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DRY CLEANING FACILITIES--BACKGROUND INFORMATION FOR PROPOSED STANDARDS

EMISSION STANDARDS DIVISION

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR AND RADIATION
OFFICE OF AIR AND QUALITY PLANNING AND STANDARDS
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U. S. ENVIRONMENTAL PROTECTION AGENCY

Background Information and Proposed Environmental Impact Statement for Perchloroethylene from the Dry Cleaning Industry

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11/8/91
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1. The proposed national emission standards for hazardous air pollutants will limit emissions of perchloroethylene from new and existing dry cleaning machines. Section 112 of the Clean Air Act (42 U.S.C. 7411), as amended, directs the Administrator to "promulgate regulations establishing emission standards for each category or subcategory of major sources and area sources of hazardous air pollutants listed." A list of these 190 hazardous air pollutants is given in Section 112.

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

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CONTENTS

CONTENTS, Continued

CONTENTS, Continued

Appendices

FIGURES

TABLES

TABLES, Continued

1.0 SUMMARY

National emission standards for hazardous air pollutants (NESHAP) are established under Section 112 of the Clean Air Act (CAA) (P.L. 101-549), as amended in 1990. Section 112(b) contains a list of 190 hazardous air pollutants (HAP's), which are the specific air toxics to be regulated by NESHAP. Section 112(c) directs the Administrator to use this pollutant list to develop and publish a list of source categories for which NESHAP will be developed. Dry cleaning facilities are included on this source category list and were selected by EPA for NESHAP development based on their "threat of adverse effects to health and the environment."

This background information document (BID) supports proposed standards for dry cleaning facilities that use one of these listed HAP's--perchloroethylene (PCE). In general, HAP dry cleaning facilities can be divided into three categories: coin-operated, commercial, and industrial. Coin-operated facilities are usually part of a laundromat. Dry cleaning is offered at these facilities on either a self-service or an over-the-counter basis. Commercial facilities are the local neighborhood shops processing suits, dresses, coats, and similar apparel. Industrial dry cleaning facilities usually clean articles such as uniforms, work gloves, or rags. These three categories were used to develop the regulatory alternatives and the costs of control.

1.1 REGULATORY ALTERNATIVES

As stated in Section 112 of the CAA, major sources (those sources emitting greater than 10 tpy of any one HAP or greater than 25 tpy of a combination of HAP's) may be controlled to a different level of stringency than area sources (all other sources).

Section 112(d)(2) states that "emission standards. . . applicable to new or existing sources of hazardous air pollutants shall require the maximum degree of reduction in emissions. . . that the Administrator, taking into consideration the cost of achieving such emission reduction, and any other nonair quality health and environmental impacts and energy requirements, determines is achievable. . . ." Furthermore, new major sources must be controlled to at least a level equivalent to the best controlled similar source. Existing major sources must be controlled at least to a level currently achieved by the average of the best 12 percent of existing sources. For dry cleaning facilities that are major sources, these two control levels are identical--95 percent control of vented process emissions. This level of control would be achieved by installing either a carbon adsorber or a refrigerated condenser on a dry-to-dry machine or by installing a carbon adsorber on a transfer machine. This level of control, which is called the "MACT floor" would be the least stringent regulatory alternative for major sources. Because more stringent controls were not identified, this level of control is the only regulatory alternative considered for major source dry cleaning facilities. This alternative would also include pollution prevention practices for the reduction of fugitive emissions.

More flexibility is allowed when controlling HAP emissions from area sources. For area sources, standards may be promulgated that require "generally available control technologies or management practices." Area sources promulgated under this authority (GACT standards) would not be subject to the "MACT floors" described above. Three regulatory alternatives were considered for area sources. All of these alternatives include pollution prevention practices for the reduction of fugitive emissions.

Regulatory Alternative I for area sources would require 95 percent control (installation of either a carbon adsorber or refrigerated condenser) on a dry-to-dry machine and 85 percent control (installation of a refrigerated condenser) on a transfer machine.

Regulatory Alternative II for area sources would require 95 percent control (installation of either a carbon adsorber or refrigerated condenser) on a dry-to-dry machine, 95 percent control (installation of a carbon adsorber) on a new or uncontrolled existing transfer machine, and 85 percent control (installation of a refrigerated condenser) on an existing refrigerated-condenser controlled machine.

Regulatory Alternative III for area sources, which is equivalent to MACT for major sources, would require 95 percent control (installation of either a carbon adsorber or a refrigerated condenser) on a dry-to-dry machine and 95 percent control (installation of a carbon adsorber) on a transfer machine.

In addition to the regulatory alternatives, three applicability cut-off levels were considered for exempting that portion of the low income sector of the dry cleaning industry that may experience undue hardship when implementing the level of control required by the NESHAP. The 3 low income ranges evaluated were: less than $25,000; from $25,000 to $50,000; and from $50,000 to $100,000. Cutoffs within these ranges would exempt a portion of the area sources, but no major sources.

1.2 ENVIRONMENTAL IMPACT

The regulatory alternative for major sources would reduce nationwide HAP emissions from 6,700 Mg/yr to 4,600 Mg/yr in 1991.

Regulatory Alternative I for area sources would reduce nationwide HAP emissions from 80,300 Mg/yr to 61,400 Mg/yr in 1991. Combining this with the regulatory alternative for major sources would result in total reduction in HAP emissions from 87,000 Mg/yr to 66,000 Mg/yr for Regulatory Alternative I.

Regulatory Alternative II for area sources would reduce nationwide HAP emissions from 80,300 Mg/yr to 60,400 Mg/yr in 1991. Combining this with the regulatory alternative for major sources would result in total reduction in HAP emissions from 87,000 Mg/yr to 65,000 Mg/yr for Regulatory Alternative II.

Regulatory Alternative III for area sources would reduce nationwide HAP emissions from 80,300 Mg/yr to 59,800 Mg/yr. Combining this with the regulatory alternative for major sources would result in total reduction in HAP emissions from 87,000 Mg/yr to 64,400 Mg/yr for Regulatory Alternative III.

As shown in Table 1-1, the reduction in nationwide HAP emissions associated with any of these regulatory alternatives would result in minimal adverse environmental impacts. There would be negligible increases in solid waste and HAP's in wastewater. Adopting any of these regulatory alternatives as the proposed standard would cause a slight increase in energy consumption due to the operation of carbon adsorbers or refrigerated condensers.

1.3 ECONOMIC IMPACT

A detailed economic analysis of the impact of these regulatory alternatives can be found in an accompanying document entitled, "Economic Impact Analysis of Regulatory Controls in the Dry Cleaning Industry," EPA-450/3-91-021.

Regulatory Alternative I would result in an increase of approximately 120 million dollars in industry-wide capital investment costs in 1991. The total net annualized costs resulting from Regulatory Alternative I would be approximately 12 million dollars. The industrial sector of the dry cleaning industry would experience a beneficial economic impact under Regulatory Alternative I due to HAP recovery.

For Regulatory Alternative II, total capital investment costs of controls in 1991 would be about 110 million dollars. This cost is lower than for Regulatory Alternative I because the capital cost of a carbon adsorber, the more stringent control, is slightly lower than the capital cost of a refrigerated condenser. The total net annualized costs resulting from Regulatory Alternative II would be approximately 25 million dollars.

For Regulatory Alternative III, total capital investment costs of controls in 1991 would be about 130 million dollars. The total net annualized costs resulting from Regulatory Alternative III would be approximately 30 million dollars.

TABLE 1-1. ASSESSMENT OF ENVIRONMENTAL AND ECONOMIC IMPACTS FOR EACH REGULATORY ALTERNATIVE CONSIDERED

Administrative action	Air impact	Water impact	Solid waste impact	Energy impact	Noise impact	Economic impact
Regulatory Alternative for Major Sources	+2**	-1**	-1**	-1**	0	-1**
Regulatory Alternative I for Area Sources	+2**	-1**	-1**	-1**	0	-1**
Regulatory Alternative II for Area Sources	+2**	-1**	-1**	-1**	0	-1**
Regulatory Alternative III for Area Sources	+2**	-1**	-1**	-1**	0	-3**
Delayed standards or No standards	+1**	0	-1**	0	0	0

KEY:
+ = beneficial impact
- = adverse impact
0 = no impact
1 = negligible impact
2 = small impact
3 = moderate impact
4 = large impact
* = short-term impact
** = long-term impact
*** = irreversible impact

1.4 PROJECTED IMPACTS OF THE PROPOSED STANDARD IN 1996

Based on selection of the proposed standard (Regulatory Alternative II), the projected maximum nationwide impacts in 1996 for facilities existing in 1991 and new facilities that begin operation between 1991 and 1996 without regard to consumption cutoff levels are presented below.[1] Impacts that include the HAP consumption cutoff level corresponding to annual receipts of $100,000 are also presented to illustrate the lowest possible impacts that could result from this proposed standard.

With the proposed standard, total maximum nationwide HAP emissions from new and existing dry cleaning facilities in 1996 could be reduced from 13,000 Mg to 11,300 Mg and from 60,700 Mg to 45,700 Mg, respectively, for a total HAP reduction of 17,100 Mg. Including the consumption cutoff, nationwide HAP emissions from new dry cleaning facilities in 1996 could be reduced to 12,300 Mg/yr and from existing facilities to 53,000 Mg/yr, for a total HAP reduction of 8,400 Mg/yr.

Total maximum nationwide capital costs in 1996 for the proposed standard would be approximately $63 million. Including the consumption cutoff, nationwide capital costs in 1996 could be as low as $26 million.

Total maximum nationwide annualized costs in 1996 for the proposed standard would be approximately $8.4 million. Including the consumption cutoff, nationwide annualized costs could be as low as $2.4 million.

1.5 REFERENCES

1. Memorandum, from Norris, C. E., and K. S. Kepford, Radian Corporation, to Dry Cleaning NESHAP Project File. November 1, 1991. Projected 1996 Impacts of the Proposed Dry Cleaning NESHAP.

2.0 INTRODUCTION

2.1 BACKGROUND AND AUTHORITY FOR STANDARDS

According to industry estimates, more than 2.4 billion pounds of toxic pollutants were emitted to the atmosphere in 1988 Superfund Amendments and Reauthorization Act of 1986 (SARA). These emissions may result in a variety of adverse health effects, including cancer, reproductive effects, birth defects, and respiratory illnesses. Title III of the Clean Air Act Amendments of 1990 provides the tools for controlling emissions of these pollutants. Emissions from both large and small facilities that contribute to air toxics problems in urban and other areas will be regulated. The primary consideration in establishing national industry standards must be demonstrated technology. Before national emission standards for hazardous air pollutants (NESHAP) are proposed as Federal regulations, air pollution prevention and control methods are examined in detail with respect to their feasibility, environmental impacts, and costs. Various control options based on different technologies and degrees of efficiency are examined, and a determination is made regarding whether the various control options apply to each emissions source or if dissimilarities exist between the sources. In most cases, regulatory alternatives are subsequently developed that are then studied by EPA as a prospective basis for a standard. The alternatives are investigated in terms of their impacts on the environment, the economics and well-being of the industry, the national economy, and energy and other impacts. This document summarizes the information obtained through these studies so that interested persons will be able to evaluate the information considered by EPA in developing the proposed standards.

National emission standards for hazardous air pollutants for new and existing sources are established under Section 112 of the

Clean Air Act as amended in 1990 [42 U.S.C. 7401 et seq., as amended by PL 101-549, November 15, 1990], hereafter referred to as the Act. Section 112 directs the EPA Administrator to promulgate standards that "require the maximum degree of reduction in emissions of the hazardous air pollutants subject to this section (including a prohibition of such emissions, where achievable) that the Administrator, taking into consideration the cost of achieving such emission reductions, and any nonair quality health and environmental impacts and energy requirements, determines is achievable...." The Act allows the Administrator to set standards that "distinguish among classes, types, and sizes of sources within a category or subcategory."

The Act differentiates between major sources and area sources. A major source is defined as "any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit considering controls, in the aggregate, 10 tons per year or more of any hazardous air pollutant of 25 tons per year or more of any combination of hazardous air pollutants." The Administrator, however, may establish a lesser quantity cutoff to distinguish between major and area sources. The level of the cutoff is based on the potency, persistence, or other characteristics or factors of the air pollutant. An area source is defined as "any stationary source of hazardous air pollutants that is not a major source." For new sources, the amendments state that the "maximum degree of reduction in emissions that is deemed achievable for new sources in a category or subcategory shall not be less stringent than the emission control that is achieved in practice by the best controlled similar source, as determined by the Administrator." Emission standards for existing sources "may be less stringent than the standards for new sources in the same category or subcategory but shall not be less stringent, and may be more stringent than--

(A) the average emission limitation achieved by the best performing 12 percent of the existing sources (for which the Administrator has emissions information), excluding those sources that have, within 18 months before the emission standard is proposed or within 30 months before such standard is promulgated, whichever is later, first achieved a level of emission rate or emission reduction which complies, or would comply if the source is not subject to such standard, with the lowest achievable emission rate (as defined by Section 171) applicable to the source category and prevailing at the time, in the category or subcategory for categories and subcategories with 30 or more sources, or

(B) the average emission limitation achieved by the best performing five sources (for which the Administrator has or could reasonably obtain emissions information) in the category or subcategory for categories or subcategories with fewer than 30 sources."

The Federal standards are also known as "MACT" standards and are based on the maximum achievable control technology previously discussed. The MACT standards may apply to both major and area sources, although the existing source standards may be less stringent than the new source standards, within the constraints presented above. The MACT is considered to be the basis for the standard, but the Administrator may promulgate more stringent standards, which have several advantages. First, they may help achieve long-term cost savings by avoiding the need for more expensive retrofitting to meet possible future residual risk standards, which may be more stringent (discussed in Section 2.6). Second, Congress was clearly interested in providing incentives for improving technology. Finally, in the Clean Air Act Amendments of 1990, Congress gave EPA a clear mandate to reduce the health and environmental risks of air toxics emissions as quickly as possible.

For area sources, the Administrator may "elect to promulgate standards or requirements applicable to sources in such categories or subcategories which provide for the use of generally available control technologies or management practices by such sources to reduce emissions of hazardous air pollutants." These area source standards are also known as "GACT" (generally available control technology) standards, although MACT may be applied at the Administrator's discretion, as discussed previously.

The standards for hazardous air pollutants (HAP's), like the new source performance standards (NSPS) for criteria pollutants required by Section 111 of the Act (42 U.S.C. 7411), differ from other regulatory programs required by the Act (such as the new source review program and the prevention of significant deterioration program) in that NESHAP and NSPS are national in scope (versus site-specific). Congress intended for the NESHAP and NSPS programs to provide a degree of uniformity to State regulations to avoid situations where some States may attract industries by relaxing standards relative to other States. States are free under Section 116 of the Act to establish standards more stringent than Section 111 or 112 standards.

Although NESHAP are normally structured in terms of numerical emissions limits, alternative approaches are sometimes necessary. In some cases, physically measuring emissions from a source may be impossible or at least impracticable due to the technological and economic limitations. Section 112(h) of the Act allows the Administrator to promulgate a design, equipment, work practice, or operational standard, or combination thereof, in those cases where it is not feasible to prescribe or enforce an emissions standard. For example, emissions of volatile organic compounds (many of which may be HAP's, such as benzene) from storage vessels containing volatile organic liquids are greatest during tank filling. The nature of the emissions (i.e., high emissions for short periods during filling and low emissions for longer periods during storage) and the configuration of storage tanks make direct emission measurements impractical. Therefore, the MACT or GACT standards may be based on equipment specifications.

Under Section 112(h)(3), the Act also allows the use of alternative equivalent technological systems: "If, after notice and opportunity for comment, the owner or operator of any source establishes to the satisfaction of the Administrator that an alternative means of emission limitation" will reduce emissions of any air pollutant at least as much as would be achieved under the design, equipment, work practice, or operational standard, the Administrator shall permit the use of the alternative means.

Efforts to achieve early environmental benefits are encouraged in Title III. For example, source owners and operators are encouraged to use the Section 112(i)(5) provisions, which allow a 6-year compliance extension of the MACT standard in exchange for the implementation of an early emission reduction program. The owner or operator of an existing source must demonstrate a 90 percent emission reduction of HAP's (or 95 percent if the HAP's are particulates) and meet an alternative emission limitation, established by permit, in lieu of the otherwise applicable MACT standard. This alternative limitation must reflect the 90 (95) percent reduction and is in effect for a period of 6 years from the compliance date for the otherwise applicable standard. The 90 (95) percent early emission reduction must be achieved before the otherwise applicable standard is first proposed. However, the reduction may be achieved after the standard's proposal (but before January 1, 1994) if prior to the proposal of the standard the source owner or operator makes an enforceable commitment to achieve the reduction. The source must meet several criteria to qualify for the early reduction standard, and Section 112(i)(5)(A) provides that the State may require additional reductions.

2.2 SELECTION OF POLLUTANTS AND SOURCE CATEGORIES

As amended in 1990, the Act includes a list of 190 HAP's. Petitions to add or delete pollutants from this list may be submitted to EPA. Using this list of pollutants, EPA will publish a list of source categories (major and area sources) for which emission standards will be developed. Within 2 years of enactment (November 1992), EPA is required to publish a schedule establishing dates for promulgating these standards. Petitions may also be submitted to EPA to remove source categories from the list. The schedule for standards for source categories will be determined according to the following criteria:

"(A) the known or anticipated adverse effects of such pollutants on public health and the environment;

(B) the quantity and location of emissions or reasonably anticipated emissions of hazardous air pollutants that each category or subcategory will emit; and

(C) the efficiency of grouping categories or subcategories according to the pollutants emitted, or the processes or technologies used."

After the source category has been chosen, the types of facilities within the source category to which the standard will apply must be determined. A source category may have several facilities that cause air pollution, and emissions from these facilities may vary in magnitude and control costs. Economic studies of the source category and applicable control technology may show that air pollution control is better served by applying standards to the more severe pollution sources. For this reason, and because there is no adequately demonstrated system for controlling emissions from certain facilities, standards often do not apply to all facilities at a source. For the same reasons, the standards may not apply to all air pollutants emitted. Thus, although a source category may be selected to be covered by standards, the standards may not cover all pollutants or facilities within that source category.

2.3 PROCEDURE FOR DEVELOPMENT OF NESHAP

Standards for major and area sources must (1) realistically reflect MACT or GACT; (2) adequately consider the cost, the nonair quality health and environmental impacts, and the energy requirements of such control; (3) apply to new and existing sources; and (4) meet these conditions for all variations of industry operating conditions anywhere in the country.

The objective of the NESHAP program is to develop standards to protect the public health by requiring facilities to control emissions to the level achievable according to the MACT or GACT guidelines. The standard-setting process involves three principal phases of activity: (1) gathering information, (2) analyzing the information, and (3) developing the standards.

During the information-gathering phase, industries are questioned through telephone surveys, letters of inquiry, and plant visits by EPA representatives. Information is also gathered from other sources, such as a literature search. Based on the information acquired about the industry, EPA selects certain plants at which emissions tests are conducted to provide reliable data that characterize the HAP emissions from well-controlled existing facilities.

In the second phase of a project, the information about the industry, the pollutants emitted, and the control options are used in analytical studies. Hypothetical "model plants" are defined to provide a common basis for analysis. The model plant definitions, national pollutant emissions data, and existing State regulations governing emissions from the source category are then used to establish "regulatory alternatives." These regulatory alternatives may be different levels of emissions control, or different degrees of applicability, or both.

The EPA conducts studies to determine the cost, economic, environmental, and energy impacts of each regulatory alternative. From several alternatives, EPA selects the single most plausible regulatory alternative as the basis for the NESHAP for the source category under study.

In the third phase of a project, the selected regulatory alternative is translated into standards, which, in turn, are written in the form of a Federal regulation. The Federal regulation limits emissions to the levels indicated in the selected regulatory alternative.

As early as is practical in each standard-setting project, EPA representatives discuss the possibilities of a standard and the form it might take with members of the National Air Pollution Control Techniques Advisory Committee, which is composed of representatives from industry, environmental groups, and State and local air pollution control agencies. Other interested parties also participate in these meetings.

The information acquired in the project is summarized in the background information document (BID). The BID, the proposed standards, and a preamble explaining the standards are widely circulated to the industry being considered for control, environmental groups, other government agencies, and offices within EPA. Through this extensive review process, the points of view of expert reviewers are taken into consideration as changes are made to the documentation.

A "proposal package" is assembled and sent through the offices of EPA Assistant Administrators for concurrence before the proposed standards are officially endorsed by the EPA Administrator. After being approved by the EPA Administrator, the preamble and the proposed regulation are published in the Federal Register.

The public is invited to participate in the standard-setting process as part of the Federal Register announcement of the proposed regulation. The EPA invites written comments on the proposal and also holds a public hearing to discuss the proposed standards with interested parties. All public comments are summarized and incorporated into a second volume of the BID. All information reviewed and generated in studies in support of the standards is available to the public in a "docket" on file in Washington, D.C. Comments from the public are evaluated, and the standards may be altered in response to the comments.

The significant comments and EPA's position on the issues raised are included in the preamble of a promulgation package, which also contains the draft of the final regulation. The regulation is then subjected to another round of internal EPA review and refinement until it is approved by the EPA Administrator. After the Administrator signs the regulation, it is published as a "final rule" in the Federal Register.

2.4 CONSIDERATION OF COSTS

The requirements and guidelines for the economic analysis of proposed NESHAP are prescribed by Presidential Executive Order 12291 (EO 12291) and the Regulatory Flexibility Act (RFA). The EO 12291 requires preparation of a Regulatory Impact Analysis

(RIA) for all "major" economic impacts. An economic impact is considered to be major if it satisfies any of the following criteria:

1. An annual effect on the economy of $100 million or more;

2. A major increase in costs or prices for consumers; individual industries; Federal, State, or local government agencies; or geographic regions; or

3. Significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of U.S.-based enterprises to compete with foreign-based enterprises in domestic or export markets.

An RIA describes the potential benefits and costs of the proposed regulation and explores alternative regulatory and nonregulatory approaches to achieving the desired objectives. If the analysis identifies less costly alternatives, the RIA includes an explanation of the legal reasons why the less costly alternatives could not be adopted. In addition to requiring an analysis of the potential costs and benefits, EO 12291 specifies that EPA, to the extent allowed by the Act and court orders, demonstrate that the benefits of the proposed standards outweigh the costs and that the net benefits are maximized.

The RFA requires Federal agencies to give special consideration to the impact of regulations on small businesses, small organizations, and small governmental units. If the proposed regulation is expected to have a significant impact on a substantial number of small entities, a regulatory flexibility analysis must be prepared. In preparing this analysis, EPA takes into consideration such factors as the availability of capital for small entities, possible closures among small entities, the increase in production costs due to compliance, and a comparison of the relative compliance costs as a percent of sales for small versus large entities.

The prime objective of the cost analysis is to identify the incremental economic impacts associated with compliance with the standards based on each regulatory alternative compared to baseline. Other environmental regulatory costs may be factored into the analysis wherever appropriate. Air pollutant emissions may cause water pollution problems, and captured potential air pollutants may pose a solid waste disposal problem. The total environmental impact of an emission source must, therefore, be analyzed and the costs determined whenever possible.

A thorough study of the profitability and price-setting mechanisms of the industry is essential to the analysis so that an accurate estimate of potential adverse economic impacts can be made for proposed standards. It is also essential to know the capital requirements for pollution control systems already placed on plants so that the additional capital requirements necessitated by these Federal standards can be placed in proper perspective. Finally, it is necessary to assess the availability of capital to provide the addition control equipment needed to meet the standards.

2.5 CONSIDERATION OF ENVIRONMENTAL IMPACTS

Section 102(2)(C) of the National Environmental Policy Act (NEPA) of 1969 requires Federal agencies to prepare detailed environmental impact statements on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. The objective of NEPA is to build into the decision-making process of Federal agencies a careful consideration of all environmental aspects of proposed actions.

In a number of legal challenges to standards for various industries, the United States Court of Appeals for the District of Columbia Circuit has held that environmental impact statements need not be prepared by EPA for proposed actions under the Act. Essentially, the Court of Appeals has determined that the best system of emissions reduction requires the Administrator to take into account counterproductive environmental effects of proposed standards as well as economic costs to the industry. On this basis, therefore, the Courts established a narrow exemption from NEPA for EPA determinations.

In addition to these judicial determinations, the Energy Supply and Environmental Coordination Act (ESECA) of 1974 (PL-93-319) specifically exempted proposed actions under the Act from NEPA requirements. According to Section 7(c)(1), "No action taken under the Clean Air Act shall be deemed a major Federal action significantly affecting the quality of the human environment within the meaning of the National Environmental Policy Act of 1969" (15 U.S.C. 793(c)(1)). Nevertheless, EPA has concluded that preparing environmental impact statements could have beneficial effects on certain regulatory actions. Consequently, although not legally required to do so by Section 102(2)(C) of NEPA, EPA has adopted a policy requiring that environmental impact statements be prepared for various regulatory actions, including NESHAP developed under Section 112 of the Act. This voluntary preparation of environmental impact statements, however, in no way legally subjects the EPA to NEPA requirements.

To implement this policy, a separate section included in this document that is devoted solely to an analysis of the potential environmental impacts associated with the proposed standards. Both adverse and beneficial impacts in such areas as air and water pollution, increased solid waste disposal, and increased energy consumption are discussed.

2.6 RESIDUAL RISK STANDARDS

Section 112 of the Act provides that 8 years after MACT standards are established, standards to protect against the residual health and environmental risks remaining must be promulgated, if necessary. An exception exists for those standards established 2 years after passage of the Act: 9 years are allowed before promulgation. In the case of area sources controlled under GACT standards, the Administrator is not required to conduct a residual risk review. The standards would be triggered if more than one source in a category or subcategory exceeds a maximum individual risk of cancer of one in 1 million. These residual risk regulations would be based on the concept of providing an "ample margin of safety to protect public health." The Administrator may also consider whether a more stringent standard is necessary--considering costs, energy, safety, and other relevant factors--to prevent an adverse environmental effect.

3.0 DRY CLEANING INDUSTRY PROCESS AND EMISSIONS

This chapter describes the process and emissions of the hazardous air pollutants (HAP's) used in the dry cleaning industry. The solvents used by the dry cleaning industry that are considered HAP's are perchloroethylene (PCE) and 1,1,1-trichloroethane (1,1,1-TCA). Section 3.1 presents a general description of the dry cleaning industry; Section 3.2 describes the HAP dry cleaning process and process emissions; and baseline HAP emissions are estimated for the dry cleaning industry in Section 3.3. References are provided in Section 3.4.

3.1 GENERAL

3.1.1 Description of Dry Cleaning Industry

The dry cleaning industry is a service industry involved in the cleaning and, to a small extent, renting of apparel. Other items besides apparel are also dry cleaned, including draperies and leather goods. In 1986, there were estimated to be over 38,000 dry cleaning plants in the United States.[1] The dry cleaning process uses an organic-based solvent to remove dirt, grease, and other soils from clothes, industrial goods (e.g., uniforms, rags), and other fabric items. The primary dry cleaning solvents are PCE and petroleum distillates. Small quantities of 1,1,1-TCA and trichlorotrifluoroethane (CFC-113) solvents also are used in specialty cleaning operations.[2]

There are currently about 35,000 HAP dry cleaning machines comprising three sectors that are characterized by the type of services they offer.[3,4] Using the assumption that one machine per plant is found in the coin-operated and industrial sectors and 1.25 machines are found per plant in the commercial sector, the breakdown of dry cleaning facilities per sector is as follows: 3,000 facilities in the coin-operated sector;

25,000 facilities in the commercial sector; and 200 facilities in the industrial sector.[5] These are commercial dry cleaners, industrial dry cleaners, and coin-operated facilities. The sectors vary in amount of clothing cleaned, amount of HAP's used, size and type of dry cleaning equipment used, and type of control techniques used. Commercial plants (SIC 7216) are the most common type of facilities that clean soiled apparel and other fine goods. They include small independently operated neighborhood shops, franchise shops, and small specialty cleaners that clean leather and other fine goods. Industrial dry cleaners (which are included in SIC 7218) are the largest dry cleaning plants, and primarily supply rental services of uniforms and other items (such as rags) to business, industrial, and institutional customers. Coin-operated facilities (SIC 7215) are usually part of laundromats. Dry cleaning is offered at these facilities on either a self-service or an over-the-counter basis. They provide low-cost dry cleaning without pressing, spotting, or associated services.

3.1.2 Solvent Types

The solvents used in dry cleaning are categorized into two broad groups: (1) petroleum solvents, which are mixtures of paraffins and aromatic hydrocarbons, and (2) synthetic solvents, which are halogenated hydrocarbons, and include PCE, CFC-113, and 1,1,1-TCA. It is estimated that 82 percent of all dry cleaning plants use PCE, 15 percent use petroleum naphtha, 3 percent use CFC-113, and less than 1 percent use 1,1,1-TCA.[2] Factors influencing the use of each solvent are described below.

Petroleum solvents are less expensive than synthetic solvents, but are flammable and may form explosive mixtures. Fire regulations often prohibit their use in areas such as shopping center locations. Chlorinated synthetic solvents are nonflammable, and usually no location restrictions apply to their use. The primary synthetic solvent, PCE, has aggressive solvent properties, which make it a desirable cleaning solvent for a variety of fabrics.

Other synthetic solvents are less commonly used due to properties that make them inappropriate for some dry cleaning applications. For example, CFC-113 is a less aggressive cleaning solvent than PCE and is more expensive. It is well suited to cleaning delicate articles, but may not clean other types of clothing as effectively as PCE. By comparison, 1,1,1-TCA is a more aggressive solvent than PCE and may damage some types of clothing. It is also more expensive than PCE.

Because of differences in solvent properties, a different type of dry cleaning machine is necessary when using solvents other than PCE. For example, because 1,1,1-TCA is a more aggressive solvent, stainless steel machines are required to prevent corrosion of the equipment parts.[6] Some plants operate multiple machines and may use two different solvents. Other than the use of spotting chemicals or small amounts of detergent, solvents are not combined in the dry cleaning process.[7]

3.2 THE HAP DRY CLEANING PROCESS AND ITS EMISSIONS

3.2.1 HAP Dry Cleaning Process Description

The principal steps in the HAP dry cleaning process are identical to those of laundering in water, except that HAP's are used instead of soap and water. A typical HAP dry cleaning plant is shown schematically in Figure 3-1. The steps and machine types used in the cleaning process are described in the following sections.

3.2.1.1 Cleaning Process Steps. The dry cleaning process involves the following major process steps: charging, washing, extraction, drying, and aeration. Before the cleaning cycle begins, a small amount of detergent and water is added to the cleaning solvent in the charging step. The detergent and water remove water-soluble dirts and soils from fabrics during washing and, thus, improve the cleaning capability of the solvent.

To begin the washing step, clothes are loaded manually into the perforated steel drum of the washer. Charged solvent (solvent with a small amount of soap and water added) is added and then clothes and solvent are agitated by rotation of the drum. After the washing step is complete, the drum spins at high

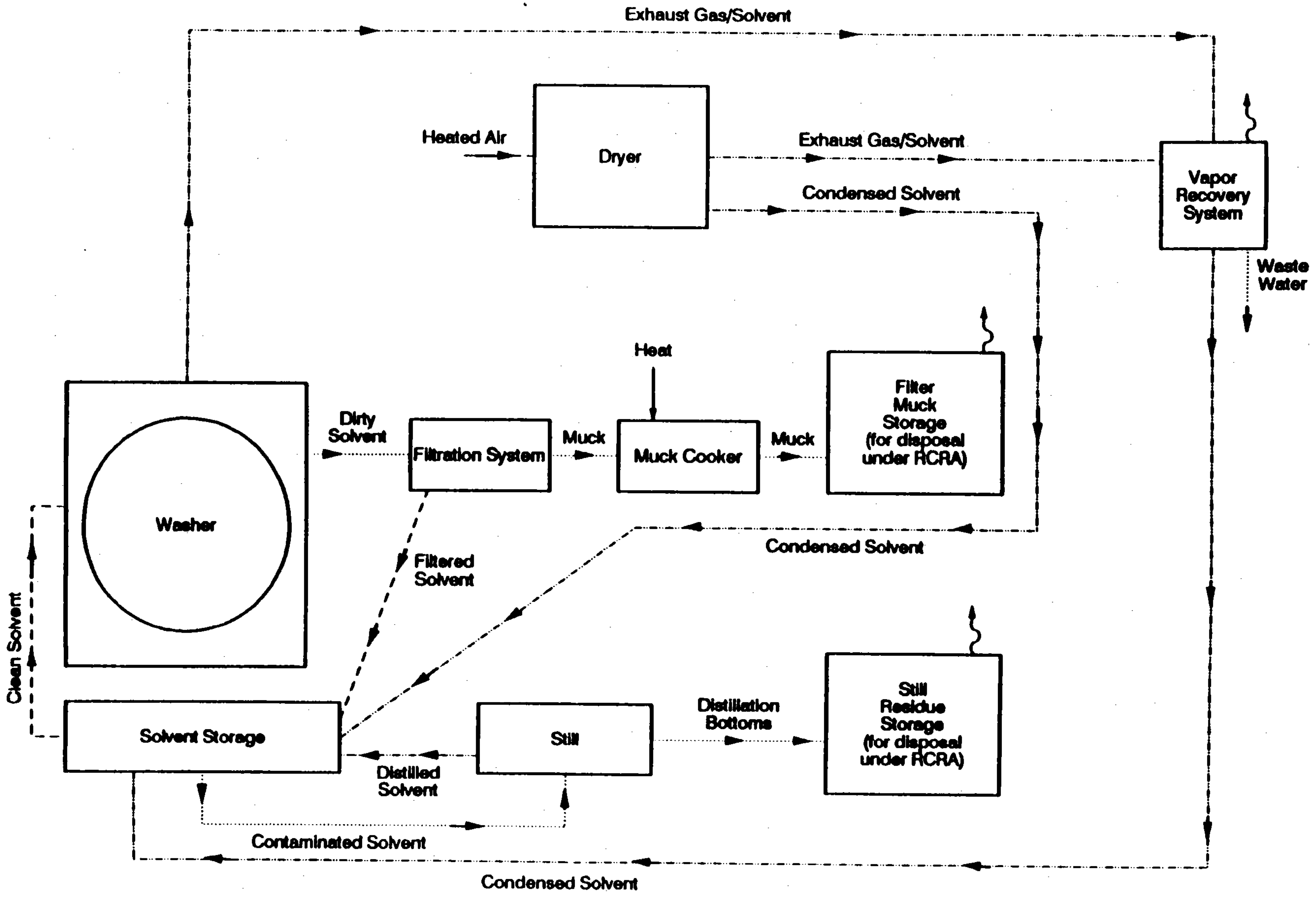

Figure 3-1. Schematic of hazardous air pollutant dry cleaning plant.[1]

speeds to remove the solvent through perforations in the drum. This step is called extraction.

Next, the clothes are tumbled dry for about 12 to 24 minutes.[8] Depending on the type of equipment used (as described in more detail in Section 3.2.1.2), the drying step may take place either in the same machine in which the clothes were washed, or in a separate dryer. In this step, recirculating warm air causes most of the remaining solvent in the clothes to vaporize. To reduce wrinkling, the drying cycle is followed by a brief cool-down cycle during which unheated air is circulated through the clothes. After cool-down, fresh ambient air is passed through the machine for 1 to 7 minutes to freshen and deodorize the clothes.[9] This process is called aeration. The HAP-laden air from this step may be vented to a control device or emitted directly to the atmosphere.

3.2.1.2 Cleaning Equipment Characteristics. There are two basic types of dry cleaning machines used in the HAP dry cleaning industry: transfer and dry-to-dry. Transfer machines include two separate units, a washer and a dryer. Because the washer is capable only of washing and extraction, clothing must be transferred to a separate dryer for drying. Dry-to-dry machines are designed to wash and dry clothes in a single unit, eliminating the need to transfer clothing to a dryer.

When compared to transfer machines, dry-to-dry systems have one potential disadvantage: a dry-to-dry operation may handle fewer loads per day than a transfer operation. In transfer operations, washing and drying are performed in different pieces of equipment so these operations can occur simultaneously on different batches of clothes. In a dry-to-dry machine, a given batch of clothes must be washed and dried in the same machine.

Dry-to-dry machines are increasingly popular in the industry. Elimination of the transfer of solvent-laden clothing between the washing and drying cycles reduces the opportunity for HAP vapors to escape into the work area. Also, dry-to-dry machines take up less floor space, are simpler to operate, and require less attention by the operator during the cleaning cycle.

Currently, both transfer and dry-to-dry machines are used in HAP dry cleaning plants. The typical type and capacity of machines in use are different for each dry cleaning sector. Coin-operated facilities typically have small dry-to-dry machines with capacities of 3.6 to 5.4 kg (8 to 12 lbs) of clothes per load. Both transfer and dry-to-dry machines are used in the commercial sector. However, over the past couple of years all new machines sold to the commercial sector have been dry-to-dry machines.[10] The most common machine capacity in the commercial sector is 35 lbs (16 kg) of clothes per load, but sizes range from 25 lbs (11 kg) to over 100 lbs (45 kg) of clothes per load. Industrial facilities generally use larger dry-to-dry machines with typical capacities of 140 lbs (64 kg) or transfer machines with typical capacities of 250 lbs (113 kg).

One dry cleaning trade association estimates that currently about 33 percent of all machines used by the dry cleaning industry are transfer machines, and about 67 percent are dry-to-dry machines.[10] Recent sales information suggests that the industry is shifting toward the use of more dry-to-dry machines. In 1986, equipment manufacturers reported that dry cleaning facilities purchased about 2,000 dry-to-dry machines, but only about 400 transfer machines.[11-20] Recent vendor discussions indicate that no new transfer machines are being sold. Accounting for this trend, the 1991 estimates reflect that about 30 percent of all machines are transfer machines and the remaining 70 percent are dry-to-dry machines.[4]

3.2.2 Solvent Recovery and Purification

Efficient operation of dry cleaning plants necessitates at least partial recovery and reuse of used solvent. As shown in Figure 3-1, there are several pieces of auxiliary equipment used at most dry cleaning plants for recovery and purification of HAP's. These include filters that remove dirt from the HAP's circulating through the washer, and stills that purify the HAP's by distillation. This section describes filtration and distillation processes and equipment, and the solid wastes generated by these processes.

3.2.2.1 Filtration and Distillation. When HAP's are removed from the washer during extraction, the solvent contains dirt and soils removed from the clothing. If these impurities are not removed from the solvent, with solvent reuse they may be redeposited on clothing. Filtration and distillation are two methods used to purify HAP's prior to reuse.

As shown in Figure 3-1, dirty HAP's from the washer are typically passed through a filtration system. The filtration process removes most insoluble soils, nonvolatile residue, and loose dyes. Most dry cleaning operations use some sort of solvent filtration, and thereby extend the useful life of the solvent.

Two main types of filters are used: (1) tubular or regenerative filters, and (2) cartridge filters. In tubular and regenerative filters, diatomaceous earth and activated carbon usually form the filter element. The filter element is removed each day and replaced with new diatomaceous earth and activated carbon. Cartridge filters have a filter medium of activated carbon or activated carbon and clay. Certain types of cartridge filters also have a filter element of pleated filter paper. All cartridge filters are disposable. It is estimated that about 90 percent of all plants use some sort of cartridge filtration, whereas about 10 percent use tubular or regenerative filters.[21]

Following filtration, the filtered solvent may either flow back to the solvent base tank or to the distillation unit (Figure 3-1). Distillation removes soluble oil, fatty acids, and greases from the solvent that are not removed by filtration. If not removed, these residues can accumulate in the solvent, and upon solvent reuse can cause improper cleaning of clothes. Consequently, solvent distillation is performed on-site by about 80 percent of all cleaners to extend their solvent mileage.[7]

Atmospheric pressure stills are used to distill HAP's.[7] Typically, the solvent and nonvolatile residue are heated with steam to 120°C (250°F). At this temperature, the HAP is vaporized and mixed with the steam. The vapors then pass through a condenser, where the HAP/water vapor mixture is condensed and subsequently separated in a water separator. The purified HAP's are then sent back to the solvent storage tank.

3.2.2.2 Solid Waste Treatment. Both filtration and distillation generate solid wastes that contain HAP's. Some plants further treat solid wastes on-site to maximize HAP recovery and minimize solid waste disposal costs. The cost of solid waste disposal ranges from $11 per standard waste cartridge to $35 for a 14-gallon drum of still residue.[1] The average annual solid waste disposal costs for a typical 35-lb machine would be about $1,500.[22]

Regenerative and tubular filters generate solid wastes in the form of filter "muck". Filter muck is the sludge that builds up on the filter as the insoluble soils, nonvolatile residue, and loose dyes are removed from the dirty solvent.[7] Solid waste also includes the filter powder (diatomaceous earth and activated carbon) that forms the filter element. Both the filter muck and filter powder contain HAP's. Therefore, some HAP plants have a still called a muck cooker that cooks the solvent out of the solid waste prior to disposal. It is estimated that the muck cooker can reduce the amount of solvent lost in filter material by about 90 percent. Hazardous air pollutants recovered by the muck cooker are condensed, separated, and then returned to the solvent storage tank.

For plants with a cartridge filtration system, solid waste is generated in the form of spent filter cartridges that contain HAP's. The HAP losses from the used cartridges can be minimized by draining the filters in their housing.[23] Some plants may also steam strip the cartridges prior to disposal to recover more solvent.

Distillation generates solid waste in the form of distillation bottoms. The so-called "still bottoms" consist of the solid residue remaining in the still after the HAP's have vaporized. This waste contains highly contaminated solvent and nonvolatile residue. The waste may contain as much as 50 percent

HAP by weight.[7] Solvent losses from distillation bottom disposal can be reduced in oil cookers (similar to muck cookers) to levels as low as 1 kg/100 kg (1 lb/100 lb) of wet waste material.[24] The HAP's recovered by the cooker may be returned to the solvent storage tank.

The HAP-laden solid wastes generated by filtration and distillation are considered hazardous wastes under the Resource Conservation and Recovery Act (RCRA).[25] Dry cleaning plants that generate 100 kg (220 lb) or more a month of hazardous wastes are regulated under RCRA and must dispose of their wastes at a licensed hazardous waste treatment or disposal facility. Most coin-operated plants generate less than 100 kg/month (220 lb/month) of hazardous wastes and, therefore, are conditionally exempt from the RCRA regulations. In contrast, most commercial and industrial plants generate between 100 kg/month (220 lb/month) and 1,000 kg/month (2,200 lb/month) of hazardous wastes; these plants are regulated as small-quantity generators under RCRA.[7]

Because of the RCRA regulations, the use of contract disposal services that recycle waste HAP's is becoming more common. Typically, these contract disposal services pick up HAP-contaminated solid wastes such as drained spent cartridge filters, still bottoms, and filter muck from the dry cleaner. The HAP's are subsequently recovered from these wastes and purified. After the HAP's have been recovered, the solid wastes contain less than 1,000 ppm HAP's and are landfilled in a licensed facility. It is estimated that 85 percent of the waste HAP solvent that is picked up by contract disposal services is recycled back to the dry cleaning industry. (The remaining 15 percent is sold for other uses).[2]

3.2.3 Emissions from HAP Dry Cleaning Equipment

This section contains a brief description of the potential HAP emission sources from transfer and dry-to-dry cleaning equipment. Estimates of HAP emissions from dry cleaning facilities with and without control devices are also presented.

3.2.3.1 Potential Emission Sources. Process emissions include vented emissions and fugitive emissions. Vented emissions include losses during aeration and emissions ducted through the stack during loading and unloading of clothing. There are no vented emissions during other parts of the dry cleaning cycle (i.e., wash cycle, dry cycle) because exhaust gases are not vented to the atmosphere during those operations.[8]

There is a high concentration of HAP's in the tumbler during the dry cycle due to vaporization, but the HAP-laden drying air stream is condensed by the water condenser and recycled to the tumbler, with no exhaust gas stream vented to the atmosphere. The aeration cycle occurs immediately after the dry cycle and lasts between 1 and 7 minutes. During aeration, fresh air is drawn into the tumbler, and residual HAP's are evaporated from the clothes. The HAP-laden aeration air stream is vented to a control device or emitted directly to the atmosphere. Thus, there is a higher potential for HAP emissions during aeration than during any other part of the dry cleaning process.

Other vented HAP emissions occur while clothes are being transferred from the washer to the dryer (in the case of facilities with transfer machines), and from the dryer to baskets in the plant. Most machines are equipped with inductive fans that are turned on when the washer and dryer doors are opened to divert the HAP-laden vapors away from the dry cleaning machine operators. The gas stream is then either vented directly through the stack or through a control device. Finally, vented HAP emissions may occur from distillation units and muck cookers, when present. The HAP-laden vapors from these units pass through a condenser, with the remaining vapors vented either into the room, directly out the stack, or through a control device.

Fugitive emissions include HAP losses from leaky process equipment (pumps, valves, flanges, seals, etc.) and in-plant evaporative losses of HAP's during clothing transfer and handling. Other potential emissions include losses from chemical and water separators, and solid waste storage. Listed below are common emission areas for liquid leaks and vapor leaks.[26]

Liquid leakage areas include:

- Hose connections, unions, couplings, and valves;
- machine door gasket and seating;
- filter head gasket and seating;
- pumps;
- base tanks and storage containers;
- water separators (lost in water due to poor separation);
- filter sludge recovery (lost in sludge by improper recovery);
- distillation unit;
- divertor valves;
- saturated lint from lint baskets; and
- cartridge filters.

Vapor leakage areas include:

- Deodorizing and aeration valves on dryers (the seals on these valves need periodic replacement);
- air and exhaust ductwork (solvent lost through tears in duct);
- doors (when left open, doors are a problem--leaks in the system should be confined to the closed washer and/or dryer, if possible);
- button traps and lint baskets (these should be opened only as long as necessary);
- open containers of solvent;
- evaporation from wet wash during the transfer process; and
- removal of articles prior to complete drying.

3.2.3.2 Emission Estimates. This section presents estimated emissions from controlled and uncontrolled HAP dry cleaners. The emission estimates presented in this section are based on a limited number of emission tests conducted by EPA and the International Fabricare Institute (IFI), and on the results of a 1987 survey of dry cleaning solvent consumption conducted by the Alliance of Textile Care Associations (ATCA). Tests were conducted using PCE as a representative HAP solvent.

Emissions from a dry cleaning machine vary according to the type and size of machine and what type of vent control (if any) is present. In addition, variations in operating, maintenance, and housekeeping practices can affect the amount of HAP emissions.

The ATCA has compiled data on "solvent mileage" for 129 dry cleaning machines.[27] Solvent mileage refers to the amount of solvent consumed by a dry cleaner to clean a given weight of clothing. Because all of the HAP's consumed during the dry cleaning process are eventually emitted to the atmosphere, solvent mileage data can be used to estimate emissions of HAP's from a dry cleaning machine in terms of kg of HAP emitted per 100 kg of clothes cleaned.

The solvent mileage data compiled by ATCA are summarized in Table 3-1. As shown, these data represent a range of machine types, sizes, and vent controls.

Based on the solvent mileage data presented in Table 3-1, emissions from uncontrolled transfer machines are estimated to range from 6.29 to 14.0 kg HAP/100 kg clothes, whereas emissions from uncontrolled dry-to-dry machines are estimated to range from 4.38 to 14.0 kg HAP/100 kg clothes. With vent controls, transfer machine emissions are estimated to be 5.85 to 7.0 kg HAP/100 kg clothes (refrigerated condensers) or 3.37 to 12.48 kg HAP/100 kg clothes (carbon adsorbers). For dry-to-dry machines with vent controls, emissions are estimated to be 2.91 to 12.94 kg HAP/100 kg clothes (refrigerated condensers) or 3.26 to 14.0 kg HAP/100 kg clothes (carbon adsorbers).

TABLE 3-1. TOTAL EMISSION ESTIMATES FROM HAZARDOUS AIR POLLUTANT DRY CLEANING PLANTS[27]

Machine description	Number of machines surveyed	Sizes of machines surveyed (lb)	Total emissions (kg HAP/ 100 kg clothes cleaned)
<u>Transfer</u>			
• Uncontrolled	6	30-65	6.29-14.00
• Refrigerated-condenser controlled	4	30-50	5.85- 7.00
• Carbon-adsorber controlled	23	30-70	3.37-12.48
<u>Dry-to-Dry</u>			
• Uncontrolled	19	25-50	4.38-14.00
• Refrigerated-condenser controlled	53	25-70	2.91-12.24
• Carbon-adsorber controlled	24	30-75	3.26-14.00

The emission estimates based on solvent mileage data in Table 3-1 represent total emissions from all sources within a dry cleaning facility, including the following:

- Vented emissions from washers and dryers;
- solid wastes; and
- miscellaneous emissions (fugitive emissions, aqueous emissions, and vented emissions from distillation units and muck cookers).

The relative contribution of these sources to the total HAP emissions from a dry cleaning facility can be determined from the results of emission tests conducted by EPA and IFI. The EPA conducted emission tests on five dry cleaning plants, including one industrial and four commercial facilities.[24,28-34] The emission tests measured the total HAP's consumed, the HAP's vented from the dry cleaning machine, and the HAP's retained in certain solid wastes. These tests are fully described in Appendix C of this document. The IFI compiled data from an unknown number of tests that represent average HAP losses at various stages of the dry cleaning process for a well-operated and well-maintained dry cleaning machine.[35]

Table 3-2 summarizes the results of the emission tests conducted by EPA and IFI. Overall, the emission estimates suggest that vented process emissions from uncontrolled dry cleaning machines contribute significantly to total solvent emissions. According to the EPA test data, process emissions for an uncontrolled machine range from 30 to 80 percent of the total emissions. For a controlled machine, process emissions contribute a much smaller portion of the total solvent emissions (i.e., 0.1 to 4 percent, according to EPA test data for carbon-adsorber controlled machines).

The amount of HAP emissions associated with solid wastes varies considerably depending on the type of filtration and distillation operations used by the dry cleaner. The EPA test data indicate that solid waste emissions contribute 0.3 to

TABLE 3-2. HAZARDOUS AIR POLLUTANT EMISSIONS FROM DRY CLEANING PLANTS[24,28-34]

	EPA Test Data		IFI Test Data	
Source	Solvent emissions[a] (kg HAP/100 kg of clothing)	Percent of total emissions	Solvent emissions (kg HAP/100 kg of clothing	Percent of total emissions
Washer and Dryer				
• Uncontrolled vented emissions	3.3-23.0[b]	30-80	3.52	N/A[h]
• Controlled vented emissions	0.002-0.97[c]	0.1-4	0.27	N/A
Solid Wastes[d]		0.3-26[e] 1.1-37[f]		
• Oil cooker residue	0.26		0.95-1.63	
• Muck cooker residue	0.96			
• Drained cartridge filter				
- paper cartridge filters with carbon core	0.6		1.76	
- activated clay cartridge filter	2.73			
Miscellaneous	0.82-4.64[g]	3-43[e] 39-98[f]	2.85	N/A

[a] Solvent losses are presented as the range of solvent losses observed among the test plants. When a single number is given for a solvent loss, data were available from only one test plant.

[b] As indicated by the HAP concentration at the carbon adsorber inlet.

[c] These emissions were controlled by a carbon adsorber.

[d] Solvent retained in discarded solid wastes.

[e] Percent of total uncontrolled emissions.

[f] Percent of total controlled emissions.

[g] Losses from miscellaneous sources were derived for each plant by subtracting measured solvent losses vented from the washer and/or dryer and retained in the treated solid wastes from the total solvent losses.

[h] These percentages cannot be calculated for these data because the solvent emissions represent average values for an unknown number of plants. A single plant would not generate all of the emissions listed here.

26 percent of total uncontrolled emissions and 1.1 to 37 percent of total controlled emissions.

The remaining emissions from dry cleaners occur from a variety of miscellaneous sources including fugitive emissions, losses from water separators, and vented emissions from distillation units and muck cookers. According to the EPA tests, these sources account for 3 to 43 percent of total uncontrolled emissions and 39 to 98 percent of total controlled emissions.

Data available from the emission tests conducted by EPA and IFI are insufficient for distinguishing between the amount of HAP emissions contributed by transfer machines versus dry-to-dry machines. In general, the relative contribution of emissions from process vents and solid wastes are not expected to differ between the two types of machines. For transfer machines, however, a potentially large source of miscellaneous emissions is the clothing transfer step. This step is eliminated in dry-to-dry equipment. Occupational exposure data compiled by the EPA Office of Pesticides and Toxic Substances and IFI have shown that worker exposure levels are as much as 50 percent less in facilities with dry-to-dry equipment compared to facilities with transfer equipment.[36-38] On this basis, it has been assumed that the amount of fugitive emissions associated with dry-to-dry machines is roughly half that emitted from transfer machines.

The test results summarized in Tables 3-1 and 3-2 were used to develop model emission factors for the dry cleaning industry. These factors are presented in Table 3-3, and their derivation is described in a background technical memorandum.[39] This table does not present the solid waste factor, which was determined to be 2.5 kg HAP/100 kg clothes cleaned.[39]

The emission factors found in Table 3-3 were used to determine national baseline emissions, as described in Section 3.3.2.

3.3 BASELINE EMISSIONS

The baseline emission level is the level of emission control achieved by the affected industry in the absence of additional EPA standards. The baseline emission level is established to

TABLE 3-3. EMISSION FACTORS FOR THE DRY CLEANING INDUSTRY (kg HAP/100 kg clothes cleaned)[39]

	Dry-to-Dry	Transfer
Uncontrolled		
Process	3.1	4
Fugitive	2.5	5
Total	5.6	9
Refrigerated Condenser-Controlled		
Process	0.2	0.6
Fugitive	2.5	5
Total	2.7	5.6
Carbon Adsorber-Controlled		
Process	0.2	0.2
Fugitive	2.5	5
Total	2.7	5.2

Note: Solid waste emissions are not shown because the wastes are transported off site for disposal. Therefore, any air emissions from solid waste disposal are not attributed to a dry cleaning machine.

facilitate comparison of economic, energy, and environmental impacts of regulatory alternatives.

This section includes a summary of the existing regulations limiting HAP emissions from dry cleaning plants and a discussion of the logic and rationale leading to the selection of the baseline emission level.

3.3.1 Applicable Existing Regulations

No Federal regulations limit emissions from HAP dry cleaners, except for Occupational Safety and Health Administration (OSHA) standards, which pertain to occupational exposure to PCE.[40] **Regulations limiting PCE emissions to the ambient air exist primarily at the State level, and occasionally at the local level.**

The rules and regulations set forth by OSHA on dry cleaning solvent vapors were first published in August 1971; the final rule was published in 1989 (29 CFR part 1910). The OSHA standard only applies to levels of PCE that workers may be exposed to within the plant. The current OSHA standard for occupational exposure is 25 ppm for an 8-hour, time-weighted average.[40]

In 1978, EPA issued a Control Techniques Guideline (CTG) document for PCE dry cleaners.[41] This document establishes reasonably available control technology (RACT) guidelines, which have been used by State agencies to develop State Implementation Plans (SIP's). Reasonably available control technology is defined as the lowest emission limit that a particular source is capable of meeting by applying control technology that is reasonably available considering technological and economic feasibility. When requested to apply RACT as outlined in the CTG, a dry cleaning facility would have to (1) reduce the dryer outlet concentration of PCE to less than 100 ppm, (2) vent the entire dryer exhaust through a carbon adsorber or equally effective control device, (3) eliminate liquid leaks, (4) limit gaseous leaks to a specified level, (5) cook filter muck so that the waste contains no more than 25 kg PCE per 100 kg of wet waste

(25 lb PCE per 100 lb of wet waste), (6) operate a still so that the residue contains no more than 60 kg PCE per 100 kg of wet waste (60 lb PCE per 100 lb of wet waste), and (7) drain filter cartridges for at least 24 hours before disposal.[42]

As of 1985, 23 States had adopted RACT regulations for PCE dry cleaners.[43] Normally, RACT regulations are only required in those areas in violation of National Ambient Air Quality Standards (NAAQS). At least 12 States, however, have adopted RACT Statewide.[44] Some local counties and municipalities have also enacted ordinances to control dry cleaning emissions. For example, in Arizona, the Maricopa County Bureau of Air Pollution Control requires the use of a vapor adsorber or a condensing system with an inlet temperature of less than 296°K (72°F) for all chlorinated hydrocarbons.[43]

3.3.2 National Baseline Emissions

For the dry cleaning source category, national baseline emissions are estimated from emission factors applied to model machine throughputs, according to machine population data and solvent sales information.[45] The total amount of HAP's consumed by the dry cleaning industry includes both fresh HAP's consumed and recycled HAP's consumed. Based on information provided by a major waste recycler, about 5 million gallons or 30,600 Mg/yr (67,500,000 lb/yr) of HAP's are carried off site in dry cleaning waste materials.[46] Several recycling firms pick up about 85 percent of this HAP waste, and charge a fee for this service. About 6,100 Mg/yr (13,450,000 lb/yr) of the HAP's are recovered from this collected dry cleaning waste, purified, and then sold back to the dry cleaning industry.[46] The unrecycled waste is disposed of as required under the RCRA.

Based on 1989 sales information from the Chemical Marketing Reported (CMR), annual fresh solvent consumption for 1991 is estimated to be 124,000 Mg/yr (273,370,000 lb/yr).[44] When adding this fresh solvent consumption to the 6,100 Mg (13,450,000 lb) of recycled HAP's indicated by the major waste recycler,[45] the total HAP's consumed by the dry cleaning industry in 1991 are estimated to be 130,100 Mg/yr (286,820,000 lb/yr).

Model machine calculations (emission factors applied to throughputs) indicate total consumption in 1991 to be 125,250 Mg/yr (276,130,000 lb/yr).[47] Because the model machine scenario is only a simulation of actual machine populations, the model machine value for national consumption was scaled up to the CMR/waste recycler value by multiplying by 1.039. This same scaling factor was applied to model machine emissions (process vent and fugitive) and solid waste emissions to reflect current sales information more accurately.

Table 3-4 presents the estimates of national baseline consumption and emissions for the three different sectors of the dry cleaning industry.[45] National HAP consumption for each sector was calculated as the sum of recycled HAP's and fresh HAP's used by that sector. Although the total amount of recycled HAP's used in dry cleaning is known, the amount of recycled HAP's used by each sector is not known. Therefore, it was assumed that the percentage of recycled HAP's used in the commercial and industrial sectors is equivalent to the percentage of fresh HAP's used in those sectors. Further, it was assumed that no recycled HAP's are sold to the coin-operated sector because no HAP waste is collected from them.

The HAP's emitted from process vents or fugitive sources, or found in solid wastes are based on the application of the emission factors described in Section 3.2.3.2 to model machines. National HAP emissions from each source type were determined by first summing the model machine estimates and then applying the above-mentioned scaling factor.

The total HAP's in waste materials disposed of off site was based on a solid waste HAP emission factor of 2.5 kg HAP/100 kg clothes cleaned.[39] This emission factor was based on the EPA and IFI tests discussed in Section 3.2.3.2. The value of 2.5 kg/100 kg clothes cleaned falls within the ranges indicated by the test data. The solid waste emission factor was applied to model machine populations and clothing throughputs. The resultant was then scaled up to reflect national consumption figures. The resulting national estimates for off-site HAP disposal are shown in Table 3-4.

Baseline estimates of on-site air emissions for each sector are calculated in a similar way, using emission factors specific to a given machine and control type. A detailed description of these calculations is presented in a background technical memorandum on national baseline emissions.[48] For the dry cleaning industry as a whole, the baseline emission estimates are equivalent to the amount of HAP's consumed by that sector minus the HAP's contained in wastes disposed of off site.

TABLE 3-4. INFORMATION FOR ESTIMATING BASELINE CONSUMPTION AND EMISSIONS FROM HAP DRY CLEANING INDUSTRY[45]

Sector	Fresh HAP use (Mg/yr) A	Recycled HAP use (Mg/yr) B	National HAP use (Mg/yr) C = A + B	HAP disposed of off site (Mg/yr) D	HAP emissions (Mg/yr) E = C - D
Commercial	116,900	5,800	122,700	40,900	81,800
Industrial	5,700	300	6,000	1,700	4,300
Coin-operated	1,400	0	1,400	500	900
Total	124,000	6,100	130,100	43,100	87,000

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4.0 EMISSION CONTROL TECHNIQUES

This chapter presents a summary of methods for controlling hazardous air pollutant (HAP) emissions from the dry cleaning process. Operating principles, emissions and solvent usage reductions, and retrofit considerations are discussed for various control techniques. Section 4.1 describes HAP emission sources during the dry cleaning process; Section 4.2 describes methods for controlling HAP dry cleaning emissions. References are provided in Section 4.3.

4.1 HAZARDOUS AIR POLLUTANT EMISSIONS FROM DRY CLEANING

As discussed in Section 3.2.3, HAP emissions occur at a number of different points in dry cleaning systems, and can be characterized as either vented process emissions or fugitive emissions. Vented process emissions include losses during aeration, emissions ducted through the stack during clothing transfer, and emissions vented from equipment such as muck cookers and distillation units. There are no vented process emissions during other parts of the dry cleaning cycle (i.e., wash cycle, dry cycle) because exhaust gases are not vented to the atmosphere during those operations. Exhaust gases are also not vented to the atmosphere from some types of no-vent dry-to-dry machines and no-vent control devices. These are discussed in Section 4.2.1.2. Control techniques for vented process emissions are described in Section 4.2.1.

Fugitive emissions include HAP losses from leaky process equipment (pumps, valves, flanges, seals, etc.), emissions of HAP's from spent cartridge filters and HAP-laden solid waste, and in-plant evaporative losses of HAP's during clothing transfer and handling. Control techniques for fugitive emissions are discussed in Section 4.2.2.

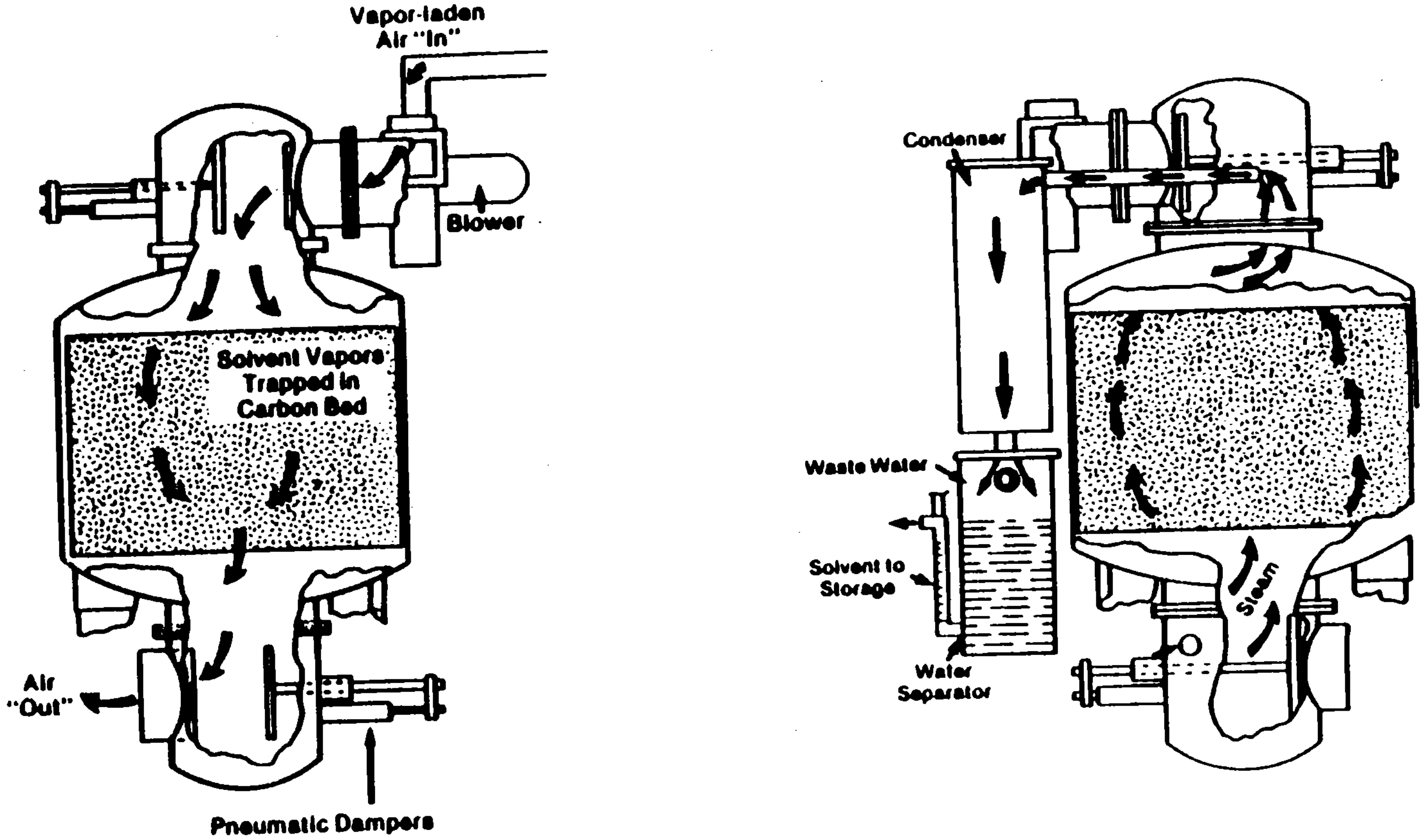
4.2 METHODS FOR CONTROLLING HAP EMISSIONS

4.2.1 Methods for Controlling Process Emissions

The two demonstrated emission control techniques used by the dry cleaning industry for vented process emissions are carbon adsorbers and refrigerated condensers.[1] These techniques are discussed in the following sections in terms of their operating principles, applicability, and emissions and solvent usage reductions.

4.2.1.1 Carbon Adsorption. Activated carbon is used in many applications for the removal, by adsorption, of organic compounds from carrier gases (usually air). It has been used extensively by the dry cleaning industry to recover HAP's from vented emissions during the aeration step. The carbon adsorber can be retrofitted to both dry-to-dry and transfer machines. Figure 4-1 illustrates the operating principles of a carbon adsorber. The activated carbon used in carbon beds has a high adsorptive capacity, or ability to retain HAP molecules that have made contact with the activated carbon surface. Different-sized carbon beds are used according to the vapor flowrate emitted from the dry cleaning system. Carbon beds used in the dry cleaning industry range in size from 60 to 450 kg (130 to 990 lb) of carbon and can handle gas flowrates ranging from several hundred cubic feet per minute (cfm) to 2000 cfm.[2] The working bed capacity (weight of solvent per weight of carbon, expressed as percent) for HAP's is about 20 percent.[3]

The activated carbon bed must be regenerated frequently, often daily, by desorbing the HAP's that collect on the carbon bed. Desorption is accomplished by passing steam through the carbon bed. The vaporized solvent is picked up by the steam, recovered downstream in a condenser, separated from the water, and then returned to the solvent storage tank. Typically, dry cleaner operators desorb carbon adsorber beds daily. Carbon adsorbers that are not desorbed regularly are rendered ineffective because of HAP breakthrough that occurs when all of the adsorptive sites of the activated carbon are occupied by HAP



ADSORPTION CYCLE

DESORPTION CYCLE

Figure 4-1. Carbon adsorber.

molecules. When this happens, the activated carbon cannot adsorb any more HAP and the outlet gas stream remains saturated.

Several emission tests conducted at dry cleaning facilities have measured HAP concentrations at the inlet and outlet of carbon adsorbers.[4-8] Summarized in Table 4-1 are the adsorber inlet and outlet data collected during the source tests. In each case, vapors were drawn from at least the dryer or dry-to-dry machine. All of the carbon adsorbers tested exhibited HAP removal efficiencies of greater than 95 percent. In general, the gas entering the carbon adsorber during the aeration step has a HAP concentration of several thousand parts per million (ppm). As shown in Table 4-1, properly designed and operated adsorbers have been shown to reduce the HAP concentration of this stream to less than 100 ppm, and in some cases to less than 10 ppm.[4-8] Additional information on test results is presented in Chapter 3 and Appendix C.

In addition to controlling emissions from the dryer during the aeration cycle, carbon adsorbers have been proven effective for controlling other HAP-containing streams. Many facilities with transfer machines have ductwork leading from the washer to the carbon adsorber. After the wash cycle, clothes are transferred manually to the dryer. When the washer door is opened, a fan turns on which draws HAP vapors from the washer through the adsorber. Also, some plants have installed floor vents that draw fugitive vapors from around the dry cleaning machines, filters, and stills through the adsorber. Emissions of HAP's from distillation units and muck and oil cookers can be minimized by ducting vents from these units directly to a carbon adsorber.

4.2.1.2 <u>Refrigerated Condensation</u>. Refrigerated condensers use refrigerants, such as chlorofluorocarbon-11 or chlorofluorocarbon-12, to remove condensible vapors (i.e., HAP's and water) from washer and dryer exhaust streams. Built-in refrigerated condensers are available on most new dry-to-dry no-vent machines. In addition, refrigerated condensers can be retrofitted to both transfer and dry-to-dry machines.

TABLE 4-1 SUMMARY OF CARBON ADSORBER TEST DATA[4-8]

Plant	Process (units vented to carbon adsorber)	Clothes cleaned per day (kg/day)	Inlet concentration (ppm)	Outlet concentration (ppm)[a]	Adsorber efficiency (%)	Estimated size of unit (floor space m^2 [ft^2])
A	Transfer, commercial (washer door, dryer floor vents, distillation unit vent)	450	600	25	96	3.7 (40)
B	"Kissing" machine[b] industrial (washer door, dryer)	1,750	5,300-6,500	2	99	5.6 (60)
C	Dry-to-dry, commercial dry-to-dry machine (dry-to-dry machine door, floor vents)	170	3,300	100[b]	97	1.1 (12)
D	Dry-to-dry, commercial machine (dry-to-dry machine)	185	400	11	97	1.5 (16)

[a] For one cycle of adsorption-desorption of a single bed.

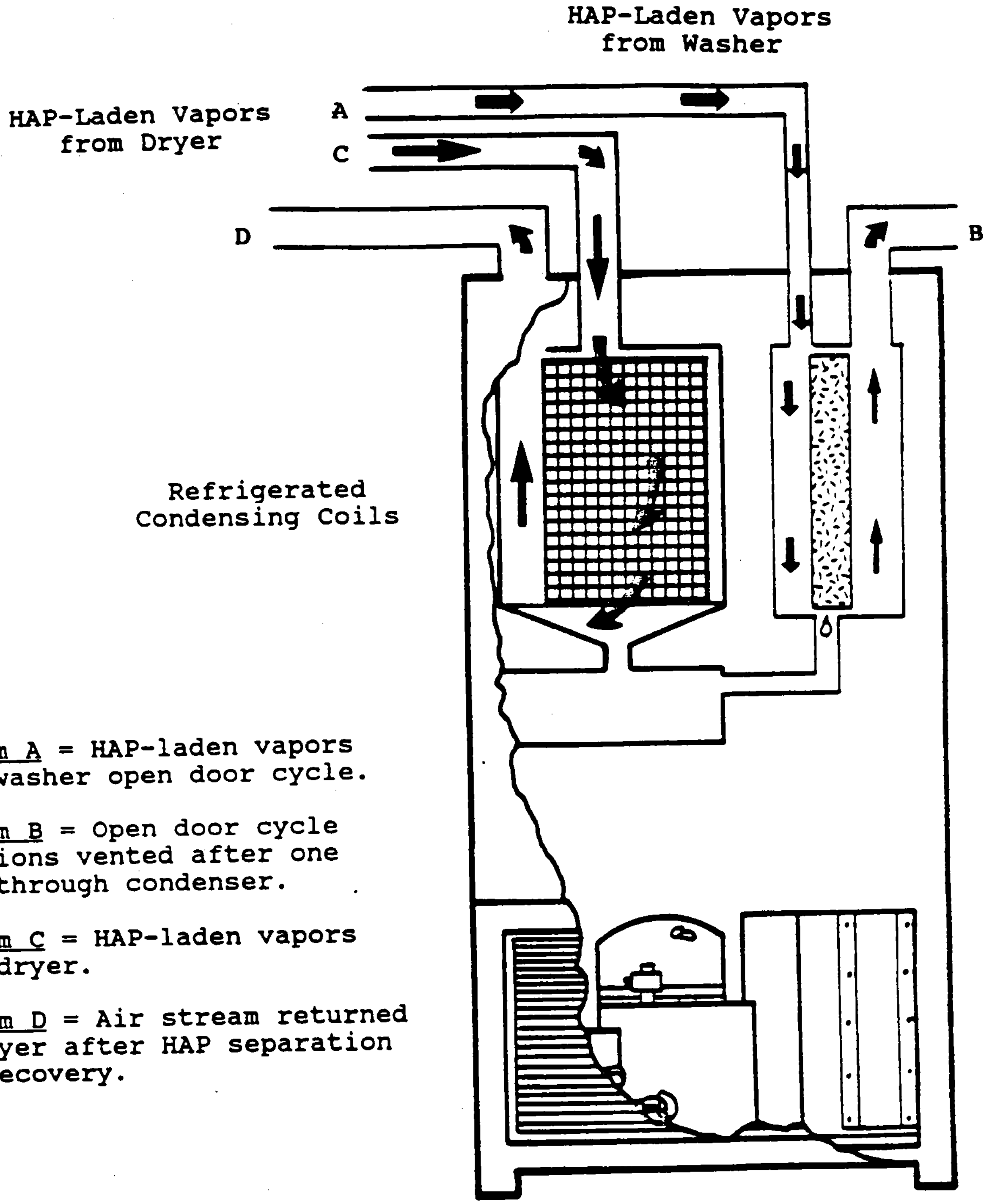
[b] With this type of machine, following the wash cycle the dryer is pneumatically rolled to within 0.3 m (1 ft) of the washer, both doors are opened, and operators pull clothes from the washer to the dryer.

[c] Limited semicontinuous data show this adsorber to have been underdesigned.

Figure 4-2 illustrates the operating principles of a refrigerated condenser. The condenser shown graphically in the figure is a retrofit unit attached to a transfer system; however, the same operating principles also apply to a retrofit or built-in unit associated with a dry-to-dry machine. In Figure 4-2, the condenser is accommodating two different HAP-laden vapor streams--one from the open door cycle and one from the aeration cycle. Stream A is composed of the gas that is drawn out of the washer by an inductive fan during the open door cycle when clothes are transferred from the washer to the dryer. The solvent-laden air is cooled to lower the temperature of the air below the dew point of the vapor, thereby causing it to condense. After one pass of the washer exhaust through the refrigerated coils, the gaseous stream, Stream B, is vented from the plant, while the condensate is sent to the HAP/water separator to recapture the HAP's. About 30 percent recovery of HAP's in the washer exhaust is achieved by the one-pass configuration. For dry-to-dry systems, Streams A and B do not exist because there are no vented emissions from the wash portion of the cycle.

During aeration, for both transfer and dry-to-dry systems, Stream C is discharged from the dryer. The stream enters the refrigerated oils, where HAP's and water are condensed. The liquid stream enters the HAP/water separator for HAP separation and recovery. The vapor stream, Stream D, which is now at approximately 45°F, is returned to the dryer, where it can remove more HAP's from the clothes; then it is recirculated back through the condenser for further HAP removal. With each successive pass, a fraction (50 percent or less) of the total HAP's in the vapor coming out of the dryer is removed.

Following the aeration cycle, the concentration of HAP's in the residual vapors is approximately 8,600 ppm.[9] The fate of the residual HAP vapors following condensation depends upon the type of condenser in use. There are two types of refrigerated condenser designs for removing HAP's from dryer exhaust: vented and ventless. In a vented condenser, all of the exhaust vapors



Stream A = HAP-laden vapors from washer open door cycle.

Stream B = Open door cycle emissions vented after one pass through condenser.

Stream C = HAP-laden vapors from dryer.

Stream D = Air stream returned to dryer after HAP separation and recovery.

Figure 4-2. A refrigerated condenser as applied to a transfer dry cleaning machine.

from the condenser are vented to the atmosphere when the door is opened at the end of the drying cycle. A ventless condenser does not vent to the atmosphere. However, some of the residual HAP in the dryer after the aeration cycle may spill out the door when it is opened. With a vented system, about 85 percent control of HAP's is achieved compared to an uncontrolled machine. With a ventless system, control efficiency may be as high as 95 percent.[9]

Refrigerated condensers have both an advantage and a disadvantage when compared to carbon adsorbers. The advantage is that refrigerated condensers do not require frequent maintenance and desorption as do carbon adsorbers. Refrigerated condensers need only to have their refrigerant replaced (yearly or even less frequently) and to have lint removed from the coils. Therefore, they are less likely to be operated incorrectly than carbon adsorbers (which are rendered ineffective unless frequently desorbed).

The disadvantage of refrigerated condensers is that, unlike carbon adsorbers, they cannot be used to control low concentration emission streams, such as fugitive emissions or muck cooker and distillation unit emissions (unless the muck cooker or distillation unit is built into a dry-to-dry machine). This is because the emissions that would be picked up by, for example, ventilation systems, have very low HAP concentrations. The HAP's in these streams are very difficult to condense at such low concentrations, but they can be adsorbed on the carbon surface. In addition, limited test data and thermodynamic analyses indicate that refrigerated condensers are less efficient than carbon adsorbers at reclaiming HAP vapors.[9,10]

4.2.1.3 Current Control Status. There has been a trend towards the use of emission control equipment in the dry cleaning industry during the past 10 years. This trend has been caused by economic incentives (reduction in solvent usage and savings on solvent purchase), growing concern over worker health and safety, State regulations, and the possibility of Federal regulations. In 1978, it was estimated that 35 percent of the commercial, 50 percent of the industrial, and 5 percent of the coin-operated sectors were controlled.[11] Current industry estimates indicate that about 50 percent of the dry cleaning machines in the commercial and industrial sectors are equipped with control devices[12], and about 47 percent of the dry cleaning machines in the coin-operated sector are controlled.[13] Of the control devices in place, the majority are either carbon adsorbers or refrigerated condensers. A small percentage of the industry uses the Solvation^R system.[14] This system is comprised of a tank, partially filled with water and an anti-foaming agent, through which PCE vapors are bubbled to form a PCE azeotrope. Based on submitted records of solvent consumption and dry cleaning throughput, it was concluded that although this system may achieve improved solvent recovery, it does not constitute equivalency with a carbon adsorber.[15] In addition, one German manufacturer makes a machine with both a refrigerated condenser and a carbon adsorber.[16] However, there is only one machine of this type known to be in operation in the United States, and test data are not available to document its performance.[17]

Ventless refrigerated condensers have become the control method of choice for the dry cleaning industry, especially for the commercial sector, because this control method provides dry cleaning with low maintenance requirements and less solid waste.[18]

Use of refrigerated condensers in the coin-operated and industrial sectors is less common. Although small dry-to-dry units with built-in refrigerated condensers are used effectively by the coin-operated sector, refrigerated condenser manufacturers do not currently make a retrofit unit small enough to accommodate single, small coin-operated machines.

Use of retrofit refrigerated condensers by the industrial sector has not been widespread because, in general, industrial dry cleaning systems are older and have more leaks than commercial systems. Leaks in the dry cleaning system lead to dilution of the stream entering the condenser, which reduces the effectiveness of condensation. However, some industrial dry cleaners are using the new dry-to-dry, no-vent systems.

Carbon adsorbers are used in varying degrees by the three dry cleaning sectors (industrial, commercial, and coin-operated). They have the highest market share in the industrial and coin-operated sectors. They are attractive to industrial dry cleaners because of their ability to handle high air flow rates. Carbon adsorbers are the most commonly used control devices on coin-operated units.[19] Use of carbon adsorbers by self-service coin-operated facilities is limited, however, because of the steam necessary to desorb the carbon bed. Most coin-operated facilities do not have any other steam demand and, consequently, do not have a boiler.[19]

Carbon adsorbers are gradually being replaced by built-in refrigerated condensers as the control of choice for dry-to-dry machines in the commercial sector. This gradual changeover to refrigerated condensers is attributed to the small wastewater streams generated from desorption of the carbon bed and the spent carbon that must eventually be disposed of as a hazardous waste. In addition, carbon adsorbers require frequent--often daily--desorption. This requires operator attention and allows a greater opportunity for error than the low-maintenance refrigerated condensers.

4.2.2 Methods for Controlling Fugitive Emissions

Fugitive emissions include HAP losses from leaky process equipment, emissions of HAP's from spent cartridge filters and HAP-laden solid waste, and in-plant evaporative losses of HAP's during clothing transfer and handling. There are two types of fugitive losses: liquid and vapor. Liquid losses can sometimes be detected by sight, and vapor leaks can be detected by screening the emission source with a portable leak detector. Common sources of liquid leaks and vapor leaks were previously described in Section 3.2.3.1.

Rapid detection and repair of leaks is essential to minimize fugitive emissions and, thus, reduce solvent losses. No single control technique is applicable to the control of all types of fugitive emissions. The techniques used to control fugitive emissions can be classified as either equipment or work practices. An equipment control technique means that some piece of equipment is used to reduce or eliminate emissions. An example of equipment control is leakless technology for valves and pumps.

In the dry cleaning industry, work practices are more commonly used than equipment control techniques to reduce solvent losses due to fugitive emissions. Work practices include periodically monitoring (surveying) sources for leaks and initiating timely repair, and good housekeeping procedures. Portable leak detectors are available that can be used on a regular basis to assist in detecting leaks before they become large enough to see or smell. Good housekeeping practices are another type of work practice that can also reduce fugitive emissions. These can include, but are not limited to, covering containers of solvent and solvent-laden waste, keeping lint traps clean, and opening the washer and/or dryer door for as short a time as possible.

4.2.3 Solvent Substitution

Theoretically, solvent substitution is also a control technique for HAP emissions from dry cleaners. As discussed in Section 3.1.2, two other solvents are used in dry cleaning. They are petroleum solvents and chlorofluorocarbon-113 (CFC-113). Substitution of one of these solvents for HAP's would eliminate HAP emissions. However, as described in Section 3.2.1.2, other factors influence the potential for replacement of HAP's by these other solvents. Petroleum use is severely restricted because of its fire potential. The CFC-113 is a less aggressive solvent with a prohibitive cost per gallon. In addition, CFC-113 is included in the Montreal Protocol, an international agreement intended to phase out certain CFC's and CFC substitutes (that contribute to stratospheric ozone depletion) by the year 2005. Finally, different solvents require different dry cleaning machines. These considerations are expected to limit the feasibility of solvent switching as an emission control technique.

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5.2.2 Equipment and Operational Changes to the Cleaning System

Any changes to an existing dry cleaning facility must be approved by the Administrator, who will also determine if the alterations are considered modifications under 40 CFR 63.5. One example of such a change would be disabling the damper that prevents HAP's from leaking into the exhaust during the drying cycle. Although this change could result in increased emission rates, the actual designation of any such change as a modification would be made on a case-by-case basis. Dry cleaning emission rates are also dependent on operational techniques. Operational changes can increase emission rates and may, therefore, be deemed modifications by the Administrator (unless they are exempt according to the definition of modification in the General Provisions [40 CFR 63.5], which is presented in Section 5.1).

5.3 DRY CLEANER CONSTRUCTION AND RECONSTRUCTION

Some changes can be made to dry cleaning facilities that may be deemed a reconstruction under 40 CFR 62.5. For example, replacement of either the washer or dryer of a transfer machine system would be considered a reconstruction, because both the washer and the dryer are considered affected facilities in their own right.

Concerning reconstruction, if an existing dry cleaner installs replacement parts that exceed over 50 percent of the fixed capital cost of the existing facility, then those changes may be deemed a reconstruction.

5.0 MODIFICATIONS, CONSTRUCTIONS, AND RECONSTRUCTIONS

This chapter presents a discussion of potential modifications, constructions, or reconstructions that a dry cleaner may undergo and thereby potentially become subject to the dry cleaning national emission standard for hazardous air pollutants (NESHAP). Section 5.1 presents background information defining these terms. Section 5.2 describes examples of potential dry cleaner modifications, and Section 5.3 describes examples of dry cleaner constructions and potential reconstructions.

5.1 BACKGROUND

Under Section 112(a) of the Clean Air Act (CAA), a new source is defined as a stationary source, the construction or reconstruction of which is commenced after the proposal date of the standard. An existing source is defined as any stationary source other than a new source. The EPA is in the process of developing procedures for ensuring that the modification provisions of Section 112(g) of the CAA are reflected in the source's operating permit obtained under Title V of the CAA.

In Section 112(g) of the CAA, a modification is defined as:

> A physical change in, or change in the method of operation of, a major source which results in a greater than de minimis increase in actual emissions of a hazardous air pollutant shall not be considered a modification, if such increase in the quantity of actual emissions of any hazardous air pollutant from such source will be offset by an equal or greater decrease in the quantity of emissions of another hazardous air pollutant (or pollutants) from such source which is deemed more hazardous.

As defined in Section 63.2 of the proposed General Provisions for 40 CFR Part 63, reconstruction means the replacement of components of an existing source to such an extent that (1) the fixed capital cost of the new components exceeds 50 percent of the fixed capital cost that would be required to construct a comparable, entirely new source, and (2) it is technologically and economically feasible for the reconstructed source to meet the relevant emission standard(s), alternative emission limitation(s), or equivalent emission limitation(s) established by the Administrator (or a State with an approved permit program) pursuant to Section 112 of the Act.

Concerning reconstruction, the owner or operator of an existing dry cleaning facility must apply for approval of any reconstruction according to the application procedures specified in Section 63.5 of the proposed General Provisions for 40 CFR Part 63 to be published in the Federal Register in the near future.

5.2 DRY CLEANER MODIFICATIONS

There are numerous equipment or process modifications that can be made to dry cleaning facilities. If an alteration can cause an increase in the emission rate of HAP's, then the alteration may be deemed a modification under 40 CFR 63.5. The following is a discussion of changes that might constitute modifications. This is not a complete list, nor are the changes listed always considered modifications. The Administrator must make the final determination on a case-by-case basis. As stated previously, EPA is in the process of developing procedures for ensuring that the modification provisions of Section 112(g) of the CAA are reflected in the source's operating permit.

5.2.1 Solvent Switching

Due to the solvent-specific nature of dry cleaning equipment design and construction materials, it is unlikely that any dry cleaner would switch from an unregulated solvent to a HAP without first purchasing a new machine. However, if such a switch is made, it could be considered a modification by the Administrator.

It is also unlikely that a solvent mixture would be used in dry cleaning equipment. If a mixture were used and the solvent mixture were changed to contain more HAP's, the Administrator could decide that a modification had occurred. The dry cleaner would then be subject to new machine regulations.

6.0 MODEL MACHINES AND REGULATORY ALTERNATIVES

This chapter describes the regulatory alternatives considered for controlling hazardous air pollutant (HAP) emissions from the dry cleaning industry and defines the model machines used for assessing the impact of each alternative. A description of the regulatory cut-off levels being considered is also included. Section 6.1 describes the model machines for each dry cleaning sector and Section 6.2 presents the regulatory alternatives. Section 6.3 presents the regulatory cut-off levels. References are provided in Section 6.4.

6.1 MODEL MACHINES

Model machines are parametric descriptions of both the types of machines that exist and those that, in EPA's judgement, may be constructed, modified, or reconstructed. For the dry cleaning industry, 15 model machines have been selected.[1] These machines represent the range of machine sizes and types used in the coin-operated, commercial, and industrial sectors. The following parameters have been defined for each model machine: machine capacity, machine type, loads of clothes cleaned per day, days of operation per year, and clothing throughput per year (the product of machine capacity, loads per day, and days of operation per year). The model machine parameters are presented in Table 6-1 and are summarized in Sections 6.1.1 to 6.1.3. These parameters apply to all machines, regardless of their level of control (see Chapters 3.0 and 4.0).

6.1.1 Model Machines for the Coin-Operated Sector

Two types of machines exist in the coin-operated sector: plant-operated and self-service. The plant-operated machine is operated by a laundromat employee, and services such as pressing and bagging, which are found at commercial facilities, are also provided. The self-service machine is operated either by the

TABLE 6-1. MODEL MACHINE PARAMETERS FOR THE DRY CLEANING INDUSTRY[a]

Machine capacity (kg [lb])	Machine type[b]	Loads/day	Operation schedule (days/yr)	Clothes Throughput	
				(kg/yr)	(lb/yr)
Coin-op					
3.6 (8)	SS, D/D	6	312	6,800	(15,000)
3.6 (8)	PO, D/D	6	312	6,800	(15,000)
Commercial					
11.3 (25)	D/D	10	250	28,400	(62,500)
13.6 (30)	D/D	10	250	34,000	(75,000)
15.9 (35)	D/D	10	250	39,700	(87,500)
15.9 (35)	T	12	250	47,700	(105,000)
20.4 (45)	D/D	10	250	51,100	(112,500)
22.7 (50)	D/D	10	250	56,800	(125,000)
22.7 (50)	T	12	250	68,100	(150,000)
27.2 (60)	D/D	10	250	68,100	(150,000)
45.4 (100)	D/D	10	250	113,500	(250,000)
45.4 (100)	T	12	250	136,200	(300,000)
Industrial					
63.5 (140)	D/D	17	250	269,900	(595,000)
113.4 (250)	D/D	17	250	481,950	(1,062,500)
113.4 (250)	T	20	250	567,000	(1,250,000)

[a] Source: References 1-4.

[b] D/D = Dry-to-dry machines.
T = Transfer machines.
SS = Self-service machines.
PO = Plant operated machines.

customer or by an attendant who loads the clothes and turns on the machine. No pressing or bagging services are provided.

The coin-operated model machines are 3.6 kg (8 lb) dry-to-dry machines that clean 6 loads of clothes per day.[1] Because coin-operated laundromats are used by the public, the model machines are assumed to operate 6 days per week (312 days per year).[1] For each of the model machines in this sector, the annual throughput of clothing, which is the product of machine capacity, loads per day, and days of operation per year, is estimated to be 6,800 kg/yr (15,000 lb/yr).

6.1.2 Model Machines for the Commercial Sector

Ten model machines were chosen to represent the wide variety of machines used in the commercial sector. The most widely used commercial machines are 16 kg (35 lb) and 23 kg (50 lb).[15] Both transfer and dry-to-dry machines are common at these capacities and are represented by model machines. Commercial dry-to-dry machines smaller than 16 kg (35 lb) are represented by 2 model machines: 11.3 kg (25 lb) and 13.6 kg (30 lb). Because the smallest transfer machine identified had a capacity of 15.9 kg (35 lb), no transfer model machines were chosen below this capacity. Commercial machines larger than 23 kg (50 lb) are represented by a 27.3 kg (60 lb) dry-to-dry model machine, a 45.4 kg (100 lb) dry-to-dry model machine, and a 45.4 kg (100 lb) transfer model machine. In addition, a 20.4 kg (45 lb) dry-to-dry model machine was included to represent machine sizes between 16 kg (35 lb) and 23 kg (50 lb). Each commercial model machine operates 5 days per week (250 days per year). Dry-to-dry model machines clean 10 loads of clothes daily, and transfer model machines clean 12 loads of clothes daily. Annual throughputs for the model machines in the commercial sector range from 28,400 kg (62,500 lb) to 136,200 kg (300,000 lb) clothes/yr.

6.1.3 Model Machines for the Industrial Sector

For the industrial sector, three model machines were selected. The typical capacity of existing machines in the industrial sector is 114 kg (250 lb).[16] To represent these machines, one 114 kg (250 lb) transfer and one 114 kg (250 lb) dry-to-dry model machine were selected. In addition, a 63.5 kg (140 lb) dry-to-dry model machine was used to represent machines of a smaller size.

Each model machine for the industrial sector operates 5 days per week (250 days per year). Each dry-to-dry model machine cleans 17 loads of clothes daily, and each transfer model machine cleans 20 loads of clothes daily. The annual throughput of clothing ranges from an estimated 269,900 kg/yr (595,000 lb/yr) to 567,000 kg/yr (1,250,000 lb/yr).

6.2 DEVELOPMENT OF REGULATORY ALTERNATIVES

Regulatory alternatives represent comprehensive programs for reducing emissions from the dry cleaning industry. The regulatory alternatives selected for analysis are based on a combination of control equipment and pollution prevention practices. The alternatives allow for analysis of the environmental and economic impacts of requiring a combination of demonstrated control equipment and pollution prevention practices to achieve varying degrees of emission reduction.

The first step in developing the set of regulatory alternatives is to evaluate the possible control options that could be applied to the different sources of emissions in dry cleaning facilities. These control options may vary according to the type of equipment, such as a transfer or dry-to-dry machine. Once the control options have been selected, they are combined to form regulatory alternatives with varied levels of emission reduction.

6.2.1 Selection of Control Options

The control options used to develop the regulatory alternatives considered for controlling HAP emissions are based on the application of control equipment as described in Chapter 4. The different control options for dry-to-dry machines and transfer machines are presented in Table 6-2. The baseline situation for comparing control options is that no additional control of HAP emissions from the dry cleaning machine would be required beyond what is currently required by State and local

TABLE 6-2. CONTROL OPTIONS FOR DRY CLEANING MACHINES

Source	Control options
Dry-to-Dry Machine	Vent Control Equipment (control of process vent emissions only) • refrigerated condenser (95%) • carbon adsorber (95%) Fugitive Emissions Control • specify pollution prevention practices
Transfer Machine	Vent Control Equipment (control of process vent emissions only) • refrigerated condenser (85%) • carbon adsorber (95%) Fugitive Emissions Control • specify pollution prevention practices

regulations. The existing regulations and control levels are described in Sections 3.3.1 and 4.2.1.3.

6.2.1.1 Vent Control Equipment Options. As shown in Table 6-2, two equipment options are available for controlling process vent emissions from dry-to-dry and transfer machines. For transfer machines, the first option (refrigerated condenser) would achieve at least 85 percent control of vented process emissions. The more stringent equipment option for transfer machines (carbon adsorber) would achieve at least 95 percent control of vented process emissions. For dry-to-dry machines, both types of control equipment provide 95 percent control of vented process emissions.

6.2.1.2 Fugitive Control Options. As mentioned in Section 4.2.2, fugitive emissions include HAP losses from leaky process equipment, spent cartridge filters, HAP-laden solid wastes, solvent storage, and in-plant evaporative losses during clothing transfer and handling.

Methods for controlling fugitive emissions include a range of pollution prevention practices, as specified in Section 4.2.2. These practices include prompt detection and repair of both liquid and vapor process equipment leaks (from places such as gaskets, valves, hose connections); storage of solvents and wastes containing HAP's in tightly sealed, nonreactive containers; and minimization of the time the door of the dry cleaning machine is open.

6.2.1.3 Replacement of Transfer Machines. In addition to the control options described in Table 6-2, another option was considered that would require all transfer machines to be replaced with dry-to-dry machines immediately upon promulgation of the regulation. As discussed in Chapter 3, fugitive emissions from dry-to-dry machines are generally 50 percent less than the fugitive emissions from transfer machines. However, this control option was discounted after considering several factors.

First, transfer machines are being replaced with dry-to-dry machines in the absence of an air emissions regulation, due to recent promulgation of more stringent worker exposure regulations.[17] Vendor information indicates that no new transfer machines have been sold since the late 1980s, and the trend is expected to continue.[18,19]

Second, there are a limited number of dry-to-dry machines being manufactured. Immediate replacement of all transfer machines would place a sudden increase in market demand for the available dry-to-dry machines, driving up prices. In addition, because of the limited number of dry-to-dry machines available, some dry cleaning facilities may not be able to obtain a new dry-to-dry machine within the time required in the standard.

Third, requiring immediate replacement of transfer machines may impose economic inequities. For example, one facility may be operating a 40-year-old transfer machine that is on the verge of breaking down, whereas another facility may have purchased a new transfer machine in 1986 and may not have budgeted for other major capital investments for the next 10 years. Imposing the immediate replacement option on this second facility would cause severe hardship and might result in closure. Immediate replacement would be more costly for this second facility; the cost for emission reduction would also be higher.

6.2.2 Regulatory Alternatives

This section presents the regulatory alternatives for both major and area dry cleaning sources. A major source is defined as a source emitting greater than 10 tons/year of any one HAP or more than 25 tons/year of any combination of HAP's. An area source is defined as any other source.[20] Because dry cleaning machines use only one HAP, the 10 tons/year criterion of the major source definition is applicable for this source category. Major and area sources include both new and existing dry cleaning machines. Under Section 112 of the Clean Air Air (CAA), as amended in 1990, emission standards for new and existing sources are to require the maximum degree of HAP emission reduction that the Administrator determines is achievable, taking into consideration the costs of achieving such emission reduction, and any nonair quality health and environmental impacts and energy requirements. This is known as the maximum achievable control technology (MACT).

The CAA further specifies that MACT may be different for new and existing sources. A new source is required to be controlled to a level of HAP emission reduction that is at least equal to the level achieved by the best controlled similar source. An existing source is required to be controlled to a level of HAP emission reduction that is at least equal to the emission level achieved by the average of the best 12 percent of existing sources. This control level is known as the MACT floor.

6.2.2.1 Major Dry Cleaning Sources. The major dry cleaning source category includes all dry cleaning machines emitting 10 tons per year or greater of HAP's. These major sources include the industrial dry cleaning machines and the 100-lb commercial transfer machines. Only one regulatory alternative for major dry cleaning sources is presented in Table 6-3. For major source dry-to-dry and transfer machines, over 12 percent of the existing sources are achieving 95 percent control efficiency. This efficiency, therefore, can be considered to represent the MACT floor for both new and existing sources. More stringent control techniques were not identified. This regulatory alternative also includes pollution prevention practices for the reduction of fugitive emissions.

The regulatory alternative would require that at least 95 percent efficient vent controls (e.g., carbon adsorbers or refrigerated condensers) be installed on all new and existing major source dry-to-dry machines. As discussed in Section 4.2.1.3, the carbon adsorber is the only type of control equipment used in the industrial sector; therefore, the regulatory alternative would require that carbon adsorbers (at least 95 percent efficient vent control) be installed on all new and existing industrial transfer machines. Refrigerated condensers are used to control process emissions from transfer machines in the commercial sector; however, these devices are capable of achieving only 85 percent control. This decreased

TABLE 6-3. THE REGULATORY ALTERNATIVE FOR MAJOR SOURCES SUBJECT TO THE DRY CLEANING NATIONAL EMISSION STANDARD FOR HAZARDOUS AIR POLLUTANTS

Machine type	Control option	Emission reduction (%)
Vented Emissions		
Dry-to-dry	Refrigerated condenser	95
	Carbon adsorber	95
Transfer	Carbon adsorber	95
Fugitive Emissions		
Dry-to-dry and transfer	Specify pollution prevention practices	N/A[a]

[a] Emission reduction for pollution prevention practices for fugitive emissions depends on the individual operator, and is therefore not quantifiable.

efficiency is attributed to the use of a one-pass refrigerated condenser on a transfer washer vent.[21] Because 95 percent control is achievable by major source transfer machines, 85 percent control by condensers would not be considered MACT. Therefore, the regulatory alternative for major source commercial transfer machines would require that carbon adsorbers (at least 95 percent vent control) be installed on all new and existing major source transfer machines.

6.2.2.2 Area Dry Cleaning Sources. Area source dry cleaners are smaller sized dry cleaning machines emitting less than 10 tons/year of HAP's. There are three regulatory alternatives for controlling emissions from area dry cleaning sources. All of the alternatives include pollution prevention practices for the reduction of fugitive emissions. The first two alternatives can be considered generally available control technology (GACT) (as discussed in Chapter 2.0) and the third is MACT. Table 6-4 shows the proposed regulatory alternatives for area sources.

Regulatory Alternative I is the least stringent level of control. It allows either type of control device, carbon adsorber or refrigerated condenser, to be applied on dry-to-dry machines to achieve 95 percent reduction from vented process emissions. It requires at least 85 percent reduction (application of a refrigerated condenser) for transfer machines.

Regulatory Alternative II would require either a carbon adsorber or a refrigerated condenser for all dry-to-dry or existing refrigerated condenser-controlled transfer machines, but would allow only carbon adsorbers for new and existing uncontrolled transfer machines. This alternative would reduce vented emissions from dry-to-dry and uncontrolled transfer machines by 95 percent. It would reduce vented emissions from existing refrigerated condenser-controlled transfer machines by 85 percent.

Regulatory Alternative III is the most stringent level of control, and can be considered MACT for area sources. It would

TABLE 6-4. REGULATORY ALTERNATIVES FOR AREA SOURCES SUBJECT TO THE DRY CLEANING NATIONAL EMISSION STANDARD FOR HAZARDOUS AIR POLLUTANTS

Machine type	Control option	Emission reduction (%)
<u>Alternative I</u>		
• Vented Emissions		
Dry-to-dry (All)	Refrigerated condenser or carbon adsorber	95
Transfer (All)	Refrigerated condenser	85
• Fugitive Emissions		
Dry-to-dry and transfer (All)	Specify pollution prevention practices	N/A[a]
<u>Alternative II</u>		
• Vented Emissions		
Dry-to-dry (All)	Refrigerated condenser or carbon adsorber	95
Transfer (Uncontrolled)	Carbon adsorber	95
(Refrigerated condenser-controlled)	Refrigerated condenser	85
• Fugitive Emissions		
Dry-to-dry and transfer (All)	Specify pollution prevention practices	N/A[a]

(continued)

TABLE 6-4. REGULATORY ALTERNATIVES FOR AREA SOURCES SUBJECT TO THE DRY CLEANING NATIONAL EMISSION STANDARD FOR HAZARDOUS AIR POLLUTANTS (Concluded)

Machine type	Control option	Emission reduction (%)
Alternative III		
• Vented Emissions		
Dry-to-dry (All)	Refrigerated condenser or carbon adsorber	95
Transfer (All)	Carbon adsorber	95
• Fugitive Emissions		
Dry-to-dry and transfer (All)	Specify pollution prevention practices	N/A[a]

[a] Emission reduction for pollution prevention practices for fugitive emissions depends on the individual operator and is, therefore, not quantifiable.

allow the use of carbon adsorbers or refrigerated condensers for dry-to-dry machines. However, for transfer machines, the only available control option would be carbon adsorbers. This alternative would reduce vented emissions from all machines by 95 percent, and this would be considered MACT. Under Alternative III, operators of existing refrigerated condenser-controlled transfer machines would be required to replace the condenser with a carbon adsorber.

6.3 EXEMPTION LEVELS

Three exemption levels were considered for excluding that portion of the low income sector of the dry cleaning industry that may experience undue hardship when implementing the level of HAP emission control required by the NESHAP. Undue hardship would be defined as severe economic impact such as the inability to afford the required control device or, at worst, plant closure. Note that only area sources are found in this low income sector. A low income dry cleaning establishment was considered to be one that grosses $100,000 or less in annual receipts.

The modelling approach used to select the three exemption levels was based on annual receipts information given in the "1987 Census of Service Industries."[23,24] According to the census information, the low income dry cleaning sector is comprised of both payroll and nonpayroll establishments.

Three low income ranges were selected for evaluating dry cleaning establishments with payroll: less than $25,000; from $25,000 to $50,000; and from $50,000 to $100,000. Because the average annual receipts for dry cleaning establishments without payroll are estimated as $21,000, these establishments were evaluated only at the two lowest income ranges: less than $25,000; and from $25,000 to $50,000.

At each of these annual receipts levels, machine distribution scenarios were developed based on the estimated 1991 model machine population.[1] The machines were distributed according to size and current level of control as described in a separate memorandum.[23] Once the distributions were complete, a corresponding annual HAP consumption per machine at each cut-off level was estimated. These resulting exemption levels for HAP consumption are presented in Table 6-5. For purposes of compliance determinations, the exemption level will be based on annual solvent consumption per machine rather than annual receipts, because this information would be more readily available from solvent purchase records.

TABLE 6-5. PROPOSED EXEMPTION LEVELS OF ANNUAL MACHINE CONSUMPTION FOR AREA SOURCES[a]

Machine type		Annual consumption per machine (kg HAP/yr)
Dry-to-Dry	Level 1	300[b]
	Level 2	600[c]
	Level 3	1,200[d]
Transfer	Level 1	400[b]
	Level 2	800[c]
	Level 3	1,600[d]

[a] A transfer machine consumes more HAP per kg clothes cleaned than a dry-to-dry machine. Dry cleaning accounts for 90 percent of total annual revenue from a commercial dry cleaning establishment.

[b] This consumption value corresponds to annual receipts of $25,000.

[c] This consumption value corresponds to annual receipts of $50,000.

[d] This consumption value corresponds to annual receipts of $100,000.

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7.0 ENVIRONMENTAL IMPACTS

Air pollution, water pollution, solid waste disposal, and energy impacts of the regulatory alternatives being considered for controlling hazardous air pollutant (HAP) emissions from dry cleaning machines have been assessed relative to the baseline conditions presented in Chapters 3.0 and 4.0. Baseline conditions represent the level of control and emissions in the absence of a NESHAP. In quantifying and qualifying environmental impacts, dry-to-dry and transfer dry cleaning machines have been treated separately for each regulatory alternative under consideration. As discussed in Chapter 6.0, three regulatory alternatives were considered for controlling HAP emissions from dry cleaning machines. In this chapter, the environmental impacts of baseline control, 95 percent control for dry-to-dry machines, and both 85 and 95 percent control for transfer machines are examined.

As discussed in Chapter 3.0, the dry cleaning industry is comprised of three sectors: coin-operated, commercial, and industrial. The estimated national number of dry cleaning machines by machine type is presented in Table 7-1.[1] Some machines are controlled at baseline due to efforts to comply with the Occupational Safety and Health Administration's (OSHA's) recently promulgated permissible exposure limit (PEL) of 25 ppm for perchloroethylene (PCE) (54 FR 2679; January 19, 1989) as well as concerns for solvent conservation. The current control status of the three dry cleaning sectors is discussed in Section 4.2.1.3.

In the coin-operated sector, an estimated 53 percent (1,620) of the dry cleaning machines (all dry-to-dry machines) are uncontrolled at baseline. The remaining 47 percent (1,430) are controlled. All of the controlled coin-operated machines are

TABLE 7-1. ESTIMATED NATIONAL NUMBER OF HAZARDOUS AIR POLLUTANT DRY CLEANERS AT BASELINE IN 1991 BY MACHINE TYPE

Sector/type	Uncontrolled	Carbon adsorber	Refrigerated condenser
Coin Operated			
Dry-to-dry[a]	1,620	1,430	0
Commercial			
Dry-to-dry	6,890	4,260	9,980
Transfer	5,250	2,530	2,530
Industrial			
Dry-to-dry	23	23	0
Transfer	42	42	0

[a] All coin-operated machines are dry-to-dry.

controlled with carbon adsorbers because refrigerated condensers are not available for this size machine.

In the commercial sector, 33 percent (10,300) of all dry cleaning machines are transfer, with the remaining 67 percent (21,100) being dry-to-dry. Sixty-one percent of commercial machines are controlled at baseline. It is estimated that 65 percent of the controlled machines in the commercial sector are controlled with refrigerated condensers and 35 percent with carbon adsorbers.

Industrial machines are comprised of 64 percent (83) transfer and 36 percent (46) dry-to-dry. Fifty percent of industrial machines are controlled at baseline. Essentially all controlled industrial machines have carbon adsorbers.

Air pollution impacts, water pollution impacts, solid waste impacts, and energy impacts are addressed in Sections 7.1, 7.2, 7.3, and 7.4, respectively. References are listed in Section 7.5.

7.1 AIR POLLUTION IMPACTS

Emissions, emissions reduction, and ambient concentrations were estimated relative to baseline conditions to measure air quality impacts of the regulatory alternatives. These estimates were conducted for two segments of the dry cleaning industry: major and area sources. Major sources include all dry cleaners in the industrial sector and the 100-lb transfer machines in the commercial sector, because these types of dry cleaners would typically emit more than 10 tpy of HAP. Area sources include all other dry cleaning machines in the commercial sector and machines in the coin-operated sector. The estimated national number of dry cleaning machines by source type is shown in Table 7-2.

Baseline emissions and ambient concentrations represent the existing conditions in the absence of a NESHAP. In addition to this baseline level, three regulatory alternatives were examined. As presented in Table 7-3, the level of control for major sources corresponding to each regulatory alternative is the maximum achievable control technology (MACT) and, therefore, remains the same: 95 percent vent control. It is the control levels for

TABLE 7-2. ESTIMATED NATIONAL NUMBER OF HAZARDOUS AIR POLLUTANT DRY CLEANERS AT BASELINE IN 1991 BY SOURCE TYPE

Sector/type	Uncontrolled	Carbon adsorber	Refrigerated condenser
Major Sources			
Dry-to-dry	65	65	0
Transfer	182	272	272
TOTAL	247	337	272
Area Sources			
Dry-to-dry	8,500	9,980	5,690
Transfer	5,070	2,260	2,260
TOTAL	13,570	12,240	7,950

TABLE 7-3. REGULATORY ALTERNATIVES FOR THE HAZARDOUS AIR POLLUTANT DRY CLEANING NESHAP

	Level of Vent Control			
		Area Sources		
Regulatory Alternative	Major sources[a] (%)	Dry-to-dry and new transfers[a,b] (%)	Existing uncontrolled transfers (%)	Existing RC controlled transfers (%)
I	(95) CA	(95) RC or CA	(85) RC	(85) RC
II	(95) CA	(95) RC or CA	(95) CA	(85) RC
III	(95) CA	(95) RC or CA	(95) CA	(95) CA

[a] CA = Carbon adsorber.
RC = Refrigerated condenser.

[b] Dry-to-dry machines are capable of achieving 95 percent control of HAP emissions by installing either a refrigerated condenser or a carbon adsorber. Transfer machines are capable of achieving 95 percent control by installing a carbon adsorber only.

area sources that vary: Regulatory Alternative I for area sources requires 95 percent vent control for all dry-to-dry and new transfer machines and 85 percent vent control for existing uncontrolled and existing refrigerated condenser-controlled transfer machines. Regulatory Alternative II for area sources requires 95 percent vent control for all dry-to-dry machines and new and existing uncontrolled transfer machines and 85 percent vent control for existing refrigerated condenser-controlled transfer machines. Regulatory Alternative III for area sources requires 95 percent vent control for all dry-to-dry and transfer machines.

7.1.1 Baseline Emissions and Concentrations

The calculation of national baseline emissions is described in Chapter 3; the values are presented in Table 7-4. National baseline emissions from existing dry cleaning machines total 87,000 Mg/yr.[2] Major sources account for about 8 percent (6,700 Mg/yr) of total emissions and area sources account for about 92 percent (80,400 Mg/yr) of total emissions.

7.1.2 Reduction in Emissions

Table 7-4 presents the national air quality impacts in terms of emission reductions and residual emissions associated with baseline and the three regulatory alternatives. Emission reductions and residual ambient concentration for major sources would remain the same for all regulatory alternatives because the 95 percent control requirement for major sources is identical for all three regulatory alternatives. Emission reductions and residual emissions achieved with add-on controls would vary for area sources between Regulatory Alternatives I, II, and III, because either a carbon adsorber or refrigerated condenser would be applied to area source transfer machines depending upon the percent control requirement. The reduction in national annual HAP emissions for both major and area sources is shown in Table 7-4 along with annual emissions remaining after implementation of the control.[3]

Emissions of HAP's from major sources for any of the regulatory alternatives would be reduced by 2,100 Mg/yr.

TABLE 7-4. EMISSIONS FOR BASELINE AND REGULATORY ALTERNATIVES I, II, AND III

Regulatory alternative	Emission reductions (Mg/yr)	Residual emission (Mg/yr)
Baseline		
Area sources	0	80,300
Major sources	0	6,700
Total	0	87,000
I. (95 Percent vent control except 85 percent vent control for existing area source transfer machines)		
Area sources	18,900	61,400
Major sources	2,100	4,600
Total	21,000	66,000
II. (95 Percent vent control except 85 percent vent control for existing, refrigerated-condenser controlled area source transfer machines)		
Area sources	19,900	60,400
Major sources	2,100	4,600
Total	22,000	65,000
III. (95 Percent vent control)		
Area sources	20,500	59,800
Major sources	2,100	4,600
Total	22,600	64,400

Implementation of Regulatory Alternative I would reduce national HAP emissions by 21,100 Mg/yr, where HAP emissions from area sources would account for 18,900 Mg/yr of this emission reduction. Implementation of Regulatory Alternative II would reduce national HAP emissions by 22,000 Mg/yr, where HAP emissions from area sources would account for 19,900 Mg/yr of this emission reduction. Implementation of Regulatory Alternative III would reduce national HAP emissions by 22,600 Mg/yr, where HAP emissions from area sources would account for 20,500 Mg/yr of this emission reduction. Under the three alternatives, the residual emissions remaining after control would range from 66,000 Mg/yr under Regulatory Alternative I to 64,400 Mg/yr under Regulatory Alternative III.

7.2 WATER POLLUTION IMPACTS

The vent control options would have little impact on water quality. The principal sources of wastewater from control operations are steam from the desorption of carbon adsorbers and effluent from water separators connected to refrigerated condensers. The potential for HAP's in wastewater is presented in Section 7.2.1. Sections 7.2.2 and 7.2.3 present wastewater impacts for major sources and area sources, respectively.

7.2.1 Potential Wastewater Impacts

The two control components that could potentially impact wastewater are the carbon adsorber and the water separator used after the refrigerated condenser. Although there are other possible methods for complying with the two levels of process vent controls (see Chapter 4.0), all impacts for the 85 percent control level for transfer machines are based on refrigerated condensers and impacts for the 95 percent control level are based on carbon adsorbers. Dry-to-dry machines could use either a refrigerated condenser or a carbon adsorber to achieve 95 percent control, but impacts are calculated for the worst-case scenario.

Due to the low operating temperature of the refrigerated condenser, water vapor in the dry cleaning system is condensed. A typical commercial facility with a refrigerated condenser generates about 1 gallon of wastewater per week.[3] Based on PCE solubility in water (150 ppm), 0.03 kg per year are emitted into aqueous wastes from either uncontrolled machines or refrigerated condenser-controlled machines.

The use of a carbon adsorber to control vented ambient HAP vapors is estimated to contribute 0.85 kg/yr for every machine equipped with this control. This impact was calculated based on the solubility of PCE in water and the estimated wastewater flowrate of 1,500 gallons/year.[4] There was no information to suggest that the wastewater discharge is dependent on machine type, so no distinction was made during the calculation of wastewater impacts.

7.2.2 Major Source Dry Cleaners

The level of control for major sources is identical for Regulatory Alternatives I, II, and III. Because major sources include only industrial machines and 100-lb commercial transfer machines, the carbon adsorber is the only control available for these machines to achieve the required 95 percent HAP emission reduction level. Therefore, the national wastewater impacts are shown in Table 7-5 for applying a carbon adsorber to all 25 uncontrolled major source dry-to-dry machines and to all 225 uncontrolled major source transfer machines. The resulting maximum wastewater impact for all major sources would be 0.21 Mg HAP/yr.

7.2.3 Area Source Dry Cleaners

Under all three regulatory alternatives, an area source dry-to-dry machine can achieve 95 percent emission control by installing either a refrigerated condenser or a carbon adsorber. As a result, the national wastewater impacts shown in Table 7-5 are for applying either type of control to all 8,500 uncontrolled area source dry-to-dry machines. If all 8,500 uncontrolled area source dry-to-dry machines install carbon adsorbers, the worst-case scenario, the maximum wastewater impact would be 7.2 Mg HAP/yr.

Under Regulatory Alternative I, all existing transfer machines can achieve 85 percent emission control by installing a refrigerated condenser. The maximum national wastewater impacts

TABLE 7-5. SECONDARY ENVIRONMENTAL IMPACTS OF REGULATORY ALTERNATIVES FOR THE DRY CLEANING INDUSTRY

Regulatory alternative	Machine type	Control level (%)	Number of affected facilities	National wastewater impact of control (Mg HAP/yr)	National solid waste impact of control (Mg carbon/20 years)
Major Sources					
I, II, or III	Dry-to-dry	(95) CA	25	0.02	11
	Transfer	(95) CA	225	0.19	101
	TOTAL		250	0.21	112
Area Sources					
I	Dry-to-dry	(95) CA or (95) RC	8,500	7.2 0.26	960 0
	Transfer[a] (Existing Uncontrolled and Refrigerated Condenser Controlled)	(85) RC	5,100	0.15	0
	TOTAL		13,600	0.41 - 7.35	960
II	Dry-to-dry	(95) CA or (95) RC	8,500	7.2 0.26	960
	Transfer (New and Existing Uncontrolled)	(95) CA	5,100	4.3	640
	Transfer (Existing Refrigerated Condenser Controlled)	(85) RC	2,500	0	0
	TOTAL		13,600	4.56 - 11.5	1,600
III	Dry-to-dry	(95) CA or (95) RC	8,500	7.2 0.26	960 0
	Transfer	(95) CA	7,600	6.4	950
	TOTAL		16,100	6.66 - 13.6	1,910

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[a] Under Regulatory Alternative I for area sources, new transfer machines would be required to install a carbon adsorber to achieve 95 percent control.

for applying refrigerated condensers to all 5,100 uncontrolled transfer machines is 0.15 Mg HAP/yr. Therefore, the resulting maximum wastewater impacts for all area sources if Regulatory Alternative I is adopted is 7.35 Mg HAP/yr.

Under Regulatory Alternative II, new and existing uncontrolled transfer machines can achieve 95 percent control by installing a carbon adsorber. Because existing refrigerated condenser-controlled transfer machines already have their control equipment in place, no additional wastewater impacts would result. The maximum national wastewater impacts for applying carbon adsorbers to all 5,100 new and uncontrolled transfer machines is 4.3 Mg HAP/yr. Therefore, the resulting maximum wastewater impacts for all area sources if Regulatory Alternative II is adopted would be 11.5 Mg HAP/yr.

Under Regulatory Alternative III, all transfer machines must achieve 95 percent emission control by installing a carbon adsorber. The maximum national wastewater impacts for applying carbon adsorbers to all 7,680 area source transfer machines would be 6.4 Mg HAP/yr. Therefore, the resulting maximum wastewater impacts for all area sources if Regulatory Alternative III is adopted would be 13.66 Mg HAP/yr.

7.3 SOLID WASTE IMPACTS

The main types of solid waste generated from controlled dry cleaning machines are spent carbon or carbon cartridges from carbon adsorption systems, solvent sludge, and still bottoms. The sludge, known as "muck", builds up on the cleaner filters and contains the insoluble soils, nonvolatile residue, and loose dyes that are removed from the dirty solvent.[5] The still bottoms result from distillation units used to purify solvents. Neither a carbon adsorber nor a refrigerated condenser would affect muck or still bottom generation, so no impact due to control alternatives was calculated for these waste types. Spent carbon from carbon adsorbers is the only type of solid waste generated by dry cleaners that is affected by the controls. This type of solid waste is discussed in Section 7.3.1. The national solid waste impacts for major sources and area sources are discussed in Sections 7.3.2 and 7.3.3, respectively.

7.3.1 Spent Carbon from Carbon Adsorbers

A regenerative carbon adsorber is generally more cost effective than cartridge adsorbers (see Chapter 8.0). A carbon adsorber uses activated carbon to remove the vaporized solvent in the incoming air stream. As solvent builds up, the effectiveness of the unit is reduced. Small pieces of lint and other particulate matter may also build up on the carbon. To restore effectiveness, the bed is regenerated with steam. Because of the strong affinity between the solvent and activated carbon, some solvent remains despite regeneration efforts. Eventually, the carbon must be replaced to maintain a desired efficiency level, generating spent carbon in need of disposal. This replacement is generally necessary about once every 20 years. Currently, all controlled coin-operated and industrial machines and 50 percent of controlled commercial machines already use carbon adsorbers and generate spent carbon wastes. These 8,281 currently controlled machines contribute approximately 497 Mg of carbon every 20 years. The impacts presented below are additional impacts of the regulatory alternatives that would require more widespread use of carbon adsorbers.

7.3.2 Solid Waste Impacts from Major Sources

The control level for major sources is identical for all three regulatory alternatives. Because major sources include only industrial machines and 100 lb commercial transfer machines, the carbon adsorber is the only control available for these machines to achieve the required 95 percent emission reduction level. All of the 250 uncontrolled major sources would install carbon adsorbers in Year 0 and discard the carbon in Year 20. Based on the amount of carbon in each machine (0.125 Mg carbon/commercial machine, 0.45 Mg carbon/industrial machine), the solid waste impact occurring approximately every 20 years would be 112 Mg for major sources.

7.3.3 Solid Waste Impacts from Area Sources

The solid waste impacts from area sources would depend on the regulatory alternative selected. A carbon adsorber in the coin-operated sector contains 0.06 Mg of carbon. Under Regulatory Alternative I, assuming the worst-case scenario where all dry-to-dry machines install carbon adsorbers and all transfer machines install refrigerated condensers, the maximum solid waste impacts occurring approximately every 20 years would be 960 Mg for the 13,600 affected area sources.

Under Regulatory Alternative II, assuming the worst-case scenario where all dry-to-dry machines and all new and existing transfer machines would install carbon adsorbers, the maximum solid waste impacts occurring approximately every 20 years would be 1,600 Mg for the 13,600 affected area sources. All refrigerated condenser-controlled transfer machines would continue to operate their condensers so there would be no contributions to solid waste impacts from these machines.

Under Regulatory Alternative III, assuming the worst-case scenario where all dry-to-dry and transfer machines install carbon adsorbers, the maximum solid waste impacts occurring approximately every 20 years would be 1,910 Mg for the 16,100 affected area sources.

7.4 ENERGY IMPACTS

Both the carbon adsorber and the refrigerated condenser require additional energy to operate. A discussion of these energy requirements on a per machine basis is presented in Section 7.4.1. The energy requirements of the regulatory alternatives are presented in Section 7.4.2.

7.4.1 Dry Cleaning Energy Requirements on a Per Machine Basis

Table 7-6 presents the energy requirements of the controls in both kilowatt hour (kw-hr) and the equivalent number of barrels of oil. The number of barrels of oil was calculated based on 1.3 barrels of oil being required to generate 1,000 kw-hr of electricity. This calculation assumed the use of number 6 fuel oil (150,000 Btu/gallon), 42.7 gallons per barrel,

TABLE 7-6. NATIONAL ENERGY REQUIREMENTS FOR EACH REGULATORY ALTERNATIVE

Regulatory Alternative	Machine type	Control option	Number of affected facilities	Energy Requirements (kw-hr/yr[a])	Energy Requirements (Barrels oil/yr)
Major Sources					
I	Dry-to-dry	CA	25	11,325	15
	Transfer	CA	225	112,500	146
		TOTAL	250	123,825	161
Area Sources					
I	Dry-to-dry	CA or RC	8,500 8,500	2,935,320 4,724,900	3,816 6,142
	Transfer	RC	5,100	8,422,400	10,949
		TOTAL	13,600	4,847,820 - 6,637,400	14,765 - 17,091
II	Dry-to-dry	CA or RC	8,500 8,500	2,935,320 4,724,900	3,816 6,142
	Transfer	CA	5,100	1,912,500	2,486
		TOTAL	13,600	4,847,820 - 6,637,400	6,302 - 8,629
III	Dry-to-dry	CA or RC	8,500 8,500	2,935,320 4,724,900	3,816 6,142
	Transfer	CA	7,600	1,037,500[b]	1,349
		TOTAL	16,100	3,972,820 - 5,762,400	5,165 - 7,491

[a] See Table 7-6 for breakdown of kw-hr per machines.

[b] Includes reduction in electricity demands resulting from 2,500 refrigerated condenser-controlled transfer machines switching to carbon adsorber controls.

and a typical efficiency of 40 percent for oil-fired power plants.[6]

The control that requires the most energy input is the refrigerated condenser. As shown in Table 7-7, the energy requirements for this device range from 604 kw-hr/machine/yr (0.8 barrels of oil) for commercial dry-to-dry machines to 725 kw-hr/machine/yr (0.95 barrel of oil/machine/yr) for commercial transfer machines. The carbon adsorber energy requirements include the energy necessary to run the control as well as the energy necessary to generate the steam for desorption. The energy requirements for carbon adsorbers are 351 kw-hr/machine/yr (0.5 barrels of oil/machine/yr) for machines in the coin-operated sector. For commercial dry-to-dry machines and commercial transfer machines, the energy requirements for carbon adsorbers are 344 and 375 kw-hr/machine/yr (0.4 and 0.5 barrels of oil/machine/yr), respectively. For industrial dry-to-dry machines and industrial transfer machines, the energy requirements for carbon adsorbers are 453 and 500 kw-hr/machine/yr (0.6 and 0.7 barrels of oil/machine/yr), respectively.

Although energy is consumed to operate controls for dry cleaning machines, solvent is also conserved. A credit was taken in calculating national energy impacts for the reduction in solvent consumption attributable to the control. It takes 1.25 barrels of oil to produce one barrel (42.7 gallons) of solvent. This is equivalent to 730 kw-hr of energy savings per barrel of solvent conserved.[7]

7.4.2 Dry Cleaning Energy Requirements of the Regulatory Alternatives

The national energy requirement for major sources is identical for all three regulatory alternatives. If all uncontrolled major sources install carbon adsorbers, the total national energy requirement would be 123,825 kw-hr (161 barrels of oil/yr), an average of about 495 kw-hr/machine/yr (0.64 barrels of oil/machine/yr).

TABLE 7-7 ENERGY REQUIREMENTS ON A PER MACHINE BASIS

Sector	Control Type[a] (kw-hr/ machine/year) CA	RC
Coin-op		
Dry-to-dry	351	-
Commercial		
Dry-to-dry	344	604
Transfer	375	725
Industrial		
Dry-to-dry	453	-
Transfer	500	-

[a] CA = Carbon adsorber.
RC = Refrigerated condenser.

Under Regulatory Alternative I, the scenario with greatest energy impacts would be if all dry-to-dry and existing transfer area sources install refrigerated condensers. The total national energy requirement for this scenario would be 13,147,300 kw-hr/yr (17,091 barrels of oil/yr), an average of 967 kw-hr/machine/yr (1.25 barrels oil/machine/yr).

Under Regulatory Alternative II, the scenario with greatest energy impacts would be if all dry-to-dry area source install refrigerated condensers and all transfer area sources except for existing refrigerated condenser-controlled transfer machines install carbon adsorbers. The total national energy requirement for this scenario would be 6,637,400 kw-hr/yr (8,269 barrels oil/yr), an average of 488 kw-hr/machine/yr (0.63 barrels oil machine/yr).

Under Regulatory Alternative III, the scenario with greatest energy impacts would be if all dry-to-dry area sources install refrigerated condensers and all transfer area sources install carbon adsorbers. The total national energy requirement for this scenario would be 5,762,400 kw-hr/yr (7,491 barrels oil/yr), an average of 358 kw-hr/machine/yr (0.46 barrels oil/yr). Although Regulatory Alternative III is the most stringent regulatory alternative, the national energy requirement is lowest of the three alternatives because the calculations include a reduction in electricity demands resulting from 2,500 refrigerated condenser transfer machines switching to carbon adsorber controls.

7.5 REFERENCES

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2. Ref. 1.

3. Memorandum from C. E. Norris and K. S. Kepford, Radian Corporation, to the Dry Cleaning Project File. National Cost Impacts of the Regulatory Alternatives for HAP Dry Cleaning. December 14, 1990.

4. Telecon. Shumaker, J., Radian Corporation with Wheless, J., Regency Plaza Cleaners and Laundromat. October 22, 1986. Conversation about wastewater PCE contamination.

5. Telecon. Norris, C. E., Radian Corporation, with Bovari, R., Safety Kleen. May 9, 1991. Conversation about the amount of perchloroethylene in dry cleaner wastewater.

6. Meeting summary, meeting between Safety-Kleen, Radian Corporation, and U. S. Environmental Protection Agency. November 12, 1986. Research Triangle Park, North Carolina. Attachment 3.

7. Combustion: Fossil Power Systems. 3rd Edition 1981 Published by Combustion Engineering, Inc., Windsor, CT.

8. U. S. Environmental Protection Agency. Organic Solvent Cleaners-Background Information for Proposed Standards. Publication No. EPA-450/2-78-045a. Research Triangle Park, North Carolina. October 1979.

8.0 COST ANALYSIS

8.1 INTRODUCTION

The costs of implementing the regulatory alternatives for controlling HAP emissions from dry cleaning plants are presented in the following sections. Detailed descriptions of the model machines and regulatory alternatives treated in this cost analysis are presented in Chapter 6.0. Section 8.2 presents a discussion of model machine cost impacts and Section 8.3 presents a discussion of national cost impacts.

8.2 MODEL MACHINE CONTROL COST IMPACTS

The updated control cost estimates presented in this section are based on information from vendors of dry cleaning equipment and control equipment. The capital and annualized costs and cost effectiveness associated with control options are presented on a model machine basis for all three dry cleaning sectors.

Machines in all three dry cleaning sectors (coin-operated, commercial, and industrial) are represented by model machines. Installed capital costs of control equipment and new dry-to-dry machine equipment are obtained from costs provided by vendors,[1-10] except costs of boilers and oil tanks (used in the coin-operated sector), which are updated from a previous perchloroethylene dry cleaners background information document (BID)[11] using the Chemical Engineering equipment cost index.[12] All annualized costs are expressed in second quarter 1989 dollars and were annualized with an interest rate of 10 percent.

The remainder of this section describes the approach and presents results of the model machine cost analyses. Section 8.2.1 presents the HAP emission reductions used to calculate cost effectiveness. Section 8.2.2 includes a discussion of the cost analyses and presents cost estimates for refrigerated condensers and carbon adsorbers.

8.2.1 Hazardous Air Pollutant Emission Reduction

The HAP consumption by uncontrolled model transfer machines is estimated to be 11.5 kilograms (kg) of HAP per 100 kg of clothes cleaned.[13] Emissions from solid waste disposal are assumed to be approximately 2.5 kg HAP/100 kg clothes cleaned, which is the same for both transfer and dry-to-dry machines. Because solid waste is disposed off site, these emissions are not included in the process emissions. Out of the total vapor emissions from a transfer machine, process emissions account for 4 kg of HAP and fugitive emissions account for 5 kg of HAP. A dry-to-dry machine emits 3.1 kg of HAP from process emissions and about half the fugitive emissions of transfer machines (or 2.5 kg) due to elimination of the clothing transfer step.[14-16] Thus, total emissions from dry-to-dry machines are calculated to be 5.6 kg of HAP per 100 kg of clothes cleaned (3.1 kg + 2.5 kg).

The addition of a refrigerated condenser to a transfer machine will reduce process emissions by 85 percent from 4 kg of HAP per 100 kg of clothes cleaned to 0.6 kg of HAP per 100 kg of clothes cleaned.[17] The addition of a refrigerated condenser to a dry-to-dry machine will reduce process emissions by 95 percent, from 3.1 kg of HAP per 100 kg of clothes cleaned to 0.2 kg of HAP per 100 kg of clothes cleaned. A carbon adsorber applied to either a transfer or dry-to-dry machine will reduce process emissions by 95 percent to 0.2 kg of HAP per 100 kg of clothes cleaned.

The HAP dry cleaning model machine emissions estimates are summarized in Table 8-1.

8.2.2 Control Costs for Model Machines

Table 8-2 shows how net annualized costs are calculated for the model machines. Capital costs of dry cleaning machines are obtained from machine vendors. Taxes and freight are assumed to be 8 percent of the uninstalled purchase costs. Annualized costs include capital recovery costs, indirect operating costs, labor and utilities costs, and overhead. As shown, capital recovery and indirect operating costs are derived from the total capital investment. Table 8-3 presents the estimated costs and cost

TABLE 8-1. EMISSION FACTORS FOR THE HAZARDOUS AIR POLLUTANT DRY CLEANING INDUSTRY[a]
(kg HAP/100 kg clothes cleaned)

	Dry-to-Dry	Transfer
Uncontrolled		
Process	3.1	4
Fugitive	2.5	5
Total	5.6	9
Refrigerated Condenser-Controlled		
Process	0.2	0.6
Fugitive	2.5	5
Total	2.7	5.6
Carbon Adsorber-Controlled		
Process	0.2	0.2
Fugitive	2.5	5
Total	2.7	5.2

[a] Solid waste emissions are not shown because the wastes are transported off site for disposal. Therefore, any air emissions from solid waste disposal are not attributed to a dry cleaning plant.

TABLE 8-2. DERIVATION OF NET ANNUALIZED COSTS

Capital Costs, $	
Purchase Cost	A
Installation	B
Taxes and Freight	C (= 0.08 x A)
Total Capital Investment	D (= A + B + C)
Annualized Costs, $/yr	
Capital Recovery Cost	E (= CRF[a] x D)
Indirect Operating Costs	F (= 0.04 x D)
Operating Labor	G
Maintenance Labor	H
Overhead	I [= 0.6 (G + H)]
Utilities	
Electricity	J
Steam	K
Total Annualized Costs, $/yr	L (= E + F + G + H + I + J + K)
Emission Reduction, kg HAP/yr	M
Recovered Solvent Credit, $/yr	N (= 0.683[b] x M)
Net Annualized Cost of Control, $/yr	O (= L - N)

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[a] CRF = Capital recovery factor.

$$= \frac{i(1 + i)^n}{(1 + i)^{n-1}}$$

where:

n = Equipment life (years).
i = Interest rate.

[b] Price of perchloroethylene is $0.683/kg (second quarter 1989 dollars).[18]

TABLE 8-3. SUMMARY OF CONTROL TECHNOLOGY COSTS AND COST EFFECTIVENESS FOR UNCONTROLLED MACHINES (2nd Quarter 1989 $)

Model plant size	Control device (%)	Total capital investment ($)	Total annualized cost ($)	Emissions reduction (kg HAP/yr)	Recovered solvent credit ($/yr)	Net annualized cost ($/yr)	Actual Cost Effectiveness ($/kg HAP) a
Coin-op Sector							
Self-Service							
3.6 kg (8 lb)	95 - CA	8,601	7,651	195	(133)	7,518	38.55
Plant Operated							
3.6 kg (8 lb)	95 - CA	3,540	3,817	195	(133)	3,684	18.89
Commercial Sector							
11.3 kg (25 lb)	95 - CA	6,760	3,832	819	(559)	3,273	4.00
	95 - RC	6,283	1,666	819	(559)	1,107	1.35
13.6 kg (30 lb)	95 - CA	6,760	3,832	986	(673)	3,159	3.20
	95 - RC	6,283	1,666	986	(673)	993	1.01
15.9 kg (35 lb)	95 - CA	6,760	3,832	1,150	(785)	3,047	2.65
	95 - RC	6,283	1,666	1,150	(785)	881	0.77
15.9 kg (35 lb) T	95 - CA	6,976	3,872	1,810	(1,236)	2,636	1.46
	85 - RC	8,424	2,201	1,620	(1,106)	1,095	0.68
20.4 kg (45 lb)	95 - CA	6,760	3,832	1,480	(1,011)	2,821	1.91
	95 - RC	6,283	1,666	1,480	(1,011)	655	0.44
22.7 kg (50 lb)	95 - CA	6,760	3,832	1,650	(1,127)	2,705	1.64
	95 - RC	6,283	1,666	1,650	(1,127)	539	0.33
22.7 kg (50 lb) T	95 - CA	6,976	3,872	2,590	(1,769)	2,103	0.81
	85 - RC	8,424	2,201	2,320	(1,585)	616	0.27
27.2 kg (60 lb)	95 - CA	6,760	3,832	1,970	(1,346)	2,486	1.26
	95 - RC	6,283	1,666	1,970	(1,346)	320	0.16
45.4 kg (100 lb)	95 - CA	6,760	3,832	3,290	(2,247)	1,585	0.48
	95 - RC	8,675	2,254	3,290	(2,247)	7	0.00
45.4 kg (100 lb) T	95 - CA	6,976	3,863	5,180	(3,538)	325	0.06
	85 - RC	10,811	2,786	4,630	(3,162)	(376)	(0.08)
Industrial Sector							
63.5 kg (140 lb)	95 - CA	9,980	4,831	7,830	(5,348)	(517)	(0.07)
113.4 kg (250 lb)	95 - CA	9,980	4,831	13,980	(9,548)	(4,717)	(0.34)
113.4 kg (250 lb) T	95 - CA	9,980	4,834	21,550	(14,719)	(9,885)	(0.46)

() = Credit

T = Transfer machines; CA = Carbon Adsorber; RC = Refrigerated Condenser

a Compared to baseline

effectiveness for installing both types of process vent controls on uncontrolled model machines. For model transfer machines equipped with refrigerated condensers, the cost and cost effectiveness of installing the more stringent carbon adsorbers have also been evaluated. The control costs and cost-effectiveness values for installing carbon adsorbers on current refrigerated condenser-controlled transfer machines are summarized in Table 8-4.

8.2.3 Coin-Operated Dry Cleaning Machines

The coin-operated model machines are 3.6 kg (8-lb) dry-to-dry machines. One machine is self-service and one is plant-operated. No transfer machines are used in the coin-operated sector. The only vent control that was evaluated for this sector is a carbon adsorber because the HAP-laden air flow from coin-operated machines is too low to be controlled efficiently by a refrigerated condenser.[19] An emission reduction of 195 kg HAP per year is obtained by applying a carbon adsorption system to the model coin-operated machines. The net annualized cost to control HAP emissions with a carbon adsorber is $7,500 per year for self-service machines and $3,700 per year for plant-operated machines. The cost-effectiveness values are $39.00 and $19.00 per kg HAP removed, respectively.

8.2.4 Commercial Dry Cleaning Machines

Control costs for both control options were evaluated for the 10 model machines for the commercial sector. The model machines range in size from 11.3 kg (25 lb) to 45.4 kg (100 lb). Seven of the model machines are dry-to-dry machines. The remaining three machines are transfer machines. The costs and cost effectiveness for vent controls on uncontrolled model machines in the commercial sector are presented in Table 8-3. With the exception of the transfer model machines, the capital and annualized costs for carbon adsorbers are greater than for refrigerated condensers for a given model machine size. In addition, the capital costs for a refrigerated condenser on a transfer machine are higher than for a refrigerated condenser on

TABLE 8-4. SUMMARY OF CONTROL TECHNOLOGY COSTS AND COST EFFECTIVENESS FOR REFRIGERATED-CONDENSER CONTROLLED TRANSFER MACHINES (2nd Quarter 1989 $)

Model machine size	Control option (%)	Total capital investment ($)	Total annualized cost ($)	Emissions reduction (kg HAP/yr)	Recovered solvent credit ($/yr)	Net annualized cost ($/yr)	Average cost effectiveness ($/kg HAP)[a]
Commercial Sector							
* 15.9 kg (35 lb)	95	6,976	3,872	191	(130)	3,742	19.59
* 22.7 kg (50 lb)	95	6,976	3,872	272	(186)	3,686	13.55
* 45.4 kg (100 lb)	95	6,976	3,872	545	(372)	3,500	6.42

( ) = Credit

[a] Compared to baseline.

the same size dry-to-dry machine due to additional duct work and refrigerated coils necessary to efficiently control vapors from both equipment pieces (i.e., washer and dryer) comprising the transfer dry cleaning machine.

The HAP emission reductions due to a refrigerated condenser range from 800 kg/yr for the 11.3 kg (25 lb) model dry-to-dry machine to 4,600 kg/yr for the 45.4 kg (100 lb) model transfer machine. The net annualized cost for the addition of a refrigerated condenser ranges from a cost of $1,100 for the 11.3 kg (25 lb) transfer model machine to a net cost savings for the 45.4 kg (100 lb) transfer model machine. Cost effectiveness ranges from $1.00/kg for the 11.3 kg (25 lb) model machine to a net credit for the 45.4 kg (100 lb) transfer model machine.

The HAP emission reduction due to a carbon adsorber ranges from 800 kg/yr for the 11.3 kg (25 lb) model dry-to-dry machine to 5,200 kg/yr for the 45.4 kg (100 lb) model transfer machine. The net annualized cost for the addition of a carbon adsorber ranges from a cost of $3,300 for the 11.3 kg (25 lb) model machine to a net cost of $300 for the 45.4 kg (100 lb) model transfer machine. Cost effectiveness ranges from $4.00/kg for the 11.3 kg (25 lb) model plant to $1.00/kg for the 45.4 kg (100 lb) model transfer machine.

Table 8-4 presents the estimated costs and cost effectiveness for installing a carbon adsorber on model transfer machines currently controlled with a refrigerated condenser. The capital and annualized costs of carbon adsorber controls are the same as those presented for uncontrolled model machines. The emission reduction and corresponding solvent recovery credit are less, however. Because a refrigerated condenser-controlled machine already has lower emissions than an uncontrolled machine, the emission reduction achievable by installing a carbon adsorber is reduced. Therefore, the resulting cost effectiveness of carbon adsorber controls on model machines already equipped with refrigerated condensers is higher than for uncontrolled machines. The emission reductions range from 200 kg/yr for a 15.9 kg (35 lb) transfer model machine to 600 kg/yr for the 45.4 kg

(100-lb) transfer model machine. Net annualized costs range from $3,700/yr to $3,500/yr for the range of commercial sector model machines. Cost effectiveness ranges from $19.60/kg to $6.40/kg for the commercial sector model machines.

8.2.5 Industrial Dry Cleaning Machines

The industrial sector model machines are a 63.5 kg (140-lb) dry-to-dry machine, a 113.4 kg (250-lb) dry-to-dry machine, and a 113.4 kg (250-lb) transfer machine. The only vent control option examined for the three industrial model machines is a carbon adsorber because refrigerated condensers are not sold for these size machines. Table 8-3 presents the estimated costs for vent controls on uncontrolled model machines. The emission reduction from the installation of a carbon adsorber is 7,800 kg/yr for a 63.5 kg (140-lb) model dry-to-dry machine, 14,000 kg/yr for a 113 kg (250-lb) model dry-to-dry machine, and 21,600 mg/yr for a 113 kg (250-lb) model transfer machine. The net annualized cost and cost effectiveness for adding a carbon absorber will be a net credit for all industrial sector model machines.

8.3 NATIONAL COST IMPACTS

The purpose of this section is to present the national cost impacts of the regulatory alternatives being considered for the HAP dry cleaning NESHAP. The national cost impacts are presented in terms of total nationwide capital costs and annualized costs. The cost effectiveness of each alternative in dollars per amount of HAP emission reduction is also presented.

Table 8-5 presents a summary of the national cost impacts for each of the regulatory alternatives. Total installed capital costs, net annualized costs, and cost-effectiveness estimates are shown. In addition, the total nationwide emissions reduction achievable in the first year after promulgation of the NESHAP are presented, as well as the number of dry cleaning machines that would be affected by each of the regulatory alternatives.

Total installed capital costs range from approximately 90 million dollars for Regulatory Alternative II to approximately 110 million dollars for Regulatory Alternative III. Emission reduction is lowest at approximately 21,900 Mg HAP per

TABLE 8-5. NATIONAL COST IMPACTS OF REGULATORY ALTERNATIVES FOR HAP DRY CLEANING

Regulatory Alternative	Number of machines affected	Capital cost (MM $)	Emissions reduction (Mg HAP/yr) (A)	Net annualized cost (MM $/yr) (B)	Cost effectiveness ($/Mg HAP) B/A
Baseline	0	0	0	0	0
I	13,800	100	21,900	17	800
II	13,800	90	22,900	24	1,000
III	16,300	110	23,600	31	1,300

year for Alternative I and greatest at approximately 23,600 Mg HAP per year for Alternative III.

Net annualized costs range from 17 million dollars per year for Alternative I to 31 million dollars per year for Alternative III.

Cost effectiveness values are presented as dollars per Mg of HAP recovered. The average cost-effectiveness values range from $800 per Mg of HAP for Alternative I to $1,300 per Mg of HAP for Alternative III.

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APPENDIX A

EVOLUTION OF THE BACKGROUND INFORMATION DOCUMENT

APPENDIX A

EVOLUTION OF THE BACKGROUND INFORMATION DOCUMENT

The purpose of this study was to develop a basis for supporting proposed national emission standards for hazardous air pollutants (NESHAP) for the dry cleaning industry.

Chronology

The chronology which follows includes those events that have occurred in developing the background information document (BID) for hazardous air pollutant (HAP) dry cleaning. Events that lead up to the proposal of the standards in the Federal Register are also included.

Date	Activity
December 26, 1985	EPA published a Notice of Intent to list PCE as a potentially toxic air pollutant to be regulated under Section 112 of the CAA (50 FR 52880)
May 19, 1988	National Air Pollution Control Technique Advisory Committee (NAPCTAC) meeting on dry cleaning, Research Triangle Park, North Carolina.
January 19, 1989	Promulgation of the Occupational Health and Safety Administration's 25 permissible exposure limit (PEL), 54 FR 2670.
July 13, 1990	Work Group meeting--background information.
July 18, 1990	Meeting with industry representatives, Radian, and EPA at EPA Offices, Durham, North Carolina.
August 20, 1990	Work Group meeting--present control options.
November 15, 1990	Enactment of CAA Amendments (Title III--Hazardous Air Pollutants).

December 18, 1990	Work Group meeting--status update.
January 30, 1991	National Air Pollution Control Technique Advisory Committee (NAPCTAC) meeting on dry cleaning, Research Triangle Park, North Carolina.
March 28, 1991	Meeting with International Fabricare Institute, Institute of Industrial Launderers, Neighborhood Cleaners Association, Halogenated Solvents Industry Alliance, R.R. Street, Radian, and EPA at International Fabricare Institute, Silver Spring, Maryland.
July 5, 1991	Work Group meeting to select option.
September 3, 1991	Work Group closure meeting.
October 15, 1991	Notice of Proposed Rulemaking and background information documents submitted to OMB.
November 15, 1991	Preamble and regulation signed by the Administrator.
November 1991	Anticipated proposal of regulation in the <u>Federal Register</u>.

APPENDIX B

INDEX TO ENVIRONMENTAL IMPACT CONSIDERATIONS

APPENDIX B

INDEX TO ENVIRONMENTAL IMPACT CONSIDERATIONS

This appendix consists of a reference system that is cross-indexed with the October 21, 1974, Federal Register (39 FR 37419) containing the Agency guidelines concerning the preparation of environmental impact statements. This index can be used to identify sections of the document that contain data and information germane to any portion of the Federal Register guidelines.

TABLE B-1. CROSS-INDEXED REFERENCE SYSTEM TO HIGHLIGHT ENVIRONMENTAL IMPACT PORTIONS OF THE DOCUMENT

Agency guidelines for preparing regulatory action environmental impact statements (39 FR 37419)	Location within the background information document
1. Background and Summary of Regulatory Alternatives	
Summary of regulatory alternatives	The regulatory alternatives from which standards will be chosen for proposal are summarized in Chapter 1.0, Section 1.1.
Statutory basis for proposing standards	The statutory basis for proposing standards is summarized in Chapter 2.0, Section 2.1.
Relationship to other regulatory agency actions	The relationships between EPA actions and other regulatory agency actions are discussed in Chapters 3.0, 7.0, and 8.0.
Industries affected by the regulatory alternatives	A discussion of the industry affected by the regulatory alternatives is presented in Chapter 3.0, Section 3.1. Further details covering the business and economic nature of the industry are presented in Chapter 9.0, Section 9.1.
Specific processes affected by the regulatory alternatives	The specific processes and facilities affected by the regulatory alternatives are summarized in Chapter 1.0, Section 1.1. A detailed technical discussion of the processes affected by the regulatory alternatives is presented in Chapter 3.0, Section 3.2.

(continued)

TABLE B-1. CROSS-INDEXED REFERENCE SYSTEM TO HIGHLIGHT ENVIRONMENTAL IMPACT PORTIONS OF THE DOCUMENT (Concluded)

Agency guidelines for preparing regulatory action environmental impact statements (39 FR 37419)	Location within the background information document
2. Regulatory Alternatives	
Control techniques	The alternative control techniques are discussed in Chapter 4.0.
Regulatory alternatives	The various regulatory alternatives are defined in Chapter 6.0, Section 6.2. A summary of the major alternatives considered in included in Chapter 1.0, Section 1.1.
3. Environmental Impact of the Regulatory Alternatives	
Air pollution	The air pollution impact of the regulatory alternatives is discussed in Chapter 7.0, Section 7.1.
Water pollution	The water pollution impact of the regulatory alternatives is discussed in Chapter 7.0, Section 7.2.
Solid waste disposal	The solid waste disposal impact of the regulatory alternatives is discussed in Chapter 7.0, Section 7.3.
Energy	The energy impact of the regulatory alternatives is considered in Chapter 7.0, Section 7.4.
4. Economic Impact of the Regulatory Alternatives	
	The economic and financial impacts of the regulatory alternatives on costs are discussed in Chapter 8.0.

APPENDIX C

EMISSION SOURCE TEST DATA

APPENDIX C

EMISSION SOURCE TEST DATA

Dry cleaning plants differ in size, control technology, design, capacity, types of articles cleaned, geographical location, age of equipment, housekeeping practices, and maintenance history. These factors affect solvent emissions. Several perchloroethylene (PCE) dry cleaning plants utilizing representative emission control technologies have been tested in order to determine the effectiveness of the emission control devices in reducing hazardous air pollutants (HAP's). Five plants were tested: four commercial plants (Plants A, C, D, and E) and one industrial plant (Plant B). Plant A is a large commercial plant using a transfer system with a washer capacity of 50 kg (110 lb). Plants C, D, and E are average-size commercial plants using dry-to-dry machines with rated capacities of 18 kg (40 lb), 20 kg (45 lb), and 30 kg (65 lb), respectively. Plant B is an average-size industrial plant that operates a "kissing machine" with a washer capacity of 136 kg (300 lb). Emission tests consisted of total hydrocarbon measurements at the inlet and outlet of the control device and PCE concentration measurements at the control device outlet. In addition, observations of housekeeping (or pollution prevention) practices at each plant were reported. Test results are summarized in Tables C-1 and C-2. Table C-1 presents emission estimates based on test results, and Table C-2 presents measured control device efficiencies. The tested plants are described in the following sections.

C.1 PLANT A

Plant A is a commercial PCE dry cleaning plant in Hershey, Pennsylvania. The transfer system operated at this facility includes a 50-kg (110-lb) capacity SM-11 washer manufactured by

TABLE C-1. SUMMARY OF PERCHLOROETHYLENE DRY CLEANING EMISSIONS TEST DATA[a]

Plant	System	Throughput (kg clothes/day [lb clothes/day])	Total solvent losses (kg PCE/ 100 kg clothes)	Carbon adsorber outlet (kg PCE/ 100 kg clothes)	Carbon adsorber inlet (kg PCE/ 100 kg clothes)	Solid waste (kg PCE/ 100 kg clothes)	Aqueous emissions (kg PCE/ 100 kg clothes)	Miscellaneous solvent losses (kg PC/100 kg clothes)
A	Transfer	473 (1,040)	5.37	0.2	4.6	0.96[b]	-	4.21
B	"Kissing" Machine	1,750 (3,850)	2.35	0.002	7.7	0.026[c]	0.026[d]	0.47 - Still vents and storage tanks vents 0.78 - Washer loading exhaust 1.05 - Fugitive emissions
C	Dry-to-dry	168 (369)	2.12	0.7	23.0[e]	0.6[f]	-	0.82
D	Dry-to-dry	184 (404)	7.47	0.1	3.3	2.73[f]	-	4.64
E	Dry-to-dry	107 (236)	3.85[g]	-	-	-	-	-

[a] Source: References 1, 2, 4-9.

[b] Muck cooker sludge samples were analyzed.

[c] Oil cooker residue samples were analyzed.

[d] These aqueous emissions were from the water separators and were discharged directly to the sewer.

[e] Inlet PCE concentration is high because this system does not include a condenser between the dry and carbon adsorber, which is an uncommon design.

[f] This figure represents PCE losses from spent cartridge filters.

[g] This plant is a closed system so actual emissions could not be measured; the figure shown represents net usage of solvent for the duration of the test.

TABLE C-2. SUMMARY OF PERCHLOROETHYLENE DRY CLEANING CONTROL DEVICE EFFICIENCY TEST DATA[a]

Plant	Dry cleaning system description[b] (units vented)	Control device throughput (kg clothes/day [lb clothes/day])	Control device inlet concentration (ppm)	Control outlet concentration (ppm)	Control device efficiency (%)	Estimated size of control device (floor space) m^2 [ft^2])
A	Transfer, commercial (washer door, dryer, floor vents)	473 (1,140)	600	20	96	3.7 (40)
B	"Kissing" machine industrial (washer door, dryer)	1,750 (3,850)	5,300-6,500	3	99	5.6 (60)
C	Dry-to-dry, commercial dry-to-dry machine (dry-to-dry machine door, floor vents)	168 (369)	3,300	100[c]	97	1.1 (12)
D	Dry-to-dry, commercial machine (dry-to-dry machine)[c]	184 (404)	400	11	97	1.5 (16)
E	Dry-to-dry, commercial machine with multi-pass refrigerated condenser	107 (236)	9,900	8,800	14[d]	0.4 (4.4)

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[a] Source: References 1, 2, 4-9.

[b] Components venting to the control device are shown in parentheses.

[c] Semi-continuous monitoring of the carbon adsorber outlet indicated that the carbon bed became saturated during the dry cleaning process.

[d] This is the efficiency for a single-pass refrigerated condenser. Actual efficiency achieved by the multi-pass configuration is much higher.

the Washex Machinery Corporation, two dryers, two solvent tanks, a muck cooker, and a dual-canister carbon adsorber manufactured by VIC Manufacturing Company. The system was installed in 1967. Testing was conducted in November 1975.[1] Emissions from the washer door vent, the dryers, and the floor vents are vented to the carbon adsorber. Figure C-1 illustrates the process equipment and emission points for Plant A. During the testing program, the plant water-proofed and flame-proofed several loads of materials. These operations are not typical dry cleaning services. The addition of water-repellant and flame-retardant solutions during the wash cycle was accounted for in material balance calculations.

Test results indicate total solvent losses of 5.37 kg of PCE per 100 kg of clothes (5.37 lb PCE/100 lb of clothes) cleaned (refer to Table C-1). Vented emissions from the carbon adsorber outlet averaged about 0.2 kg PCE/100 kg of clothes (0.2 lb PCE/100 lb of clothes). The inlet to the carbon adsorber measured approximately 4.6 kg PCE/100 kg of clothes. Thus, as shown in Table C-2, the carbon adsorber was achieving a 96 percent removal efficiency.

Sludge samples from the muck cooker contained 0.96 kg PCE/100 kg of clothes (0.96 lb PCE/100 lb of clothes).

Based on observations during the test, housekeeping practices at Plant A were poor. Liquid leaks were sighted and buckets of solvent on the outlets of the water separators were left uncovered. The scent of PCE was prevalent throughout the plant. These unquantified emissions, as well as aqueous emissions from the water separators and vapor emissions during clothing transfer from the washer to the dryer, totaled 4.21 kg PCE/100 kg of clothes (4.21 lb PCE/100 lb of clothes).

C.2 PLANT B

Plant B is an industrial PCE dry cleaning plant. The plant, located in San Antonio, Texas, began operation in 1957 and was tested in March 1976.[4] The dry cleaning system, installed between 1970 and 1975, is an American Laundry Machinery system that includes a washer/extractor with a capacity of 136 kg

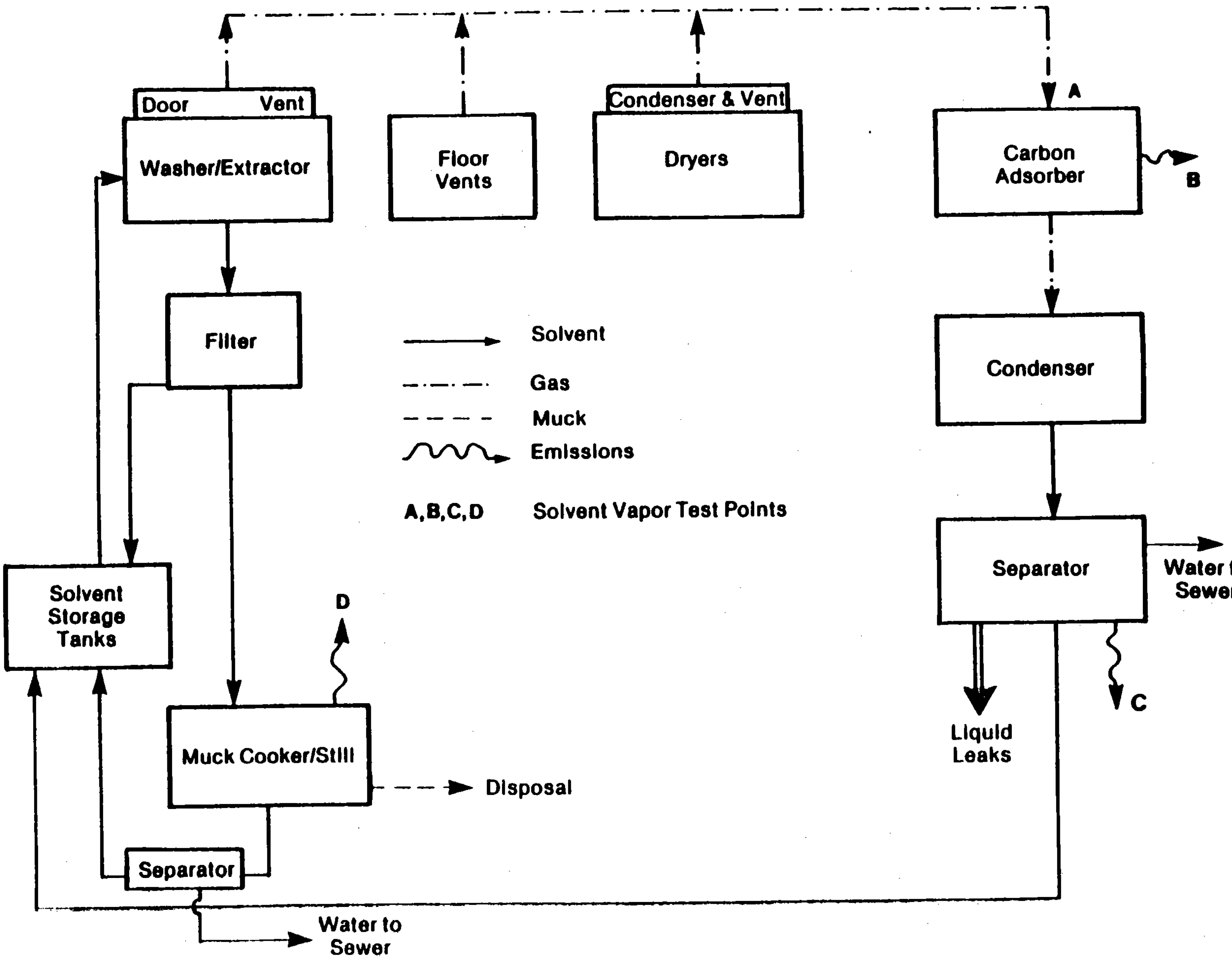

Figure C-1. Flow diagram of Plant A.

(300 lb), a "kissing" dryer, distillation unit, muck cooker and single-bed carbon adsorber (refer to Figure C-2). Only emissions from the washer and dryer are vented to the adsorber. The carbon adsorption unit collects PCE during clothing transfer, aeration, and dryer unloading. Figure C-2 illustrates the process equipment and emission points for Plant B.

The "kissing" washer/dryer is uncommon in the dry cleaning industry. At the end of the wash cycle, the dryer is pneumatically rolled to within 0.3 meters (approximately 1 ft) of the washer, both doors are opened, and operators pull clothes from the washer to the dryer. This design reduces the time that PCE-laden clothes are exposed to the workspace compared to standard transfer systems. During the transfer operation, exhaust fans inside both the washer/extractor and the dryer operate to divert emissions of PCE from the room to the atmosphere.

Test results in Table C-1 show a total solvent loss of approximately 2.35 kg of PCE per 100 kg of clothes (2.35 lb PCE/100 lb of clothes) cleaned. Vented emissions from the adsorber averaged about 0.002 kg PCE/100 kg of clothes (0.002 lb PCE/100 lb of clothes). The inlet to the carbon adsorber measured 7.7 kg PCE/100 kg of clothes (7.7 lb PCE/100 lb of clothes). Thus, as shown in Table C-2, the adsorber achieved greater than 99 percent removal efficiency. Most of the PCE emissions were from a washer-loading exhaust, a distillation unit vent, and a muck cooker vent. The washer-loading exhaust is vented to the atmosphere during loading of the washer drum. The distillation unit and muck cooker are vented through a water-cooled condenser to the atmosphere. Samples were taken of these sources and total average emissions were 1.25 kg PCE per 100 kg of clothes cleaned (1.25 lb PCE/100 lb of clothes).

Exemplary housekeeping practices were followed at the plant, thereby reducing fugitive emissions. No solvent leaks were detected by sight or smell. Miscellaneous solvent losses totaled 1.08 kg PCE per 100 kg of clothes cleaned (1.08 lb PCE/100 lb of

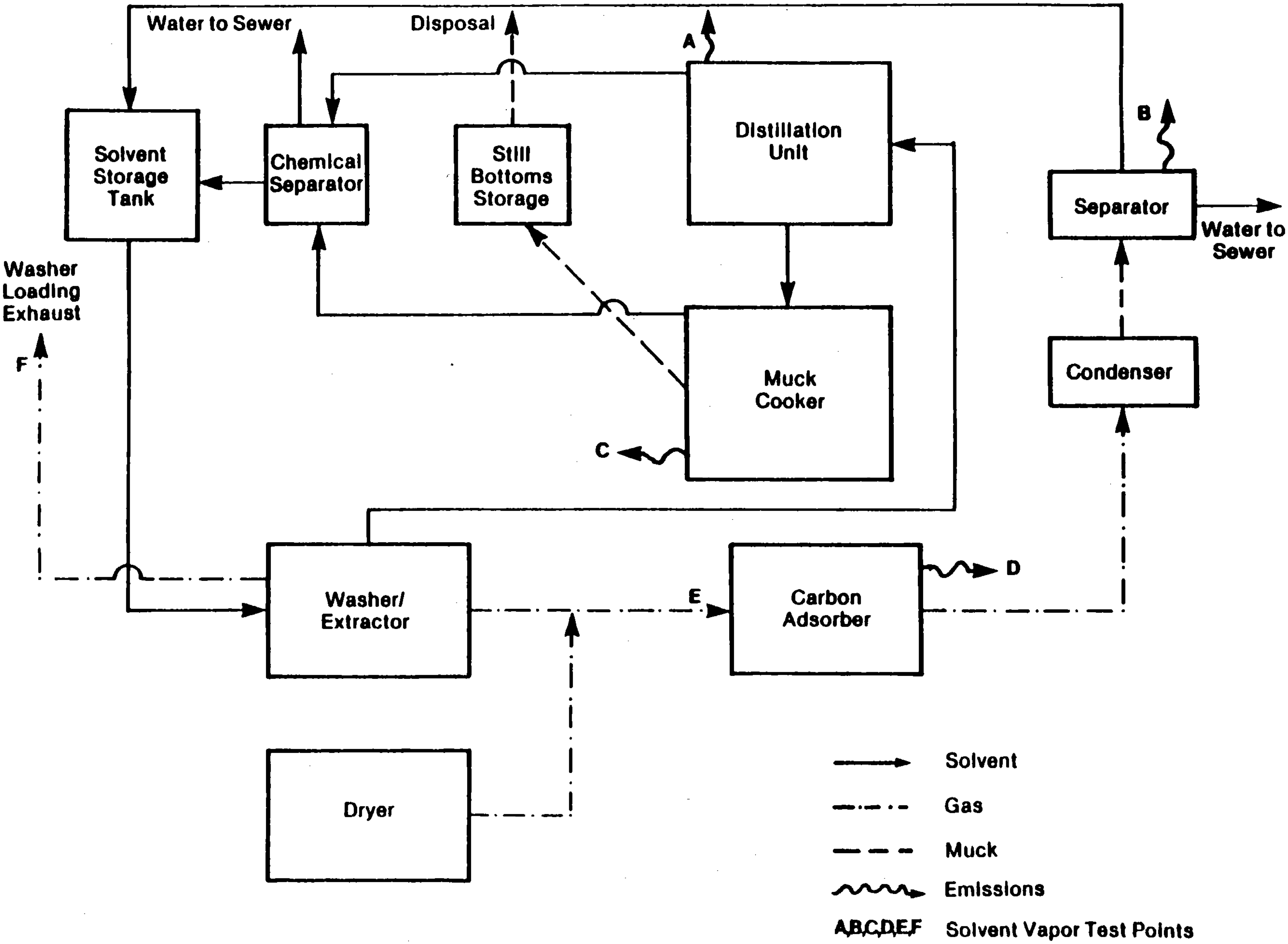

Figure C-2. Flow diagram of Plant B.

clothes). Of this amount, 0.026 kg PCE/100 kg of clothes (0.026 lb PCE/100 lb of clothes) were aqueous emissions from water separators, and the remainder were unquantified fugitive emissions and muck cooker solid waste.

C.3 PLANT C

Plant C is a commercial PCE plant located in Kalamazoo, Michigan. Testing was performed in April 1976.[6] Plant C includes a dry-to-dry VIC Model 221 Strato system with a capacity of 18 kilograms (40 lb). This is an average-size commercial dry-to-dry machine. The plant also includes a dual-canister carbon adsorber and a disposable 14-cartridge paper filter. The dry cleaning machine vents to the carbon adsorber during the drying cycle and open door cycle. Floor vents are connected to the carbon adsorber, also. The cartridge filter purifies PCE after the wash cycle. Figure C-3 illustrates the process equipment and emission points for Plant C.

Test results yielded an emission rate of 2.12 kg of PCE per 100 kg of clothes cleaned (2.12 lb/100 lb of clothes). Because there is no condenser between the dryer and carbon adsorber to collect PCE, the PCE concentration at the inlet of the carbon adsorber averaged 23.0 kg PCE/100 kg of clothes cleaned (23.0 lb PCE/100 lb of clothes). Emissions from the carbon adsorber outlet averaged 0.7 kg PCE/100 kg of clothes cleaned (0.7 lb PCE/100 kg of clothes). As shown in Table C-2, the carbon adsorber achieved an efficiency of 97 percent. Cartridge filter losses, determined by weighing used filters before and after the PCE had evaporated from them, amounted to 0.6 kg PCE/100 kg of clothes cleaned (0.6 lb PCE/100 lb of clothes). Unquantified fugitive emissions and aqueous emissions from the water separator were 0.82 kg of PCE/100 kg of clothes (0.82 lb PCE/100 lb of clothes).

C.4 PLANT D

Plant D is a commercial PCE dry cleaning plant located in Cortland, New York (Figure C-4). Testing was performed in March 1979.[8] The plant uses a dry-to-dry machine with a capacity of 20 kg (45 lb). The machine, a Detrex Model 11-20-H, was

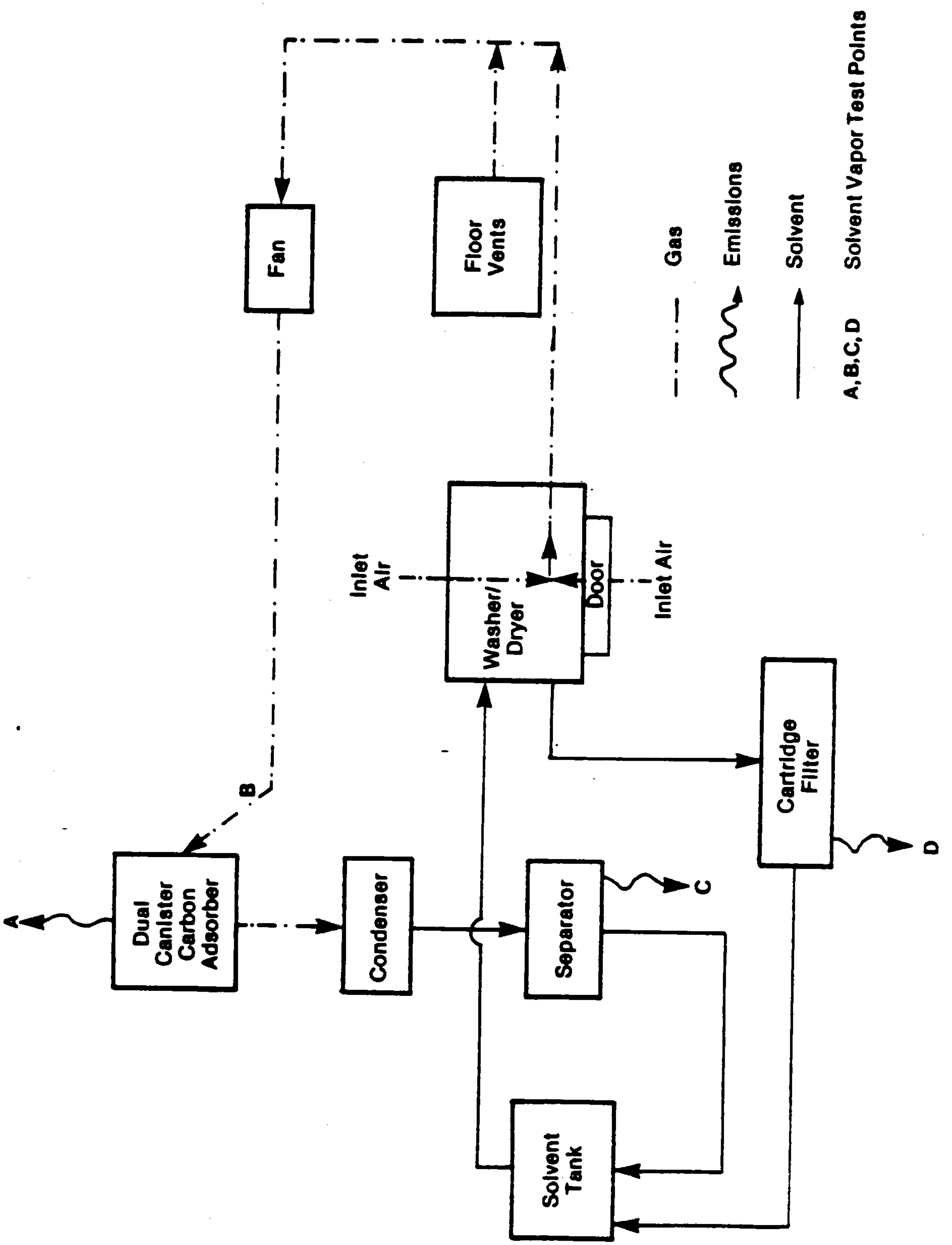

Figure C-3. Flow diagram of Plant C.

installed in 1976. The dry cleaning system uses a Kleen-Rite (model #34-1200) disposable cartridge filter system for purifying the PCE. A 17-year-old Hoyt Model I carbon adsorber (with the original carbon) receives emissions from the dry cleaning machine only during the aeration and open-door cycles.

Test results (refer to Tables C-1 and C-2) indicate a total emission rate of 7.47 kg of PCE per 100 kg of clothes cleaned (7.47 lb PCE/100 lb of clothes). Emissions from the carbon adsorber outlet averaged about 0.1 kg PCE/100 kg of clothes (0.1 lb PCE/100 lb of clothes). The inlet to the carbon adsorber averaged approximately 3.3 kg PCE/100 kg of clothes cleaned (3.3 lb PCE/100 lb of clothes) when the carbon adsorber was desorbed daily. Therefore, the adsorber was achieving a 97 percent removal efficiency. This system demonstrated that carbon adsorption can achieve high removal efficiencies even with older carbon beds, as long as the bed is desorbed frequently. In this test, when the adsorber Figure C-3 was desorbed the day before, the efficiency was 97 percent and the adsorber outlet concentration never exceeded 25 ppm. When the bed was not desorbed the day before, carbon bed breakthrough occurred. The efficiency dropped to 83 percent and the adsorber outlet concentration reached 100 ppm.

The majority of losses from this dry cleaning system came from the cartridge filters. Cartridge filter losses were determined by weighing used filters before and after the PCE had evaporated from them. The PCE loss from the cartridge filters was 2.73 kg/100 kg throughput (2.73 lb/100 lb throughput), which represents over one-third of the total losses.

The remainder of the emissions were attributed to fugitive emissions, including leaks from valves in the solvent lines to the filters. Enough PCE leaked during the night to form a small puddle on the base tank of the machine. Fugitive losses totaled 4.64 kg PCE/100 kg of clothes (4.64 lb PCE/100 lb of clothes).

C.5 PLANT E

Plant E is a commercial PCE dry cleaning plant located in Northvale, New Jersey. The dry cleaning equipment at this plant

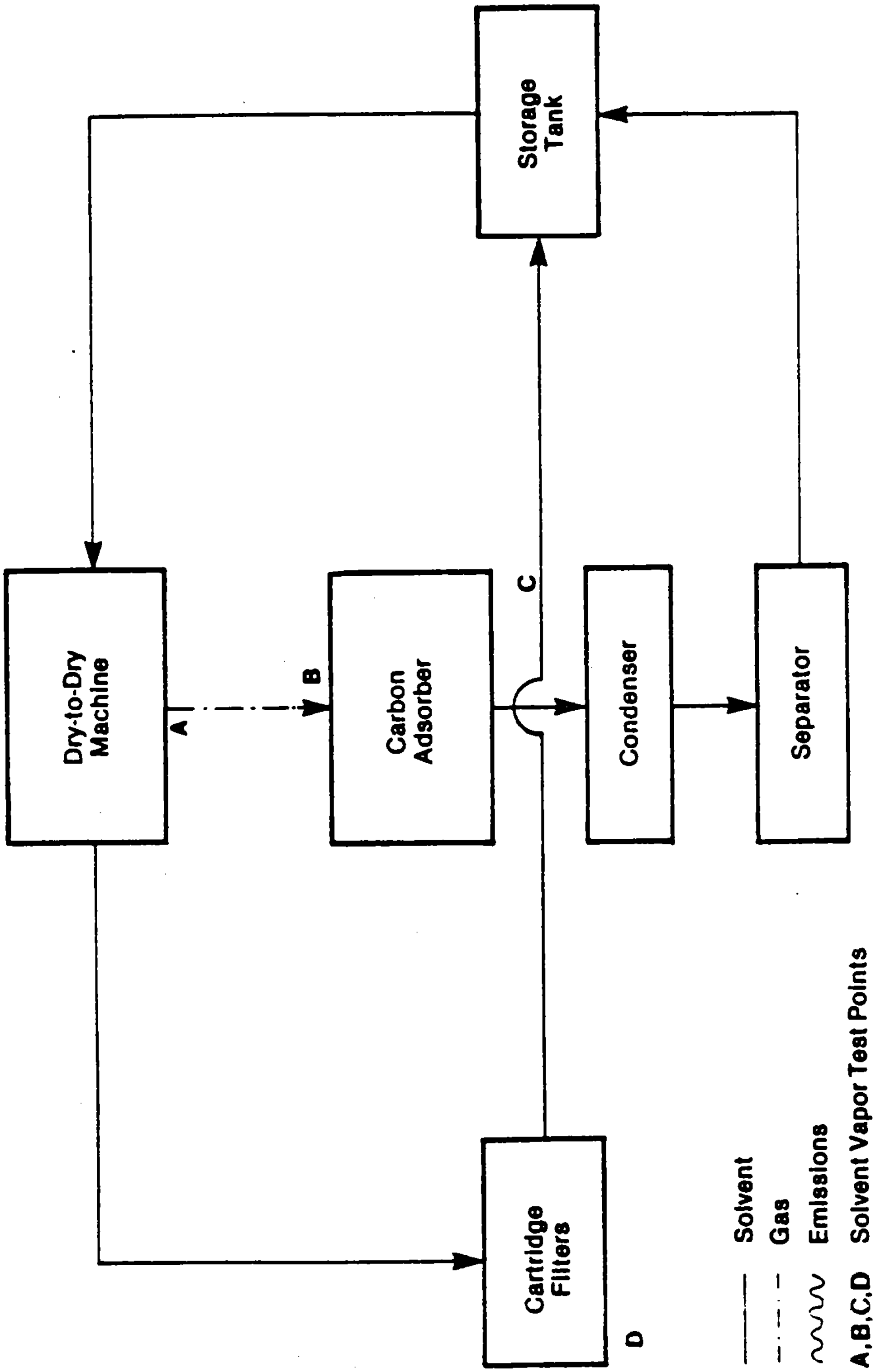

Figure C-4. Flow diagram of Plant D.

consists of a Neil and Spencer Limited dry-to-dry machine and a refrigerated condenser. The plant was estimated to be 5 years old, whereas the dry cleaning machine was 6 months old at the time of testing in June 1979.[9] The dry cleaning machine had a rated capacity of 30 kg (65 lb). The refrigerated condenser was designed to serve up to a 30-kg (65-lb) machine.

Inlet and outlet concentrations to the dryer were measured. However, because the system is completely closed, emissions from the process could not be measured. Although an emissions removal efficiency has been calculated for a single-pass control device, this condenser is a closed system with a multi-pass configuration, so its removal efficiency is expected to be much higher. Net usage of PCE during the duration of the test was 3.85 kg PCE/100 kg of clothes cleaned (3.85 lb PCE/100 lb of clothes cleaned).[10] Thus, when fugitive and filter losses are minimal, refrigerated condensers can achieve solvent loss rates equivalent to carbon adsorber-equipped facilities.

Four documented but unquantified leaks existed at the plant. Vapor leaks occurred at a muck drain valve, the water separator lid, and a connecting valve between the dryer and condenser. Liquid PCE leaked from the base of the dryer drum.

C.6 REFERENCES

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APPENDIX D

EMISSION MEASUREMENT AND MONITORING

APPENDIX D

EMISSION MEASUREMENT AND MONITORING

D.1 EMISSION MEASUREMENT METHODS

D.1.1 Emission Measurement Method for Perchloroethylene from Exhaust Vents

The primary method used to gather perchloroethylene emissions data from exhaust vents has been an integrated bag sampling procedure followed by gas chromatographic/flame ionization detector analysis (GC/FID). Conditional Test Method 011 (CTM-011), distributed by the Emission Measurement Technical Information Center (EMTIC), entitled "Determination of Halogenated Organics from Stationary Sources," describes this approach. For this method, the integrated bag sampling technique was chosen over charcoal adsorption tubes for two reasons: (1) less uncertainty about sample recovery efficiency, and (2) only one sample portion to analyze per sample run. A GC column is employed that has been recommended by a major manufacturer of chromatographic equipment as useful for the separation of chlorinated solvents.

The method was written after an initial EPA-funded study of halogenated techniques identified the need. In particular, the study cited leaking bags and bag containers as probable cause of poor correlation between integrated and grab samples taken from an emission site. In light of these findings, more rigorous leak-check procedures were incorporated into the original method. The subsequent test conducted by EPA with the improved method compared both integrated bag and grab sampling techniques in order to gather quality control data. The test showed very good correlation between the two techniques.

In the EPA tests, all nonmethane hydrocarbon peaks were summed to yield a total value. Since perchloroethylene was anticipated to be the major constituent, all calibrations and calculations were based on perchloroethylene standards. In the three tests performed by EPA, little, if any, nonmethane hydrocarbon other than perchloroethylene was measured.

With slight modifications as noted in the test reports, velocity measurements on inlet and outlet ducts were done according to EPA Test Methods 1 and 2.

D.1.2 Perchloroethylene from Still Residues and Wet Waste Material from Regenerable Filters

The method used to determine perchloroethylene content in the still residues and wet waste material from regenerable filters has been a distillation procedure. Conditional Test Method 010 (CTM-010), distributed by the EMTIC, entitled "Determination of Perchloroethylene Content of Wet Waste Materials from Filters and Still Bottoms," describes this approach. A known sample mass is mixed with water and placed in a glass still equipped with a Liebig* straight-tube type reflux condenser and a Bidwell-Sterling* type graduated trap. Water and perchloroethylene in the sample are separated through repeated distillation until all the perchloroethylene has been recovered in the trap and the volume recorded. The mass of perchloroethylene collected is determined from the product of its volume and specific gravity. The total weight of perchloroethylene obtained is divided by the total weight of sample analyzed to obtain the perchloroethylene content of the wet waste residue.

D.2 LEAK DETECTION MONITORING

Hand-held halogen detectors are currently available for leak monitoring in dry cleaning facilities. The detectors respond to gases containing chloride. The TIF* detector uses a computer-like beeping sound that increases in both speed and frequency as the leak source is approached. The detector also automatically recalibrates itself when turned off and on. The cost of a monitoring instrument ranges from about $130 to $200 depending on the operating features and accessories.

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*The mention of a trade name or specific product does not constitute endorsement by the Environmental Protection Agency.

D.3 PERFORMANCE TEST METHODS

D.3.1 Perchloroethylene from Exhaust Vents

The CTM-011, "Determination of Halogenated Organics from Stationary Sources," is recommended as the emission test method for exhaust vents. An improved leak check procedure has been added to CTM-011, at the suggestion of an EPA contractor who studied the vinyl chloride test method. This contractor coincidentally performed the second and third dry cleaning emission data tests and was previously aware of the need for exercising particular caution with respect to leak detection. No significant problems with the use of CTM-011 are expected, provided that strict adherence is given to the leak-check procedures.

The costs for conducting a CTM-011 emission test in triplicate by a source testing contractor will depend on the length of the process cleaning cycle and the distance travelled by testing personnel, and are accordingly estimated at $3,000 to $5,000 for single unit installation. The testing cost per unit would be lower if several units at a single site were serially tested.

D.3.2 Perchloroethylene from Still Residues and Wet Waste Material from Regenerable Filters

The CTM-010 test method as described in D.1.2 is recommended as the performance test method. No problems are anticipated with the use of this method.

The cost for conducting the analytical portion of this test on triplicate samples is estimated at $200.

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16. ABSTRACT

National emission standards for the control of hazardous air pollutant emissions from the dry cleaning industry are being proposed under the authority of Section 112 of the Clean Air Act, as amended. These standards apply to existing and new dry cleaning facilities, the construction or reconstruction of which began on or after the date of proposal. This document contains a summary of the technical information used to support development of the standards. This document also discusses the regulatory alternatives considered during development of the proposed standards and the environmental and cost impacts associated with each alternative. A detailed "Economic Impact Analysis of Regulatory Controls in the Dry Cleaning Industry" is contained in EPA-450/3-91-021 dated October 1991.

17. KEY WORDS AND DOCUMENT ANALYSIS

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