U.S. Environmental Protection Agency
Office of Air and Radiation

Office of Air Quality
Planning and Standards

Control Techniques for Volatile Organic Compound Emissions from Stationary Sources

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This report was prepared by the Office of Air Quality Planning and Standards, and has been reviewed by the Emission Standards Division of the Office of Air Quality Planning and Standards, EPA, and approved for publication. Government Institutes determined that it contained information of interest to those outside EPA, so we are reproducing this material in order to serve those interested.

This document is a summary document containing general information on sources of volatile organic compound (VOC) emissions, applicable control techniques, and the impacts resulting from control applications. It references other documents which contain much more detailed information on individual sources and control techniques. This is the third edition of a report originally published by the Department of Health, Education, and Welfare (HEW) titled, "Control Techniques for Hydrocarbon and Organic Solvent Emissions from Stationary Sources (AP-68)." Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

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PREFACE

This is the third edition of a report originally published by the Department of Health, Education, and Welfare (HEW) titled, "Control Techniques for Hydrocarbon and Organic Solvent Emissions from Stationary Sources (AP-68)." The first edition was published in March 1970 by the National Air Pollution Control Administration, a part of HEW. The second edition, was published by the U. S. Environmental Protection Agency in May 1978. It contained numerous changes from the original and was retitled "Control Techniques for Volatile Organic Emissions from Stationary Sources" (EPA-450/2-78-022) to better express the EPA's concern with pollutants other than hydrocarbons. This third edition incorporates the knowledge gained by the Agency during the years subsequent to 1978 and condenses it for easy reference.

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1.0 SUMMARY

This document is a summary document containing general information on sources of volatile organic compound (VOC) emissions, applicable control techniques, and the impacts resulting from control applications. It references other documents which contain much more detailed information on individual sources and control techniques.

1.1 INTRODUCTION AND PURPOSE

In March 1970, the U. S. Department of Health, Education and Welfare published Control Techniques for Hydrocarbon and Organic Solvent Emissions from Stationary Sources (AP-68) as one of a series of documents summarizing control techniques information for criteria air pollutants. Section 108(b) of the Clean Air Act (CAA) as amended in 1977 instructs the Administrator to review and modify these control techniques documents from time to time as appropriate:

> ". . . the Administrator shall, after consultation with appropriate advisory committees and Federal departments and agencies, issue to the States and appropriate air pollution control agencies information on air pollution control techniques, which information shall include data relating to the cost of installation and operation, energy requirements, emission reduction benefits, and environmental impact of the emission control technology. Such information shall include such data as are available on available technology and alternative methods of prevention and control of air pollution. Such information shall also include data on alternative fuels, processes, and operating methods which will result in elimination or significant reduction of emissions."

Additionally, Section 183(c) of the CAA as amended in 1990, provided:

> ". . . the administrator shall issue technical documents which identify alternative controls for all

> categories of stationary sources of volatile organic compounds and oxides of nitrogen which emit, or have the potential to emit 25 tons per year or more of such air pollutant."

This third edition, incorporates new information on VOC emissions and technologies gathered during the development of national air emission standards under Section 111 and 112 of the CAA, during the preparation of control technique guidelines, alternative control technology documents, and other technical studies to aid States in developing VOC regulations, and during the review and comment period on the draft of this document by Federal and State agencies, industry and other public groups and individuals, and the National Air Pollution Control Technical Advisory Committee.

The CAA included this document primarily as a general reference for State and local air pollution control engineers. Based on the interest shown in this and previous editions by the industrial community, it will serve a much broader clientele. Because of the general nature of the document, it should not be used as the basis for developing regulations or enforcing them although it can be helpful as a basic reference from which to begin such an effort. It can be used to provide:

1) summary information and reference material on sources of oxidant precursors and control of these sources,
2) estimates of control costs, and
3) estimates of emission reductions achievable through control.

The costs presented in the text are the averages for a variety of differing industrial applications and consequently can be considered only rough estimates for any specific application. Actual costs for a particular installation may differ substantially from the average costs presented.

VOC is of concern because it contributes to lower atmospheric ozone formation, which in turn causes health and welfare effects. An estimate of nationwide VOC emissions is presented in Chapter 2.0, as is a brief discussion of the

mechanism by which photochemical oxidants (ozone) are formed in the lower atmosphere. The health effects associated with volatile organic and their secondary atmospheric reaction products are discussed in an EPA report Air Quality Criteria for Ozone and Other Photochemical Oxidants.

The techniques for control of VOC described in this report represent a broad spectrum of information from many technical fields. The devices, methods, and principles have been developed and used over many years and are constantly being revised and improved. These techniques vary in type, application, effectiveness, and cost. The "best technique" is to design and operate process equipment for maximum product yield, i.e., complete and efficient use of the raw materials being processed. Failing this, control equipment can be used to recover or destroy materials that otherwise would escape as air pollution.

Operating principles, design characteristics, disadvantages, applications, costs, and energy considerations for a variety of air pollution control equipment and other control techniques are described in Chapter 3.0.

Chapter 4.0 provides a more focused view of a number of industrial processes and source categories. Emission characteristics for each process are described. The control techniques that can be applied to reduce VOC from each process are reviewed. The proper choice of a method of controlling VOC emissions from a specific source depends on many factors, including the source characteristics. No attempt is made here to review all possible combinations of control techniques that may be used to reduce a certain emission.

As the title indicates, this report presents information on VOC control only for stationary sources. Information on control of emissions of VOC from mobile sources is available from the EPA's Office of Mobile Sources in Washington, D.C.

1.2 EMISSION SOURCES AND LEVELS

For purposes of this document, a volatile organic compound

(VOC) is any organic compound that participates in atmospheric photochemical reactions to form ozone. Nearly all organic react photochemically in the atmosphere to produce ozone and other oxidants, furthermore, as increasingly more information becomes available, we find many VOC's are individually toxic. Oxidants have long been associated with a variety of adverse health and welfare effects and were designated a criteria pollutant in 1971. Some organics are hazardous pollutants and may also be VOC (e.g., vinyl chloride and benzene) or be in the same emission stream as VOC. Therefore, controlling VOC often indirectly reduces hazardous pollutants. Therefore, volatile organic emissions are an important concern in the Agency's quest to protect the public health.

Figure 1-1 presents estimates of nationwide emissions of VOC for each general industrial (or source group) category for 1985. Notice that about two-thirds of volatile organic emissions from all sources are from stationary source. These estimates take into account Federal, State and local air pollution regulations. Also, it should be noted that the percentages shown in the bar graph are a function of how the sources are grouped together. A breakdown of each grouping is shown on Table 2-5 of Chapter 2.

1.3 CONTROL TECHNIQUES

The two methods commonly employed to reduce emissions of VOC's to the atmosphere are:

1. Installation of so called "add-on" control equipment to recover or destroy off-gas pollutants. Equipment to capture the emissions is often required in conjunction with add-on devices themselves.

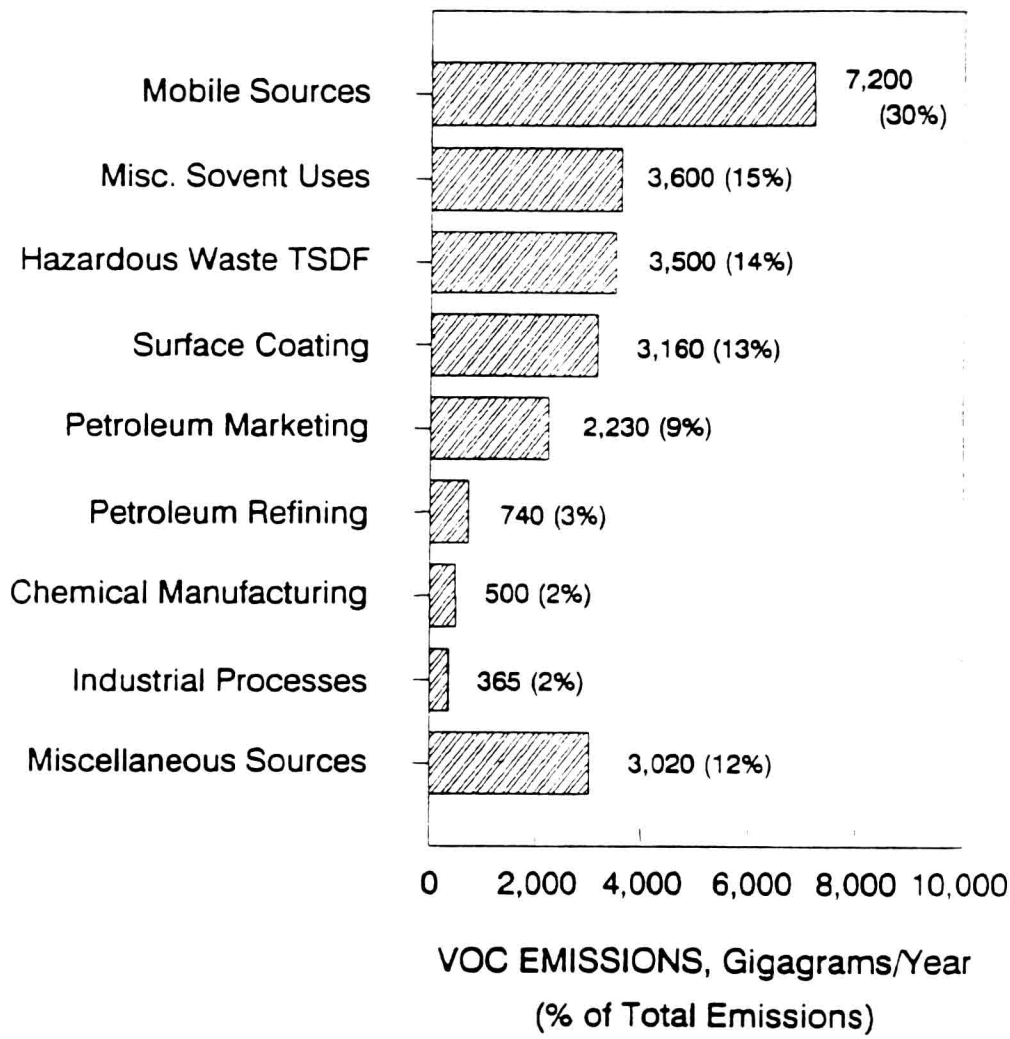
2. Changes in a process and/or raw material to eliminate or reduce generation of pollutants by the process.

1.3.1 Add-On Control Equipment

There are five widely used add-on control techniques for limiting emissions of VOC. These five are: combustion, adsorption, absorption, and condensation.

Figure 1-1. SOURCES OF VOC EMISSIONS AND 1985 NATIONAL VOC AIR EMISSION ESTIMATES

(Total = ~24,300 Gg/yr OR ~26,800,000 Tons/yr)



Tables 1-1 and 1-2 present a listing of these "add-on" control techniques including control levels achievable with some of these techniques, and critical design conditions. In the case of flares, boilers and thermal incinerators, emission testing on a variety of VOC streams has shown that if you meet the design conditions presented in the table, the VOC stream will be reduced by at least 98 percent. Adsorption equipment have been shown to achieve at least 95 percent removal efficiency, but the efficiency is dependent on the basic design parameters listed. As with adsorption equipment, catalytic incinerators, absorbers and condensers VOC control efficiencies are more dependent on the VOC streams characteristics. Thus for these techniques the equipment must be designed for each application.

Below is a general discussion of the operation principals for add-on equipment. A detailed discussion of each technology is presented in Chapter 3.

Combustion. Essentially all VOC will burn; hence combustion is the technique most universally applicable to reducing VOC emissions. Gases containing organic are usually burned if they have little recovery value or contain contaminants that make recovery unprofitable. Combustion devices include thermal incinerators, catalytic incinerators, boilers and process heaters.

Incinerators destroy pollutants through thermal or catalytic oxidation and control efficiencies should be at least 98 percent. Pollutant streams not capable of sustaining combustion may require additional fuel. Fuel costs can be at least partially offset by employing various methods of heat recovery. In addition, some pollutant streams can be directly vented into a process boiler's flame, thus reducing energy costs for the boiler and alleviating the need (or cost) of an add-on control device. Incineration has been successfully applied to aluminum chip dryers, petroleum processing and marketing operations, animal blood dryers, automotive brakeshoe debonding ovens, citrus pulp dryers, coffee roasters, wire enameling ovens, foundry core