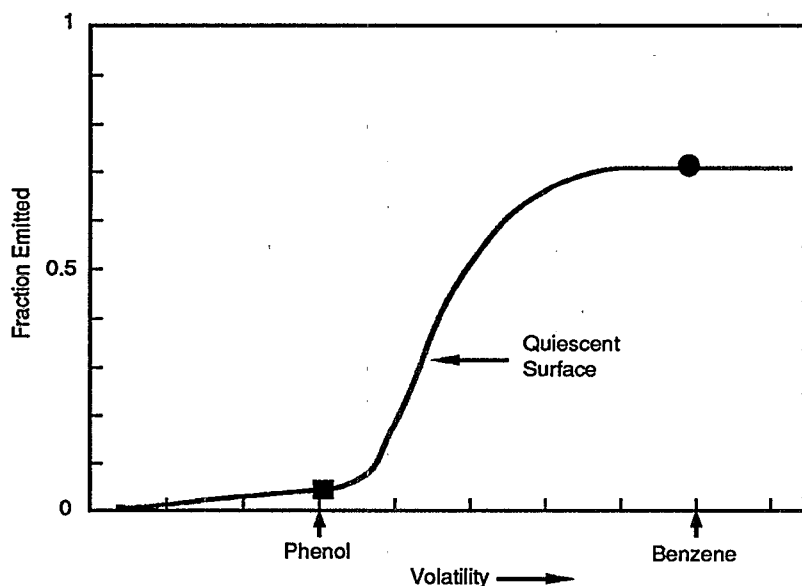


Figure 8-7 Effect of volatility on emissions from a surface impoundment.

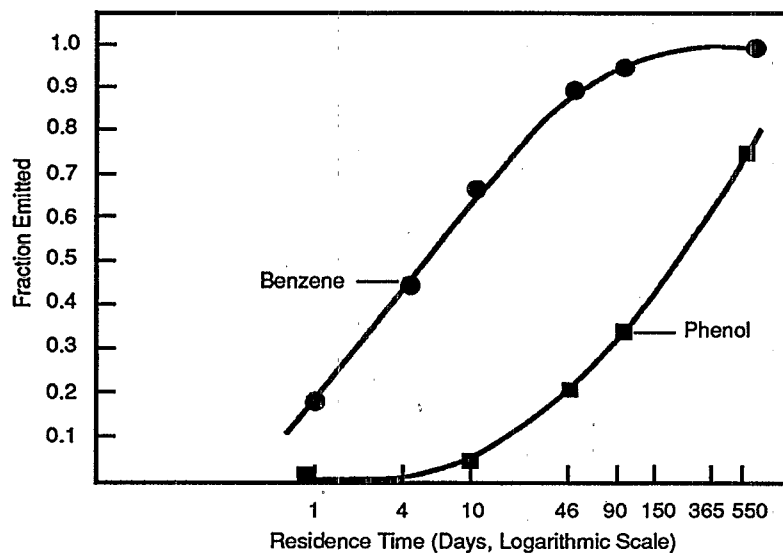


Figure 8-8. Effect of residence time on emissions from an impoundment.

aeration, additional parameters are needed. For example, the additional factors affecting emissions from turbulent surfaces include the horsepower supplied to the aerators, impeller diameter and speed, and the fraction of the total area that is turbulent. The fraction that is turbulent has a direct effect on emissions because the rate of emissions is much higher for the turbulent portion.

As illustrated in Figure 8-9, the modeling must also consider the presence of mechanisms other than volatilization that may contribute to the disappearance of an organic compound. The models that will be discussed evaluate removal with the effluent from the unit, biodegradation within the unit, and adsorption onto and removal with the sludge.

A biodegradation model has been incorporated into the emission models for those units that are designed to promote

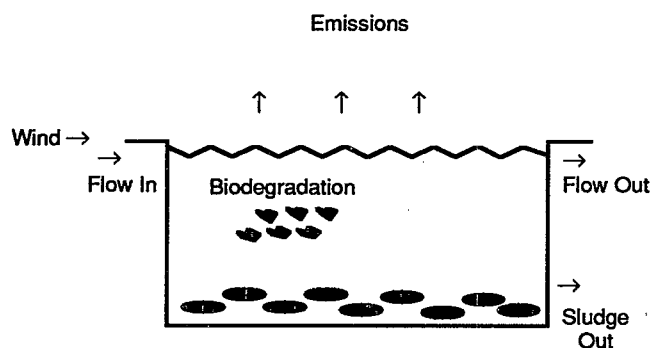


Figure 8-9. Fate of organics: emissions, effluent, biodegradation, sludge.

biodegradation. After review and consultation, the models were revised to incorporate Monod kinetics to describe the rate of biodegradation. In Monod kinetics, the rate is first order with respect to (directly proportional to) the constituent concentration for very dilute concentrations. At very high concentrations, the rate of biodegradation becomes independent of concentration (zero order). The rate is also proportional to the concentration of biomass in the system.

Data are available for the Monod parameters for over 90 compounds from various biodegradation tests in the literature. For other compounds, techniques have been devised to estimate the Monod parameters for the model. The first choice is to use parameters that have been measured for the specific compounds and the system of interest. A second choice would be to use values for the same compounds in other systems, such as the literature values in the emission modeling database. A third choice is to use values for compounds that are structurally similar to the compound of interest. Finally, some empirical relationships have been developed to provide rough estimates of the biodegradation parameters based on the compound's octanol-water partition coefficient.

Several specialized forms of the models have been developed for specific applications. For example, the most commonly used form of the model is based on well-mixed conditions occurring in the tank or impoundment. However, some wastewater treatment tanks are designed for plug flow instead of well-mixed flow. Models are available for both types of flow systems. Some tanks or impoundments have a layer of oil floating on the surface of the water. For this case, an oil-film model was developed. This specialized application of the model assumes that the gas-phase rate controls the overall rate of mass transfer, and the volatile organics of interest are in the oil layer. A model was also developed for diffused air systems based on the assumption that the rising air bubbles reach equilibrium with the organics in the liquid. Finally, models are available for disposal impoundments (no flow out) in which the waste is placed and the liquid is allowed to evaporate. For this model, the time since disposal must be specified to estimate emissions.

The typical inputs that must be specified to use the models for open liquid surfaces (shown in Figure 8-10) include certain features of the waste, the unit itself, and ambient conditions. For the waste, the individual constituents must be

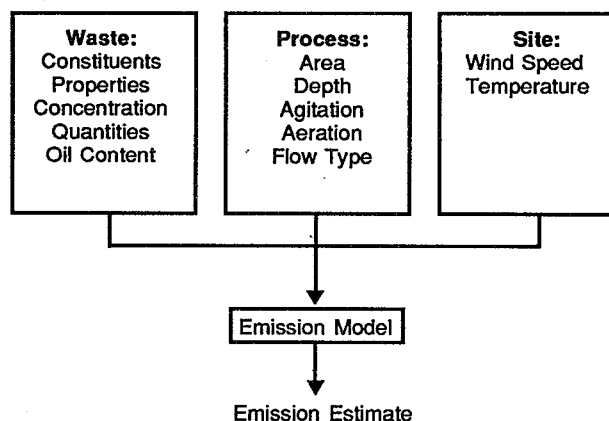


Figure 8-10. Typical model inputs (liquid surfaces).

known, their physical properties, concentrations, waste quantity, and the oil content if a separate oil layer forms. For the process unit (such as the aerated lagoon shown in Figure 8-11), the input parameters include the surface area, depth, type of flow, biomass concentration, and certain aeration or agitation parameters if the unit is aerated. The typical wind speed and ambient temperature are also needed as inputs to the models.

Models for Porous Solids

The models developed for porous solids include putting the waste on top of a soil layer or incorporating it into the soil. For the first case, the modeling assumes that a thin layer of waste is spread on the soil surface and that the gas-phase rate of mass transfer is rate controlling. After the waste is mixed with the soil, the modeling assumes that the air in the soil and the organics in the soil/waste mixture are in equilibrium. In addition, the emission mechanism that is modeled is the diffusion of the organic through air voids to the surface, where the organics are emitted.

One of the most common questions that has arisen about these models is the difference between air porosity and total porosity, which is illustrated in Figure 8-12. Air porosity is the fraction of the soil/waste matrix that is air. Total porosity is that fraction of the soil/waste matrix that is not solid, or the sum of the fractions that are made up of air, water, and oil.

The different pathways for organic compounds in land treatment are illustrated in Figure 8-13. The model for land treatment incorporates options for either oily or aqueous wastes (this affects how volatility is estimated) and accounts for biodegradation within the soil. The major mechanism for mass transfer is diffusion through the air voids. Absorption by oil or water and adsorption onto soil particles are neglected as alternate removal mechanisms.

The biodegradation model used for land treatment and landfills is a simple first-order model and not the Monod model developed for wastewater treatment. The primary basis is information obtained on the biodegradation of benzene and toluene in petroleum refinery sludges that are land treated. These data were used with the biodegradation data for benzene and toluene in water to extrapolate to other compounds for which the aqueous data were available. Consequently, the predicted biodegradation in soil is more uncertain than esti-

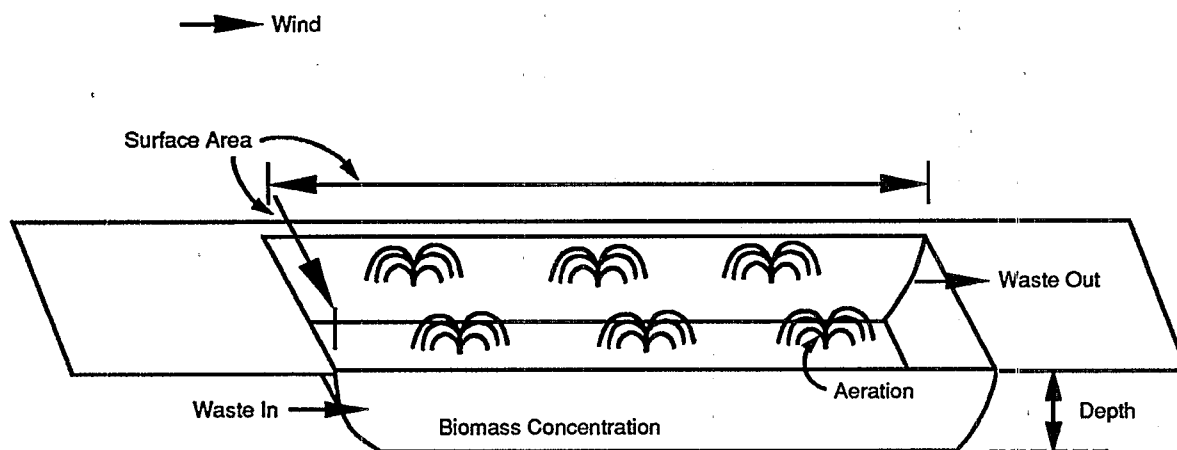


Figure 8-11. Model inputs for an aerated lagoon.

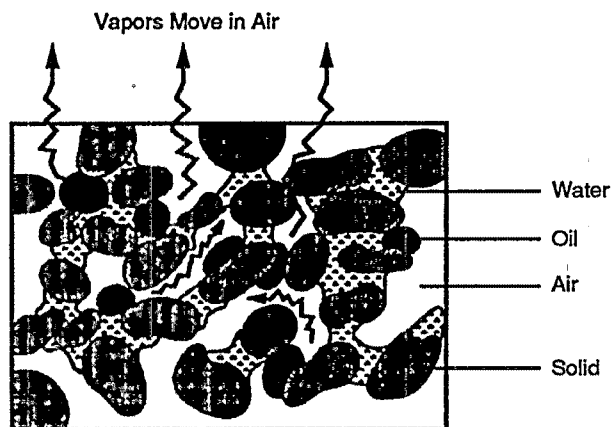


Figure 8-12. Air porosity vs. total porosity.

mates of biodegradation in water because of the scarcity of data.

The typical inputs that are needed for the porous solids model are shown in Figure 8-14 and include characteristics of the waste, the land disposal source, and ambient conditions. The features of the waste that are needed include the constituents, their properties, concentrations, waste quantity, porosity, and oil content (if present). For the source (such as the land treatment plot shown in Figure 8-15), the surface area, depth of application of the waste, porosity, and the time since the waste was applied or disposed of are the items needed to run the models. The typical wind speed and ambient temperature must also be specified. For the covered landfill shown in Figure 8-16, the cap thickness and its porosity must also be known.

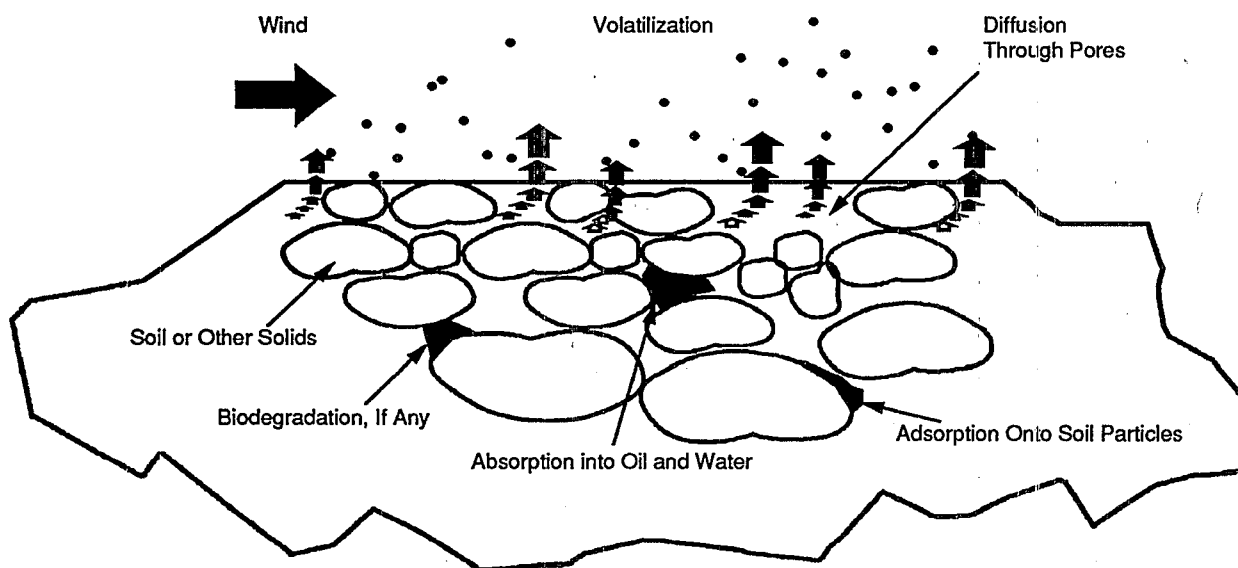


Figure 8-13. Land treatment emission mechanisms.

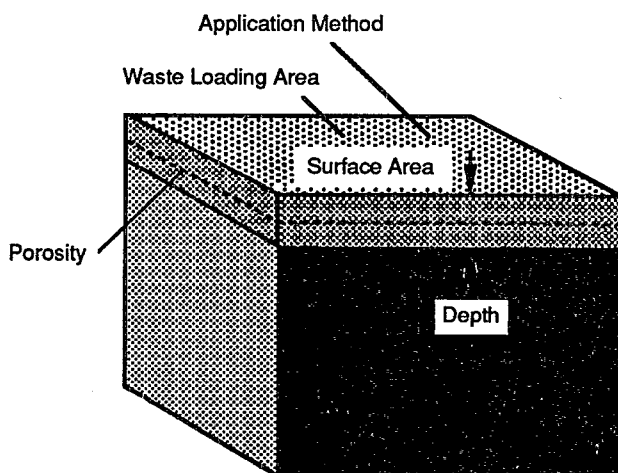
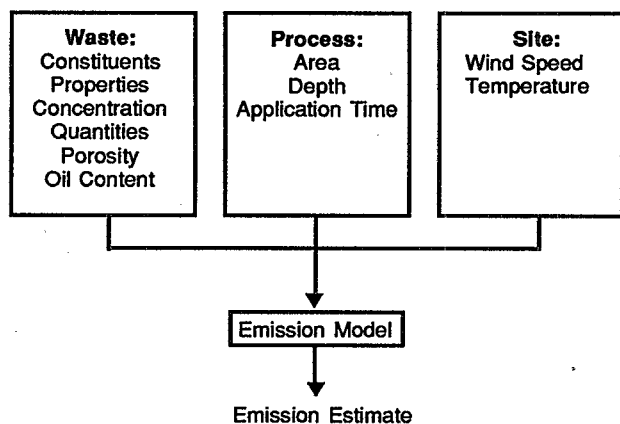


Figure 8-14. Typical model inputs (porous solids).

Figure 8-15. Model inputs for land treatment.

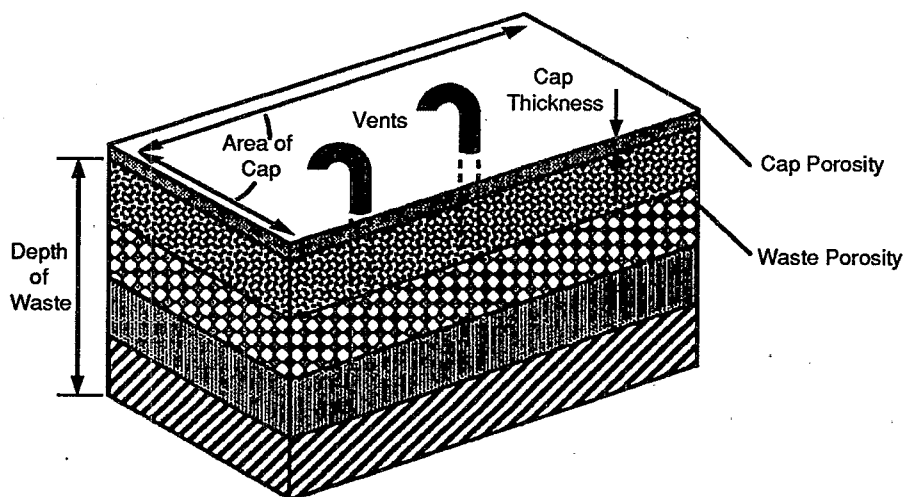


Figure 8-16. Model inputs for a covered landfill.

Questions and Answers

Question—Is EPA recommending or endorsing the use of the indirect sampling techniques to measure emissions?

Answer—No. The information is being provided to let people know that they exist. However, an important part of the discussion deals with their limitations, including inaccuracy, cost, and measurements that represent emissions for a single point in time. In many cases, mass balance or emission modeling can provide more accurate long-term estimates of emissions at a fraction of the cost of the indirect sampling techniques.

Question—The schematic of the flux chamber shows an impeller for mixing. Is this a standard item for all flux chambers?

Answer—No. Mixing is important; however, it can be accomplished without the impeller by having multiple outlets for the sweep gas to enter the chamber and mix with the vapors.

Question—Do the biodegradation models account for the presence of toxic metals or organics in some wastes that may inhibit biodegradation?

Answer—No. The models are based on laboratory studies that involved a biodegradation system that was fully acclimated to the waste. Consequently, the biodegradation model

assumes that the conditions are favorable for biodegradation. If the waste contains compounds that will inhibit biodegradation, the emission model can be run with no biodegradation (set the biomass equal to zero).

Question—Are the emission models conservative?

Answer—The models were intended to provide unbiased estimates of long-term emissions. Actual emissions for any given unit may be higher or lower than the model predictions. By incorporating biodegradation, the models are less likely to overestimate emissions from biologically active systems.

Question—Are the measurements and estimates for Henry's law constant based on a single pure component dissolved in distilled water? If so, is this a reasonable approach for the many constituents and waste matrices that make up hazardous waste?

Answer—The data for Henry's law constant are as described. The preferred approach would be to have direct measurements of a constituent's volatility from a sample of the waste. These measurements have not been made on very many wastes. Some measurements are based on a single compound in distilled water, and these are used for specific compounds when available. In the absence of measurements, the estimating technique of vapor pressure divided by solubility in water provides a reasonable approximation of volatility.

Chapter 9

Benzene Waste Operations NESHAP

NOTE: Since the time the workshops were given, EPA has determined that clarifications to the Benzene Waste Operations NESHAP are required. Revisions to the rule were proposed March 5, 1992 (57 FR 8017). Thus interpretations given during the workshop may have changed. For the latest interpretation, contact Bob Lucas, Emissions Standards Division, OAQPS (919) 541-0884.

Benzene is listed as a hazardous air pollutant by EPA because it is a known human carcinogen. National emission standards for hazardous air pollutants (NESHAP) are established by EPA in accordance with Section 112 of the Clean Air Act (CAA). On March 7, 1990, EPA promulgated the benzene waste operations NESHAP (Table 9-1). This rule was one of the last NESHAP promulgated under the "old Section 112" (i.e., Section 112 as in effect prior to the CAA Amendments enacted November 15, 1990). The 1990 CAA Amendments change the approach EPA will use to develop future air standards for hazardous air pollutants.

As applied to the development of the benzene waste operations NESHAP, the old Section 112 directed EPA to establish national standards to control benzene emissions with an "ample margin of safety" from those sources that present significant risks to human health. To comply with this directive, EPA adopted a risk-reduction policy that strives to achieve a level of emission reduction that (1) limits to no greater than approximately 1 in 10,000 (also expressed as 1×10^{-4}) the estimated additional cancer risk to the individual living in the location that receives the maximum exposure to benzene emissions from waste operations (referred to as "maximum individual risk"), and (2) minimizes the number of people nationwide exposed to estimated additional cancer risks of greater than 1 in 1 million (also expressed as 1×10^{-6}).

A four-step regulatory approach is used as the basis for the requirements specified in the benzene waste operations NESHAP. This approach consists of (1) identifying the facilities where benzene emissions from waste operations pose a health risk to the people living around the facility; (2) identifying those waste streams that cause the benzene emission problem; (3) treating the identified waste streams to remove

or destroy the benzene; and (4) using organic emission controls on all units in which the waste stream is managed prior to and during treatment.

The EPA performed an analysis to identify those industrial categories where benzene emissions from waste operations potentially could present a significant risk to human health. This analysis indicated that large quantities of benzene can be contained in the wastes generated by chemical manufacturing plants, petroleum refineries, and coke by-product recovery plants. Waste operations at these facilities or at offsite hazardous waste treatment, storage, and disposal facilities (TSDF) receiving wastes from these facilities are potential sources of significant benzene emissions to the atmosphere. Therefore, the benzene waste operations NESHAP is applicable to four specific industrial categories—chemical manufacturing plants, petroleum refineries, coke by-product plants, and offsite TSDF that receive wastes from any of these three industries. Note that if a TSDF receives all of its benzene-containing wastes from industries other than chemical manufacturing plants, petroleum refineries, or coke by-product plants, the rule is not applicable to the TSDF.

Some individual facilities in the affected industrial categories manage wastes that contain little or no benzene. To avoid requiring these facilities with low benzene emission potential to be subject to the treatment and control standards under the benzene waste operations NESHAP, a cutoff level related to the facility's benzene emission potential is specified in the rule. This cutoff level identifies which facilities in the four affected industrial categories have the potential for presenting significant risks to human health as a result of benzene emissions from waste operations and, consequently, need to treat and control benzene-containing waste streams. The cutoff level is based on the total annual quantity of benzene in the waste managed at a facility (referred to here as the "facility-wide TAB"). The EPA determined that those facilities in the affected industrial categories with a facility-wide TAB of 10 Mg/yr or more need to control certain waste streams containing benzene in order to achieve the EPA risk policy goals.

The definition of "waste" used for the benzene waste operations NESHAP is the same definition used for other CAA standards (specifically the volatile organic liquid (VOL) storage New Source Performance Standard [NSPS] in 40 CFR

Table 9-1. Background of Benzene Waste Operations NESHAP

- | |
|---|
| • Benzene waste rule one of last under "old Section 112" |
| • Rules promulgated March 7, 1990 (45FR 8292) |
| • Impacts of standards |
| - Reduce benzene emissions from 6,000 to 450 Mg/yr |
| - Reduce maximum risk from 2×10^{-3} to 5×10^{-5} |
| - Reduce annual cancer incidence from 0.6 to 0.05 |

60 Subpart Kb). Note that this definition is not the same definition of waste used for the Resource Conservation and Recovery Act (RCRA) rules. The waste definition used for the benzene waste operations NESHAP is very broad and generally includes all waste materials generated at a facility except for those waste materials specifically excluded under the applicability section of the rule. As specified in this section, the benzene waste operations NESHAP does not apply to (1) wastes in the form of gases and vapors, and (2) wastes managed in segregated stormwater sewer systems (i.e., a sewer system used exclusively for collecting rainfall runoff at a facility). Once a liquid or solid waste stream exits the process unit that generates the waste, that waste stream is regulated by this rule even if the material eventually is recycled or recovered.

The EPA specified that the facility-wide TAB be calculated by summing the annual quantity of benzene in all aqueous waste streams managed at a facility (Table 9-2). An aqueous waste, for purposes of implementing the rule, is a waste with a water content of 10 percent or more (or that at any time is mixed with water or other wastes and the resulting mixture has a water content of 10 percent or greater). The facility-wide TAB calculation procedure is based on EPA's assessment that benzene in aqueous wastes (e.g., process wastewater, tank drawdown, landfill leachate) are the dominant source of benzene emissions from wastes operations. However, it is important to note that even though the facility-wide TAB calculation does not include organic wastes (wastes with a water content less than 10 percent that are never mixed with water), benzene emissions from organic wastes contribute to the overall health risks, and the impacts of the rule were estimated based on the assumption that these wastes would also be controlled. Therefore, if the facility-wide TAB is 10 Mg/yr or more, then all benzene-containing waste streams at the facility regardless of a stream's water content are subject to treatment and control requirements under the rule. The water content of a waste stream is relevant only to identifying whether the waste stream is to be included in the calculation of the facility-wide TAB.

For the purpose of calculating the facility-wide TAB, an owner or operator can determine the waste stream quantities and benzene contents by direct measurement or by his or her knowledge of the process or operation that generates the waste. The waste stream quantity and benzene content are required under the rule to be determined at the point of waste generation. The general definition of point of waste generation as used for the rule is the location where a waste exits the

production process or waste management unit that generates it or the point the waste enters the first downstream waste management unit provided the waste has not been exposed to the atmosphere or mixed with other wastes. Determining the waste benzene quantity at this location ensures that all potentially significant sources of benzene emissions from waste operations at these facilities are regulated by the rule. Note that in applying the rule, there are exceptions to this general definition for a few special situations (e.g., coke by-product recovery plants regulated by 40 CFR 61 Subpart L and petroleum refinery sour water plants).

The benzene waste operations NESHAP requires that certain waste streams containing benzene be treated by a means other than dilution to remove or destroy benzene, and each waste management unit that manages the waste prior to and during treatment must use emission controls. In general, the waste streams that require control are those streams that have an annual average benzene concentration of 10 parts per million by weight (ppmw) or more as determined at the point of waste generation. In other words, all waste streams with an annual average benzene concentration less than 10 ppmw are exempt from the treatment and control requirements.

Under the rule, certain process wastewater streams are exempt from the treatment and control requirements (Table 9-3). Process wastewater is a specifically defined in the rule as water that contacts benzene within the manufacturing process unit. Specific examples of waste streams that are not process wastewater are listed in the rule. A process wastewater stream is exempt if it meets one of two flow conditions regardless of the benzene content of the stream. First, if the flow rate of a process wastewater stream is less than 0.02 L/min, it is exempt from the treatment and control requirements. Second, if the total mass flow rate of a process wastewater stream is less than 10 Mg/yr, it is exempt from the treatment and control requirements. As an alternative to these flow-rate exclusions, the owner or operator can choose to meet an alternative standard for all process wastewater streams at an affected facility. This alternative standard excludes process wastewater streams with an annual average benzene concentration of 10 ppmw or more from the treatment and control requirements provided sufficient process wastewater streams are treated (in accordance with the requirements of the rule) to reduce the total amount of benzene in all process wastewaters at a facility to 1 Mg/yr.

The benzene waste operations NESHAP requires that affected waste streams with an annual average benzene concentration of 10 ppmw or more be treated to remove or destroy benzene. These treatment requirements are specified in terms of performance standards. The rule requires that each

Table 9-2. Total Annual Benzene in Waste (TAB)

$TAB = \sum_{i=1}^n (Q_i C_i)$	
Q	= annual waste quantity
C	= annual average benzene concentration
n	= number of affected waste streams with >10% water content

Table 9-3. Process Wastewater Exclusions

•	Waste streams less than 0.02 L/min or 10 Mg/yr
•	Waste streams >10 ppmw benzene if process wastewater TAB less than 1 Mg/yr for combination of:
-	TAB in untreated streams at point of generation
-	TAB in treated streams at exit to treatment unit

affected individual waste stream be treated to (1) remove benzene from the waste stream to a level less than 10 ppmw on a flow-weighted annual average basis; (2) remove or destroy the quantity of benzene in the waste by 99 percent on a mass basis; or (3) comply with the treatment standards of other relevant EPA standards (i.e., RCRA waste combustion rules, RCRA land disposal restrictions, benzene-specific effluent guidelines and standards). Dilution of the waste stream to comply with the treatment standards is prohibited. However, mixing of waste to facilitate treatment is allowed as described below.

At affected facilities having many wastewater streams containing benzene such as petroleum refineries, owners and operators often prefer to combine wastewater streams to facilitate treatment in a single process. For this situation, there are special treatment requirements specified in the rule. These requirements apply to a wastewater treatment system in which wastewater streams having annual average benzene concentrations of 10 ppmw or more are mixed with wastewaters having annual average benzene concentrations below 10 ppmw (Table 9-4). A wastewater treatment system is specifically defined in the rule as a unit that ultimately discharges in accordance with a National Pollutant Discharge Elimination System (NPDES) permit. All waste management units making up the wastewater treatment system handling these mixed wastewater streams are required to use controls except for those units that meet two conditions. The first condition is the annual average benzene concentration of the waste entering the unit is less than 10 ppmw. The second condition is the total annual benzene quantity in the wastewaters first entering all affected uncontrolled units constituting wastewater treatment systems facility-wide is less than 1 Mg/yr. Determination of this total annual benzene quantity does not include wastewaters entering an enhanced biodegradation unit. Application of these special treatment requirements for wastewater treatment systems can be complex. For additional information about this provision of the rule, the reader is referred to the case study in this workbook titled "Application of Benzene Waste Operations NESHAP to Wastewater Treatment Systems."

The benzene waste operations NESHAP requires that controls be applied to certain waste management units managing benzene-containing waste prior to and during treatment (Table 9-5). In general, the basic control requirements are to cover the unit and vent the unit through a closed-vent system

to a control device that removes or destroys the organics in the vent stream by 95 percent. The affected waste management units are tanks, surface impoundments, containers, oil-water separators, and individual drain systems. The specific control requirements for each type of waste management unit are summarized below.

Tanks are required to be covered with a fixed roof, which is vented through a closed-vent system to a control device that removes or destroys the organics in the vent stream by 95 percent. As an alternative to using a fixed roof vented to a control device, an internal or external floating roof can be used.

Table 9-5. Benzene Waste Operations NESHAP—General Control Requirements

•	Apply controls prior to and during treatment
•	Cover or enclose waste management unit
•	Generally, convey emissions through closed-vent system to control device
•	Control devices remove or destroy $\geq 95\%$ of organics

Surface impoundments are required to be covered and vented through a closed-vent system to a control device that removes or destroys the organics in the vent stream by 95 percent.

Containers are required to be tightly covered except when waste is being added to or removed from the container. Waste that is transferred (i.e., pumped) into a container must be added by submerged fill. If the container is used for certain treatment processes such as waste fixation, the container needs to be placed in an enclosure that is vented to a control device during the periods when the container is open.

Oil-water separators are required to be covered and vented to a control device that removes or destroys the organics in the vent stream by 95 percent. As an alternative, an owner or operator may elect to use a floating roof or comply with the requirements specified in the Petroleum Refinery Wastewater System NSPS (40 CFR 60 Subpart QQQ).

Individual drain systems are required to have covers installed and a closed-vent system that routes all organic vapors from the drain system to a control device. As an alternative, an owner or operator may elect to comply with the requirements specified in 40 CFR 60 Subpart QQQ and, in addition, control box junction emissions by equipping the junction box with a system to prevent the flow of organic vapors from the junction box vent pipe during normal operation (e.g., water seals on the inlet sewer line connections to the junction box) or connecting the vent pipe to a closed-vent system and control device (e.g., a carbon canister).

The benzene waste operations NESHAP requires the owner or operator to submit to EPA an initial report summarizing the initial determination of TAB (Table 9-6). If the facility-wide TAB is less than 1 Mg/yr there are no further reporting requirements (Figure 9-1). If the facility-wide TAB is less than 10 Mg/yr but greater than or equal to 1 Mg/yr, the owner or operator is required to submit an annual report

Table 9-4. Alternative Standards for WWTS

•	If wastes with ≥ 10 ppmw benzene mixed with wastes < 10 ppmw benzene in WWTS, special provisions apply
•	All units in WWTS must be controlled until both: <ul style="list-style-type: none"> - The wastes entering an uncontrolled unit are < 10 ppmw - The WWTS TAB first entering an uncontrolled unit is < 1 Mg/yr
•	TAB entering enhanced biodegradation is excluded from the 1-Mg/yr determination

updating the facility-wide TAB determination. If the facility-wide TAB is 10 Mg/yr or more, then the owner or operator is required to submit certification of compliance documenting the installation and proper operation of all equipment necessary to comply with the treatment and control requirements of the rule (Table 9-7).

Table 9-6. Initial Determination of TAB

• Existing facilities report June 7, 1990
• Updates allowed as new information obtained
• New sources report at startup
• Report to include:
- TAB for wastes with 10% water
- Identification of streams to be controlled
- Details on basis for benzene waste streams not controlled

To ensure that the treatment processes and emission control equipment are properly operated and maintained, the rule requires the owner or operator to install instrumentation to monitor the treatment process and control device operation continuously and to conduct monthly effluent testing for treatment processes. Emission control equipment covers must be visually checked at least quarterly to ensure that equipment is being used properly (e.g., covers are closed and latched except when workers require access to a tank or container) and that equipment is being maintained in good condition (e.g., no holes or gaps have developed in covers). Annual leak detection monitoring using EPA Reference Method 21 is required for closed-vent systems to ensure all fittings remain leak-tight.

As a means of verifying compliance, recordkeeping and reporting requirements are specified in the rule. The owner or operator is required to record certain information documenting all waste determination results, treatment and control equipment design, and inspection and monitoring results. This information must be maintained in onsite facility files for at least 2 years and must be readily available for review by EPA enforcement personnel during onsite compliance inspections. Certain information must be reported to EPA regularly includ-

ing quarterly and annual reports documenting inspection and incidences of upset for the treatment processes and control devices.

Table 9-7. Certification of Compliance

• Submitted by March 7, 1992, or by date of new source startup
• Certifies installation of required equipment
• Certifies completion of initial testing and inspections

In summary, the benzene waste operations NESHAP is applicable to chemical manufacturing plants, petroleum refineries, coke by-product recovery plants, and offsite TSDF that receive wastes from any of these three industrial categories. If the facility-wide TAB is 10 Mg/yr or more, the facility owner or operator is required to treat certain benzene-containing waste streams having an annual average benzene concentration of 10 ppmw or more. Tanks, surface impoundments, containers, oil-water separators, and individual drain systems used to manage the waste prior to and during waste treatment must be controlled by covering all openings and venting the unit through a closed-vent system to a control device that removes or destroys the organics in the vent stream by 95 percent. For some of the waste management unit categories, alternative controls may be used.

Questions and Answers

Question—Does the rule require controls for any wastes that contain benzene when the benzene in the wastes does not originate from petroleum refineries, chemical plants, or coke by-product recovery plants?

Answer—No. Additional clarification has been provided in a *Federal Register* notice (55 FR 37230).

Question—Does the rule apply to publicly owned treatment works (POTW) and municipal solid waste landfills (MSWLF)?

Answer—For most cases, the rule does not apply to POTW or to MSWLF. When the coverage of the proposed rule was clarified in a *Federal Register* notice (54 FR 51423) on December 15, 1989, POTW and MSWLF were not included. An additional clarification has been published in the *Federal Register* following promulgation of the rule (55 FR 37230). There are two special cases in which the rule could apply: (1) when these facilities are also a commercial hazardous waste facility with a permit under Subtitle C of RCRA, or (2) when these facilities accept affected waste streams from chemical plants, petroleum refineries, or coke by-product recovery plants. It is the generator's responsibility to obtain an agreement from the offsite treatment or disposal facility to ensure compliance with the benzene waste rule for treatment of the benzene waste.

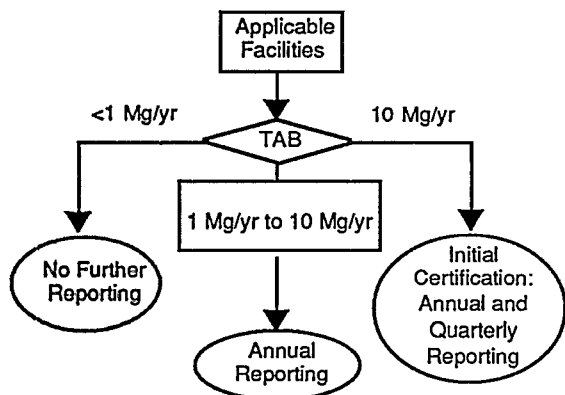


Figure 9-1 Benzene waste operations NESHAP reporting requirements.

Question—When must commercial hazardous waste facilities control wastes that contain benzene?

Answer—Commercial hazardous waste facilities permitted under Subtitle C of RCRA must apply controls when they receive benzene waste from chemical plants, petroleum refineries, or coke by-product recovery plants, and the total annual benzene in water (TAB) in the wastes received from these industries is 10 Mg/yr or more. (See the clarification in 55 FR 37230.) In addition, commercial hazardous waste facilities must comply with the control requirements for a specific waste stream if that waste stream has been identified by the generator as requiring control under the rule.

Question—Are aqueous wastes that are generated infrequently, accidentally, or intermittently included in the calculation of TAB?

Answer—Yes. If aqueous benzene wastes are generated infrequently, the initial report should include the facility's estimate of the quantity and concentration for these wastes based on measurements, historical data, or engineering analysis. If a new or unexpected aqueous waste is generated, this waste must be added to the initial report and included in the facility's determination of TAB. Wastes that are generated infrequently or intermittently are subject to control under the rule if the TAB and benzene concentration criteria are exceeded.

Question—What is the basis for the term "annual" in the determination of TAB?

Answer—This determination is based on any 12 consecutive months of operation. If the waste has not been generated for a full year, the facility should provide its best estimate and the basis for an annual projected quantity. If the waste is generated periodically every few years, the estimate of TAB should be based on the quantity produced during the year with the highest generated quantity.

Question—Are organic wastes that contain less than 10 percent water and are discharged to the wastewater system included in the calculation of TAB? For example, drainings from low points in lines or pumps that handle an organic product (or even pure benzene) may enter the sewer system.

Answer—Although the discharge of organic products to the sewer was not anticipated in the development of the regulation, they should be included in the calculation of TAB because once they enter the wastewater treatment system and are mixed with wastewater, they become aqueous wastes (10 percent or more water). Theoretically, the benzene in the organic waste should be counted toward the TAB if the organic waste is mixed with the water or other waste and the resulting mixture has a water content of 10 percent or more. Because this would be difficult, two other options are to (1) include the benzene in the organic waste at its point of generation or (2) measure the benzene in the combined waste at the oil-water separator and include any benzene lost prior to the separator.

Question—Are process wastewaters that qualify for the low flow cutoff (0.02 L/min or 10 Mg/yr) in Section 61.342 (c)(3) included in determining the TAB for the facility?

Answer—Yes, all benzene-containing wastes managed at a facility are included in determining the facility's TAB.

Question—Is the benzene in wastewater discharged from a facility counted in the determination of TAB?

Answer—The quantity of benzene in the wastewater discharge is not counted unless the discharge is the point of generation for the waste. Facilities should avoid double counting, such as adding the quantity at the point of generation in the process to the quantity that is eventually discharged.

Question—Is the determination of flow-weighted annual average water content (for comparison to a value of 10 percent) based on percent by volume or by weight?

Answer—Aqueous wastes are those that contain 10 percent or more water by volume as total water. This has been clarified in a *Federal Register* notice (55 FR 37230).

Question—When are controls required for new sources?

Answer—Applicability determinations are made on a facility basis (entire geographical plant site). A new facility must be in compliance with the regulation at startup. Benzene-containing wastes managed in a new unit at an existing facility above the 10-Mg/yr TAB cutoff must be controlled by March 7, 1992.

Question—Do all chemical plants, petroleum refineries, coke by-product recovery plants, and commercial hazardous waste facilities have to submit an initial report of their determination of TAB, even if they do not use or produce benzene or manage wastes that contain benzene?

Answer—Yes. All facilities in these four affected industries are subject to at least a one-time reporting requirement of TAB. If the plant does not use or produce benzene, if it is present only in small quantities, or if no wastes containing benzene are managed, the initial report should state this clearly. Whether waste streams should be controlled is determined by the TAB and benzene concentration data presented in the report.

Question—What waste streams must be included in the initial report of TAB determinations (due June 5, 1990), what accuracy is required, can it be amended, and should controls be identified?

Answer—These questions arose because some facilities have hundreds of waste streams, many of which have not been measured for benzene quantity or concentration, and their data collection effort may not be completed within the 90-day period. A clarification has been published in the *Federal Register* (55 FR 37230). The purpose of the initial report is to identify facilities subject to the control requirements, to identify which streams must be controlled,

and to provide the basis for exemption of streams. There are situations where knowledge of the waste could be the basis for the estimates. Knowledge of waste could be based on engineering analyses, material balances, similarity of streams, purchase records, etc. For example, wastes that do not contact materials containing benzene do need not to be listed. When new or more accurate information is obtained or the process is redesigned, a resubmittal of the report may be appropriate. Controls do not need to be identified in the initial report; however, controls must be in place by the March 7, 1992, compliance date.

Question—If a facility hardpipes several waste streams to a single point or location, are they required to measure each individual waste stream at the point of generation or can they measure the flow and concentration of the combined stream? When are controls required for mixed wastes?

Answer—The rule does not require *measurement* at the point of generation. Consequently, the facility can measure the combined stream and, coupled with other knowledge of the individual processes or streams, estimate the flow and concentration of individual streams at the point of generation to calculate the TAB.

Process wastewater, which is defined in the rule and specifically excludes certain wastes, may be excluded from the control requirements under certain conditions, even if it is a mixture that contains individual streams with 10 ppm or more. The requirement for the process wastewater exclusion is that the TAB in process wastewater be less than 1 Mg/yr for the sum of (1) the TAB in untreated streams at the point of generation and (2) the TAB in untreated streams at the exit to the treatment unit.

There is also an alternative standard that addresses the mixing of waste streams in a wastewater treatment system.

The wastewater treatment units handling the mixture must be controlled until both (1) the waste entering an uncontrolled unit is less than 10 ppm and (2) the TAB first entering an uncontrolled unit is less than 1 Mg/yr. The TAB entering an enhanced biodegradation unit is excluded from this 1-Mg/yr determination. In other words, controls would not be required on the enhanced biodegradation unit unless the benzene concentration entering the unit is 10 ppm or higher.

Question—Are controls for intermediate product tanks and day tanks required under the rule?

Answer—No. The rule does not require controls for tanks that manage products or intermediates. The rule applies only to tanks that manage wastes containing benzene. However, benzene wastes could be generated from these tanks (as from water drawdown), and these wastes could be subject to control under the rule.

Question—Does the rule require water seals on the junction box vent?

Answer—No. This has been clarified in a *Federal Register* notice (55 FR 37230) to indicate that water seals are required on the junction box and not on the vent. The purpose is to isolate the junction box to prevent wind or induced air drafts from sweeping through the wastewater collection system.

Question—Must the three samples required in Section 61.355 (c)(2)(i) be collected at different times or can they be collected at the same time?

Answer—The rule does not specify a time between samples. The applicable requirement is that the samples be representative of the waste that is being analyzed.

Chapter 10

Case Study:

Application of Benzene Waste Operations NESHAP to Wastewater Treatment Systems

NOTE: Since the time the workshops were given, EPA has determined that clarifications to the Benzene Waste Operations NESHAP are required. Revisions to the rule were proposed March 5, 1992 (57 FR 8017). Thus interpretations given during the workshop may have changed. For the latest interpretation, contact Bob Lucas, Emissions Standards Division, OAQPS (919) 541-0884.

Overview

Examples of the application of the National Emission Standard for Benzene Waste Operations (40 CFR 61 Subpart FF) to wastewater treatment systems are provided in this case study. The standards for wastewater treatment systems that manage and treat aggregated or mixed waste streams are reviewed using some simple examples. A case study problem is then presented to illustrate the application of the standard to a "real world" wastewater treatment system at a petroleum refinery.

Standards for Wastewater Treatment Systems

The Benzene Waste Operations NESHAP requires owners and operators of affected facilities at which the total annual benzene quantity from the facility waste is equal to or greater than 10 Mg/yr to remove or destroy benzene contained in certain waste streams using a treatment process or wastewater treatment system. Section 61.348 of the rule establishes the treatment standards for treatment processes or wastewater treatment systems. These standards require that if an owner or operator chooses to aggregate or mix waste streams to facilitate treatment in a wastewater treatment system, the waste streams must be treated in a wastewater treatment system that meets special requirements. Each waste management unit that comprises the wastewater treatment systems at the facility must use the appropriate emission controls as specified under Sections 61.343 through 61.347 until *both* of the following conditions are met:

1. The waste entering an uncontrolled unit is less than 10 ppmw benzene; and
2. The total facility-wide wastewater treatment system annual benzene quantity first entering any uncontrolled unit is less than 1 Mg/yr.

Application of Basic Standards

The application of the basic standards is illustrated in Figure 10-1. The drainage system, the oil/water separator, and

the dissolved air flotation (DAF) unit shown in Figure 10-1 require controls because they receive waste with benzene concentrations of 10 ppmw or higher. The next three units require controls because even though the benzene concentration is below 10 ppmw, the mass flow rate of benzene (i.e., the annual benzene quantity) entering the units is greater than 1 Mg/yr.

Enhanced Biodegradation Units

One minor exclusion to the 1 Mg/yr benzene quantity limit is: The benzene quantity entering an "enhanced biodegradation" unit from the total annual benzene quantity inventory for the wastewater treatment system is excluded if the enhanced biodegradation unit is the first exempt unit. Section 61.348(b)(2)(ii)(B) provides guidelines regarding operating conditions for what is defined as an "enhanced biodegradation" unit. These guidelines basically describe the operation of a conventional activated sludge wastewater treatment process. Activated sludge systems with benzene concentrations of 10 ppmw or higher in any influent stream will still require controls, but, if the benzene concentration is less than 10 ppmw, the annual benzene quantity entering an activated sludge system does not count towards the 1 Mg/yr control limit. Therefore, if we replace the surface impoundment in Figure 10-1 with an activated sludge system (refer to Figure 10-2), no controls are required after the equalization basin.

Multiple Wastewater Treatment Systems

The 1 Mg/yr of benzene control limit pertains to the total annual benzene quantity of the facility's wastewater treatment system and not to the annual benzene quantity of a single waste stream. For example, referring to Figure 10-3, Equalization Basin #1 has an annual benzene quantity of 0.8 Mg/yr while the groundwater waste stream entering Equalization Basin #2 has an annual benzene quantity of 0.6 Mg/yr. In a single train system, these equalization basins would not require controls. However the cumulative or total annual benzene quantities for the uncontrolled units in this dual train facility is 1.4 Mg/yr, which exceeds the 1.0 Mg/yr control limit. Therefore, one of the equalization basins in Figure 10-3

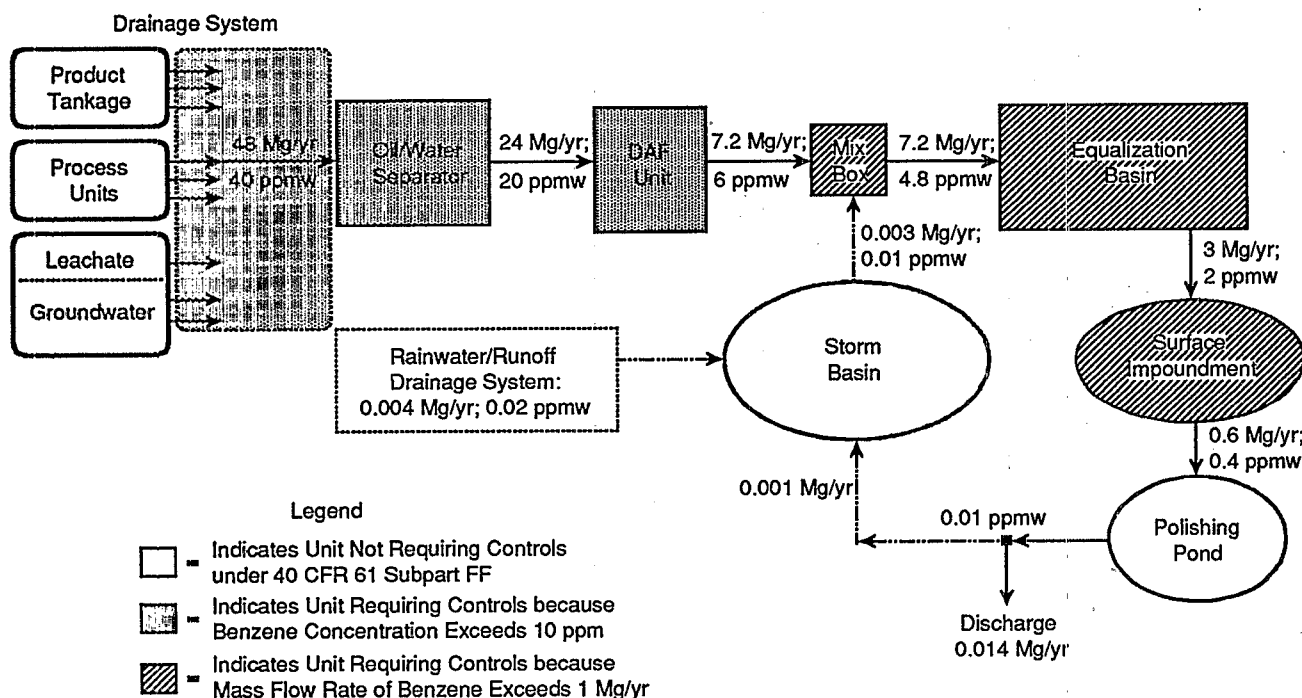


Figure 10-1. Wastewater treatment system showing benzene concentrations and flow rates: Example 1.

must be controlled. No requirement is provided in the rule that determines which basin is controlled since controlling either basin reduces the total annual benzene quantity in the uncontrolled units to less than 1 Mg/yr. Therefore, to comply with the rule, the facility owner or operator can choose which of the equalization basins is controlled as is shown in Figures 10-3a and 10-3b. Note that if Equalization Basin #2 is selected to be controlled, the groundwater drainage system must also be controlled.

Case Study Problem:

Application of Benzene Waste Operations NESHAP to Wastewater Treatment Systems

The ABC Oil Company operates a refinery that is determined to have a facility total annual benzene (TAB) quantity greater than 10 Mg/yr, and is therefore required to treat and control certain benzene-containing waste streams at the refinery to comply with the National Emission Standard for Benzene Waste Operations (40 CFR 61 Subpart FF). Individual process wastewater streams, product tank drawdown streams, and landfill leachate streams generated by refinery processes are collected in the refinery's drain systems for the purpose of managing these wastewaters in a central wastewater treatment system. Wastewaters that have an annual average benzene concentrations above 10 ppmw are mixed with wastewaters that have an annual average benzene concentrations below 10 ppmw in the refinery drain systems. Wastewater containing hydrogen sulfides is first treated in a sour water stripper to remove the hydrogen sulfides before the wastewater is mixed with other wastewaters.

A flow diagram of the ABC Oil Refinery wastewater treatment system is shown in Figure 10-4. The annual average benzene concentration and annual benzene quantity for each wastewater stream are identified on the figure. To comply with the treatment standards under Section 61.348 of the rule, the refinery manager has decided to treat the benzene-containing wastewater streams using the refinery's existing wastewater treatment system. The refinery manager has asked you to determine which units comprising the wastewater treatment system are required to use controls in accordance with the rule. Refer to Table 10-1 for the problem and Table 10-2 for the solution.

Under Section 61.348(b) of the Benzene Waste Operations NESHAP, special requirements apply to a wastewater treatment system in which wastewater streams having annual average benzene concentrations of 10 ppmw or more are mixed with wastewaters having annual average benzene concentrations below 10 ppmw. The waste management units handling these mixed wastewater streams are required to use controls except for those units that meet two conditions: (1) the annual average benzene concentration of the waste entering the unit is less than 10 ppmw; (2) the total annual benzene (TAB) quantity in the wastewaters first entering all affected uncontrolled units comprising wastewater treatment systems facility-wide is less than 1 Mg/yr. The wastewater treatment system configuration used for the case study problem is shown in Figure 10-4. The same configuration showing the case study solution is shown in Figure 10-5. A discussion of the reasons why each unit shown in the figures is or is not required to use controls is presented below.

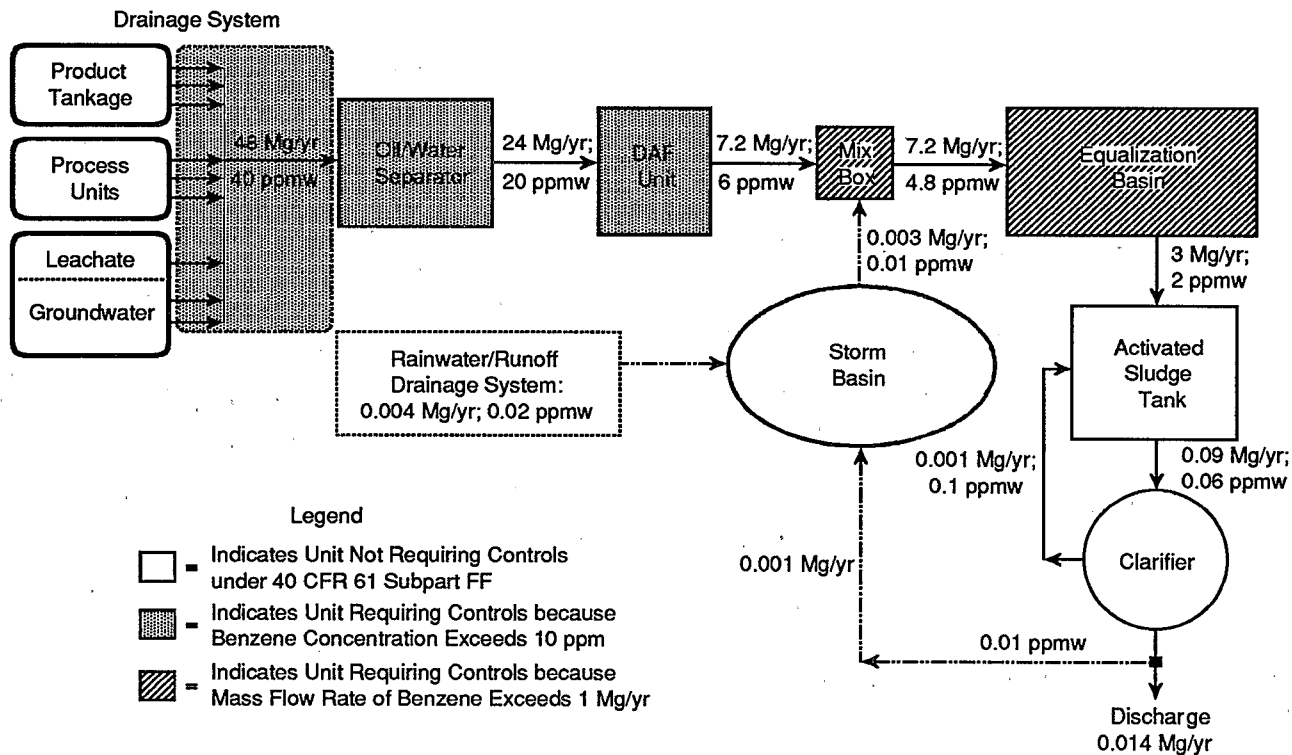


Figure 10-2. Wastewater treatment system showing benzene concentrations and flow rates: Example 2.

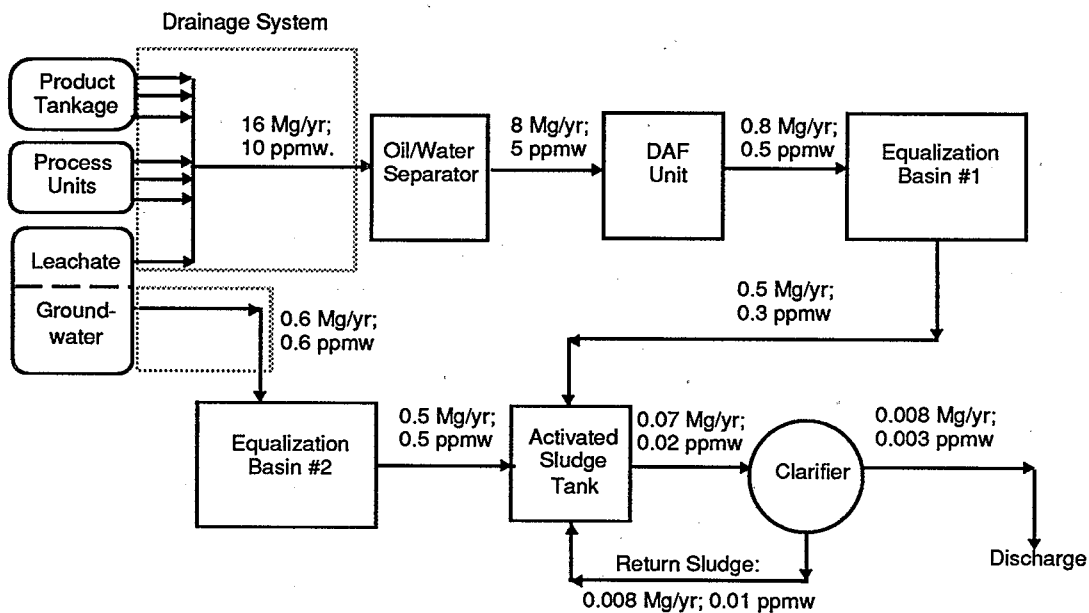


Figure 10-3. Wastewater treatment system showing benzene concentrations and flow rates: Example 3.

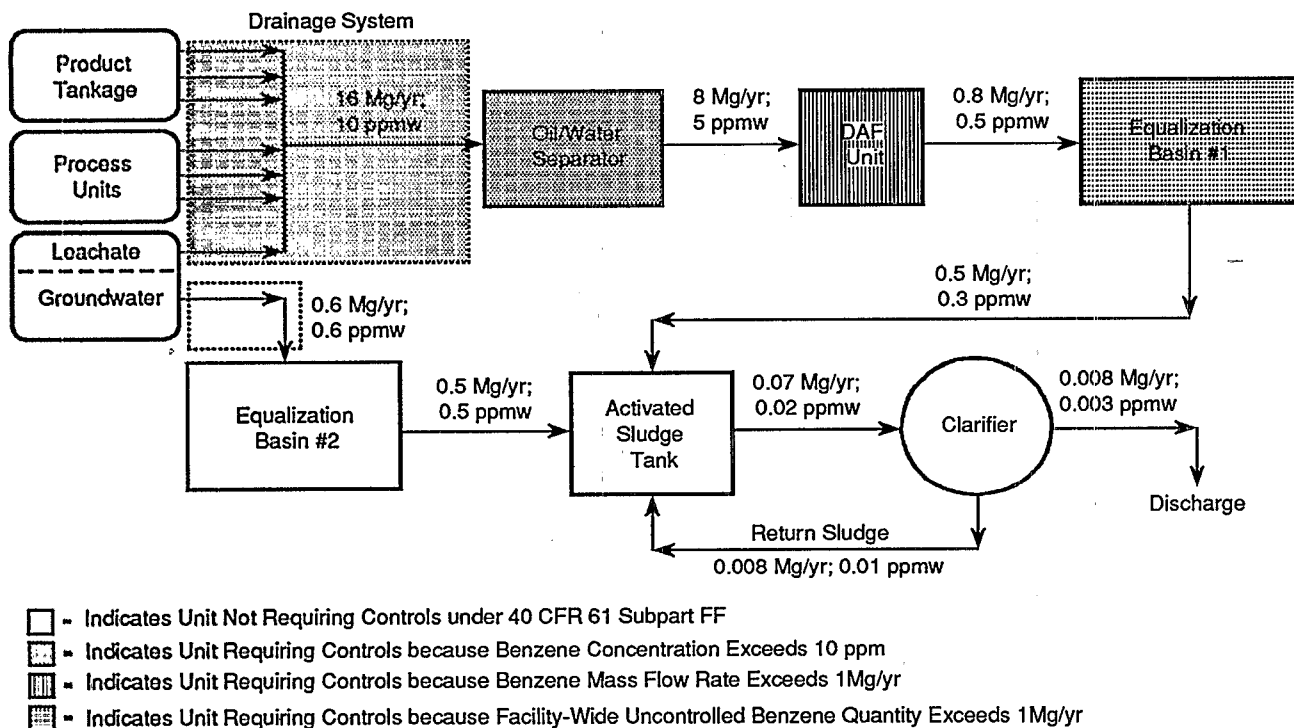


Figure 10-3a. Wastewater treatment system showing benzene concentrations and flow rates: Example 3; Solution A.

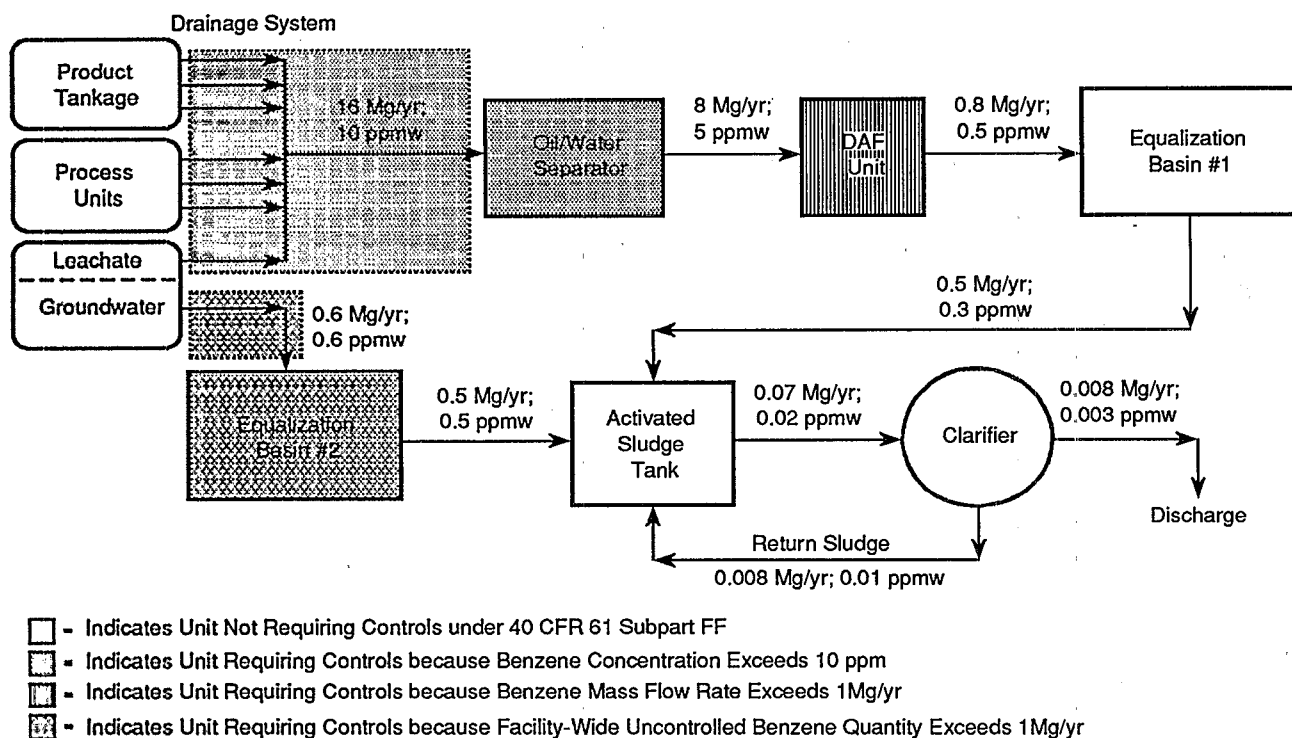


Figure 10-3b. Wastewater treatment system showing benzene concentrations and flow rates: Example 3; Solution B.

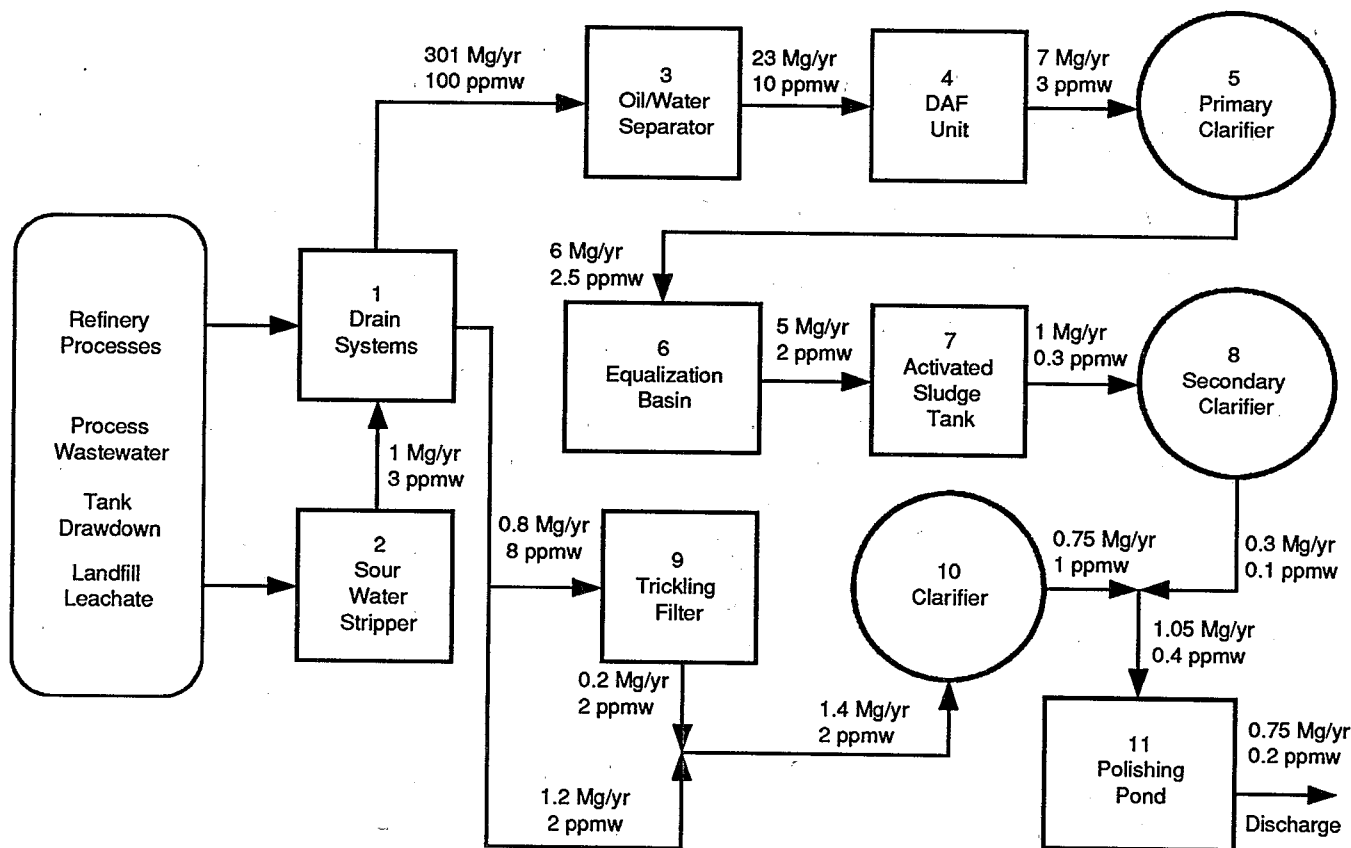


Figure 10-4. ABC Oil Refinery wastewater treatment system—case study problem. (Annual average benzene concentration and annual benzene quantity shown for each wastewater stream.)

Table 10-1. Case Study Problem

Possible answers for each waste management unit are:

- A. No controls required.
- B. Controls required: Annual average benzene concentration entering the unit is 10 ppmw or more.
- C. Controls required: Annual benzene quantity entering the unit is 1 Mg/yr or more.
- D. Controls required: Total annual benzene (TAB) quantity first entering uncontrolled waste management units comprising the refinery wastewater treatment system is 1 Mg/yr or more.

For each waste management unit shown on Figure 10-4, circle the letter or letters corresponding to all correct answers for the unit (more than one answer may be correct for a particular unit).

Waste Management Unit	Answer			
1. Drain Systems	A	B	C	D
2. Sour Water Stripper	A	B	C	D
3. Oil/Water Separator	A	B	C	D
4. DAF Unit	A	B	C	D
5. Primary Clarifier	A	B	C	D
6. Equalization Basin	A	B	C	D
7. Activated Sludge Tank	A	B	C	D
8. Secondary Clarifier	A	B	C	D
9. Trickling Filter	A	B	C	D
10. Clarifier	A	B	C	D
11. Polishing Pond	A	B	C	D

Drain Systems

The refinery drain systems combine wastewaters having annual average benzene concentrations above 10 ppmw with wastewaters having annual average benzene concentrations below 10 ppmw. This results in three mixed wastewater streams: a stream having an annual average benzene concentration of 100 ppmw and annual benzene quantity of 301 Mg/yr; a stream having an annual average benzene concentration of 8 ppmw and annual benzene quantity of 0.8 Mg/yr; and a stream having an annual average benzene concentration of 2 ppmw and annual benzene quantity of 1.2 Mg/yr. At this point in the analysis, none of the waste management units are controlled under the rule, so the TAB quantity for the refinery wastewater treatment system is 303 Mg/yr (calculation of this value is discussed below under the oil/water separator unit). Control requirements for drain systems are specified in Section 61.346 of the rule. Thus, the drain systems are required to use controls because the conditions specified in answers "b," "c," and "d" are not met.

Sour Water Stripper

For the purpose of implementing the Benzene Waste Operations NESHAP, EPA has specified that, for a sour water stripper unit, the determination of the flow-weighted annual average benzene concentration shall be made at the exit to the unit. A "sour water stripper" must be controlled to meet the

Table 10-2. Case Study Solution

Possible answers for each waste management unit are

- A. No controls required.
- B. Controls required: Annual average benzene concentration entering the unit is 10 ppmw or more.
- C. Controls required: Annual benzene quantity entering the unit is 1 Mg/yr or more.
- D. Controls required: Total annual benzene (TAB) quantity first entering uncontrolled waste management units comprising the refinery wastewater treatment system is 1 Mg/yr or more.

For each waste management unit shown on the figure, the correct answers are circled below.

Waste Management Unit	Answer			
1. Drain Systems	A	(B)	(C)	(D)
2. Sour Water Stripper	A	B	C	D
3. Oil/Water Separator	A	(B)	(C)	(D)
4. DAF Unit	A	(B)	(C)	(D)
5. Primary Clarifier	A	B	(C)	(D)
6. Equalization Basin	A	B	(C)	(D)
7. Activated Sludge Tank	(A)	B	C	D
8. Secondary Clarifier	(A)	B	C	D
9. Trickling Filter	A	B	C	(D)
10. Clarifier	A	B	(C)	(D)
11. Polishing Pond	(A)	B	C	D

definition in the rule, i.e., it must be "operated in such a manner that the offgases are sent to a sulfur recovery unit, processing unit, incinerator, flare, or other combustion device." Consequently, none of the listed answers are appropriate. Controls are required, but not because of the reasons listed in "b," "c," or "d."

Oil/Water Separator

The annual average benzene concentration of the waste entering the oil/water separator is greater than 10 ppmw (100 ppmw). The annual benzene quantity in the waste entering the unit is greater than 1 Mg/yr (301 Mg/yr). Thus, neither of the two conditions required for an exemption from controls is met. At this point in the analysis for an actual facility, you would conclude that the oil/water separator requires controls because it does not meet either condition, and then move on to the next downstream unit. However, for the purpose of this case study problem, we will also determine the TAB quantity first entering the uncontrolled waste management units comprising the refinery wastewater treatment system from the inlet to the oil/water separator.

The TAB quantity is calculated by summing the individual waste stream annual benzene quantities for each location where a waste stream first enters an affected uncontrolled waste management unit that is included in the facility wastewater treatment system. Assuming that Unit 3 and the remaining units (i.e., Units 4 through 11) are uncontrolled, the TAB quantity is then calculated by summing the annual benzene

quantity in three wastewater streams: (1) the stream flowing directly from the drain system to the oil/water separator (301 Mg/yr); (2) the stream flowing directly from the drain system to the trickling filter (0.8 Mg/yr); and (3) the stream flowing directly from the drain system to the clarifier (1.2 Mg/yr). The TAB quantity is calculated to be 303 Mg/yr which is well above the 1 Mg/yr limit. Thus, the oil/water separator is required to use controls because the conditions specified in answers "c," and "d" are not met.

DAF Unit

The annual average benzene concentration of the waste entering the DAF unit is equal to 10 ppmw. Remember that the rule requires the annual average benzene concentration of the waste entering the unit to be *less than* 10 ppmw as one of the conditions to be met for the exemption from controls. The annual benzene quantity of the waste entering the unit is greater than 1 Mg/yr (23 Mg/yr). Assuming at this step in the analysis that Unit 4 and the remaining units (i.e., Units 5 through 11) are uncontrolled, the TAB quantity that would be managed in the uncontrolled waste management units is calculated to be 25 Mg/yr. Thus, the DAF unit is required to use controls because the conditions specified in answers "c," and "d" are not met.

Primary Clarifier

The annual average benzene concentration of the waste entering the primary clarifier unit is less than 10 ppmw (3 ppmw). However, the annual benzene quantity of the waste entering the unit is greater than 1 Mg/yr (7 Mg/yr). Assuming at this step in the analysis that Unit 5 and the remaining units (i.e., Units 6 through 11) are uncontrolled, the TAB quantity that would be managed in the uncontrolled waste management units is calculated to be 9 Mg/yr. Thus, the primary clarifier is required to use controls because the conditions specified in answers "c," and "d" are not met.

Equalization Basin

The equalization basin only receives wastewater from the primary clarifier. Consequently, the annual average benzene concentration of the waste entering the unit remains less than 10 ppmw (2.5 ppmw). However, the annual benzene quantity of the waste entering the unit still is greater than 1 Mg/yr (6 Mg/yr). Assuming at this step in the analysis that Unit 6 and the remaining units (i.e., Units 7 through 11) are uncontrolled, the TAB quantity that would be managed in the uncontrolled waste management units is calculated to be 8 Mg/yr. Thus, the equalization basin is required to use controls because the conditions specified in answers "c," and "d" are not met.

Activated Sludge Tank

The activated sludge tank is considered to be an "enhanced biodegradation unit" in accordance with Section 61.348(b)(2)(ii)(B) of the rule. This section specifies that the annual benzene quantity managed or treated in an enhanced biodegradation unit is not included in the calculation of the TAB quantity if the enhanced biodegradation unit is the first uncontrolled unit in which the waste is managed or treated. This means that for the purpose of calculating the TAB quantity, the annual benzene quantity entering the enhanced biodegradation unit is set to 0 Mg/yr if the annual average

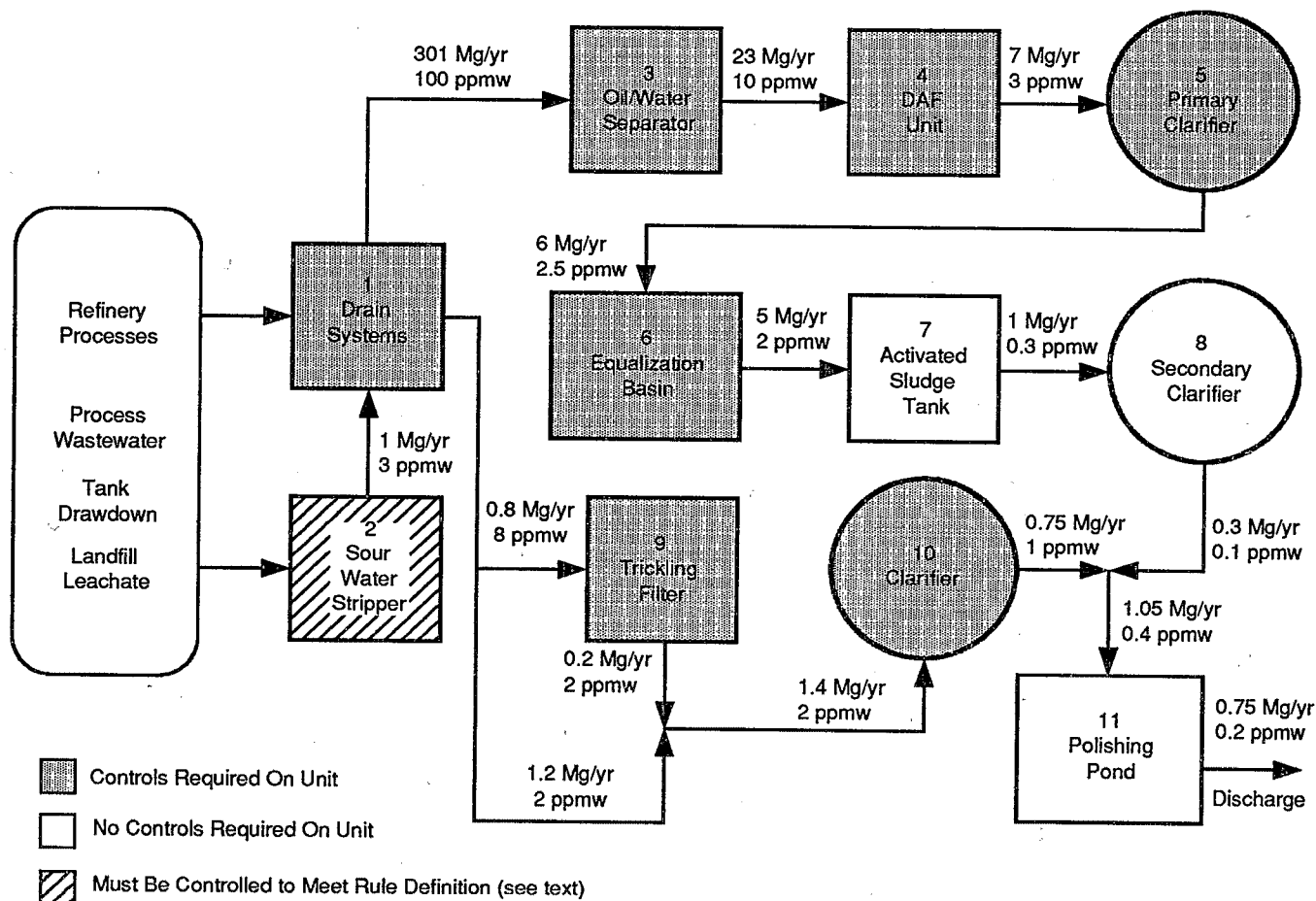


Figure 10-5. ABC Oil Refinery wastewater treatment system—case study solution.

benzene concentration of the waste entering the unit is less than 10 ppmw. For the case study problem, the annual average benzene concentration of the waste entering the activated sludge tank is 2 ppmw. Even though the actual annual benzene quantity of the waste entering the unit is greater than 1 Mg/yr (5 Mg/yr), the TAB quantity condition that the upstream units must meet in order to be exempted from using controls is not applicable to the activated sludge tank because it is an enhanced biodegradation unit in which the annual average benzene concentration of the waste entering the unit is less than 10 ppmw. Therefore, the activated sludge unit is *not* required to use controls (answer “a”).

Secondary Clarifier

The secondary clarifier only receives wastewater from the activated sludge tank. As discussed above, the activated sludge unit is an enhanced biodegradation unit which is exempt from having to use controls. For the purpose of calculating the TAB quantity, the annual benzene quantity entering the activated sludge tank is set to 0 Mg/yr. Consequently, it must follow that the wastewater stream entering the secondary clarifier is also set to 0 Mg/yr. Even though the annual benzene quantity of the waste entering the secondary clarifier is equal to 1 Mg/yr, the TAB quantity condition is not applicable to this unit because all of the waste managed in the

secondary clarifier is received from an uncontrolled enhanced biodegradation unit. Thus, the secondary clarifier is *not* required to use controls (answer “a”).

Trickling Filter

The trickling filter is not considered to be an “enhanced biodegradation unit” because it is a supported growth process rather than a suspended growth process, and it does not recycle biomass. Therefore, the trickling filter must meet both the benzene concentration and TAB quantity conditions to be exempt from having to use controls. The annual average benzene concentration of the waste entering the trickling filter is less than 10 ppmw (8 ppmw). Also, the annual benzene quantity of the waste entering the unit is less than 1 Mg/yr (0.8 Mg/yr). Thus, whether or not the trickling filter is required to use controls depends on the TAB quantity first entering the uncontrolled waste management units comprising the refinery wastewater treatment system.

The TAB quantity is calculated based on the annual benzene entering Units 9, 10, and 11 and the decision as to which of these units will be controlled. As discussed under the activated sludge tank unit, Unit 7 does not require controls and, for the purpose of calculating the TAB quantity, the annual benzene quantity entering the activated sludge tank is

set to 0 Mg/yr. Assuming that Units 9 and 10 are uncontrolled, the TAB quantity is calculated to be 2.0 Mg/yr by summing the annual benzene quantity entering the trickling filter (0.8 Mg/yr) plus the annual benzene quantity entering the clarifier directly from the drain system (1.2 Mg/yr). Assuming that Units 9 and 11 are uncontrolled, the TAB quantity is calculated to be 1.55 Mg/yr by summing the annual benzene quantity entering the trickling filter (0.8 Mg/yr) plus the annual benzene quantity entering the polishing pond from the clarifier (0.75 Mg/yr—determination of this value is discussed under the polishing pond unit). For either assumption, the TAB quantity is calculated to be greater than 1 Mg/yr. Thus, for the particular set of benzene quantities selected for the case study problem, the trickling filter is required to use controls because the condition specified in answer "d" is not met.

Clarifier

The annual average benzene concentration of the waste entering the clarifier is less than 10 ppmw (2 ppmw). However, the annual benzene quantity of the waste entering the unit is greater than 1 Mg/yr (1.4 Mg/yr) as a result of the mixing of the waste stream from the trickling filter with a waste stream directly from the drain systems. Knowing at this step in the analysis that Unit 7 is uncontrolled and assuming that Units 10 and 11 are uncontrolled, the TAB quantity that would be managed in uncontrolled waste management units is

calculated to be 1.4 Mg/yr (the sum of the annual benzene quantities entering the activated sludge tank, which is set to 0 Mg/yr, plus the clarifier). Thus, the clarifier is required to use controls because the conditions specified in answers "c" and "d" are not met.

Polishing Pond

Two wastewater streams also mixed together prior to entering the polishing pond; one stream from the secondary clarifier and one stream from the clarifier. The annual average benzene concentration of the waste entering the polishing pond is less than 10 ppmw. The annual benzene quantity in the wastewater stream from the clarifier is 0.75 Mg/yr. The annual benzene quantity in the wastewater stream from the secondary clarifier is 0.3 Mg/yr. However, for the purpose of determining compliance with the rule, the annual benzene quantity for the wastewater stream entering the secondary clarifier is set to 0 Mg/yr (refer to the discussion for the secondary clarifier unit). Consequently, it must follow that the wastewater stream exiting the secondary clarifier is also set to 0 Mg/yr. Even though the total annual benzene quantity of the wastewater streams entering the polishing pond is actually 1.05 Mg/yr, the TAB quantity of the waste entering the unit is calculated to be 0.75 Mg/yr for the purpose of determining compliance with the rule. Thus, the TAB quantity of the waste entering the polishing pond is less than 1 Mg/yr, and the unit is *not* required to use controls (answer "a").

Chapter 11

Case Study:

Process Vent Rule Applicability and Compliance

Process Vent Case Study—Review of RCRA Air Emission Standard for Process Vents Hazardous Waste TSDF Operations

Situation

The XYZ Manufacturing Company operates various manufacturing processes that generate approximately 1,000 tons of hazardous waste per year. This qualifies the XYZ Manufacturing Company as a large quantity generator under RCRA. The facility is a RCRA TSDF operating under interim status and has an on-site wastewater treatment system with a National Pollution Discharge Elimination System (NPDES)

permit. As the owner/operator of the facility, you are required to

- 1) determine the applicability of the RCRA air rules for process vents (i.e., 40 CFR 265, Subpart AA) to the hazardous waste management unit emission sources at the facility,
- 2) determine compliance status of current process vent emissions and emission controls in relation to the control requirements in 40 CFR 265, Subpart AA,
- 3) determine what action can be taken to comply with the regulation, if the emission reductions are required under the process vents standards.

Determinations

1. Determine which process vents are subject to the requirements of Subpart AA and why. For each process vent identified in Figures 11-1 and 11-2, circle all of the following statements that are correct (Note: Some vents will have more than one applicable statement; all relevant and appropriate choices should be circled.)
 - a. Vent is a process vent associated with one of the unit operations specified in the rule that manages a hazardous waste with an organic concentration greater than 10 ppmw and therefore is subject to the requirements of Subpart AA.
 - b. Vent is not a process vent as defined in the rule and therefore is not subject to the requirements of Subpart AA.
 - The operation/process associated with the vent is not one of the unit operations specified in Subpart AA applicability (Section 265.1030(b)),
- or
- The passage of gases (i.e., vent emissions) into the atmosphere is not process-related. For example, emissions are caused by tank loading and unloading (working losses) rather than the process or unit operation.

Comments

- a. The process vent rules apply only to those waste management units or unit operations that are specified in the rules. Affected unit operations include: distillation, fractionation, thin-film evaporation, solvent extraction, steam stripping and air stripping.

Vents on control devices (e.g., condensers and carbon adsorbers) and on tanks serving the affected unit operations (e.g., distillate receivers, bottoms receivers, surge control tanks, decant separator tanks, or hot wells) are also subject to the standards if emission from the process are vented through them (e.g., uncondensed overhead vapors from a distillation operation).
- b. A process vent means any open-ended pipe or stack that is vented to the atmosphere either directly, through a vacuum-producing system, or through a tank or air pollution control device. Emissions (i.e., gases or fumes) must be process-related, such as evaporation produced by heating or caused by mechanical means such as a vacuum-producing system.

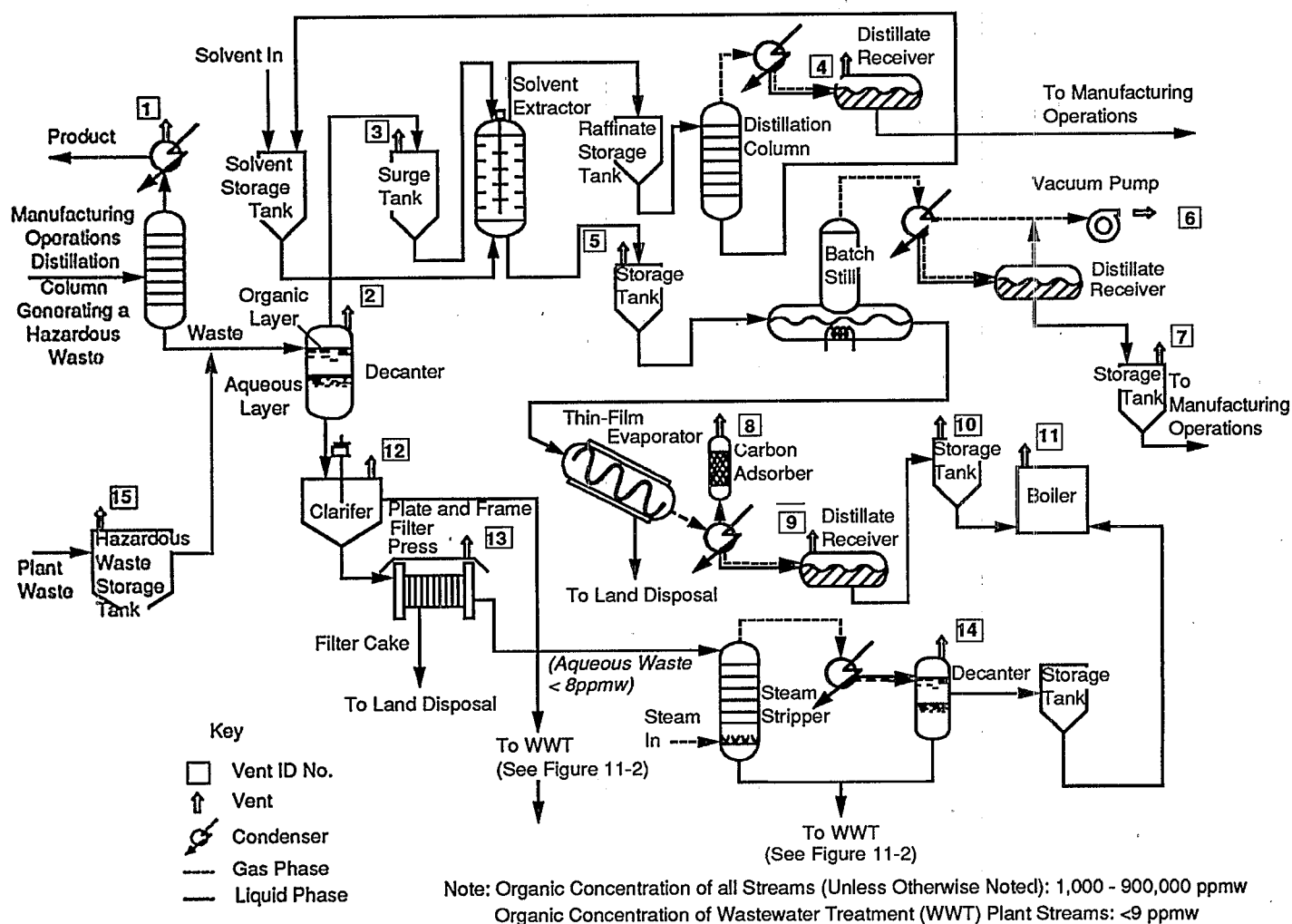


Figure 11-1. Facility XYZ case study.

c. Vent is not subject to the requirements of Subpart AA because the waste managed in the unit has an organic concentration of less than 10 ppmw.

c. The process vent rules apply to affected units managing hazardous waste with a total organic concentration of 10 ppmw or greater on an annual average basis. Units managing wastes with an annual average of *less* than 10 ppmw are not subject to the rules.

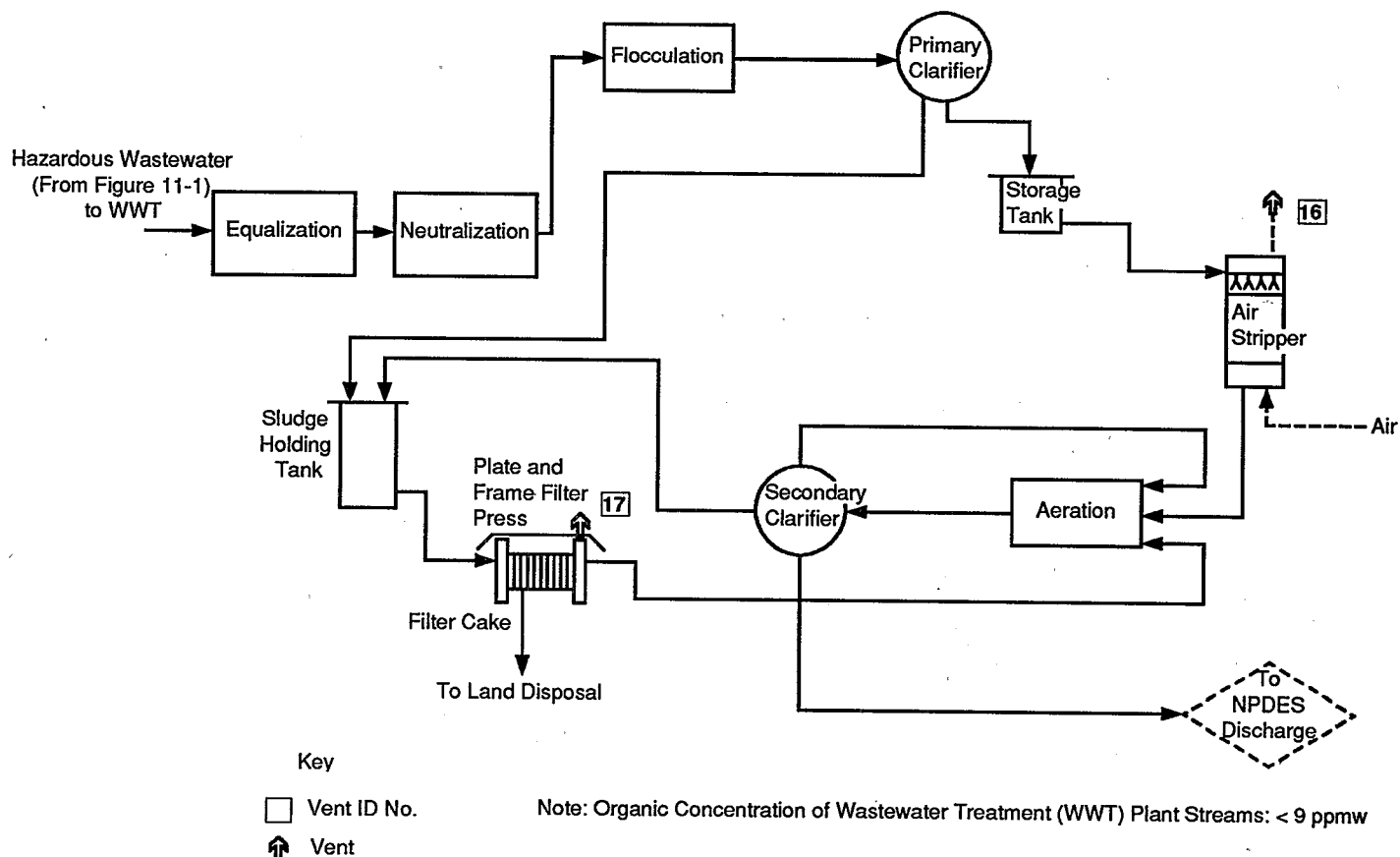


Figure 11-2. Case study of Facility XYZ wastewater treatment plant (WWT) with NPDES permit.

- d. Vent is not subject to the requirements of Subpart AA because the operation/process unit associated with the vent is not subject to RCRA Subtitle C or is exempt from RCRA permitting.

Vent No.	Answers	Vent No.	Answers
1	a,b,c,d	10	a,b,c,d
2	a,b,c,d	11	a,b,c,d
3	a,b,c,d	12	a,b,c,d
4	a,b,c,d	13	a,b,c,d
5	a,b,c,d	14	a,b,c,d
6	a,b,c,d	15	a,b,c,d
7	a,b,c,d	16	a,b,c,d
8	a,b,c,d	17	a,b,c,d
9	a,b,c,d		

- d. If the unit is exempt from RCRA Subtitle C, it is not subject to the requirements of Subpart AA. Examples of types of RCRA exempt units are listed below:

- Units such as product (not hazardous waste) distillation columns generating organic hazardous waste still bottoms are not subject to the standards while the wastes are in the product distillation column unit.
- Elementary neutralization and wastewater treatment tanks as defined by 40 CFR 260.10.
- Units managing Subtitle D wastes or nonhazardous wastes.
- Generators that accumulate hazardous waste in tanks and containers for 90 days or less.

2. Calculate the total facility process vent emission rate (ER).

Case 1:

$$\begin{array}{l} \text{ER}_{(\text{Hourly})} = \\ \text{ER}_{(\text{Annually})} = \end{array}$$

Case 2:

$$\begin{array}{l} \text{ER}_{(\text{Hourly})} = \\ \text{ER}_{(\text{Annually})} = \end{array}$$

3. Based on the total facility process vent emission rate (ER) calculated above (from summing appropriate individual quantities given in Table 11-1), identify which course of action, from among those listed below, is appropriate:

- No emission reduction required.
- Reduce emissions from each individual process vent by 95%.
- Reduce total facility process vent emissions by 95%.
- Control one or more vents to get below the emission rate limits.
- Reduce operating hours to get below the emission rate limits.

Recommended Control Action

Case 1: _____

Case 2: _____

Total facility ER is equal to the sum of the emission rates for all individual process vents located at the facility that are subject to the requirements of Subpart AA.

$$\text{ER}_{\text{Facility}} = \sum_{i=1}^n \text{ER}_{\text{pvi}}$$

After identifying all affected process vents, you must determine whether the total facility affected process vent emission rate is below the emission rate limits (see operating data under #2 and compliance criteria given below.)

If the total facility process vent emission rate for hourly or yearly emissions exceeds the limits in the regulation, action must be taken to reduce emissions below the limits. If the emission rate limits cannot be attained, total facility process vent emissions must be reduced, by 95% or more through use of a control device.

Emission Rate Limits (Compliance Criteria)

Total facility process vent emission rate must be below the following emission rate limits:

Short Term – <1.4 kg/h (3 lb/h) AND

Long Term – < 2.8 Mg/yr (3.1 short tons/yr)

Table 11-1. Process Vent Emission Rate (ER) and Operating Hour (OH) Data

Case 1:

Vent Id #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ER (lb/hr)	9.3	6.1	0.07	0.49	0.16	1.0	0.20	0.12	1.2	0.13	0.06	6.1	8.9	1.2	0.13	0.84	1.5
OH (hr/yr)	4160	4160	8760	2000	8760	2000	8760	2000	2000	8760	2000	4160	2000	2000	2000	4160	2000
ER (ton/yr)	19.3	12.7	0.31	0.49	0.7	1.0	0.88	0.12	1.2	0.57	0.06	12.7	8.9	1.2	0.13	1.7	1.5

Case 2:

Vent Id #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ER (lb/hr)	8.1	5.2	0.11	1.0	0.18	0.8	0.08	0.11	1.0	0.15	0.05	4.5	9.0	1.1	0.15	1.7	2.2
OH (hr/yr)	4160	4160	8760	4000	8760	4000	8760	2000	2000	8760	2000	4160	2000	2000	2000	4160	2000
ER (ton/yr)	16.8	10.8	0.48	2.0	0.79	1.5	0.35	0.11	1.0	0.66	0.05	9.3	9.0	1.1	0.15	3.5	2.2

A solution to the case study on RCRA air emission standards for process vents is presented in Table 11-2, and a discussion follows.

Table 11-2. Review of RCRA Air Emission Standard for Process Vents from Hazardous Waste TSDF Operations—Case Study

Solution

1. Vent Answer

1—d	5—b	9—a	13—b,d	17—b,c,d
2—b	6—a	10—b	14—c,d	
3—b	7—b,d	11—b	15—b,d	
4—a	8—a	12—b,d	16—c,d	

2. Case 1:

$$ER \text{ Hourly} = \sum_{i=1}^n ER_{pvi} = 0.49 + 1.0 + 0.12 + 1.2 = \boxed{2.81 \text{ lb/hr}}$$

$$ER \text{ Annual} = \sum_{i=1}^n ER_{pvi} = 0.49 + 1.0 + 0.12 + 1.2 = \boxed{2.81 \text{ lb/hr}}$$

Case 2:

$$ER \text{ Hourly} = \sum_{i=1}^n ER_{pvi} = 1.0 + 0.8 + 0.11 + 1.0 = \boxed{2.91 \text{ lb/hr}}$$

$$ER \text{ Annual} = \sum_{i=1}^n ER_{pvi} = 2.0 + 1.5 + 0.11 + 1.0 = \boxed{4.61 \text{ lb/hr}}$$

- 3. Case 1:** Total Hourly Facility Emission = 2.81 lbs/hr
 Total Hourly Facility Emission Cutoff = 3 lbs/hr
 2.81 < 3; Total Hourly Facility Emission below cutoff

Total Annual Facility Emission = 2.81 tons/hr
 Total Annual Facility Emission Cutoff = 3.1 short ton/yr
 2.81 < 3.1; Total Annual Facility Emission below cutoff

- (a) Total facility emissions are below emission rate limits, therefore no further emission reduction required.

Case 2: Total Hourly Facility Emission = 2.91 lbs/hr
 Total Hourly Facility Emission Cutoff = 3 lbs/hr
 2.91 < 3; Total Hourly Facility Emission below cutoff

Total Annual Facility Emission = 4.61 tons/yr
 Total Annual Facility Emission Cutoff = 3.1 short ton/yr
 4.61 > 3.1; Total Annual Facility Emission above cutoff

- (b), (c), (d), (e)

Total facility annual emissions are above the cutoff; can reduce emissions from each individual process vent by 95%, reduce facility process vent emissions by 95%, or control one or more vents to get the total facility process vent emissions below the emission rate limits, or reduce operating hours on affected units (e.g., by at least 50% on vent 4 and 6) to get below the emission rate limits.

Discussion of Solutions to the Process Vent Rule (Subpart AA) Case Study

Applicability Determinations

Vent No. 1: *d*. This is a production unit, i.e., distillation unit, that is part of the manufacturing operations. This unit is

generating an organic hazardous waste, the still bottoms. However, under 40 CFR 261.4(c), a hazardous waste that is generated in a manufacturing process unit is not subject to regulation under Parts 262 through 265, 268, 270, 271, and 124 until it exits the unit in which it was generated, unless the hazardous waste remains in the unit more than 90 days after the unit ceases to be operated for manufacturing. Therefore, because the unit is not subject to RCRA permitting, the vent on this unit is not subject to the Subpart AA process vent rules.

Vent No. 2: *b*. The vent on this decanter tank is not subject to the Subpart AA rules because the vent is not a process vent associated with one of the affected unit operations, i.e., distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping.

Vent No. 3: *b*. The vent on this surge tank is not covered by the Subpart AA. Although this tank is associated with (or a part of) one of the affected unit operations, the vent on this tank does not meet the definition of a process vent as specified in the rule. This is because the emissions from the tank are not process-related. Emissions from one of the affected unit operations are not vented through this tank; emissions are working and breathing losses.

Vent No. 4: *a*. This vent is subject to Subpart AA. The vent on this distillate receiver is a process vent associated with a distillation column, one of the affected unit operations. Overhead gases from the distillation column are sent to a condenser; the condensed organic (liquid) and the uncondensed vapors go to the distillate receiver where the uncondensed gases are vented to the atmosphere. The emissions from this vent are related directly to the distillation operation.

Vent No. 5: *b*. The vent on this storage tank, which holds the hazardous waste after a portion of the waste has been extracted, is not covered by the Subpart AA rules. Although this tank is associated with (or a part of) one of the affected unit operations, the vent on this tank does not meet the definition of a process vent as contained in the rule. Emissions from the tank are not process-related. As shown in Figure 11-1, the solvent extraction operation is basically a liquid-liquid extraction operation; no gases or vapors are generated nor is any heat applied to the waste stream as is the case in distillation. Emissions from the tank are not process-related but are working and breathing losses. If the hazardous waste stream was heated in the process unit to enhance extraction and the heated waste was stored in this tank at a temperature greater than ambient, the argument could be made that the emissions from the tank were indeed process-related. Therefore, the vent, in the case where heat is applied, would be a process vent associated with an affected unit operation and come under the authority of Subpart AA.

Vent No. 6: *a*. This vent is subject to Subpart AA. The exhaust gases from the vacuum pump serving the batch still are considered a process vent associated with a distillation unit, one of the affected unit operations. Overhead gases from the batch still pass through the condenser; the pump drawing a vacuum on the condenser and distillate receiver is exhausting uncondensed gases from the distillation operation to the atmosphere. The emissions from this vent are related directly to the distillation operation.

Vent No. 7: *b,d*. The vent on this storage tank, which holds the liquid distillate recovered from the batch still operation, is not subject to Subpart AA. The vent on this tank does not meet the definition of a process vent as specified in the rule; emissions from this vent are not process-related. In addition, under 40 CFR 261.3 (c)(2)(i), the definition of hazardous waste, materials that are reclaimed from solid waste and that are used beneficially, are not solid wastes and hence are not hazardous wastes unless the reclaimed material is burned for energy recovery or used in a manner constituting disposal. In this example, the distillate reclaimed in the distillation operation is returned to or reused in the manufacturing operation; therefore, the material stored in this tank is no longer a hazardous waste, and as a result the tank is not subject to regulation under RCRA Subtitle C.

Vent No. 8: *a* This vent is subject to Subpart AA. The exhaust gases from the carbon adsorber serving the condenser on the thin-film evaporator (TFE) are considered a process vent associated with the TFE, one of the specified unit operations. Overhead gases from the TFE pass through the condenser; a portion of the uncondensed gases are directed to the carbon adsorber which emits any unadsorbed gases to the atmosphere. Emission from the control device are directly related to the TFE operations.

Vent No. 9: *a* This vent is subject to Subpart AA. The vent on this distillate receiver is a process vent associated with the thin-film evaporator (TFE), one of the unit operations affected by the process vent rules. Overhead gases from the TFE are sent to a condenser; the condensed distillate (liquid) and a portion of the uncondensed vapors from the TFE go to the distillate receiver where the uncondensed gases are vented to the atmosphere. The emission from this vent are related directly to the TFE operation.

Vent No. 10: *b*. The vent on this storage tank, which holds the liquid distillate recovered from the thin-film evaporator, is not subject to Subpart AA. The vent does not meet the definition of a process vent as specified in the rules; emissions from the vent are not process-related. The losses from the tank would be working and breathing losses.

Vent No. 11: *b*. The vent or exhaust gas from the boiler used to burn the hazardous waste is not subject to Subpart AA, the process vent rules. This boiler is not one of the unit operations specified in the rule, i.e., distillation, fractionation, thin-film evaporation, solvent extraction, and air and steam stripping. Also, the boiler is not being used as a control device to reduce emissions from an affected process vent. The boiler, however, would likely be subject to other RCRA regulation such as the recently promulgated final rule regulating the burning of hazardous waste in boilers and industrial furnaces (56 FR 7134, February 21, 1991).

Vent No. 12: *b,d*. The vent on the clarifier unit is not subject to Subpart AA. This unit (i.e., a tank) is not one of the unit operations specified in the rule; nor are emissions from an affected process unit vented through this tank (i.e., the clarifier).

In addition, under 40 CFR 264.1(g)(6), 265.1(c)(10), and 270.1(c)(2)(v) wastewater treatment units are not subject to

RCRA Subtitle C hazardous waste management standards provided the unit is part of a wastewater treatment facility that is subject to regulation under either Section 402 or Section 307(b) of the Clean Water Act. Accordingly, any hazardous waste tank system that is used to store or treat wastewater that is managed at an on-site wastewater treatment facility with a National Pollution Discharge Elimination System (NPDES) permit or that discharges to a Publicly Owned Treatment Works (POTW) is exempt from the RCRA regulations. In this example, the facility has an NPDES wastewater permit as indicated on Figure 11-2. The clarifier unit is a tank treating wastewater (i.e., the aqueous layer from the decanter) that is managed on-site; therefore this tank is exempt from the RCRA regulations.

Vent No. 13: *b,d*. The vent on the enclosed plate and frame filter press is not subject to Subpart AA. This unit does not involve one of the unit operations specified in the rule. Also, the filter press which meets the RCRA definition of a tank can be considered a RCRA exempt wastewater treatment tank (See Vent No. 12.)

Vent No. 14: *c, d*. This vent is not subject to Subpart AA. Although the vent on the decanter is a process vent associated with one of the specified unit operations (i.e., a steam stripper), the organic concentration of the waste managed in the unit is less than the applicability criteria of 10 ppmw on an annual average basis. In addition, the steam stripping column, which meets the RCRA definition of a tank, can be considered a RCRA exempt wastewater treatment tank (See Vent No. 12.)

Vent No. 15: *b,d*. The vent on this storage tank is not covered by Subpart AA because the vent is not a process vent associated with one of the affected unit operations. In addition, under 40 CFR 262.34 generators that accumulate hazardous wastes in tanks for 90 days or less are not subject to RCRA permitting requirements for these tanks, provided they comply with the provisions of 40 CFR 262.34. As noted Figure 11-1, this is considered a generator's 90-day accumulation tank and therefore is exempt from the RCRA rules. (Note: EPA intends to modify this exemption at a later date.)

Vent No. 16: *c,d*. The vent on this air stripper is not subject to the RCRA process vent rules. Although the vent (or air stripper exhaust) is a process vent associated with one of the specified unit operations, the organic concentration of the waste managed in the unit is less than the applicability criteria of 10 ppmw on an annual average basis, as noted in Figure 11-2. In addition, the air stripping column, which meets the RCRA definition of a tank, can be considered a RCRA exempt wastewater treatment tank (See Vent No. 12.)

Vent No. 17: *b,c,d*. The vent on the enclosed plate and frame filter press is not subject to Subpart AA. This unit does not involve one of the unit operations specified in the rules. Also, the organic concentration of the waste managed in the unit is less than the applicability criteria of 10 ppmw. In addition, the filter press, which is a tank under RCRA, can be considered a RCRA exempt wastewater treatment tank (See Vent No. 12.)

Chapter 12

Case Study:

Equipment Leaks Testing—EPA Method 21

As indicated in Table 12-1, this chapter is organized into four areas. First the Method 21 requirements are described, both for the instruments that are used for leak detection and for the person operating the instrument. The second segment of the chapter describes the various types of instruments that can be used for leak detection and how they operate. Included are highlights of an 11-minute training videotape describing pre-use checks to be performed on the instruments before they are taken into the field, a discussion of instrument calibration and how response factors are used to select the correct instrument for particular monitoring situations. The third part of the chapter discusses field monitoring problems. This includes highlights from a videotape lesson that describes some typical problems related to field monitoring work, e.g., how to orient the sampling probe and what happens if it is not done correctly. The fourth and last segment compares instruments that can be used for this type of work.

Table 12-1. Overview

- Method 21
- Instruments and their operation
- Field monitoring concerns
- Comparison of available instruments

Method 21 Requirements

As directed by Subpart BB, Method 21 is used only to determine whether or not equipment subject to the rules leaks. Method 21 is not used for quantification of the emissions in terms of pounds per hour or grams per second. Measurements of concentrations are made, and if they exceed the leak definition, that equipment is determined to be leaking and must be repaired. The method was promulgated in Appendix A of Part 60 of the *Code of Federal Regulations* and most recently revised on June 22, 1990 (see Appendix A to this chapter for revised method).

The method specifications require that the instruments used for leak detection be capable of responding to specific organic compounds. That is, compounds likely to be present in the facility to be tested must be known in order to select an instrument capable of responding to them.

The method also requires that the scale on the instrument be readable to 2-1/2 percent of the leak concentration defini-

tion. For Subpart BB, that leak concentration definition is 10,000 ppm. That means the scale must be readable to the nearest 500 ppm (± 250 ppm). The sample gas flow rate for the instruments used must be in the range of 0.1 to 3 L/min. The revision in June 1990 reduced the minimum flow from 0.5 Lpm to 0.1 Lpm to allow some photoionization type analyzers that did not previously meet the criteria to qualify.

The instruments that are used have to be rated intrinsically safe. Intrinsically safe means that they can be used in an explosive environment without risk of setting off an explosion that will destroy the instrument and the user.

To use an instrument in a specific monitoring situation, the response factor of that instrument for the compounds that may be leaking has to be less than 10. Response factors will be discussed in more detail later in this section. The response time of the instruments must be less than 30 seconds. This is important because the facilities in which leaks are monitored often contain hundreds of valves. The method requires that the sampling probes be kept in the vicinity of a potentially leaking source for up to twice the response time of the instrument in order to determine if a leak is present. If you have an instrument that responds in 30 seconds instead of one that responds in 5 seconds, that may significantly prolong the inspection work that you are doing.

The calibration precision, i.e., the repeatability of the measurements, must be equal to or less than 10 percent of the calibration gas concentration. Calibration gas concentration is the leak definition concentration (10,000 ppm) so the precision of the instrument has to be repeatable within 1,000 ppm. The calibration precision of the instrument, i.e., the repeatability of the measurements, has to be checked at least once every 3 months.

Response factors are needed for each compound that may be present in a leak. Response times for the instruments must be checked when you purchase the instrument and then any time that modifications that could affect sample flow are made to the instrument. For instance, changing the sampling probe by making it longer may change response time. Adding a glass wool plug at the end of the probe to keep particulate matter out of the sampling probe may also affect sample flow rate. When such changes are made, the sample flow rate must

be rechecked and response time to make sure they comply with the ranges specified by the method.

Instruments and Their Operation

Instrument Descriptions

Instruments generally used for this type of work and pre-use checks and calibrations are discussed in this segment. The definition of response factor is presented and a number of examples are given to show how response factors are used to select the correct type of instrument.

Four types of portable organic analyzers can be used for this work: Flame-ionization, catalytic combustion, photoionization, and infrared. Although infrared devices can be used, they are not typically used in this work.

A flow schematic of one type of flame-ionization analyzer is shown in Figure 12-1. The sample gas is drawn in through the sampling probe where particle filter prevents contamination of the sampling probe and internal plumbing with particulates. The sample passes through a flow indicator into the detector chamber. Hydrogen comes from an internal fuel tank, passing through some pressure regulators, and mixes with the sample gas stream, and the mixture is combusted in the detector chamber. On each side of the detector chamber are sintered metal flame arrestors that are part of the intrinsically safe design of the instrument. They prevent flame in the combustion chamber from escaping and igniting an explosion in an area where an explosive gas mixture may be present.

The combustion reaction in the detection chamber produces positive ions. The ion current is amplified to get a meter reading that is proportional to the organic concentration in the sample gas stream.

Figure 12-2 is a photograph of the front of one type of flame-ionization analyzer.

The second type of instrument that could be used is a photoionization analyzer. In this instrument, the organic vapors that are drawn into the sampling probe are exposed to a source of ultraviolet light. That ultraviolet light causes the organic compounds present in the sample gas mixture to ionize. When those ions are formed, they generate a current that is amplified and produces a meter reading proportional to the organic vapor concentration. Different organic compounds ionize at different voltages. Lamps purchased for use in the photoionization analyzers are available in several voltages. The lamp voltage should be selected on the basis of the compounds anticipated to be present. For example, this type of analyzer does not respond to hexane or methane and paraffinic type organic compounds at the lamp voltages typically available. It does respond very well to oxygenated or halogenated compounds such as ketones, aldehydes, or chlorinated solvents, but certain of these compounds ionize more readily than others. Thus, in some situations this instrument is better than others for detecting organic vapor emissions.

Appendix B of the attachment to this session includes a table that has response factors; the table also lists ionization potentials for some organic compounds. This table can be used to determine what voltage ultraviolet light to select. In addition, the instrument manufacturer should have further information on which to base a selection.

The lamp inside the analyzer and the window on the surface of that lamp that needs to be cleaned after it has been exposed to organic compounds for a period of time are shown in Figure 12-3. Deposits will build up on the window which

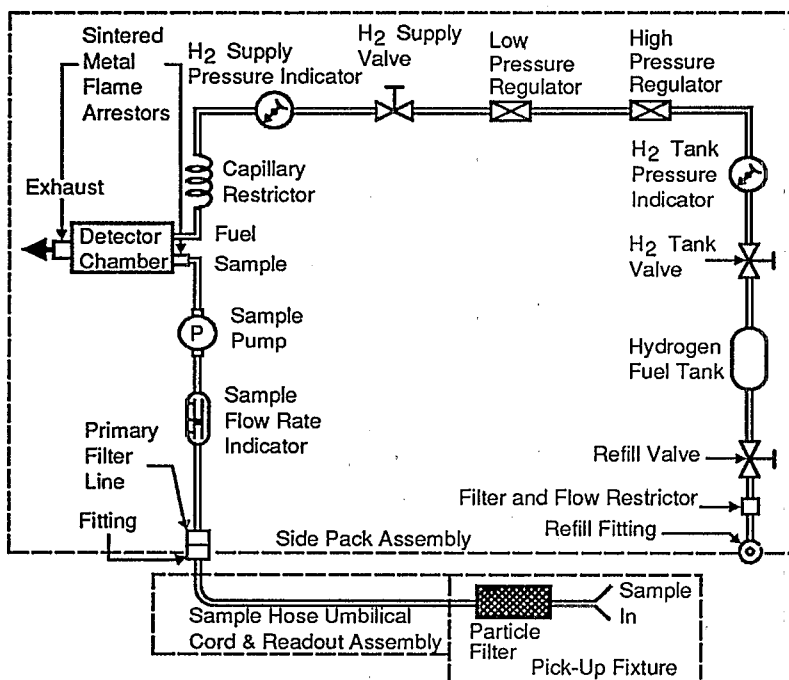


Figure 12-1. Flow schematic of one type of flame-ionization analyzer.

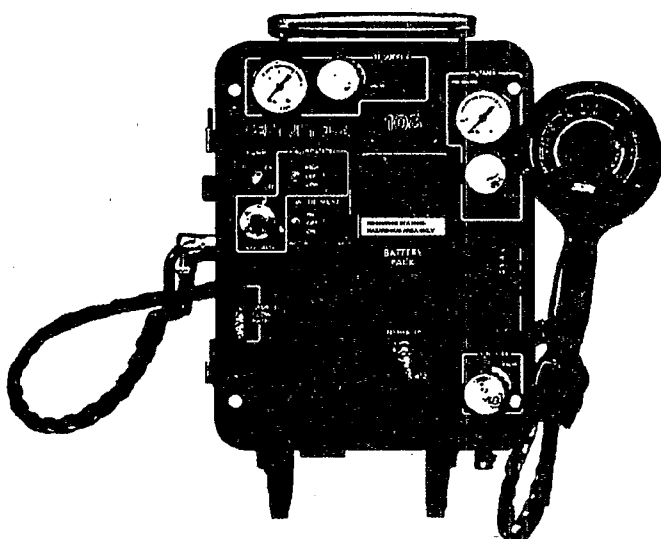


Figure 12-2. Photograph of the front of one type of flame-ionization analyzer.

will have to be cleaned to maintain the instrument's sensitivity. It can be cleaned with the lamp in place.

This instrument is somewhat more compact than the flame-ionization type analyzer. In this particular case, the photoionization lamp is located in the box that contains the meter.

Another design is shown in Figure 12-4 in which the photoionization lamp is located on the end of an umbilical cord. In this case, the lamp is outside the box that contains the meter.

The third type, the catalytic combustion analyzer (Figure 12-5), is similar to the flame-ionization type detector in that the sample gas drawn into the instrument is combusted (oxidized) by a heated catalyst wire inside the instrument that promotes the combustion reaction. When combustion takes place, the resistance of the catalyst-coated wire changes, and the resistance change is detected in the metering circuit. That change in resistance is proportional to the concentration of the organic materials that are present in the sample gas stream.

One difference between the catalytic combustion analyzer and the flame-ionization analyzer is that no hydrogen gas is supplied or required. The combustion reaction is promoted through the presence of oxygen that is drawn with the sample gas stream.

No hydrogen tank is inside this device as shown in Figure 12-5. This box is somewhat more compact than the flame-ionization type device.

Daily Use Prechecks

This section describes some of the steps that should be taken before the instrument is brought into the field. The precheck list shown here is specifically for a flame-ionization detector; the list may vary for other types of instruments.

Prechecks require only a modest amount of time. Time invested in conducting a precheck is well spent, since work should not be attempted if the instrument is not functioning properly or if it will fail soon after you begin. The following instrument prechecks are recommended as a means of ensuring adequate instrument performance during leak surveys:

Hydrogen Supply

Confirm sufficient hydrogen is present to fuel instrument. (Note: Insufficient hydrogen pressure can result in erroneous readings.)

- Read pressure gauge

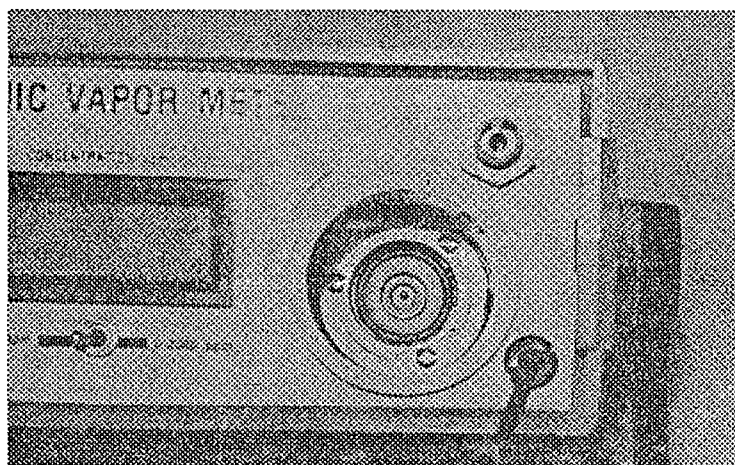


Figure 12-3. Lamp inside analyzer and window on surface of lamp.

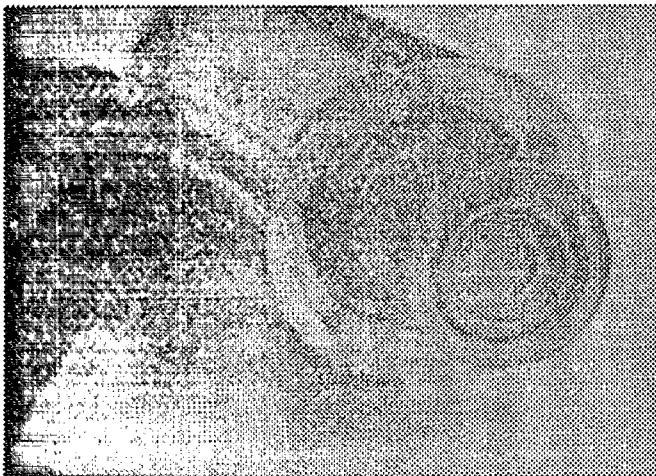


Figure 12-4. Photolization lamp on the end of an umbilical cord.

Battery

Confirm battery is adequately charged. (Note: Failure to adequately charge battery could lead to a deep discharge necessitating installation of new batteries.)

- Disconnect battery from external charger and connect instrument gauge to instrument. Watch for proper gauge response. Take a spare fully charged battery to the inspection site.

Flame Arrestor

Confirm the presence of the flame arrestors before each use to prevent hydrogen flame exposure to outside air. (Note: Precheck is critical in preventing potential explosive conditions.)

- Visually verify flame arrestors are in the proper location.

Amplifier

Confirm amplifier electronic linearity. (Note: Lack of amplifier electronic linearity will result in erroneous readings.)

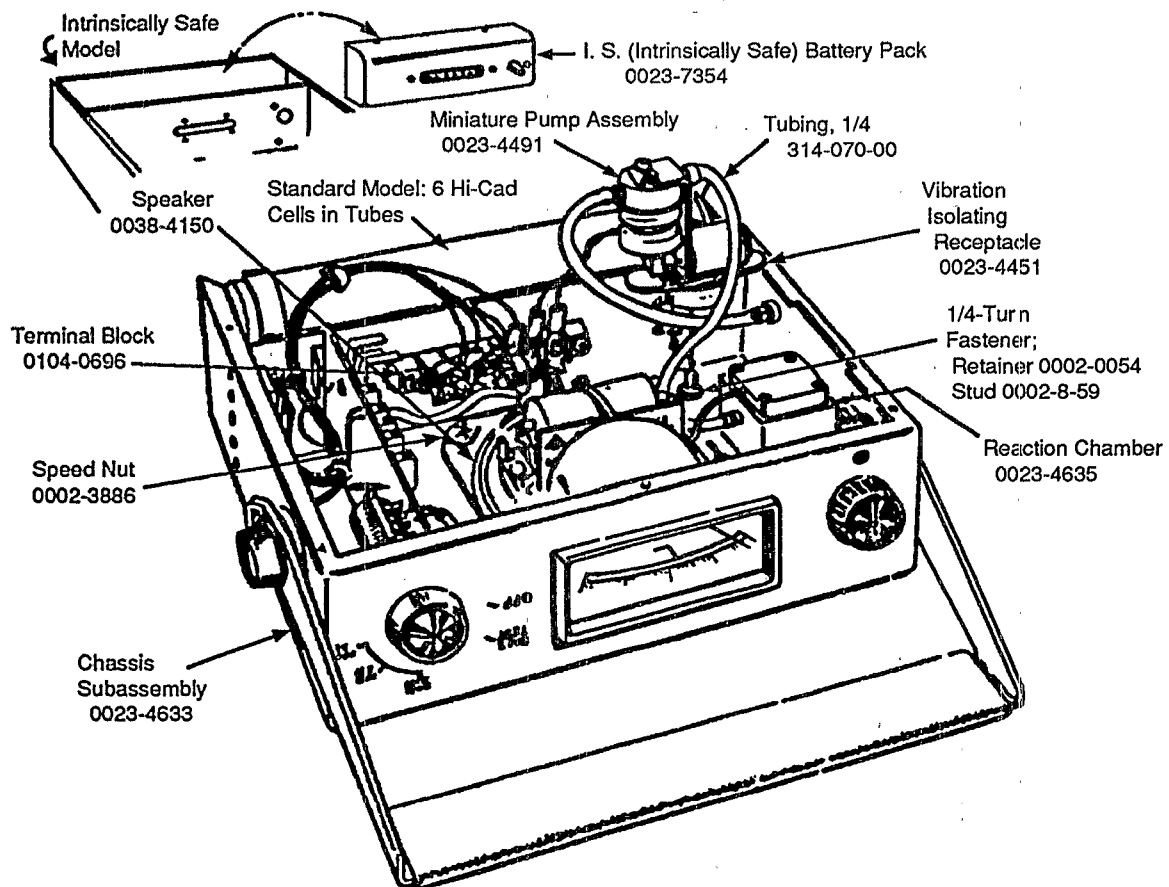


Figure 12-5. Catalytic combustion analyzer.

- Turn on amplifier system allowing 10-minute warmup. If linearity is adequate, move the calibration knob to yield a reading of 10,000 ppm with high calibration scale and 10 ppm with the low switch. If linearity is not adequate, adjust internal calibration.

Prefilter and Probe

Check prefilter and probe for contamination. (Note: Contamination of probe or prefilter could affect instrument performance.)

- Visually examine the probe for deposits of material on the filter or organic deposit of moisture on the probe.

Probe and Sample Gas Handling System

Confirm that no leaks are in the sample gas handling system. (Note: Leaks could bias the instrument's response low and even reduce the unit's capability to draw fugitive gas into the probe.)

- Turn pump on and briefly block the sample gas line at various locations and listen for starved pump sound. If not heard, air leak must be found and eliminated.

Sample Flow Rate

Measure the sample gas flow rate into the probe and conduct a leak check to confirm no infiltration at the top of the rotameter. (Note: Leak could bias flow readings low.)

- Attach a calibrated rotameter or a soap bubble flowmeter to the probe and record flow rate in a bound notebook.

Sample Valve to Gas Chromatograph (GC) Column or Scrubbing Column

Confirm closure of valves that direct sample gas to GC column or activated charcoal scrubbing column that are not used in fugitive emissions testing. (Note: Opening these valves will cause the VOC readings to suddenly decrease to negligible levels.)

- Visually check valve buttons to verify they are not depressed.

Instrument

Method 21 *requires daily calibration* of the instrument. (Note: The readings after calibration are only a general indication of the leak concentration unless you have calibrated with the precise gas or gas mixture being detected.)

- Calibration should be done with instrument under a hood using either a gas cylinder standard or a volatilized liquid mixture. Fill a 5-liter Tedlar bag with calibration gas, then disconnect bag from the regulator and connect to the instrument probe. Due to short response time of units, gauge should deflect within several seconds and quickly reach the anticipated concentration

readily. If necessary, the calibration knob is adjusted to give the calibration gas concentration.

Instrument

Recordkeeping of instrument's response time.

- At least quarterly, observe and record the response time of the instrument. The procedure mentioned directly above in calibrating should be repeated at least three times and the time required to reach 90 percent of the calibration concentration recorded in a bound notebook.

The Subpart BB rules require that calibration be done either with 10,000 ppm of methane in air or normal hexane in air. Although not required by the method, calibration should be done at 500 ppm, which for some of the equipment is the concentration level below which no detectable emissions are demonstrated (the readings must be less than 500 ppm above background). Flame-ionization detectors and catalytic combustion analyzers should be calibrated with methane or hexane in air. The photoionization analyzers do not respond well to paraffinic type compounds, but, specifically, photoionization analyzers cannot be calibrated with methane and hexane; they must be calibrated with some other gas. Photoionization analyzers are often calibrated with butadiene or benzene or some other compound that may be present in the mixtures for which leak monitoring would be attempted.

If a photoionization analyzer is selected, a conversion factor must be developed to show the relationship between the calibration of that instrument with whatever compound is selected for the calibration and the readings that would be obtained if it were calibrated with methane and hexane.

Photoionization analyzers generally will not read beyond the 1,000- to 2,000-ppm range of organic concentration. So, if a photoionization analyzer is selected for a leak detection survey, a dilution probe or some means must be used of supplying a known amount of air to mix with the sample gas stream when it is drawn into the instrument. That dilution probe will reduce the concentration into the measurable range. By knowing the dilution ratio for that probe and instrument, the true reading may be determined.

Response Factors

Response factors in Method 21 are defined as the actual concentration of a known gas sample divided by the meter reading that is produced for that known gas sample on the instrument after the instrument has been calibrated with the selected calibration gas.

The next several tables show how to use response factors to help choose the instrument to be used in a specific leak monitoring situation. The first example (Table 12-2) is a catalytic combustion analyzer exposed to a known concentration of 10,000 ppm of methanol vapors that have been made up as a standard. After this instrument has been calibrated with methane or hexane, a meter reading of 5,000 ppm is produced when the instrument is exposed to the 10,000-ppm concentration of methanol. So actual concentration divided by meter reading gives a response factor of 2. Method 21 requires

Table 12-2. Catalytic Combustion Analyzer Exposed to 10,000 ppm Methanol Vapors

Instrument	→	Catalytic combustion
Organic vapor	→	Methonal
Actual concentration	→	10,000 ppm
Meter reading	→	5,000 ppm
Response factor	→	2

that the response factor for the compounds for which you are attempting to find leaks be less than 10. Thus, this instrument would be acceptable for finding methanol leaks.

The second example (Table 12-3) is a flame-ionization analyzer used to detect orthochlorotoluene vapors made up in an actual concentration of 3,000 ppm. The meter, after the instrument has been calibrated with methane or hexane, produced a reading of 6,000. Actual concentration divided by meter reading is 0.5, obviously well below 10. This instrument is sensitive to orthochlorotoluene vapors, more sensitive to them than it is to methane. It is actually giving a higher reading than the true concentration.

Table 12-3. Flame-Ionization Analyzer Used to Detect Orthochlorotoluene Vapors

Instrument	→	Flame ionization
Organic vapor	→	O-Chlorotoluene
Actual concentration	→	3,028 ppm
Meter reading	→	6,056 ppm
Response factor	→	0.5

In the third example, Table 12-4, a catalytic combustion analyzer is being used for detection of tetrachloroethane vapors that are present in an actual concentration of 6,000 ppm. The instrument reading of 430 shows the instrument is not very sensitive to tetrachloroethane. The response factor is 14, so the instrument would not be acceptable for monitoring leaks of tetrachloroethane.

Table 12-4. Catalytic Combustion Analyzer Used to Detect Tetrachloroethane Vapors

Instrument	→	Catalytic combustion
Organic vapor	→	1,1,2,2-Tetrachloroethane
Actual concentration	→	5,980 ppm
Meter reading	→	427 ppm
Response factor	→	14

The next three examples show that response factors can vary with organic vapor concentration, so the response factor determinations must be made at the leak definition level.

In the example shown in Table 12-5, methanol standards were made up over a concentration range of 50 to 20,000 ppm, and the response factors determined varied between 1.3 and 2.5. Some scatter exists, but the response is increased with increasing concentration. All of these data show that the

Table 12-5. Response Factors at Various Concentrations, Example 1

Instrument	→	Catalytic combustion
Organic vapor	→	Methonal
Actual concentration (ppm)	→	Response factors
50		1.7
500		1.4
2000		1.3
5000		1.8
10000		2.1
20000		2.5

instrument would be acceptable to measure concentrations of leaking vapors of methanol.

In Table 12-6, orthochlorotoluene standards in the concentration range of 200 to 3,100 ppm were made. The response factors decrease slightly with increasing concentration. Two points are illustrated with this example; one is that the response factors vary with concentration. The second is that situations may exist in which obtaining a mixture of a particular compound at 10,000 ppm is not possible. The mixture may be made up in concentration levels that can be achieved in the laboratory, over a concentration range, and then a statistical method may be used to project what the response factor would be at 10,000 ppm.

Table 12-6. Response Factors at Various Concentrations, Example 2

Instrument	→	Flame ionization
Organic vapor	→	O-Chlorotoluene
Actual concentration (ppm)	→	Response factors
200		0.6
1500		0.5
3100		0.5

In the next example, Table 12-7, the catalytic combustion analyzer with tetrachloroethane vapors is in the concentration range of 210 to 1,453 ppm. The response factors at 210 and 572 ppm are around 8. Above 1,000 the response factors have increased to 11. So at 10,000 ppm, you would project from this information that it would not be an acceptable instrument to use for detecting tetrachloroethane leaks.

Table 12-7. Response Factors at Various Concentrations, Example 3

Instrument	→	Catalytic combustion
Organic vapor	→	1,1,2,2-Tetrachloroethane
Actual concentration (ppm)	→	Response factors
210		8.3
572		8.3
1453		11.0
1453		11.0

Published response factor tables that are in Appendix B give response factors at 10,000 ppm. A set of tables gives response factors at 500 ppm as well. The calibration gas selected, whether it is methane or hexane, may affect the value of the response factor for a particular compound.

Response factors are used only to select the correct type of instrument for a particular monitoring situation. Response factors are not used to adjust meter readings obtained during leak tests. Once the instrument selection is made, the readings are taken exactly as they come off the meter. The only time the meter readings would have to be adjusted is when the calibration gas used is different from the ones indicated by the rules.

The method allows use of the published response factors as a basis for demonstrating that the instrument selected is acceptable. One problem with using published response factors is that data are not available for all organic compounds. Only about 300 for which data are available to the public actually have been tested. So, if working with compounds that are not on the list of 300, response factors must be determined experimentally. Another reason for the experimental determinations is that variations exist between instruments of the same type. In the next example a flame ionization analyzer is being used to detect cyclohexanol vapors in the range of 200 to 1,200 ppm. Some slight differences in response factors between the two units are evident. The trend would indicate that at 10,000 ppm the response factors would be less than 10 (Table 12-8).

Table 12-8. Instrument Variations, Example 4

Instrument	→	Flame ionization
Organic vapor	→	Cyclohexanol
Actual concentration	→	Response factors
(ppm)		Unit #1 Unit #2
200		2.0 2.2
700		1.7 1.7
1200		1.2 1.4

In the next example (Table 12-9), two catalytic combustion instruments, supposedly identical, were used to detect concentrations of meta-xylene over the range of 200 to 7,000 ppm. One unit gives response factors in the range of 1.5 to 2; the other unit gives readings in the range of 3.5 to 37.9. This

Table 12-9. Instrument Variations, Example 5

Instrument	→	Catalytic combustion
Organic vapor	→	Meta-xylene
Actual concentration	→	Response factors
(ppm)		Unit #1 Unit #2
200		3.5 1.7
1500		9.4 2.0
3000		12.8 1.6
4500		15.0 1.5
7000		37.9 1.7

shows that extreme reading differences could occur between two supposedly identical units. A reason may exist for this difference; for example, in this catalytic combustion unit, the catalyst coated wire was damaged from exposure to high organic vapor concentrations.

Field Monitoring Problems

This segment of the chapter is related to actual field use of the instrument. In conducting field monitoring, several common problems need to be considered in order to identify leaks reliably. Such problems in field monitoring procedures, including limited capture, extreme volatile organic compound (VOC) quantities, and weather conditions, are discussed below.

Limited Capture

Before discussing problems in field monitoring procedures as they relate to capture, the differences between gas flow under positive pressure versus gas flow under negative pressure must be understood. The portable VOC analyzer works under negative pressure. Because of its negative pressure characteristics, the sample gas capture and distance of effectiveness is nearly zero, several diameters away from the probe entrance. Leaks leaving the leaking equipment are under positive pressure. The characteristic effects of the positive pressure result in limited dispersion and gradual deceleration causing the leak to persist out as a narrow jet.

Because of the effects of negative and positive pressure mentioned above, limited capture is related to instrument sample gas flow rates and probe orientation to the VOC "plume." Limited capture can result in nondetection of some leaks. Instruments with low gas sampling rates are especially sensitive to the capture problems. For this reason, leaks are easy to miss unless the following steps are taken:

- Locate the probe fairly close to the leak itself.
- Orient the probe so that the positive pressure characteristics of the leak benefit the capture (injects material into the probe and does not act as a cross draft which would make capture poor).

Extreme VOC Quantity

Extreme VOC quantity problems can result because the instrument is too good at capture, thus taking in a high concentration of VOC material. In the case of a flame ionization detector (FID), the unit may not operate properly because the detector flame may go out due to lack of adequate oxygen to support combustion, or condensation may occur of non-volatile components in sample line, flame arrestor leading to the mixer burner, or exhaust flame arrestor. Photoionization detectors, however, present a somewhat different problem. Flame-out is not the problem under consideration, but rather deposits of some of the nonvolatile compounds on the lamp surface. This can result in loss of instrument sensitivity and inability to read anything even though the probe may be sitting in a high concentration leak.

For these reasons, emphasis must be placed not only on getting close to the leak and proper orientation, but also on not staying near the leak for very long. As soon as a leak is indicated, the instrument should be withdrawn. The instru-

ment should not be at a high concentration for a very long time. A mistake of this nature will shut the instrument down for a day and will necessitate a thorough cleaning, which could take hours. For best results, the instrument probe should be moved as slowly as possible around the potential leaking area due to the limited capture problems that can make leaks disappear. However, because of the potential for extreme VOC quantities, the probe should be withdrawn immediately if a high concentration is found.

Adverse Weather

In addition to procedures that minimize problems because of limited capture and extreme VOC intake, instrument problems that can be created by adverse weather conditions must be considered. Portable VOC analyzers should not be used in the rain. Droplets inadvertently drawn into the probe can cause minor damage to the various types of sensors (e.g., flame ionization units—water can partially plug flame arrestors; photoionization detectors—droplets can coat the optical surfaces).

Even after the rain is over, some care is necessary in checking for leaks. Taking in water from small pools can damage the instrument. Exercise caution when downwind of small steam vents or other sources of moisture. A sudden change in wind direction can cause intake of fine droplets and damage.

Safety

Follow plant safety procedures. Avoid hot surfaces, rotating equipment, and valves that may be reached only by standing on a fixed caged ladder. Do not use portable ladders and avoid valves in high locations unless a safe and convenient access exists. In addition, only those portable analyzers and equipment that have been rated as intrinsically safe should be taken into these areas.

In conclusion, several problems may be encountered in field monitoring procedures that cause or prevent the adequate determination of leaks including limited capture, extreme VOC quantities, and weather conditions. To minimize these problems, locate the probe close to equipment because of capture limitations, vary probe orientation to find leaks, withdraw the probe if the gauge suddenly spikes above the action level, avoid any droplet intake into equipment due to rain or spray, and work safely during the fugitive VOC screening.

Health and safety considerations during field monitoring are shown in Table 12-10. These precautions should be observed in addition to following general plant safety guidelines.

Comparison of Available Instruments

With respect to Method 21 requirements, the major comparison point to consider is whether the response factor is acceptable for a particular instrument applied to detecting a particular compound. Perhaps a choice exists of two or three different types of devices for a particular monitoring situation. After determining that response factors are within acceptable ranges for more than one type of instrument, go on to the next set of criteria.

Table 12-10. Health and Safety Considerations

Inhalation hazards

Keep portable organic analyzer on at all times to indicate localized areas where pollutants have accumulated

Use relatively long probe so user does not have to be exposed to leak plume

Electrical and explosion hazards

Use only instruments rated intrinsically safe for Class 1, Division 1, and Class 2, Division 1 conditions

Use only instrument recorders which satisfy the above requirements

Do not touch rotating shafts with metallic probes or other parts

Do not use cigarette lighters to check instrument response

Burn hazards

Avoid hot surfaces adjacent to equipment being screened

Walking and climbing hazards

Avoid exposed rotating equipment

Avoid equipment more than 2 meters above secure platforms or surfaces

Climb ladders properly

Ease of Use

The ease of use points are response time, configuration, calibration, and reliability. The method allows you to use instruments with response times up to 30 seconds, but if you have a large facility with many sources, you should look for an instrument that has shorter response times. Otherwise, much time can be spent around the pumps and valves that are not leaking because the method requires continuing to search for a leak up to twice the length of the response time for the instrument.

With respect to configuration, placement of the meter in relation to the sampling probe is important. This point is discussed more in a later section.

Instrument Costs

Most people tend to focus on the purchase price of the instrument initially, but factors also exist that affect the cost of the instrument over its operating life. For instance, ultraviolet light replacement in the case of the photoionization analyzer is an important operating cost. In the flame-ionization detector case, the hydrogen supply must be replaced. A hydrogen tank must be available to recharge the instrument tank (Table 12-11).

Comparison Summary

Available instrument types are compared in Table 12-11. Across the top of the table are the four types of analyzers that can be used for leak detection work. Down the side are the considerations to be made if a choice among these types is possible. For response times, both the photoionization and flame-ionization analyzers are indicated to be fast responding, catalytic combustion medium, and infrared slow. These all are

Table 12-11. Comparison of Available Instruments*

Criteria	Analyzer type			
	Flame ionization	Photo-ionization	Catalytic combustion	Infra-red
Ease of Use				
Response time	Fast	Fast	Medium	Slow
Weight (portability)	Heavy	Light	Light	Heavy
Contamination susceptibility	Low	Moderate	Low	Moderate
Configuration	Excellent	Adequate	Adequate	Adequate
Maximum concentration capability	Excellent	Adequate	Excellent	Excellent
Costs				
Capital	Moderate	Moderate	Low	Moderate
Operating	Moderate	Moderate	Moderate	Moderate
Other Concerns				
Ruggedness	Good	Good	Good	Good
Maximum hold feature	No	Yes	No	No
Calibration	Good	Good	Good	Good
Capture capability	Excellent	Adequate	Moderate	Moderate

* A variety of models are available; the comparisons are subjective and based on experience with a limited number of models.

within the 30-second response time requirement of the method, but for the flame ionization and photoionization types fast may mean 5 seconds, and for infrared slow may mean 25 seconds. Flame-ionization analyzers are typically equipped with lead acid batteries and a hydrogen tank that makes them relatively heavy. The catalytic and photoionization instruments are relatively light.

The photoionization analyzer and infrared analyzers are moderately susceptible to contamination. The window is a potential problem in both that may require more frequent attention, although it may not be a major difficulty in keeping the instruments in operating condition.

Configuration refers to the issue of where the sampling probe is in relation to the meter that must be read while doing the survey. Designs that locate the meter directly behind or at the end of the probe are easier to use. The method requires the probe tip to be placed close to the equipment that is being surveyed. Position the meter and probe so that both can be seen at the same time.

With respect to maximum concentration capability, only the photoionization analyzer is rated differently. Because photoionization analyzers are not capable of directly reading concentrations that exceed 1,000 to 2,000 ppm, a dilution probe must be used with this instrument if looking for leaks at 10,000 ppm.

The cost information presented here was obtained from telephone quotes. The flame-ionization type analyzer generally is available for \$4,000 to \$7,000. The photoionization analyzers are available for \$4,000 to \$6,000. These instruments come equipped with other convenient features that may

not be essential to the leak detection work but may cause the cost to vary. Cost of the catalytic combustion analyzers is in the \$2,000 to \$4,000 range. They are shown as being a relatively low-cost device, but reasons may exist for their not being as good for leak detection as the other types.

A moderate cost for infrared is indicated in Table 12-11. However, the one quote received for an infrared device was \$16,000, which would not be moderate. Apparently some are available for less than that.

No difference is shown in operating costs. Consider the portions of the instrument that may fail or need replacement, such as the lamps, the hydrogen supply, and batteries. Instrument manufacturers are probably the best source for information about these operating costs for their particular instrument.

All instruments are rated similarly for ruggedness or how they stand up to abuse in the field.

The maximum hold feature may be important for instruments that have the sampling probe and meter in two different locations. An analyzer that locks in the maximum concentration that the meter achieves while in the middle of a survey can be helpful. One photoionization analyzer has this feature.

All instruments are rated similarly for calibration. Capture capability is really a reference to the flow rates of the instruments. The flame-ionization analyzer is rated as excellent because it is at the high end of that flow rate range allowed by the method. Photoionization is indicated as adequate because it is at the low end of the acceptable flow range. Low flow rates do not capture the leaking vapors as well.

Questions and Answers

Question—What factors should be considered in choosing a lamp for a photoionization detector?

Answer—Photoionization lamps that operate at different voltage levels are available for purchase. The first consideration in choosing the lamp is the ionization potential of the compounds for which measurements will be needed. The lamp selected should be capable of ionizing any compound likely to be present, i.e., the compound with the highest ionization potential. Published tables are available that list compound ionization potentials. The information may also be obtained from the instrument or lamp suppliers. Lamp voltages in the 9- to 11-electron volt range are common. The higher voltage lamps are more sensitive to a broad range of organic compounds, but have shorter service lives than the lower voltage lamps. Therefore, more frequent replacement and higher operating costs for the instruments can be anticipated with the higher voltage lamps.

Question—How can photoionization analyzers be used for leak monitoring if they cannot read concentrations higher than 1,000 to 2,000 ppm?

Answer—Photoionization analyzers can be used to demonstrate that equipment designated for no detectable emissions has no detectable emissions, i.e., no measured concentration of emissions 500 ppm or greater than background level. If photoionization analyzers are to be used to monitor equipment for leaks that are defined by concentrations of 10,000 ppm or greater, a dilution probe must be used with the instrument. The dilution probe mixes a known volume of air with the sampled gas stream to ensure that a sampled gas stream concentration of 10,000 ppm will be diluted to a concentration within the capability of the instrument to measure when the combined stream enters the detection chamber. The measured concentration reported by the instrument meter must be multiplied by the dilution ratio to give the concentration of the sampled gas stream. For example, if the dilution ratio for the dilution probe is 6 parts of air to 1 part of sampled gas, a meter reading of 1,000 ppm means that the concentration of organics in the sampled gas stream is 6,000 ppm.

Question—Wastes may contain a large number of organic compounds; how do you determine whether a particular instrument will adequately respond to the combination of vapors that may leak from equipment?

Answer—According to Method 21, the instrument response factor for each compound that is to be measured must be less than 10. With a mixture of a few compounds, checking

the published response factors and verifying their compliance is not difficult. Some limited study suggests that the response factor for a mixture is simply the weighted average response factor of the multiple components when the compounds are similar, such as the two forms of tetrachloroethane (1,1,2,2 and 1,1,1,2). For other mixtures involving compounds with substantially different molecular structures and volatility characteristics, this may not be the case. Also, the relative concentrations of vapors present above a mixture of organics could be substantially different than the relative concentrations of those compounds in leaking liquids, so the correct weighted average to use may not be obvious. A possible solution to the problem would be to prepare a mixture of known concentrations to simulate the waste, and then experimentally determine the response factor for vapors of the mixture. If the response factor for the mixture is less than 10, the instrument may be used. For a mixture composed of a very large number of compounds, this may not be practical. Perhaps a mixture that represents 90 percent of the compounds present in the waste would be a suitable basis for response factor determination. The acceptability of the latter approach would need to be discussed with EPA officials before adopting it.

Question—Can analyzers that use combustion to detect the presence of organic vapors be safely used in potentially explosive atmospheres?

Answer—Both flame ionization and catalytic combustion type analyzers have flames present in their detection chambers when organic vapors are present. Certain models of these devices are rated intrinsically safe, and can be used in explosive atmospheres safely. The intrinsically safe models are constructed with flame arrestors to prevent the propagation of flame into the explosive atmosphere. In Method 21, the instruments used are required to be intrinsically safe as defined by the applicable standards such as the National Electric Code by the National Fire Prevention Association. They must at a minimum be safe for Class 1, Division 1 conditions, and Class 2, Division 1 conditions as defined by the above code.

Question—When an instrument response factor for a particular compound is 9.5, which means the actual concentration being measured is 9.5 times higher than indicated by the meter, can severe leaks be missed?

Answer—Leaks, when they occur, tend to generate very high concentrations. The concentrations are generally much higher than the 10,000-ppm leak definition, typically in the 100,000- to 500,000-ppm range. Given this behavior, instrument response factors up to 10 would still yield an indication that a leak is present.

Appendix A

***Federal Register* Excerpt**

Revised Method 21

ENVIRONMENTAL PROTECTION AGENCY

[AD-FRL-3727-3]

40 CFR Part 60

Standards of Performance for New Stationary Sources; Test Methods

AGENCY:

Environmental Protection Agency (EPA).

ACTION: Final rule.

Summary

Method 21 applies to the determination of volatile organic compounds (VOC) leaks from process equipment such as valves, flanges and connections, pumps and compressors, and pressure relief devices. Since Method 21 was promulgated in 1983, several deficiencies in the method that could lead to inconsistencies in the determination of VOC leaks from such devices have come to the attention of EPA in the form of questions as to the proper application of the method. On May 30, 1989, EPA proposed appropriate additions and revisions to Method 21 to alleviate any deficiencies (54 FR 22920). This action promulgates those additions and revisions.

Dates

Effective Date. June 22, 1990. **Judicial Review.** Under section 307(b)(1) of the Clean Air Act, judicial review of the actions taken by this notice is available only by the filing of a petition for review in the U.S. Court of Appeals for the District of Columbia Circuit within 60 days of today's publication of this notice. Under section 307(b)(2) of the Clean Air Act, the requirements that are the subject of today's notice may not be challenged later in civil or criminal proceedings brought by EPA to enforce these requirements.

Addresses

Docket. A docket, number A-88-29, containing information considered by EPA in development of the promulgated rulemaking is available for public inspection between 8 a.m. and 4 p.m., Monday through Friday, at EPA's Air Docket Section (LE-131), room M-1500, First Floor, Waterside Mall, 401 M Street SW., Washington, DC 20460. A reasonable fee may be charged for copying.

For Further Information Contact

William Grimley or Roger T. Shigehara, Emission Measurement Branch (MD-19), Technical Support Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, telephone (919) 541-2237.

Supplementary Information

I. The Rulemaking

Section 2.4 is being revised to remove a description of the leak determination procedure, which is already given, and more properly belongs in section 4.3.2. The example of an acceptable increase in surface concentration versus local concentration is incorrect, and is being removed, as all existing regulatory subparts state that any reading less than 500 ppm constitutes "no detectable emissions." The definition is now expressed in terms of the instrument readability specification.

Section 3.1.1(b) is being revised because it is important to call attention to the possibility that the leak definition concentration may be beyond the linear response range of some instruments for some VOC. This potential problem is not identified by the existing calibration procedure, which specifies a single upscale VOC calibration gas. An argument could be made that a multipoint calibration should, therefore, be required. However, adding that requirement would increase the method's performance burden and cost.

Section 3.1.1(c) is being revised in consideration of existing regulatory subparts, where the intention is for the readability to be to the nearest 500 ppm. Since the leak definition in existing subparts is 10,000 ppm, the nearest 500 ppm represents ± 2.5 percent, not ± 5 percent.

Section 3.1.1(d) is being revised to prevent any flow interruption from occurring, such as could occur if a manually operated device was used for a pump. The minimum flow rate specification of 0.50 liter per minute is reduced to 0.10 liter per minute to prevent the exclusion of some instruments that do meet the response time specification and could be acceptable if this change was made. The flow rate specification has been qualified as to where, and under what conditions, it applies in order to prevent misunderstandings that it might apply at the instrument detector, or with no flow restriction in the probe. The upper flow limit specification of 3.0 liters per minute is retained because some upper limit on flow rate is required to prevent dilution of any leaking VOC to a concentration below the definition of a leak.

Section 3/1/1(e) is being revised in consideration of comments that have been made to EPA that existing wording is not clear and should be more specific. In addition, it has been reported that inexperienced sampling personnel have been observed to use a portable flame ionization analyzer with the exhaust flame arrestor not replaced after removal for cleaning.

Section 3.1.1(f) is being added to emphasize that the instrument is meant to sample a discrete area. Some probes have been observed to have a relatively large inlet area. The addition is necessary so as to provide as much consistency in the identification of leaks as is reasonably possible. All measurements made by EPA in support of its VOC-leaks regulatory development activities have been made with probes not over 1/4 in. in outside diameter.

Section 3.1.2(a) is being revised to include a procedure that is needed for those instances where an instrument is not available that meets the response criteria when calibrated with the specified (in regulation) VOC calibration gas. The new procedure should meet the spirit of existing VOC-leak regulations.

Finally, Section 3.1.2(b) is being revised by replacing the word "configuration" with all of the items of sampling equipment that might be between the probe tip and the detector during testing.

This rulemaking does not impose emission measurement requirements beyond those specified in the current regulations, nor does it change any emission standard. Rather, the rulemaking would simply add methods for the achievement of emission testing requirements that would apply irrespective of this rulemaking.

II. Public Participation

The proposed amendment to 40 CFR part 60 that contained proposed revisions and additions to Method 21 was published in the Federal Register on May 30, 1989 (54 FR 22920). Public comments were solicited at the time of proposal. To provide interested persons the opportunity for oral presentation of data, views, or arguments concerning the proposed action, a public hearing was scheduled for July 14, 1989 beginning at 10 a.m., but was not held because no one requested to speak. The public comment period was from May 30, 1989 to August 14, 1989. Two comment letters were received that contained comments concerning the proposed methods. The comments were supportive of the proposed additions and revisions, with one exception. That comment has been carefully considered, but no changes were made to the proposed rulemaking.

III. Comments and Changes to the Proposed Standards

Two comment letters were received from synthetic organic chemical manufacturers on the proposed methods. All but one of the comments therein were statements to the effect that the commenter agreed with the proposed additions and revisions. The one exception stated that the commenter did not agree that an electrically driven pump should be required in section 3.1.1(d).

The EPA believes it is necessary to specify that an electrically driven pump be used in order to eliminate any potential for imprecise results due to variations or interruptions in sample flow arising from the use of a hand operated squeeze pump. It may be possible for a given person to use a hand operated pump satisfactorily, but EPA believes that technique is too prone to operator fatigue over the course of an extensive leak survey to permit its use in a reference method, and is, therefore, not making any change in the requirement for an electrically driven pump.

IV. Administrative

The docket is an organized and complete file of all the information considered by EPA in the development of this rulemaking. The docket is a dynamic file, since material is added throughout the rulemaking development. The docketing system is intended to allow members of the public and industries involved to identify readily and locate documents so that they can effectively participate in the rulemaking process. Along with the statement of basis and purpose of the proposed and promulgated standards, and EPA responses to significant comments, the contents of the docket, except for

interagency review materials, will serve as the record in case of judicial review [Clean Air Act, section 307(d)(7)(A)].

Under Executive Order 12291, EPA is required to judge whether a regulation is a "major rule" and, therefore, subject to the requirements of a regulatory impact analysis. The Agency has determined that this regulation would result in none of the adverse economic effects set forth in section 1 of the Order as grounds for finding a regulation to be a "major rule." The rulemaking does not impose emission measurement requirements beyond those specified in the current regulations, but instead, provides methods for performing emission measurement requirements that would apply irrespective of this rulemaking. The Agency has, therefore, concluded that this regulation is not a "major rule" under Executive Order 12291.

The Regulatory Flexibility Act (RFA) of 1980 requires the identification of potentially adverse impacts of Federal regulations upon small business entities. The Act specifically requires the completion of an RFA in those instances where small business impacts are possible. Because these standards impose no adverse economic impacts, an RFA has not been conducted.

Pursuant to the provisions of 5 U.S.C. 605(b), I hereby certify that the promulgated rule will not have any economic impact on small entities, because the rule does not add either to the existing requirement for flow rate measurements, or increase their associated performance cost.

This regulation was submitted to the Office of Management and Budget (OMB) for review as required by Executive Order 12291. Any written comments from OMB and any written EPA responses are in the docket.

List of Subjects in 40 CFR Part 60

Air pollution control, Intergovernmental relations, Synthetic Organic Chemicals Manufacturing Industry, Reporting and record keeping requirements.

Dated: June 7, 1990.

William K. Reilly,

Administrator.

Method 21, appendix A of 40 CFR part 60 is amended as follows:

1. The Authority for 40 CFR part 60 continues to read as follows:

Authority: Sections 101, 111, 114, 116, and 301 of the Clean Air Act, as amended (42 U.S.C. 7401, 7411, 7414, 7416, 7601).

Appendix A [Amended]

2. By revising section 2.4 to read as follows:

2.4 No Detectable Emission. Any VOC concentration at a potential leak source (adjusted for local VOC ambient concentration) that is less than a value corresponding to the instrument readability specification of section 3.1.1(c) indicates that a leak is not present.

3. By revising section 3.1.1 (b), (c), (d), and (e) and adding (f) to read as follows:

3.1.1 Specifications.

* * * * *

(b) Both the linear response range and the measurable range of the instrument for each of the VOC to be measured, and for the VOC calibration gas that is used for calibration, shall encompass the leak definition concentration specified in the regulation. A dilution probe assembly may be used to bring the VOC concentration within both ranges; however, the specifications for instrument response time and sample probe diameter shall still be met.

(c) The scale of the instrument meter shall be readable to ± 2.5 percent of the specified leak definition concentration when performing a no detectable emission survey.

(d) The instrument shall be equipped with an electrically driven pump to insure that a sample is provided to the detector at a constant flow rate. The nominal sample flow rate, as measured at the sample probe tip, shall be 0.10 to 3.0 liters per minute when the probe is fitted with a glass wool plug or filter that may be used to prevent plugging of the instrument.

(e) The instrument shall be intrinsically safe as defined by the applicable U.S.A. standards (e.g., National Electric Code by the National Fire Prevention Association) for operation in any

explosive atmospheres that may be encountered in its use. The instrument shall, at a minimum, be intrinsically safe for Class 1, Division 1 conditions, and Class 2, Division 1 conditions, as defined by the example Code. The instrument shall not be operated with any safety device, such as an exhaust flame arrestor, removed.

(f) The instrument shall be equipped with a probe or probe extension for sampling not to exceed 1/4 in. in outside diameter, with a single end opening for admission of sample.

4. By revising section 3.1.2 (a) and (b) to read as follows:

3.1.2 Performance Criteria.

(a) The instrument response factors for each of the VOC to be measured shall be less than 10. When no instrument is available that meets this specification when calibrated with the reference VOC specified in the applicable regulation, the available instrument may be calibrated with one of the VOC to be measured, or any other VOC, so long as the instrument then has a response factor of less than 10 for each of the VOC to be measured.

(b) The instrument response time shall be equal to or less than 30 seconds. The instrument pump, dilution probe (if any), sample probe, and probe filter, that will be used during testing, shall all be in place during the response time determination.

[FR Doc. 90-13845 Filed 6-21-90; 8:45 am]

Appendix B

Published Response Factors (From EPA 340/1-88-015)

Table B-1. Response Factors for TECO Model 580 Photoionization Type Organic Vapor Analyzers 10.0 ev Lamp

Compound	Ionization Potential (ev)	Response Factor
Acetone	9.58	1.7
Acetophenone	N.D.*	4.2
Acrolein	N.D.	25.0
Ammonia	10.15	24.5
Aniline	7.70	0.6
Benzene	9.25	0.7
1,3-Butadiene	9.07	1.0
Carbon disulfide	10.0	2.3
Chlorobenzene	9.07	0.5
Cyclohexane	9.98	2.1
1,2-Dichloroethane	N.D.	50.0
Diethylamine	N.D.	2.0
Dimethyl sulfide	8.69	1.3
Ethyl benzene	8.75	1.7
Ethylene oxide	10.57	33.8
Ethyl ether	9.53	1.5
Hexane	10.18	11.3
Hydrogene sulfide	10.45	7.3
Isopropanol	10.16	19.8
Methyl ethyl ketone	9.53	1.6
Methyl isocyanate	10.57	12.5
Methyl mercaptan	9.4	1.3
Methyl methacrylate	N.D.	4.2
Nitric oxide	9.25	44.9
Ortho chloro toluene	8.83	0.5
Ortho xylene	8.56	0.8
Pyridine	9.32	0.6
Styrene	N.D.	3.3
Sec butyl bromide	9.98	1.7
Tetrachloroethene	9.32	1.6
Tetrachloroethylene	N.D.	1.9
Tetrahydrofuran	9.54	3.7
Toluene	8.82	0.5
Trichloroethylene	N.D.	1.3

* N.D. = not detected

Table B-2. Response Factors for the Hun Systems, Inc., Model ISPI-101 Photoionization Analyzer

Compound	Actual Concentration	Instrument Concentration	Response Factor
Acetal	1000	925	1.1
	5000	7200	0.69
	10000	13200	0.76
Carbon disulfide	1000	1990	0.50
	10000	12900	0.78
Carbon tetrachloride	500	784	0.64
	1000	1070	0.94
	10000	6070	1.6
Chloroform	1000	756	1.3
	5000	2550	2.0
	10000	5250	1.9
Diketone	1000	148	6.8
	5000	318	16.0
	10000	460	22.0
Perchloromethyl mercaptan	5000	103	48.0
Toluene	1000	1180	0.85
Tetrachloroethane, 1,1,2,2-	1000	736	1.4
	5000	1170	4.3
	10000	1880	5.3
Trichloroethane, 1,1-	1000	1020	0.98
	5000	6170	0.81
	10000	9430	1.1
Trichlorotrifluoroethane, 1,1,2-	5000	155	32.0
	10000	430	23.0

Table B-3. Response Factors for Foxboro OVA-108 and Bacharach TLV Sniffer at 10,000 ppmv Response

Compound	Response Factor OVA-108	Response Factor TLV Sniffer	Compound	Response Factor OVA-108	Response Factor TLV Sniffer
Acetic acid	1.64	15.60	Ethylbenzene	0.73	4.74 D
Acetic anhydride	1.39	5.88	Ethylene	0.71	1.56
Acetone	0.80	1.22	Ethylene oxide	2.46	2.40
Acetonitrile	0.95	1.18	Ethylenediamine	1.73	3.26
Acetyl chloride	2.04	2.72	Formic acid	14.20	B
Acetylene	0.39		Glycidol	6.88	5.55
Acrylic acid	4.59	B	Heptane	0.41 I	0.73
Acrylonitrile	0.97	3.49 I	Hexane, n-	0.41	0.69
Allene	0.64	15.00	Hexene, 1-	0.49	4.69 D
Allyl alcohol	0.96	X	Hydroxyacetone	6.90	15.20
Amylene	0.44	1.03	Isobutane	0.41	0.55
Anisole	0.92	3.91	Isobutylene	3.13	B
Benzene	0.29	1.07	Isoprene	0.59	X
Bromobenzene	0.40	1.19	Isopropanol	0.91	1.39
Butadiene, 1,3-	0.57	10.90	Isopropyl acetate	0.71	1.31
Butane, n	1.44 I	4.11	Isopropyl chloride	0.68	0.98
Butanol, sec-	0.76	1.25	Isovaleraldehyde	0.64	2.19 D
Butanol, tert	0.53	2.17	Mesityl oxide	1.09	3.14
Butene, 1-	0.56	5.84	Methacrolein	1.20	3.49 D
Butyl acetate	0.66	1.38	Methanol	4.39 P	2.01
Butyl acrylate, n-	0.70	2.57 I	Methoxy-ethanol, 2-	2.25	3.13
Butyl ether, n	2.60	3.58 I	Methyl acetate	1.74	1.85
Butyl ether, sec	0.35	1.15	Methyl acetylene	0.61	6.79
Butylamine, n	0.69	2.02	Methyl chloride	1.44	1.84
Butylamine, sec	0.70	1.56	Methyl ethyl ketone	0.64	1.12
Butylamine, tert-	0.63	1.95	Methyl formate	3.11	1.94
Butyraldehyde, n-	1.29	2.30	Metayl methacrylate	0.99	2.42
Butyronitrile	0.52	1.47 I	Methyl-2-pentanol, 4-	1.66	2.00
Carbon disulfide	B	3.92	Methyl-2-pentone, 4-	0.56	1.63
Chloroacetaldehyde	9.10	5.07	Methyl-3-buten-2-ol, 2	0.59	X
Chlorobenzene	0.38	0.88	Methylcyclohexane	0.48	0.84
Chloroethane	5.38 I	3.90 P	Methylcyclohexene	0.44	2.79
Chloroform	9.28	B	Methylstyrene, a-	13.90	B
Chloropropene, 1-	0.67	0.87	Nitroethane	1.40	3.45
Chloropropene, 3-	0.80	1.24	Nitromethane	3.52	7.60
Chlorotoluene, m-	0.48	0.91	Nitropropane	1.05	2.02
Chlorotoluene, o-	0.48	1.06	Nonane-n	1.54	11.10
Chlorotoluene, p-	0.56	1.17 I	Octane	1.03	2.11
Crotonaldehyde	1.25	B	Pentane	0.52	0.83
Cumene	1.87	B	Picoline, 2-	0.43	1.18
Cyclohexane	0.47	0.70	Propane	0.55 I	0.60 P
Cyclohexanone	1.50	7.04	Propionaldehyde	1.14	1.71
Cyclohexene	0.49	2.17	Propionic acid	1.30	5.08 D
Cyclohexylamine	0.57	1.38	Propyl alcohol	0.93	1.74
Diacetyl	1.54	3.28	Propylbenzene, n-	0.51	B
Dichloro-l-propene, 2,3-	0.75	1.75	Propylene	0.77	1.74 I
Dichloroethane, 1,1-	0.78	1.86	Propylene oxide	0.83	1.15
Dichloroethane, 1,2-	0.95	2.15	Pyridine	0.47	1.16
Dichloroethylene, cisl, 2-	1.27	1.63	Styrene	4.22	B
Dichloroethylene, transl, 2-	1.11	1.66	Tetrachloroethane, 1,1,1,2	4.83 D	6.91
Dichloromethane	2.81	3.85	Tetrachloroethane, 1,1,2,2	7.89	25.40
Dichloropropane, 1,2-	1.03	1.54	Tetrachloroethylene	2.97	B
Diisobutylene	0.35	1.41	Toluene	0.39	2.68 D
Dimethoxy ethane, 1,2-	1.22	1.52	Trichloroethane, 1,1,1-	0.80	2.40
Dimethylformamide, n-	4.19	5.29	Trichloroethane, 1,1,2-	1.25	3.69
Dimethylhydrazine 1,1-	1.03	2.70	Trichloroethylene	0.95	3.93
Dioxane	1.48	1.31	Trichloropropane, 1,2,3-	0.96	1.99
Epichlorohydrin	1.69	2.03	Triethylamine	0.51	1.48
Ethane	0.65	0.69 I	Vinyl chloride	0.84	1.06
Ethanol	1.78	X	Vinylidene chloride	1.12	2.41
Etboxy ethanol, 2-	1.55	1.82	Xylene, p-	2.12	7.87
Ethyl acetate	0.86	1.43	Xylene, m-	0.40	5.87 D
Ethyl acrylate	0.77	X	Xylene, o-	0.43	1.40
Ethyl chloroacetate	1.99	1.59			
Ethyl ether	0.97	1.14			

I Inverse Estimation Method
D Possible Outliers in Data
N Narrow Range of Data

X No Data Available
B 10,000 ppmv Response Unachievable
P Suspect Points Eliminated

Response Factor Test Results

The calculated response factors are presented in Table B-4. This table is organized by compound name, with the response factors presented for the test instruments. Qualifiers for the data are noted.

Those compounds for which a large response factor was determined (e.g., five and greater) indicate a problem, and these values should not be used. The response factor is a multiplier, and errors in field measurements caused by changes in calibration response, battery condition, parallax errors in reading the panel meters, etc., would be unduly compounded.

Response factors were determined specifically for 500 ppm and should be used as a leak/no leak indicator. The response factors do not remain constant as the concentrations change from 500 ppm. Use of these response factors to

determine concentrations at 2500 ppm, for example, would be inaccurate, and the operator would be best advised to redetermine a response factor specifically for the new conditions or use a published value at the correct level.

Operators of portable leak detection devices should be thoroughly familiar with their instrumentation. Even under the best of circumstances, no two analyzers will perform exactly the same, and the knowledge of how changes in instrument parameters affect accuracy become paramount. Other external quality controls, such as a checklist periodically noting battery condition, fuel pressure, post-survey calibration checks, etc., will bolster the validity of the data. An audit program testing both the operator and the analyzer should be a requirement whenever a situation warranting an exacting determination of a fugitive emission is encountered.

Source: *Method 21 Evaluation for the HON (90-ME-07)*, September 30, 1990, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

Table B-4. Response Factors Summation Table

Manufacturer Analyzer Serial Number	Foxboro OVA-108 20868	Foxboro OVA-128 41092	Foxboro OVA-128 41102	Health DP 111 1001	HNU HW-101 See Text	Foxboro Miran 1B2 322214
<i>Compound/Calculated Response Factor</i>						
Vinyl chloride	2.03	2.11	2.11	1.76	2.18	Recal-A
Benzene	0.56	0.54	0.50	0.38	1.00	OK-B 200
Acetonitrile*	1.20	1.24	1.27	1.27	N/R	OK-B 200
Hexane	1.42	1.49	1.33	0.93	1.49	OK-A
Isooctane	1.05	1.05	0.89	0.56	0.98	Recal-B
Methyl ethyl ketone	1.78	1.84	1.59	1.19	2.92	OK-A
Methyl isobutyl ketone	1.65	1.69	1.40	0.98	1.46	Recal-B
Carbon tetrachloride*	12.07	15.99	13.72	11.11	3.06	OK-B 200
Chloroform	2.06	2.38	1.91	1.38	3.35	OK-A
Benzyl chloride	1.43	1.42	1.21	0.95	1.34	OK-B 100
1,4-Dioxane	3.74	4.27	3.60	3.21	1.66	OK-A
Toluene	0.87	0.87	0.76	0.57	1.25	OK-A
Carbon Disulfide*	33.87	53.06	N/R	57.06	0.71	Recal-A
Methanol*	13.24	17.34	N/R	21.73	4.59	OK-A
1,1,2-Trichloroethane	1.19	1.27	1.11	0.79	1.33	Recal-A
1,1,1-Trichloroethane	1.09	1.16	1.03	0.70	1.85	OK-A
Ethylene dichloride	1.37	1.59	1.41	1.19	1.42	Recal-A
Tetrachloroethylene	1.77	2.09	1.72	1.20	0.74	OK-A
Ethylbenzene	0.77	0.76	0.66	0.51	1.08	Recal-A
Methyl tert-butyl ketone	1.23	1.25	1.03	0.72	1.69	Recal-B
ortho-Xylene	0.95	0.95	0.80	0.6	1.09	Recal-A
para-Xylene	0.89	0.88	0.74	0.54	0.93	Recal-A
meta-Xylene	0.89	0.89	0.75	0.54	0.96	Recal-A
Acetophenone**	2.71	2.62	2.43	2.92	3.07	Recal-A
Styrene oxide**	2.61	2.49	2.06	2.61	3.03	Recal-B
Nitrobenzene***	16.41	16.52	N/R	26.01	19.98	Recal-A
Chloroacetyl chloride	1.86	1.93	1.66	1.28	3.21	Recal-B
1,1,2,2-Tetrachloroethane	1.64	1.69	1.66	1.14	1.52	Recal-A
Ethylene glycol***	24.81	39.39	N/R	33.13	10.91	Recal-B
2-Methoxyethanol***	9.61	9.87	N/R	7.91	2.80	Recal-A
Isophorone***	28.80	40.71	N/R	29.69	17.76	Recal-B
1,2-Epoxybutane	2.67	2.54	2.16	1.89	2.68	Recal-B
Trichloroethylene	2.26	2.60	2.14	1.25	1.09	OK-A
Chlorobenzene	0.62	0.60	0.54	0.38	1.06	Recal-A
Acetaldehyde*	8.41	9.96	7.95	5.36	6.07	OK-B 400
1,2-Propyleneimine	1.75	1.52	1.53	1.33	2.31	Recal-B
Propylene oxide	2.02	2.14	1.78	1.26	3.09	OK-B 200
Vinylidene chloride	2.73	2.97	2.61	1.79	1.70	Recal-A
1,3-Dichloropropene	2.03	2.08	1.93	1.23	1.18	Recal-B
Acrolein*	6.25	6.69	5.64	3.71	2.73	Recal-B
Allyl chloride	2.77	2.73	2.51	1.56	1.46	Recal-B
Cumene**	2.05	1.82	1.55	0.79	1.87	Recal-A
Vinyl acetate	3.63	3.36	2.80	1.48	2.07	Recal-A
Methyl methacrylate	2.02	2.16	1.81	0.92	1.84	OK-B 250
Ethyl acrylate	2.49	2.64	2.18	1.16	1.09	Recal-B
Styrene	1.10	1.08	0.93	0.57	1.36	OK-B 200
Aniline***	14.44	20.45	22.68	14.71	15.23	Recal-A
Epichlorohydrin	2.30	2.41	2.07	1.27	1.95	Recal-B
Propionaldehyde*	4.01	4.27	3.95	2.53	4.79	Recal-B
Hexachlorobutadiene***	16.28	22.99	18.06	14.56	19.34	Recal-B
Methylene chloride	1.67	1.72	1.41	0.84	2.06	OK-A
Propylene dichloride	1.49	1.48	1.26	0.84	1.37	Recal-B
2-Nitropropane	1.86	1.91	1.60	1.06	3.29	Recal-B
Triethylamine	0.47	0.49	0.48	0.35	0.73	Recal-B
Iodomethane*	8.06	8.76	7.35	4.59	0.72	Recal-A
Bromoform*	5.90	6.71	5.68	5.12	0.62	Recal-A

(continued)

Table B-4. Continued

Manufacturer Analyzer Serial Number	Foxboro OVA-108 20868	Foxboro OVA-128 41092	Foxboro OVA-128 41102	Health DP 111 1001	HNU HW-101 See Text	Foxboro Miran 1B2 322214
<i>Compound/Calculated Response Factor</i>						
Acrylic acid***	10.51	10.81	9.63	8.61	8.91	Recal-B
Methyl hydrazine**	5.47	5.50	5.74	5.44	3.93	Recal-B
Dimethyl formamide*	6.42	6.38	7.20	7.09	5.73	Recal-A
1,1-Dimethylhydrazine	2.68	2.84	3.00	2.89	2.29	Recal-B
Acrylonitrile	1.55	1.58	1.56	1.47	3.04	OK-B 100
1,3-Butadiene	2.41	2.69	2.37	1.68	2.15	OK-A
Carbonyl sulfide*	103.95	N/R	N/R	N/R	3.14	Recal-B
Chloromethyl-methyl ether*	7.77	9.76	7.52	4.28	1.65	Recal-B
50% Chloropyrene/xylene	1.46	1.47	1.27	0.77	1.37	
Dichloroethyl ether***	22.12	25.10	24.48	16.88	8.79	Recal-A
Ethyl chloride	1.68	1.84	1.65	1.10	2.38	OK-A
Ethylene dibromide	2.03	2.22	2.03	1.36	0.98	Recal-A
Ethylene oxide*	2.40	2.77	2.40	1.81	6.61	OK-B 100
Formalin	18.83	31.39	27.66	16.50	4.04	Recal-A
(37% formaldehyde/H ₂ O)						
Methyl bromide	3.71	3.83	3.46	2.43	1.47	Recal-A
Methyl chloride	1.97	2.38	1.97	1.27	1.77	OK-A
Vinyl bromide	2.14	2.41	2.33	1.68	1.37	Recal-B
ortho-Cresol			Solid—Not Tested			Recal-B
meta-Cresol***	75.60	115.20	N/R	N/R	N/R	Recal-A
para-Cresol	N/R	N/R	N/R	N/R	N/R	Recal-B
Phenol (90% carboxylic acid)	16.38	44.89	47.01	N/R	71.06	Recal-B
1,2,4-Trichlorobenzene	12.55	16.71	N/R	18.66	16.58	Recal-B
Ethylidene dichloride		Not available in pure form from vendors				Recal-B
2-Butoxyethanol***	19.37	26.11	24.69	13.93	9.23	Recal-B
2-Ethoxyethanol*	3.55	4.09	3.50	2.02	1.70	Recal-B
1,4-Dichlorobenzene			Solid—Not Tested			
Maleic anhydride			Solid—Not tested			

N/R = No response or O/L = Off-Line

* = Low instrument response detected/high response factor calculated.

** = Unstable response and tailing of instrument strip chart record over time noted.

*** = Volatility problem with compound.

Miran 1B2

OK-A = Compound listed in Miran fixed library at/above 500 ppm.

OK-B = Compound listed in Miran fixed library below 500 ppm, yet gave satisfactory results when tested at 500 ppm; the library range is also listed.

Recal-A = Compound listed in Miran fixed library; most under 100 ppm but gave unsatisfactory results when tested at 500 ppm; required recalibration of Miran 1B2 for 500 ppm range.

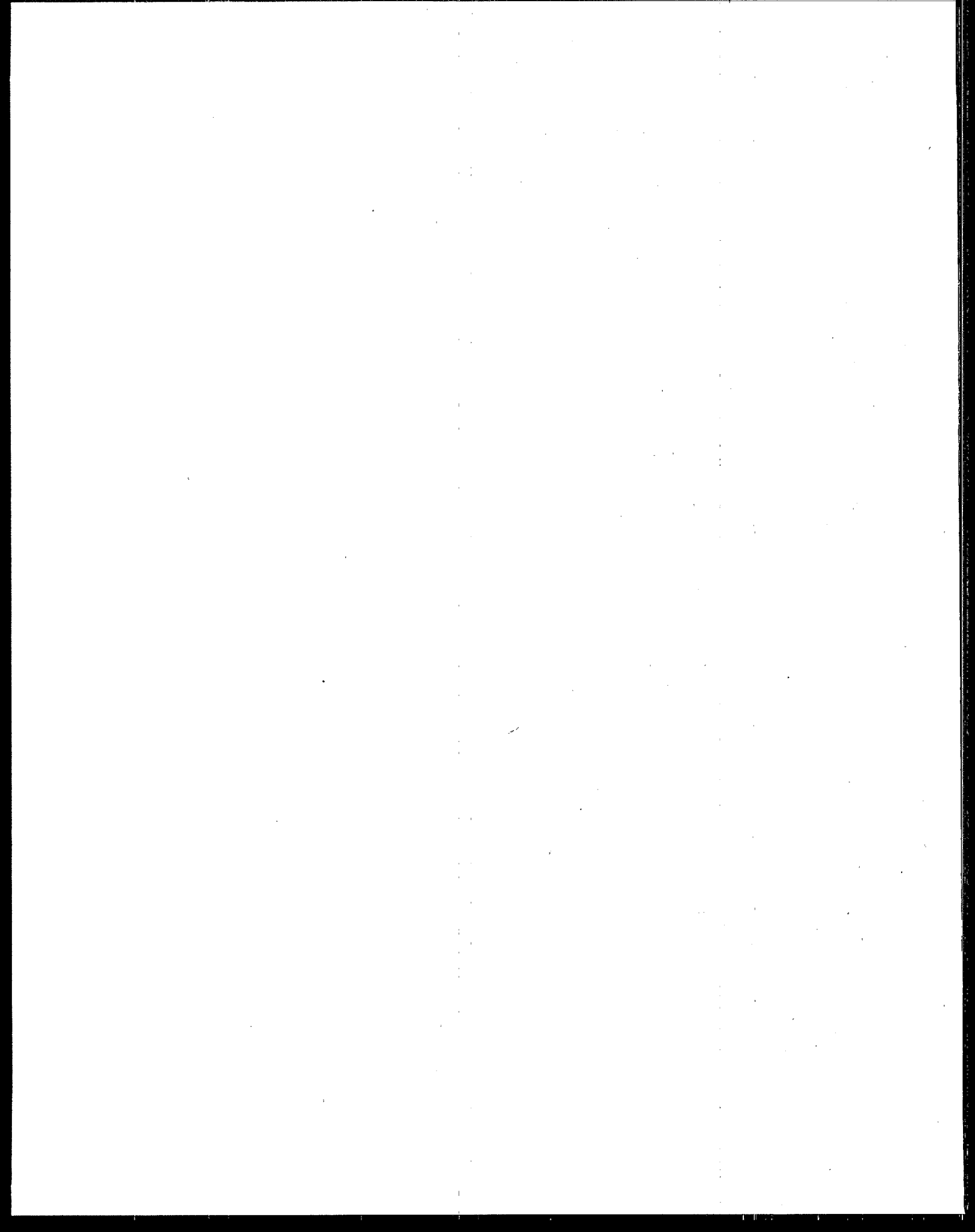
Recal-B = Compound not listed in Miran fixed library and needs complete user listing, peak identification, and calibration of analyzer for 500 ppm.

Appendix C

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Equipment Leak Monitoring

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