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Pollution Prevention and the Clean Air Act:

*Benefits and Opportunities for
Federal Facilities -- Volume II*

Part I Cleaning and Degreasing
Part II Painting and Depainting

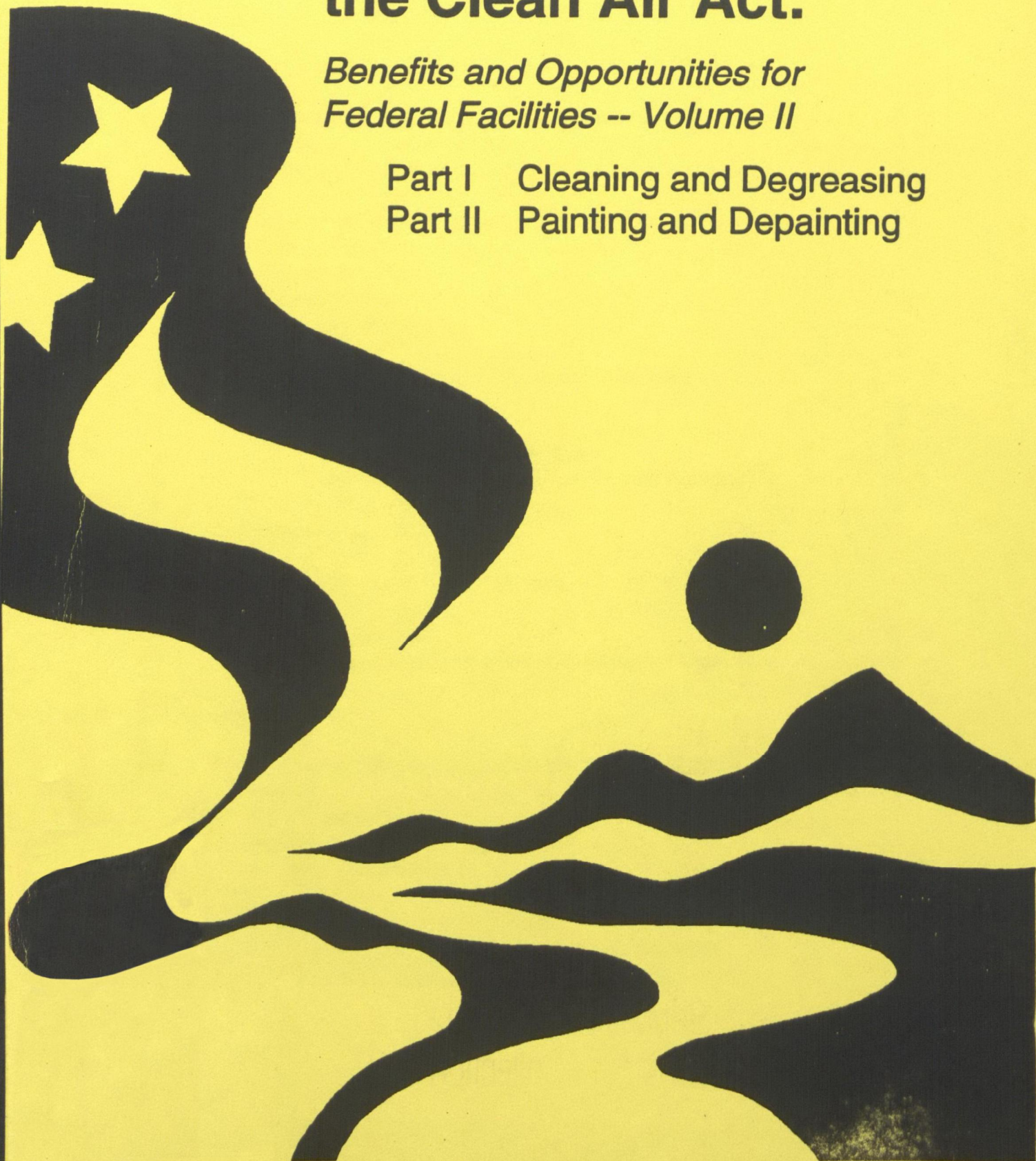


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EXECUTIVE SUMMARY

Federal facilities are under increased scrutiny to control their use of chemical solvents to meet requirements under the Clean Air Act. Opportunities exist to move away from the use of regulated solvents through the use of pollution preventative approaches.

Several programs established under the Clean Air Act limit the use of solvents. These programs are intended to control:

- **Volatile Organic Compounds (VOCs)** which react in the atmosphere and contribute to ground level ozone formation. A National Ambient Air Quality Standard (NAAQS) has been set to protect public health from ozone. This standard is exceeded in major urban areas (Los Angeles, Houston, etc.) and in extended geographic areas (Northeast Corridor). States are required to control VOC emissions in these areas. Cleaning and degreasing processes and painting and repainting activities are traditionally major users of VOCs.
- **Hazardous Air Pollutants (HAPs)**, listed substances with potentially significant health effects. HAP air emissions are to be reduced through the application of Maximum Achievable Control Technology (MACT) standards to major stationary sources. MACT standards have been set for cleaning and degreasing and for painting and repainting in the aerospace industry. MACT standards have also been set for cleaning and degreasing processes using halogenated solvents. Additional MACT standards have been proposed for painting and repainting activities in the shipbuilding and ship repair, and wood furniture manufacturing industries.
- **Ozone Depleting Chemicals (ODCs)** which react in the stratosphere and destroy the ozone layer. The production and use of the most significant ODCs, the Class I chemicals, is to end by January 1, 1996. ODCs are used in cleaning and degreasing processes. They have had limited use in painting formulations.

These programs create limits which can be met through the use of control equipment, or through the use of alternative processes and substitute materials or pollution prevention.

Federal facilities have the opportunity to investigate pollution preventative approaches when developing strategies to comply with the requirements of the Clean Air Act. Examples include:

- Replacing vapor degreasers and cold cleaners with aqueous cleaning systems;
- Converting to powder coatings from conventional solvent-based spray coatings;
- Using media blasting instead of chemical-based paint strippers.

In these examples, the applicability of the Clean Air Act is eliminated including the associated compliance demonstration burdens for monitoring, recordkeeping, and reporting. Eliminating emissions means the elimination of emission fees. Potential additional benefits include reduced material costs, elimination of worker exposure to solvents, reduced expenses for protecting workers, elimination of hazardous waste streams, and potential labor savings.

This report provides information on the applicability of specific Clean Air Act requirements to these processes and identifies sources of information on pollution prevention opportunities. Pollution prevention examples are identified. Federal facilities are encouraged to investigate the pollution preventative approaches available for complying with the Clean Air Act requirements for cleaning and degreasing and for painting and depainting activities.

INTRODUCTION

This is the second of two reports that form a pilot effort to provide information to environmental management personnel at Federal facilities to assist in their decision making process on how to comply with the Clean Air Act. The first report, "Pollution Prevention and the Clean Air Act: Benefits and Opportunities for Federal Facilities," provides an overview of the breadth and scope of programs established under the Clean Air Act and describes how Federal facilities can incorporate pollution prevention approaches into compliance decision making. This report summarizes the applicability of the Clean Air Act as it applies to cleaning and degreasing activities in Part I, and to painting and repainting activities in Part II. Cleaning and degreasing and painting and repainting processes are the focus of this report because they traditionally rely on the use of organic solvents. Opportunities exist to move away from the use of organic solvents through pollution preventative approaches.

The mission of Federal facilities often requires the use of processes which lead to waste generation. The fabrication, maintenance and repair of mechanical and electrical equipment are routine processes at Federal sites. These processes typically include cleaning and degreasing and painting and repainting steps that can produce air emissions that must be managed under the Clean Air Act. This report profiles how the Clean Air Act regulates these operations, and more importantly, how pollution preventative approaches to complying with Clean Air Act requirements can lead to reduced costs and material consumption rates, improved workplace environments, and potentially eliminate the applicability of Clean Air Act requirements altogether. Investing in alternatives that reduce or eliminate waste generation can make life more tolerable under the Clean Air Act.

EPA has defined pollution prevention as "source reduction" consistent with the Pollution Prevention Act. Pollution preventative approaches are those activities which reduce the generation of waste at the source. This includes changes in raw materials, operating practices and processes which result in the reduced use or the reduced release of toxic materials. The Pollution Prevention Act established a "waste management hierarchy" with a clear first preference for pollution prevention or source reduction. Under this hierarchy, if source reduction options are not available, then consideration should be given to environmentally sound recycling of waste. If pollution prevention and recycling are not feasible, then treatment options followed by safe disposal should be considered as the least desirable choice for waste management. This report focuses on the opportunities for the preferred option, source reduction.

In many instances cleaning and degreasing and painting and repainting processes depend on the use of organic solvents, many of which are receiving considerable attention by environmental programs, including those of the Clean Air Act. Volatile Organic Compounds (VOCs), Hazardous Air Pollutants (HAPS), and Ozone Depleting Compounds (ODCs) are regulatory terms for chemicals whose use is limited by the Clean Air Act. In many settings, facilities are taking steps to get out from under the regulatory burdens associated with these substances through the implementation of pollution preventative alternatives. These alternatives

allow process operators to achieve the same endpoint, but without the use of these targeted compounds. By eliminating the use of these regulated materials, the need to consider the use of control systems and to continually demonstrate compliance with applicable requirements are also eliminated. Significant savings of time and resources can be achieved by reducing permitting, monitoring, recordkeeping, and reporting compliance burdens associated with Clean Air Act limitations.

There are no "cookbook" approaches to implementing pollution prevention. Every operation has unique needs; careful consideration is required. For degreasing and cleaning, consideration must be given to the nature of the substrate to be cleaned, potential contaminants, and the degree of cleanliness required for the next processing step. In some instances, the need to clean altogether can be eliminated using no-clean production technologies. For painting and repainting, consideration must be given to the properties of the specific substrate and the requirements for the coating used. This report provides information sources to assist Federal facilities in their investigation of preventative alternatives to meet Clean Air Act requirements.

Part I Cleaning and Degreasing

CHAPTER 1

CLEANING- AND DEGREASING- SPECIFIC ENVIRONMENTAL FACTORS

CLEANING AND DEGREASING PROCESS

Cleaning and degreasing processes remove from surfaces undesirable materials which might interfere with the further processing or appearance of a substrate or part. Common contaminants include oil, grease, dirt, dusts, and processing aids. Processing aids include cutting fluids, fluxes, and polishing compounds. Solvents are typically used to clean these surfaces in combination with a variety of cleaning technologies. The choice of solvent and cleaning technology is a function of the characteristics of the substrate to be cleaned, the contaminant to be removed, and the performance or cleanliness expectations.

Cleaning and degreasing processes are generally characterized by whether the solvent cleans as a liquid or as a vapor, and by the type of process: spot or wipe cleaning, batch operation, or a continuous, in-line, process.

The term "cold cleaning" refers to processes where solvent, as a liquid, contacts the part's surface to clean. Cold cleaning can be spot, batch, or continuous. Cold cleaners operate below the solvent's boiling point temperature, typically slightly above room temperature. Cold cleaners range from simple dip tanks to automated washing machines operating much like a household dishwasher. The solvent in cold cleaners dissolves and/or mechanically removes the impurities.

"Vapor degreasing", on the other hand, relies on vapor contact with the surface to be cleaned. The liquid solvent is heated above its boiling point to generate a vapor phase. The parts are suspended in this vapor phase. The vapor condenses on the part's surface and drips back into the boiling liquid carrying the impurities with it. Vapor degreasers operate as batch processes, in heated, open tanks, such as an open top vapor degreaser, or as a continuous process, such as a conveyORIZED cleaning unit.

Cleaning solvents are chosen based on consideration of available cleaning equipment, compatibility of solvents to the substrate for cleaning, the effectiveness of the solvent in attacking the impurities of concern, and the degree of cleaning required. The integrity of the substrate must not be altered by the cleaning solvent. Environmental considerations such as the Clean Air Act requirements are also impacting the selection of cleaning technologies and solvents.

ENVIRONMENTAL FACTORS

Emissions from cleaning operations are a concern to workers operating the equipment and to the ambient air in the community. Some cleaning solvents are flammable, potentially explosive, and their use requires special precautions to protect the health and safety of workers. Many solvents used in cleaning and degreasing processes are also regulated by the Occupational Safety and Health Administration to limit exposure to workers. Their use also leads to the generation of hazardous wastes.

Solvent vapors can escape cleaning units as a fugitive release into the workplace and out building vents into the environment. To protect workers in cleaning and degreasing activities, engineering controls such as local exhaust ventilation systems can be necessary to reduce solvent concentration levels. Personal protective equipment, such as gloves and respirators, may also be necessary for some chemicals and cleaning technologies. The use of personal protective equipment necessitates proper training of workers on how to use the equipment, such as proper fitting of respirators or selection of glove material, and maintenance of the equipment. Pollution preventative approaches can eliminate the use of solvents of concern and lessen the need for these added controls and requirements to protect workers.

CHAPTER 2

CLEANING AND DEGREASING SOLVENTS AND THE CLEAN AIR ACT

A variety of solvents have been used in cleaning and degreasing: halogenated solvents, aromatic compounds, alcohols, etc. Solvents in each of these categories have been the subject of regulations under the Clean Air Act - as VOCs, HAPs, and ODCs. The requirements under Clean Air Act programs which control the use of these solvents continue to evolve. The development of pollution preventative techniques for these processes is in part driven by the opportunity to meet the same process needs but without dependence on compounds regulated under the Clean Air Act. Using regulated compounds not only brings the burden of controlling their use, but also the need to obtain permits, pay emission fees and continually demonstrate compliance through monitoring, testing, reporting and recordkeeping. This chapter describes how solvents in each of these processes are regulated.

CLEAN AIR ACT PROGRAMS

Table 1 shows the primary solvent categories and some of the dominant solvents used in each category. The specific Clean Air Act programs which limit the use of these solvents are also identified by the chemical regulatory category. Many of these solvents are also subject to reporting releases and waste generation to the Toxic Release Inventory (TRI) under the Emergency Response and Community Right-to-Know Act (EPCRA). For Federal facilities, the TRI will be the measure of progress in meeting the pollution prevention planning requirements of Executive Order 12856. Table 1 indicates the applicability of the TRI program to these solvents as well.

Control of VOCs

VOCs are regulated under the Clean Air Act because they react in the atmosphere with nitrogen oxides and produce ground level ozone. A VOC is considered any organic compound that will react in the atmosphere. This includes all organic compounds except a list of "exempt" solvents (methane, ethane and several halogenated solvents) with negligible reactivity in the atmosphere. An ambient Air Quality Standard (NAAQS) for ozone was been established under Title I of the Clean Air Act to protect public health. Emissions of VOCs and nitrogen oxides are to be reduced in geographic areas not meeting this ambient standard, the so called "non-attainment areas."

TABLE 1

**APPLICABILITY OF THE CLEAN AIR ACT AND TOXIC RELEASE INVENTORY
REPORTING REQUIREMENTS TO CLEANING AND DEGREASING SOLVENTS**

Solvent Category/Example	Clean Air Act Applicability			TRI
	VOC	HAP	ODC	
CHLOROFLUOROCARBONS (CFCs)				
CFC-113			Class I	X
HYDROCHLOROFLUOROCARBONS (HCFCs)				
HCFC-225			Class II	X
HALOGENATED SOLVENTS				
Methyl Chloroform (1, 1, 1 Trichloroethane)		X	Class I	X
Carbon Tetrachloride		X	Class I	X
Methylene Chloride		X		X
Perchloroethylene	X ¹	X		X
Trichloroethylene		X		X
KETONES				
Methyl Ethyl Ketone	X	X		X
Methyl Isobutyl Ketone	X	X		X
Acetone ²				
ALCOHOLS				
Methanol	X			X
Ethanol	X			
Isopropanol	X			

¹Perchloroethylene was proposed for exclusion from the definition of a VOC (10/26/92, 57 FR 48490). No further action has been taken on this proposed change to date.

²Acetone was excluded from the definition of a VOC (6/16/95, 60FR31633); Acetone was also removed from the TRI list (6/16/95, 60FR31643).

TABLE 1 -- continued

Solvent Category/Example	Clean Air Act Applicability			TRI
	VOC	HAP	ODC	
AROMATIC HYDROCARBONS				
Toluene	X	X		X
Xylene	X	X		X
ALIPHATIC HYDROCARBONS				
Mineral Spirits	X			
Naptha	X			
OTHER CATEGORIES AND COMPOUNDS				
N-Methyl Pyrrolidone	X			
Glycol Ethers	X	X ¹		X ²
Terpenes	X			

VOC - Volatile Organic Compound, regulated under the non-attainment provisions of Title I of the Clean Air Act.

HAP - Hazardous Air Pollutant, regulated under the air toxics provisions of Title III of the Clean Air Act.

ODC - Ozone Depleting Compound, regulated under the stratospheric ozone protection provisions of Title VI of the Clean Air Act.

TRI - Toxic Release Inventory; annual reporting of releases to the environment required for TRI chemicals under the Emergency Response and Community Right-to-Know Act (EPCRA).

¹ Both the Hap and TRI lists identify Glycol Ethers as a chemical category for those Glycol Ethers which are derivatives of Mono-, Di-, or Tri-Ethylene Glycol. Ethylene Glycol is also listed as an individual compound on both lists.

States are required to develop air quality management plans or State Implementation Plans (SIPs) to achieve the NAAQSs in these non-attainment areas. These SIPs include requirements for the application of "reasonably available control technology" (RACT) to reduce emissions from VOC sources in the non-attainment areas.

EPA provides guidance to States on RACT through "Control Technique Guidelines (CTGs)". CTGs identify control approaches for VOC processes which are considered technically and economically feasible for facilities to implement. States generally implement RACT through rules which are State adopted and federally approved. These rules apply to industrial and commercial processes which emit VOC emissions. Most states' RACT rules include requirements for cleaning and degreasing processes.

The Clean Air Act also provides for the control of VOCs (and other pollutants) through the development of New Source Performance Standards (NSPSs) for new or modified equipment. These standards are developed for individual source categories, and reflect best available control technology at the time the standard was set. An NSPS has been proposed for use of non-halogenated solvents in immersion, cold cleaning machines to limit VOC emissions. (September 9, 1994, 59FR46602).

Control of HAPS

Title III of the 1990 Amendment to the Clean Air Act lists 189 chemicals (some are chemical categories) that are considered significant threats to public health. These chemicals and chemical categories are known as the hazardous air pollutants or HAPS. EPA is required to establish standards for categories of major sources emitting these chemicals which represent the maximum achievable control technology (MACT) for that operation. Major sources have the potential to emit 10 tons or more of an individual HAP or 25 tons or more of all HAPs in aggregate. These requirements apply to both new and existing sources. Major source categories have been identified and a ten year program through the year 2000 was initiated to develop MACT standards for these sources. Smaller sources of these pollutants may also be regulated through less stringent control requirements. If EPA fails to develop standards in accordance with the 10 year plan, States must control sources in their jurisdiction using case-by-case determination of MACT.

The Title III MACT standard program schedule will be difficult to meet; EPA's limited resources have lead to delays in developing some of the early MACT standards. State programs are likely to be required to develop MACT standards for some source categories in their jurisdiction. Source categories identified which require the development of MACT standards include cleaning and degreasing.

Control of ODCs

The Montreal Protocol, an international agreement phasing out ozone depleting substances, lead to the inclusion of Title VI of the Clean Air Act in the 1990 Amendments. The United States is committed to an accelerated phase out of the production and use of ozone depleting chemicals (ODCs). Federal agencies, through Executive Order 12843 (issued April 21, 1993) are encouraged to accelerate replacement of ODCs with safe alternatives and abide by the requirements of Title VI. Many US industries have established company goals to expedite the elimination of their use of ODCs.

The CAA defines ODCs in two groups, Class I, and Class II. Class I substances have the greatest ozone depleting potential. They include chlorofluorocarbons (CFCs), halons, methyl chloroform and carbon tetrachloride. Class II substances are hydrochlorofluorocarbons (HCFCs). For the U.S., the phaseout deadline for the production of Class I chemicals was set at January 1, 1996 (12/10/93, 58 FR 65018). The phaseout of Class II chemicals is required by January 1, 2015. As shown on Table 1, ODCs are used in degreasing and cleaning processes.

Procedures to implement Title VI of the CAA include the Significant New Alternatives Program (SNAP). The SNAP process reviews and lists acceptable and unacceptable substitutes for Class I and Class II substances. Use of substitutes may be authorized with use limitations. Rulemaking will be required when the use is restricted or unacceptable. EPA has prepared initial lists for known potential substitutes. Manufacturers of new substitutes must file a SNAP notice to EPA for approval and listing of new substitutes.

The listings are based on EPA's review of available information and determination whether the use of the substitute may present adverse effects to human health or the environment. The initial list of acceptable and unacceptable substitutes was published with the SNAP rule on March 18, 1994 (59 FR 13044). These lists were updated on August 26, 1994 (59 FR 44240), January 13, 1995 (60FR3318), June 13, 1995 (60FR31092), and July 28, 1995 (60FR38729). EPA anticipates quarterly additions and annual updates of the entire list.

Reporting to TRI

Reporting to the Toxic Release Inventory (TRI) is required for many of the solvents identified in Table 1. The TRI was created by the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA, also referred to as Title III, Superfund Amendments and Reauthorization Act (SARA)). Regulations for the TRI are at 40 CFR 372. The TRI requires submittal of annual reports on the releases and offsite transfers of over six hundred listed chemicals and chemical categories. The thresholds for reporting are 25,000 pounds manufactured and/or processed and 10,000 pounds otherwise used for each chemical listed. The 1990 Pollution Prevention Act (PPA) expanded the TRI reporting requirements to include information on waste generation and the use of source reduction and recycling to limit waste generation. A "Form R" is used for reporting. For 1987 through 1993 reporting was required for over three hundred chemicals and chemical categories. EPA then added 32 chemicals and 2 chemical categories to

the list of TRI substances, requiring reporting for the first time for calendar year 1994 (12/1/93, 58FR63496 and 58FR63500). An additional 286 chemicals were added for the 1995 calendar year reporting requirements (11/30/94, 59FR61432), bringing the number of listed chemicals to over 600.

Federal facilities must file TRI reports. Executive Order 12856 (dated August 3, 1993) established a pollution prevention planning process for Federal facilities, requiring all Federal facilities to comply with EPCRA. Initial reporting was required for the 1994 calendar year. The TRI reports will serve as the accounting system for demonstrating compliance with the pollution prevention goals established in EO 12856. With the 1994 reports, each federal facility defined their baseline release levels. They now must develop their pollution prevention strategy or facility plan to reduce these reported levels. The initial 1994 reports were due to EPA by July 1, 1995. Subsequent reports must be filed by the following July 1. The facility plans are due on December 31, 1995. The EO requires each Agency to achieve a 50 percent reduction in reported TRI releases in aggregate for all of their facilities by 1999. Implementation of individual facility plans are expected to collectively provide the necessary reductions in waste generation to achieve each agency's goals.

For many facilities, the chemicals in Table 1 will be major contributors to their baseline levels. Therefore, identifying preventative approaches to meeting Clean Air Act requirements will also benefit the development of pollution prevention plans and meeting their Agency's goals.

REQUIREMENTS FOR SOLVENT CLEANING AND DEGREASING

VOC Limitations

Many of the solvents used for cleaning and degreasing are VOCs (see Table 1) targeted for control. An estimated 33 States have regulated VOC solvent use in cleaning and degreasing. Many of the State regulations are patterned after an EPA CTG, "Control of Volatile Organic Emissions from Solvent Metal Cleaning" (EPA-450/2-77-022, November 1977), which recommended limits for VOC emissions.

State regulations generally apply to cold cleaning, vapor degreasing and conveyorized degreasing processes. The provisions are based on design and operating requirements, rather than emission limits, because of the difficulty in measuring emissions. The specific requirements in each State's regulation will have some different features. They may include applicability criteria based on minimum surface area of the cleaning unit (such as 10 square feet for cold cleaning units) or the physical/chemical property of the cleaning solvent (such as vapor pressure of 0.3 psi at 100°F). The thrust of these State regulations are summarized below.

Cold Cleaning. The regulation of VOCs from cold cleaners is generally based on design and operating requirements. Typical provisions require the use of a cover for the coldcleaning unit during periods of non-use, and facilities to provide for

draining parts prior to removal from unit. The addition of control equipment (for example, a carbon adsorption system) may be required if the solvent is heated.

Vapor Degreasing. Design and operating requirements include covers which open only for parts entry or exit from the unit to limit the spread of vapors; "free-board" minimum, that is the height above the vapor to the lip of the unit must equal or exceed, for example, 0.75 times the width of the unit; refrigerated condenser coils in the unit lid to recover vapors; or control systems to collect vapors such as a carbon adsorption system.

Conveyorized Degreasers. Facilities to minimize carry-out of solvent with parts by rotating parts in baskets and allowing sufficient time for drainage; vapor recovery through the use of chilled coils or capture and collection with a carbon adsorption system; and covers for the exit and entrance of the unit when not in use.

The purpose of these provisions is to limit the generation of solvent vapors, thereby controlling emissions. Add-on controls can be applied if the same degree of control can be demonstrated. Examples of pollution preventative approaches which eliminate the use of VOCs for many cleaning and degreasing requirements will be presented in Chapter 5.

HAP Rules

Several halogenated solvents used in cleaning processes and are listed have HAPs in the CAA (see Table 1). "Halogenated Solvent Cleaning" was listed as a category targeted for development of control limitations as required by the CAA (7/16/92, 57 FR 31592). On December 2, 1994 a MACT standard applicable to halogenated solvent cleaning was published by EPA (59FR 61805). A correction to this standard was published on June 5, 1995 (60FR29484).

"Aerospace Manufacturing and Rework Facilities" was also listed as a major source category. A MACT standard was published for this category on September 1, 1995 (60FR45948), which includes requirements for solvent cleaning and degreasing.

Halogenated Solvent Cleaning

The MACT standard controls the use of halogenated solvents in cleaning machines which are batch vapor phase units (such as open top vapor cleaners), and in-line (continuous) units based on cold or vapor phase cleaning. A separate standard was set for batch cold cleaners which requires covers and a water layer over the solvent. The majority of batch cold cleaning units do not use halogenated solvents. Halogenated solvent use in cold cleaners is believed to be limited to the use of methylene chloride in carburetor cleaning units.

The halogenated solvent MACT standard provides three options for the control of batch vapor and in-line cleaning units. Compliance with the standard can be demonstrated by meeting one of three sets of requirements:

- a. Stringent equipment design and operating practices with monitoring, recordkeeping and worker training to substantiate their use; or,
- b. Minimum equipment design and operating requirements and an emission limitation based on the surface area of the cleaning unit determined by a proposed reference test method; or,
- c. A three month rolling average limitation on solvent loss per unit surface area of the cleaning unit based on material balance through record keeping for quantities solvent added and removed from unit and specified calculation procedures.

The standard offers an array of options for the equipment design and operating requirements, each with a related set of monitoring requirements. These include consideration of freeboard ratio, cover designs, and freeboard refrigeration. Existing facilities must comply with this standard by December 2, 1997. New or modified facilities must meet this standard upon startup. For more detailed information on this MAC standard the reader is referred to the report "Guidance Document for the Halogenated Solvent Cleaner NESHAP" (EPA-453/R-94-081) and the published rule.

Aerospace Manufacturing and Rework Facilities

The MACT standard for the aerospace industry applies to new and existing commercial, civil and military manufacturing and rework facilities. The standard addresses a number of aerospace processes which may use HAPs including surface coating, depainting, and cleaning activities.

Cleaning activities covered by the standard include HAP solvent use in hand wipe, spray gun and flush cleaning operations. The standard establishes housekeeping requirements intended to limit HAP emissions from the storage of solvents and solvent laden cleaning materials including the use of containers which are designed to close and contain vapors. Solvent handling and transfer procedures designed to limit the potential for spills are also required.

Solvents used in hand-wipe cleaning must meet certain criteria. They either must be an aqueous formulation (at least 80 percent water), a hydrocarbon formulation containing no HAPs or ODCs with a vapor pressure of less than 7 mm Hg at 20°C, or any cleaning formulation with a vapor pressure less than 45 mm Hg at 20°C. Determination and recordkeeping of the cleaning solvents' constituents and their vapor pressures is required.

For spray gun cleaning, several options are provided to contain vapors during cleaning including the use of closeable cleaning units and cleaning solvent receiving vessels. Work practices are included for flush cleaning of parts and coating unit components. The standard exempts a number of specific cleaning operations from the hand-wipe criteria such as cleaning electronic components or surfaces prior to adhesive bonding. For more detailed information on

this rule, the reader is referred to the Final Rule and the Background Information Document (EPA-453/R-94-036a).

Control of ODCs

CFC-113 and methyl chloroform are two Class I substances which have been widely used in cleaning and degreasing activities. Federal facilities should be in a process to identify and begin the use of suitable substitutes prior to the January 1, 1996 phaseout deadline.

Several Class II chemicals, and particularly HCFC-225, are being pursued as alternatives to serve in many of the same functions and applications as CFC-113 and methyl chloroform. The use of HCFC-225 has been proposed as an acceptable substitute, subject to use limitations, for CFC-113 and methyl chloroform (9/26/94, 59FR49108). Appendix B includes a composite listing of the approved alternatives for degreasing and cleaning from the SNAP publications.

LIVING WITH THE CLEAN AIR ACT

Regulatory programs created by the Clean Air Act impact directly on the use of solvents in cleaning and degreasing activities. Once control requirements are established, permitting and compliance demonstration requirements follow. Given the scope of the Clean Air Act mandate and its direction and focus on chemical substances, research and development in the area will continue to evolve. Greater pressure for reductions in VOCs is expected in geographic areas having difficulty achieving the ozone non-attainment standards (Los Angeles, Northeast Corridor). The use of HAPS will be increasingly regulated in the coming years. The termination of production of Class I substances is on the near horizon with Class II substances following in the not too distant future. It is reasonable to expect a continuing tightening down on the use of chemical solvents.

For Federal facilities, environmental performance will be more visible as a result of Executive Order 12856. The required reporting on chemical releases to the Toxic Release Inventory and the development of facility plans for reducing these releases will be open to public scrutiny.

The use of organic solvents in cleaning and degreasing processes has been the target of activities by government, industry and environmental organizations to identify and encourage the use of pollution prevention alternatives. Pollution preventative approaches have been developed and implemented in many industrial scenarios. They can serve as models for Federal facilities, helping them not only to meet or exceed potential Clean Air Act requirements, but to reduce costs for materials, waste disposal, reporting, and recordkeeping. In addition, implementation of pollution preventative approaches help in reducing potential liabilities from waste generation and exposure to workers.

The remainder of this report presents information on pollution prevention alternatives for the processes under review. A large part of the pollution prevention effort has been in the pursuit of the "safer substitute." Given the emphasis on safer substitutes, this report focuses on potential substitute materials and processes for current processes using HAPs, ODCs and VOCs. Safer can mean different things to different decision makers. Generally it means the use of less regulated and less hazardous compounds, providing benefits such as reduced solvent losses and exposure to workers, and lessened concern for worker safety, flammability, and waste management requirements.

CHAPTER 3

POLLUTION PREVENTION OPPORTUNITIES IN CLEANING AND DEGREASING

INFORMATION SOURCES

The search for alternatives to the use of ODCs, HAPs, and VOCs for cleaning and degreasing has lead to the development of several reports on alternatives to these chemicals. A listing of many of these reports and who to contact to obtain them is presented in Appendix A. Included in Appendix A are the contact points for key EPA information sources including:

- **EnviroSense** - is an electronic bulletin board providing access to a wide array of environmental and pollution prevention information as well as professionals active in the environmental management area. EnviroSense is accessible by modem and the World Wide Web on the Internet.
- **Technology Transfer Network** - TTN is a bulletin board system on Clean Air Act programs operated by the Office of Air Quality Planning and Standards (OAQPS). TTN provides access to the latest documents on supporting policy, technical and rulemaking activities and is accessible by modem.
- **Pollution Prevention Information Clearinghouse** - PPIC provides access to materials developed by EPA and State pollution prevention program activities.
- **Stratospheric Ozone Hotline** - provides policy, technical, and rulemaking information on the phase out of ozone depleting compounds.

These sources provide useful information on all technical and regulatory activities related to the Clean Air Act and pollution prevention.

Some recent reports which are particularly useful in the investigation of cleaning and degreasing alternatives include:

- **Solvents - The Alternatives** - provides a summary of key factors to consider when investigating solvent substitutes including a lists of suppliers of aqueous and semi-aqueous cleaners and equipment suppliers (prepared by Bob Carter of the Waste Reduction Resource Center for the Southeast (800-476-8686), P.O. Box 27687, 3825 Barrett Drive Raleigh, NC 27611-7687).
- **Guide to Cleaner Technologies: Alternatives to Chlorinated Solvents for Cleaning and Degreasing** (2/94, EPA/625/R-93/016) - outlines the different

cleaning and degreasing requirements, identifies current and emerging cleaning alternatives (prepared by EPA's National Risk Management Research Laboratory (formerly The Risk Reduction Engineering Laboratory), Cincinnati, Ohio 45268).

- **Eliminating CFC-113 and Methyl Chloroform in Aircraft Maintenance Procedures** (10/93, EPA/430/B-93/006) - identifies alternatives and suppliers of substitutes and alternative cleaning equipment (prepared by EPA and the Industry Cooperative of Ozone Layer Protection (ICOLP)).

The investigation of alternative solvents can be facilitated by comparative data on solvents. Several data systems have been developed to provide assistance in the selection of alternative solvents. To use these systems, the user must know the characteristics about the substrate and soil to be cleaned. Systems identified include:

- **SAGE** - "Solvent Alternatives Guide" - Developed by EPA's Office of Research and Development as an on-line tool to assist in making educated decisions on alternative solvents providing information on costs, secondary impacts and use requirements (Contact Mr. Charles Darvin (919-541-7633), National Risk Management Research Laboratory (MD-61), ORD, EPA, RTP, NC 27711). Also accessible through EnviroSense.
- **HSSDS** - "Hazardous Solvent Substitution Data System" - developed by the Department of Energy's Idaho National Engineering Laboratory; on-line system that provides a full array of technical data on individual solvents (Contact Kevin Twitchell (208-526-6956), Idaho National Engineering Laboratory, P.O. Box 1625, Mailstop 1604, Idaho Falls, ID 83415-1604).
- **NCMS Solvent Database** - developed by the National Center for Manufacturing Sciences to provide information on alternatives to ozone depleting solvents (contact Mike Wixom (313-995-4910), National Center for Manufacturing Sciences, 3025 Boardwalk, Ann Arbor, MI 48108-3266)

More information on each of these data systems is presented in Appendix C.

POLLUTION PREVENTION ALTERNATIVES IN CLEANING AND DEGREASING

Investigating alternatives to replace the use of a CFC, HAP or VOC requires information on the substrate, soil, and cleanliness needs and expectations. Generic fixes are not generally available, but rather case specific information must be considered in the context of available alternatives. A number of prevention technologies are available for cleaning and degreasing which eliminate the need for HAPS, ODCs, and VOCs in many situations. Table 2 identifies several technologies and their reported applications as alternatives to organic solvent systems. For

comparison purposes, similar information is presented on controlling a solvent-based, vapor degreaser. Information on the benefits and limitations to each of these alternatives is presented in Table 3. Much of the information in Table 2, and 3 was adapted from the EPA report described above, **Guide to Cleaner Technologies: Alternatives to Chlorinated Solvents for Cleaning and Degreasing** (2/94, EPA/625/R-93/016). The reader is referred to this report for more information on each of these alternatives.

Clean Air Act emission requirements can be achieved by controlling organic solvent based systems, such as enclosing a vapor degreaser, as shown in Table 3. However, the choice of a preventative technologies, i.e., aqueous cleaner, eliminates use of organic solvents and applicability of the Clean Air Act requirements altogether. Demonstrating compliance on a continuous basis through monitoring, reporting and recordkeeping will no longer be necessary for these technologies.

Several examples of alternative technologies implemented to meet Clean Air Act requirements are shown in Table 4. More information on these examples can be found in the listed references. These examples illustrate some of the benefits that have been realized through the implementation of pollution preventative approaches as a result of individual facilities efforts to move away from the use of regulated compounds. In many of these cases, these facilities could have been faced with significant expenses to control VOC or HAP emissions. However, in these examples they found solutions to their cleaning and degreasing needs which resulted in cost savings and elimination of the burden of demonstrating compliance with Clean Air Act requirements.

TABLE 2**PREVENTION TECHNOLOGIES FOR CLEANING AND DEGREASING**

Technology	Reported Application	Waste Products and Emissions	Example Capital Costs
Automated Aqueous Cleaning	Cleaning of small parts.	Spent cleaning solution.	\$180,000 approximately for a unit with 1,000 lb/hr processing speed for steel parts.
Aqueous Power Washing	Cleaning of large and small parts.	Spent cleaning solution.	\$12,000 approximately for 1,000 lb capacity, 4' x 4' chamber.
Ultrasonic Cleaning	Cleaning of ceramic, aluminum, plastic, and metal parts, electronics, glassware, wire, cable, rods.	Spent cleaning solution.	Approximately \$10,000 for console w/ 25" x 18" x 15" chamber.
Low-Solids Fluxes	Soldering in the electronic industry.	No waste products.	No additional capital cost.
Inert Atmosphere Soldering	Soldering in the electronics industry.	No waste products.	Varies widely.
Completely Enclosed Vapor Cleaner	Same as conventional open-top vapor degreasers.	Solvent air losses. Spent solvent. Water in water separator.	Approximately \$200,000 for a unit with 560 lb/hr processing speed for steel parts.

Adapted from: Guide to Cleaner Technologies: Cleaning and Degreasing Process Changes (2/94; EPA/625/R-93-017).

TABLE 3

PREVENTION TECHNOLOGIES FOR CLEANING AND DEGREASING: BENEFITS AND LIMITATIONS

Technology	Pollution Prevention Benefits	Other Benefits	Limitations
Automated Aqueous Cleaning	Eliminates solvent use by using water-based cleaners.	Eliminates use of ODCs, HAPs, and VOCs. Eliminates solvent hazards. Reduces water consumption. Cleaning chemicals are reused. Easy to install and operate. Eliminates emission fees and compliance demonstration requirements for monitoring, recordkeeping, and reporting.	May not be able to replace vapor degreasing for some delicate parts. Requires more space than vapor degreasing. Wastewater treatment required. Relatively higher energy requirement.
Aqueous Power Washing	Eliminates solvent use by using water-based cleaners.	Eliminates use of ODCs, HAPs, and VOCs. Eliminates solvent hazards. Reduces cleaning time. Eliminates emission fees and compliance demonstration requirements for monitoring, recordkeeping, and reporting.	Pressure and temperature may be too great for some parts. Wastewater treatment required.
Ultrasonic Cleaning	Eliminates solvent use by making aqueous cleaners more effective.	Eliminates use of ODCs, HAPs, and VOCs. Eliminates solvent hazards. Can clean in small crevices. Cost effective. Faster than conventional methods. Inorganics are removed. Neutral or biodegradable detergents can often be employed. Eliminates emission fees and compliance demonstration requirements for monitoring, recordkeeping, and reporting.	Part must be immersible. Testing must be done to obtain optimum solution and cavitation levels for each operation. Thick oils and grease may absorb ultra-sonic energy. Energy required usually limits parts sizes. Wastewater treatment required if aqueous cleaners are used.

TABLE 3 -- continued

Technology	Pollution Prevention Benefits	Other Benefits	Limitations
Low-Solids Fluxes	Eliminates need for cleaning and, therefore, eliminates solvent use.	Eliminates use of ODCs, HAPs, and VOCs. Eliminates solvent hazards. Little or no residue remains after soldering. Closed system prevents alcohol evaporation and water absorption. Eliminates emission fees and compliance demonstration requirements for monitoring, recordkeeping, and reporting.	Conventional fluxes are more tolerant of minor variations in process parameters. Possible startup or conversion difficulties. Even minimal residues are unacceptable in many military specifications.
Inert Atmosphere Soldering	Eliminates need for flux and, therefore, eliminates solvent cleaning.	Eliminates use of ODCs, HAPs, and VOCs. Eliminates solvent hazards. Economic benefits from elimination of flux. Eliminates emission fees and compliance demonstration requirements for monitoring, recordkeeping, and reporting.	Requires greater control of operating parameters. Temperature profile for reflow expected to play more important role in final results.
Completely Enclosed Vapor Cleaner	Reduces solvent air emissions.	Can provide for compliance with VOC and HAP regulations. Virtually eliminates air emissions and workplace hazards. Cleaning principle remains the same; user does not have to switch to aqueous cleaning. Significant recovery of solvent. Reduced operating costs.	High initial capital cost. Slower processing time. Relatively higher energy requirement. Monitoring, recordkeeping and reporting required to demonstrate continuous compliance. Operating permit may be required. Residual emissions subject to emission fees.

Adapted from: Guide to Cleaner Technologies: Cleaning and Degreasing Process Changes (2/94; EPA/625/R-93-017)

TABLE 4**EXAMPLES OF POLLUTION PREVENTION OPPORTUNITIES FOR
CLEANING/DEGREASING FOR CLEAN AIR ACT COMPLIANCE**

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Automated Aqueous Parts Washing (Ref 1)	Quality Rolling and Deburring Company, Inc., metal finishing company, added an automated aqueous washer to provide cleaning needs for plant expansion. Also replaced some plant cleaning done by vapor degreasing, alkaline tumbling, and hand aqueous cleaning. Chemical costs for the automated washer were 40% lower compared to alkaline tumbling and 95% lower compared to hand-aqueous washing.	\$60,000 annual sav- ings	Allowed for plant growth in VOC non-attainment area Reduced quantity of cleaning chemi- cals required Reduced waste- water generated	High initial investment, \$200,000 was quickly offset by annual savings Vapor degreaser still used for delicate parts Hand washing still used for difficult cleaning jobs
Batch Aqueous Power Washer (Ref 1)	The Seattle Metro Garage in Seattle, Washington uses an aqueous power washer to clean parts removed during overhaul and maintenance. The unit eliminates the need for solvent to clean parts. Discharges from the unit pass through an oil/water separator and then to the sanitary sewer system.	Eliminated cost of solvent	Eliminated organic solvent use Eliminated hazard- ous waste genera- tion	Investigating smaller system for car and truck parts

TABLE 4 -- continued

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Aqueous Ultrasonic Cleaning Process (Ref 2)	The Ross Gear Division of TRW in Greenville, Tennessee replaced trichloroethylene (TCE) vapor degreaser for removing lapping oils from parts with three stage aqueous (alkaline) process utilizing an ultrasonic cleaning step. Reduced overall plant hazardous waste by 50% and decreased disposal costs. TRW replaced a vapor degreasing system on one of their processes with a three-stage aqueous/ultrasonic system washer. Prior to the washer, the process, which removes oil-based lapping compound from parts, generated 14,090 lb of TCE still bottoms, 3,740 lb of filtration powder, and 50,300 lb of fugitive and stack emissions in one year. In addition, the plant recently switched to a water-based lapping solution.	Eliminated cost of TCE	Eliminated use of TCE Eliminated generation of hazardous waste from cleaning process	Installed ultrafiltration system to separate nonhazardous oil from wastewater sent to sanitary sewer
No-Clean Technology (Ref 2)	AT&T Bell Labs in Columbus, Ohio converted to a low-solids flux cleaning system in 1988. With this system, the plant has eliminated post-solder cleaning and the use of 30,000 gallons of perchloroethylene (PERC) annually.	\$145,000 annual savings	Eliminated use of PERC Eliminated generation of hazardous waste from process	

TABLE 4 -- continued

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Semi-Aqueous Batch Cleaning Process (Ref 2)	Four Star Tool, Inc. of Rosemont, Illinois replaced a manual cold cleaning process using trichloroethylene (TCE) by installing a four step semi-aqueous process using d-limonene. The switch allows the plant to eliminate use of 20 drums of TCE and save \$5,805 per year in solvent costs.	\$5,805 annual sav- ings	Eliminated use of TCE	Oily material is skimmed from spent cleaner which is dis- charged to sanitary sewer
Semi-A- queous Batch Cleaning System (Ref 3)	APS Materials, Inc. of Dayton, Ohio cleans specialty cobalt/molybdenum and titanium parts prior to application of a plasma coating. APS replaced 1,1,1, trichloroethane and methanol in their heated, batch ultrasonic degreasing operation with a terpene-based cleaner, limonene. A re-quired capital cost of \$1,793, with pay back of 4.5 months and annual savings of \$4,800.	\$4,800	Eliminated use of 1,1,1, and meth- anol Eliminated haz- ardous waste from cleaning process	Bonding strengths of coatings slightly im- proved with new cleaning formulation
Low VOC Wipe Solvent (Ref 4)	The Lockheed Fort Worth Company developed a low vapor pressure organic solvent for CFC-113 based cleaning solvent used in surface wiping of aircraft parts, components, and assemblies. As a result, the plant reduced CFC emissions by 100%, VOC emissions by 75%, and solvent costs by 87%	Reduced costs by 87%	Eliminated use of CFCs in wipe cleaning Significant reduc- tion in VOC generation	Effective at removing a variety of soils including inks, oils greases, waxes, and un- cured resins Reported as having low toxicity and non- flammable

TABLE 4 -- continued

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Aqueous Degreasing System (Ref 5)	Ford Motor Company's Climate Control Division is replacing their current trichloroethylene (TCE) vapor degreasing system with an aqueous degreasing system. Their pilot system resulted in a superior process, lower costs, improved plant environment, and reduced environmental impact.	Eliminated cost of TCE	Elimination of use of TCE Reduced hazardous waste generation	Used Total Quality Management approach to investigate alternatives Process will be used Division wide
Automated Aqueous Cleaning System (Ref 6)	The Naval Undersea Warfare Station in Keyport, Washington is replacing their Agitene (mineral spirits and lanolin) dip tanks for cleaning parts and fuel tanks with automatic parts washers which using biodegradable cleaners: water/detergent in an agitator washer system or an ultrasonic cleaner. Initial equipment costs would be recovered quickly due to decreased costs of labor, hazardous waste disposal, and purchase of cleaning solvents.		Reduced use of Agitene and VOC generation	

¹ Elimination of regulated compound also provides reduced compliance demonstration expenses for monitoring, recordkeeping and reporting. Regulatory liabilities are also reduced.

TABLE 4 -- continued

REFERENCES FOR POLLUTION PREVENTION EXAMPLES

1. United States Environmental Protection Agency, Office of Research and Development. "Guide to Cleaner Technologies, Cleaning and Degreasing Process Changes." Publication No. EPA/625/R-93/017, Washington, DC. February 1994.
2. United States Environmental Protection Agency, Office of Research and Development. "Achievements in Source Reduction and Recycling for Ten Industries in the United States." Publication No. EPA/600/2-91/051, Washington, DC. September 1991.
3. United States Environmental Protection Agency, Office of Research and Development. "Pollution Prevention Case Studies Compendium." Publication No. EPA/600/R-92/046, Washington, DC. April 1992.
4. United States Environmental Protection Agency, Office of Air and Radiation. "Eliminating CFC-113 and Methyl Chloroform in Aircraft Maintenance Procedures." Publication No. EPA/430/B-93/006, Washington, DC. October 1993.
5. President's Commission on Environmental Quality, Quality Environmental Management Subcommittee. "Total Quality Management, A Framework for Pollution Prevention." Washington, DC. January 1993 (report available through US Council on Environmental Quality).
6. United States Environmental Protection Agency, Office of Research and Development. "Waste Minimization Opportunity Assessment, Naval Undersea Warfare Engineering Station, Keyport, Washington." NTIS Publication No. PB91-216457, Cincinnati, OH. July 1991.

Part II Painting and Depainting

CHAPTER 4

PAINTING- AND DEPAINTING-SPECIFIC ENVIRONMENTAL FACTORS

PAINTING

Painting or surface coating involves the use of a full array of coatings and coating application technologies for application on a variety of shapes and surfaces. Coatings are applied to enhance corrosion resistance, improve appearance, or provide both these benefits. Surface shapes may be flat, cylindrical, round or multifaceted. Surface materials may be wood, metal, ceramic, fabric, plastic or a variety of composite materials. The coatings may be applied by hand or by machine using a variety of application techniques: brush, roller, dip, flow, and spray techniques.

Several spray application techniques exist including conventional air spray, airless, air-assisted airless, electrostatic, and high-volume low-pressure (HVLV) spray. The effectiveness of a spray system in applying coating to a particular surface is characterized by its "transfer efficiency." The greater the transfer efficiency, the greater the portion of the coating that is sprayed ends up on the surface. Overspray represents the coating that is sprayed, but does not reach or adhere to the intended surface.

Coating formulations contain a number of components including resins (body of the coating), pigments (for color), application additives (flow control), drying additives (curing and film control agents) and solvents. Solvents serve as vehicles or carriers for the coating ingredients. Some coatings dry on their own, like latex house paint, or require the assistance of heat (drying ovens) or energy (radiation-cured coatings). Multiple coating layers may be applied to meet the end objective. Coatings are characterized as conventional solvent-based, waterborne, high solids, radiation-cured, and powder coatings.

Environmental Factors

Toxic or hazardous concerns can be associated with materials used in any of the coating components. Solvents, however, have received the most attention under the Clean Air Act. They are released from the coating during application, drying and curing. Solvents can make up a few percent to over 90 percent of the coating formulation. Once the coating is dry, all of the solvent in the coating formulation has been released to the air.

Workers must be protected from the coating solvent vapors; many are regulated compounds under the Occupational Safety and Health Act. The released solvent vapors can be captured using exhaust ventilation systems on both the application process (paint booth) and the drying process (drying oven). The exhaust air can be released to the ambient air or sent to an air pollution control device.

Air releases of coating components other than solvents occur only with spray application technologies. The sprayed coating which ends up as overspray can become suspended in air. Spray

operations typically control overspray with exhaust ventilation systems to protect workers and limit contamination of the work area. These systems collect and filter the air carrying the overspray particles. Particle filters will collect the overspray but not the solvent vapors.

Pollution prevention technologies can reduce or eliminate the use of solvents in coatings. For spray applications, they can improve the transfer efficiency. These techniques can lead to improved worker protection and Clean Air Act compliance.

DEPAINTING

Depainting or paint stripping is required in many painting, maintenance and repair operations. Paint application equipment must be cleaned to remove paint buildup which might interfere with its operation. Equipment with defective or worn coatings may require coating removal prior to application of a new coating. Repair and inspection activities may also require coating removal.

Several approaches to depainting are available. They rely on chemical, mechanical and/or thermal processes to remove the coating. The most common approaches utilize a chemical solvent stripper, such as those based on methylene chloride, or a blasting agent like sand or plastic media to mechanically remove the coating.

Chemical solvent strippers either dissolve the coating or penetrate and swell it to separate it from the surface. The stripper is spread on the coated surface and given time to work. The weakened coating is then removed with the residual stripper by scraping or flushing with water. The spent paint stripper and paint sludge must be collected and disposed of. The chemical solvent stripper must be effective in removing the coating, but must not impact the integrity of the surface being stripped.

Blasting techniques spray a blasting agent repeatedly onto the coated surface, cracking and abrading the surface of the coating. The blasting agents can be separated from the coating fragments and recycled until they deteriorate and become ineffective. The blasting continues until there are no remnants of the coating. Care must be taken in selecting the blasting agent. The blasting agent must be abrasive to the coating but not the underlying substrate.

Environmental Factors

The use of chemical solvent strippers produces solvent vapors and a waste stream containing spent stripper, dissolved coating, water and possibly metals. The vapors and waste stream are generally considered hazardous. The solvency requirements for a chemical stripper make about any solvent selected hazardous for workers to handle in stripping operations. Methylene chloride, for example, the most popular ingredient in chemical strippers, has significant toxicity concerns requiring great care in handling. It is listed as a Hazardous Air Pollutant (HAP) and its use is regulated in the workplace under the Occupational Safety and Health Act. Many other stripping formulations have chemical ingredients which require equal care in their use. The waste sludge from chemical stripping operations can require

handling as a hazardous waste. Chemical strippers tend to be very effective. However, the degree of caution required to safely use them is one of the reasons alternative approaches are sought for depainting.

The use of blasting technologies can generate dust from coating fragments and deteriorating blasting media. Workers must be protected from this dust, particularly if the coating itself contains hazardous constituents, such as metalized pigments. Although spent blasting media is typically not considered hazardous, the collected paint fragments may require treatment as a hazardous waste.

CHAPTER 5

PAINTING AND DEPAINTING: SOLVENTS AND THE CLEAN AIR ACT

A variety of solvents have been used for painting and repainting: halogenated solvents, aromatic compounds, alcohols, etc. Solvents in each of these categories have been the subject of regulations under the Clean Air Act - as VOCs, HAPs, and/or ODCs. The requirements under Clean Air Act programs which control the use of these solvents continue to evolve. The development of pollution preventative techniques for these processes is in part driven by the opportunity to meet the same needs but without depending on compounds regulated under the Clean Air Act. Using regulated compounds not only brings the burden of controlling their use, but also the need to obtain permits, pay emission fees and continually demonstrate compliance through monitoring, testing, reporting and recordkeeping. This chapter describes how solvents in each of these processes are currently regulated.

CLEAN AIR ACT PROGRAMS

Table 5 shows the primary solvent categories and some of the dominant solvents used in each category. The specific Clean Air Act programs which limit the use of these solvents are also identified by the chemical regulatory category. Many of these solvents are also subject to reporting releases and waste generation to the Toxic Release Inventory (TRI) under the Emergency Response and Community Right-to-Know Act (EPCRA). For Federal facilities, the TRI will be the measure of progress in meeting the pollution prevention planning requirements of Executive Order 12856. Table 5 indicates the applicability of the TRI program to these solvents as well.

Control of VOCs

VOCs are regulated under the Clean Air Act because they react in the atmosphere with nitrogen oxides to produce ground level ozone. A VOC is considered any organic compound that will react in the atmosphere. This includes all organic compounds except for certain "exempt" solvents (methane, ethane and several halogenated solvents) with negligible reactivity in the atmosphere. A list of these exempt solvents is located in 40 CFR Part 51.1. An ambient Air Quality Standard (NAAQS) for ozone was been established under Title I of the Clean Air Act to protect public health. Emissions of VOCs and nitrogen oxides are to be reduced in geographic areas not meeting this ambient standard, the so called "nonattainment areas." States are required to develop air quality management plans, or State Implementation Plans (SIPs) to achieve the NAAQSs in non-attainment areas.

TABLE 5

**APPLICABILITY OF THE CLEAN AIR ACT AND TOXIC RELEASE INVENTORY REPORTING REQUIREMENTS TO
PAINTING AND DEPAINTING SOLVENTS**

Solvent Category/Example	Process Area		Clean Air Act Applicability			TRI
	Painting	Depainting	VOC	HAP	ODC	
HALOGENATED SOLVENTS						
Methyl Chloroform (1, 1, 1 Trichloroethane)	X			X	Class I	X
Methylene Chloride	X	X		X		X
KETONES						
Methyl Ethyl Ketone	X	X	X	X		X
Methyl Isobutyl Ketone	X		X	X		X
Acetone ¹	X	X				
ALCOHOLS						
Methanol	X	X	X			X
Ethanol	X		X			
Isopropanol	X		X			
AROMATIC HYDROCARBONS						
Toluene	X	X	X	X		X

¹ Acetone was excluded from the definition of a VOC (6/16/95, 60FR31633); Acetone was also removed from the TRI list (6/16/95, 60FR31643)

TABLE 5 -- continued

Solvent Category/Example	Process Area		Clean Air Act Applicability			TRI
	Painting	Depainting	VOC	HAP	ODC	
Xylene	X	X	X	X		X
ALIPHATIC HYDROCARBONS						
Mineral Spirits	X	X	X			
Naptha	X	X	X			
OTHER CATEGORIES AND COMPOUNDS						
N-Methyl Pyrrolidone		X	X			
Glycol Ethers	X	X	X	X		X ¹
Terpenes	X		X			

VOC - Volatile Organic Compound, regulated under the non-attainment provisions of Title I of the Clean Air Act.

HAP - Hazardous Air Pollutant, regulated under the air toxics provisions of Title III of the Clean Air Act.

ODC - Ozone Depleting Compound, regulated under the stratospheric ozone protection provisions of Title VI of the Clean Air Act.

TRI - Toxic Release Inventory; annual reporting of releases to the environment required for TRI chemicals under the Emergency Response and Community Right-to-Know Act (EPCRA).

¹ Both the HAP and TRI lists identify Glycol Ethers as a chemical category for those Glycol Ethers which are derivatives of Mono-, Di-, or Tri-Ethylene Glycol. Ethylene Glycol is also listed as an individual compound on both lists.

These SIPs include requirements for the application of "reasonably available control technology" (RACT) to reduce emissions from VOC sources in the non-attainment areas.

EPA provides guidance to States on RACT through "Control Technique Guidelines (CTGs). CTGs identify for VOC processes control approaches that are considered technically and economically feasible for facilities to implement. States generally implement RACT through rules which are State adopted and federally approved. These rules apply to industrial and commercial processes which emit VOC emissions. Most States' RACT rules include requirements for painting processes.

The Clean Air Act also provides for the control of VOCs (and other pollutants) through the development of New Source Performance Standards (NSPSs) for new or modified sources. These standards are developed for individual source categories, such as metal furniture coating, and reflect best available control technology at the time the standard was set. Several NSPSs have been developed for surface coating operations which limit VOC emissions.

Control of HAPS

Title III of the Clean Air Act lists 189 chemicals (some are chemical categories) that are considered significant threats to public health. These chemicals and chemical categories are known as hazardous air pollutants or HAPs. EPA is required to establish standards for categories of major sources emitting these chemicals which represent the maximum achievable control technology (MACT) for that operation. Major sources have the potential to emit 10 tons or more of an individual HAP or 25 tons or more of all HAPs in aggregate. These requirements apply to both new and existing sources. Major source categories have been identified and a ten year program extending through the year 2000 was initiated to develop MACT standards for these sources. Smaller sources of these pollutants may also be regulated through less stringent control requirements. If EPA fails to develop standards in accordance with the 10 year plan, States must control sources in their jurisdiction using case-by-case determinations of MACT.

The Title III MACT standard program schedule will be difficult to meet; EPA's limited resources have led to delays in developing some of the early MACT standards. State programs are likely to be required to develop MACT standards for some source categories in their jurisdiction. Source categories identified which require the development of MACT standards include painting and repainting.

Control of ODCs

The Montreal Protocol, an international agreement phasing out ozone depleting substances, led to the inclusion of Title VI of the Clean Air Act. The United States is committed to an accelerated phase out of the production and use of ozone depleting chemicals (ODCs). Federal agencies, through Executive Order 12843 (issued April 21, 1993) are encouraged to accelerate replacement of ODCs with safe alternatives and abide by the requirements of Title VI. Many US industries have established company goals to expedite the elimination of their use of ODCs.

The CAA defines ODCs in two groups, Class I, and Class II. Class I substances have the greatest ozone depleting potential. They include chlorofluorocarbons (CFCs), halons, methyl chloroform and carbon tetrachloride. Class II substances are hydrochlorofluorocarbons (HCFCs). For the U.S., the phaseout deadline for the production of Class I chemicals was set for January 1, 1996 (12/10/93, 58 FR 65018). The phaseout of Class II chemicals is required by January 1, 2015. As shown in Table 5, ODCs are not typically used in painting and repainting. However, methyl chloroform has been found in some paint formulations.

Reporting to TRI

Reporting to the Toxic Release Inventory (TRI) is required for many of the solvents identified in Table 5. The TRI was created by the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA, also referred to as Title III, Superfund Amendments and Reauthorization Act (SARA)). Regulations for the TRI can be found in 40 CFR Part 372. The TRI requires submittal of annual reports on the releases and offsite transfers of over six hundred chemicals and chemical categories. The thresholds for reporting are 25,000 pounds manufactured and/or processed and 10,000 pounds otherwise used for each chemical listed. The 1990 Pollution Prevention Act (PPA) expanded the TRI reporting requirements to include information on waste generation and the use of source reduction and recycling to limit waste generation. A "Form R" is used for reporting. For 1987 through 1993, reporting was required for over three hundred chemicals and chemical categories. EPA then added 32 chemicals and 2 chemical categories to the list of TRI substances, requiring first time reporting for calendar year 1994 (12/1/93, 58FR63496 and 58FR63500). An additional 286 chemicals were added for the 1995 calendar year reporting requirements (11/30/94, 59FR61432), bringing the number of listed chemicals to over 600.

Federal facilities must file TRI reports. Executive Order 12856 (dated August 3, 1993) established a pollution prevention planning process for Federal facilities, requiring all Federal facilities to comply with EPCRA. Initial reporting was required for the 1994 calendar year. The TRI reports will serve as the accounting system for demonstrating compliance with the pollution prevention goals established in EO 12856. With the 1994 reports, each federal facility defined their baseline release levels. They now must develop their pollution prevention strategy to reduce these reported levels. The initial 1994 reports were due to EPA by July 1, 1995. Subsequent reports must be filed by the following July 1. The facility plans are due on December 31, 1995. The EO requires each Agency to achieve a 50 per cent reduction in reported TRI releases in aggregate for all of their facilities by 1999. Implementation of individual facility plans are expected to collectively provide the necessary reductions in waste generation to achieve each agency's goals.

For many facilities, the chemicals in Table 5 will be major contributors to their baseline levels. Therefore, identifying preventative approaches to meeting Clean Air Act requirements will also benefit the development of pollution prevention plans and meeting their Agency's goals.

REQUIREMENTS FOR PAINTING OPERATIONS

VOC Limitations

Painting operations use a wide array of solvents which are VOCs. VOCs have been regulated through RACT requirements for existing sources in SIPs and for new sources through New Source Performance Standards (NSPS).

RACT

Many states have established VOC limits for surface coating operations. These requirements are based on the RACT guidance in CTGs published by EPA. These CTGs addressed surface coating of cans, coils, paper, fabric, motor vehicles, metal furniture, magnet wire insulation, large appliances, flat wood paneling, and metal parts and products. The development of MACT standards has resulted in the initiation of new CTGs addressing VOC controls for several MACT source categories including coating operations in the aerospace, plastic parts, shipbuilding and wood furniture manufacturing industries.

State RACT limitations for VOCs from surface coating operations are generally expressed in terms of mass of VOC per unit volume of coating. The unit volume of the coating is adjusted to account for the use of non-VOC diluents by subtracting the volume of water or exempt solvents (i.e., halogenated solvents which are not considered VOCs, see Table 5). Coatings which meet these limits are termed "compliant coatings." Compliance can also be achieved through the use of add-on control technologies and improvements in transfer efficiency provided the equivalent degree of control can be demonstrated. RACT limits may also be expressed in terms mass of VOC per unit of surface area coated (pounds of VOC per square foot of paneling coated) or mass of VOC per volume of coating solids applied. Applied generally means solids reaching the substrate. The reader is referred to the appropriate State rules to determine the VOC limits applicable to specific coating operations. Examples of VOC limits are presented in Appendix D (taken from Recordkeeping Guidance Document for Surface Coating Operations and the Printing Industry 7/89, EPA 340/1-88-003).

Demonstrating compliance with VOC limits can require recordkeeping on the amount of specific coating formulations and any solvent diluents used on a daily basis. Eliminating the use of VOCs in surface coating operations would also eliminate this recordkeeping burden.

NSPSs

New source performance standards (NSPSs) have also been published for a number of surface coating operations. These requirements apply to new or modified coating operations only, those constructed after the effective date of the applicable rule. NSPS are published in Part 60 of Title 40 of the Code of Federal Regulations. Surface coating NSPS's apply to new coating lines for:

- Metal Furniture - Subpart EE (47 FR 49287, 10/29/82)
- Automobile and Light Duty Truck - Subpart MM (45 FR 85415, 12/24/80)

MACT Major Source Categories for Surface Coating Operations	Scheduled Publication Date
Aerospace Industry	September 1, 1995 Final Rule Published
Auto and Light Duty Truck	November, 2000
Flatwood Paneling	November, 2000
Large Appliance	November, 2000
Magnetic Tape	December 15, 1995 Final Rule Published
Metal Can	November, 2000
Metal Coil	November, 2000
Metal Furniture	November, 2000
Misc. Metal Parts and Products	November, 2000
Paper and Other Webs	November, 2000
Plastic Parts and Products	November, 2000
Fabrics	November, 2000
Shipbuilding and Repair	December 6, 1994 Proposed Rule Published
Wood Furniture	December 6, 1994 Proposed Rule Published

The aerospace, shipbuilding and wood furniture standards have potential applicability to Federal facilities and will be described below.

Aerospace Manufacturing and Rework Facilities

The MACT standard for the aerospace industry applies to commercial, civil and military manufacturing and rework facilities which are major sources. The regulation addresses a number of aerospace processes including surface coating, repainting, and cleaning activities.

For surface coating, the MACT standard limits organic HAP emissions and VOC emissions on a pound per gallon of coating, as applied, basis. For the HAP limits, the volume of coating is adjusted by subtracting any water; for VOCs, the volume is adjusted by subtracting water and any exempt (non-VOC) solvents. The specific limits are shown below.

Pollutant Limits	Primer	Topcoat
HAPs lbs/gal (less water)	2.9	3.5
VOCs lbs/gal (less water, exempt solvents)	2.9	3.5

Sources can comply with these limits by using compliant coatings, or several different coatings which on a daily, volume-weighted average basis, meet the limit. Rather than complying with these coating limits, sources can choose to control emissions. The combination of the effectiveness of the capture (source enclosure) and collection systems (treatment device) must limit HAP or VOC emissions by 81 percent. Sources cannot average between primer and topcoat limits, nor between compliant coatings and the control equipment option.

The MACT standard also includes equipment standards for application technologies. The use of the following is required: flow coat, roll coat, brush coat, dip coat, electrostatic attraction, or high volume low pressure (HVLP) spray guns. Alternative application techniques could be used if equivalent control of emissions is demonstrated in comparison to electrostatic or HVLP.

To demonstrate compliance with the standard, records must be maintained on the VOC and HAP content of each coating used. Using coatings which individually meet the proposed limits would require records be kept of VOC and HAP determinations for each coating and monthly use volumes. However, if the source chooses to average VOC and HAP content across several coatings which are both compliant and non-compliant, then records of daily volume-weighted average determinations would be necessary. The use of control devices would trigger monitoring requirements. Preventative approaches based on use

of compliant coatings would limit these compliance burdens. Using coatings void of HAPs and VOCs would eliminate the applicability of the MACT standard altogether.

Ship Building and Ship Repair

The proposed MACT will limit the use of volatile organic HAPs, termed VOHAPS, at facilities that build, repair, paint and repaint, convert or alter ships. The standard applies to work performed on all military and commercial cargo and passenger ships including cruise ships, ferries, barges, tankers, container ships, patrol and pilot boats, buoys, and dredges. Facilities with potential VOHAP emissions meeting the major source criteria of 10 tons for an individual VOHAP or 25 tons for all VOHAPs will be subject to the standard. The standard does not address HAP emissions from non-volatile coating materials such as metal compounds in pigments.

The proposed standard provides two alternatives to meet as applied VOHAP coating content limits. The basic standard includes limits on the pounds of VOHAP per gallon of coating, less the portion of coating volume which is water, non-HAP, or VOC "exempt" solvents (not a VOC or a HAP). Acetone, for example, is now a non-HAP "exempt" solvent. The alternative standard is based on pounds of VOHAP per gallon of coating solids. Limits were proposed for general coating use and 22 specialty coatings. These limits are summarized below. The reader is referred to the proposed rule for the individual specialty coatings and limits set by the proposed rule.

	VOHAP Standard	Alternate VOHAP Standard
Units	lbs/gallon (minus water and non-HAP, VOC exempt solvents)	lbs/gallon coating solids
General Use Coatings	2.83	4.76
Specialty Coatings	2.83 to 6.5	4.76 to 92.46

The rule requires that compliance be demonstrated on a monthly basis. Sources can also petition for approval of an alternative approach for using non-compliant coatings such as through the use of a control system. Good housekeeping practices and training are also required as part of the proposed rule. The preamble to the proposed rule provides more information on the requirements of this standard.

Wood Furniture Manufacturing

Facilities which manufacture wood furniture and have potential emissions meeting the major source criteria would be subject to this proposed MACT standard. The proposed standard limits volatile HAPs (called VHAPs in this proposal) in finishing materials, adhesives, and strippable spray coatings used in the production of wood furniture. Included with the standard are requirements for work practices for finishing and cleaning operations and training.

The standard proposes separate limits for new and existing manufacturing facilities based on pounds of VHAP per pound of coating solid. The standard proposes overall limits for each facility and specific limits for individual finishing materials, cleaning operations, and adhesives. Equivalent limits for alternative control approaches are also proposed. The reader is referred to the proposed rule for the specific coatings and VHAP limits in the rule. A summary of the limits is provided below.

	Existing Facilities lbs VHAP/lb Solid	New Facilities lbs VHAP/lb Solid
Overall Coating average as applied	1.0	0.8
equivalent control alternative	1.0	0.8
Individual Finishing Materials		
Stains	1.0	1.0
Thinners	10.0	10.0
Other Coating Materials	0.8	0.8
Strippable Booth Coatings	0.8	0.8
Contact Adhesives		
Foam Adhesives for flammability requirements	1.8	0.2
All other Adhesives	1.0	0.2
equivalent control alternative	1.0	0.2

The rule requires compliance be demonstrated on a monthly basis and the maintenance of records on VHAP content and material use. The preamble to the proposed rule provides more information on the requirements of this proposed MACT rule.

REQUIREMENTS FOR DEPAINTING OPERATION

Chemical-based depainting operations have traditionally relied almost exclusively on methylene chloride-based stripper formulations. Methylene chloride is an exempt solvent and is not considered a VOC. Solvent emissions from depainting operations have not been the target of State RACT rules. Methylene chloride is a HAP, however, and "paint stripper users" is listed as a source category for the development of MACT standards. The MACT standard for paint stripper users is scheduled for publication by November, 2000. The aerospace MACT standard published on September 1, 1995 includes provisions for the control of HAP emissions from depainting operations in the aerospace industry.

Aerospace Manufacturing and Rework Facilities

The aerospace MACT standard limits HAP emissions from stripping the outer surface of wings, stabilizers and entire aerospace vehicles. The use of HAPs in these depainting activities is prohibited. The standard does not apply to stripping parts. Exceptions are provided for spot stripping and decal removal. For these activities, annual use limits per aircraft for HAP containing stripper are provided. These limits allow for up to 26 gallons for commercial aircraft and up to 50 gallons for military aircraft. The rule also requires non-chemical based equipment (such as media blasting technology) be operated in accordance with manufacturers' recommendations. If the equipment fails, up to 14 days per year of HAP containing stripper can be used.

The standard requires records be maintained on the volume and HAP content of any chemical based formulation used. Records must also be kept for any time periods of malfunction for the non-chemical based equipment.

LIVING WITH THE CLEAN AIR ACT

Regulatory programs resulting from the Clean Air Act impact directly on the use of solvents in painting and depainting activities. Once control requirements are established, permitting and compliance demonstration requirements follow. Given the scope of the Clean Air Act mandate and its direction and focus on chemical substances, research and development in this area will continue to evolve. Greater pressure for reductions in VOCs is expected in geographic areas having difficulty achieving the ozone non-attainment standards (Los Angeles, Northeast Corridor). The use of HAPS will be increasingly regulated in the coming years. The termination of the production of Class I substances is on the near horizon with Class II substances following in the not too distant future. It is reasonable to expect a continuing tightening down on the use of chemical solvents.

For Federal facilities, environmental performance will be more visible as a result of Executive Order 12856. The required reporting on chemical releases to the Toxic Release Inventory and the development of facility plans for reducing these releases will be open to public scrutiny.

The use of organic solvents in painting and depainting processes has been the target of activities by government, industry and environmental organizations to identify and encourage the use of pollution prevention alternatives. Pollution preventative approaches have been developed and implemented in many industrial scenarios. They can serve as models for Federal facilities, helping them not only to meet or exceed potential Clean Air Act requirements, but to reduce costs for materials, waste disposal, reporting, and recordkeeping. In addition, implementation of pollution preventative approaches help in reducing potential liabilities from waste generation and exposure to workers.

The remainder of this report presents information on pollution prevention alternatives for the processes under review. A large part of the pollution prevention effort has been in the pursuit of the "safer substitute." Given the emphasis on safer substitutes, this report focuses on potential substitute materials and processes for current processes using HAPs, ODCs and VOCs. Safer can mean different

things to different decision makers. Generally it means the use of less regulated and less hazardous compounds, providing benefits such as reduced solvent losses and exposure to workers, and lessened concern for worker safety, flammability, and waste management requirements.

CHAPTER 5

POLLUTION PREVENTION OPPORTUNITIES IN PAINTING

INFORMATION SOURCES

The search for alternatives to ODCs, HAPs, and VOCs for painting has lead to the development of several reports on alternatives to these chemicals. A listing of many of these reports and who to contact to obtain them is presented in Appendix A. Included in Appendix A are contact points with key EPA information sources including:

- **EnviroSense** - is an electronic bulletin board providing access to a wide array of environmental and pollution prevention information as well as professionals active in the environmental management area. EnviroSense is accessible by modem and the World Wide Web on the Internet.
- **Technology Transfer Network** - TTN is a bulletin board system on Clean Air Act programs operated by the Office of Air Quality Planning and Standards (OAQPS). TTN provides access to the latest documents on supporting policy, technical and rulemaking activities and is accessible by modem.
- **Pollution Prevention Information Clearinghouse** - PPIC provides access to materials developed by EPA and State pollution prevention program activities.
- **Stratospheric Ozone Hotline** - provides policy, technical, and rulemaking information on the phase out of ozone depleting compounds.

These sources provide useful information on all technical and regulatory activities related to the Clean Air Act and pollution prevention.

Information on alternative coating technologies is available in a report titled "National Emission Standard for Hazardous Air Pollutants for the Aerospace Industry - Background Information for the Proposed Standards" (April, 1994, EPA-453/R-94-036a, also available through TTN). This document outlines the technologies considered by EPA's Office of Air Quality Planning and Standards in developing the MACT standards for the aerospace industry. Appendix A identifies additional reports with information on surface coating alternatives.

POLLUTION PREVENTION ALTERNATIVES IN PAINTING

Pollution preventative approaches to complying with the Clean Air Act requires consideration of both the coating technology and the coating formulation. A variety of coating application technologies

are available, from brush to spray application as identified on Table 6. Pollution prevention benefits can be achieved through improvements in transfer efficiency, particularly with spray application techniques. Moving from 20 to 40 percent transfer efficiency with a conventional spray gun system to the 90 to 95 transfer efficiencies achievable with electrostatic spray guns can result in significant savings in paint usage and solvent loss from paint application.

Changes in the application technique alone are not likely to bring compliance with VOC and HAP limitations. Developing coating techniques using "compliant" coatings will eliminate the need for add-on control equipment. The use of coatings which are HAP and VOC free will eliminate the applicability of Clean Air Act requirements altogether. Table 7 identifies the types of coating formulations available. The use of conventional coatings, typically with high solvent content, will usually require the application of a treatment system. Waterborne and high solids coatings can be potential compliant coatings. Their use can result in reduced solvent emissions, particularly when used with high efficiency application methods. Powder

Several examples of pollution prevention achievements in coating operations are shown in Table 8. These examples show the benefits of investigating alternative coating formulations (powder coatings) and application systems (HVLPP). Benefits achieved include reduced material costs and reduced hazardous waste generation. Solvent free coatings, like solvent free cleaning agents, eliminate the compliance demonstration burdens as well. coatings and radiation-cured coatings essentially eliminate solvent emissions.

TABLE 6
AVAILABLE APPLICATION TECHNOLOGIES FOR PAINTING

Technology	Transfer Efficiency (%)	Benefits	Limitations
Conventional Application Methods			
Conventional Airspray	20-40	Versatile.	High energy requirements. High air pressures required. High coating use with low transfer efficiency.
Airless Spraying	35-50	Improved transfer efficiency over conventional airspray.	High hydrostatic pressure required.
Air-assisted Airless Spray System	30-60	More manageable than airless spray alone, uses lower pressures, lower air and fluid rates.	
Dip Coating	High	High transfer efficiency.	Limited to parts that can fit into the dip tank.
Roll Coating	High	High transfer efficiency with high rates of application and automation.	Surfaces must be flat.
Brush Coating	High	Useful for touch-up and detail painting operations that cannot tolerate spray gun over-spray.	High labor costs, increased production time, and poor coating thickness control are typical.
Flow Coating	High	High transfer efficiency.	Typically limited to flat sheets and non-critical parts. Coating thickness is difficult to control.
High Efficiency Application Methods			
High Volume Low Pressure Spray Guns (HVLV)	High	Low air pressures allow for well controlled spray patterns with less overspray and bounce back from substrate.	High solids coatings may require turbine to reduce to viscosity of the coating. Cannot be used with extension nozzles and may slow production rates due to low fluid delivery rates.

TABLE 6 -- continued

Technology	Transfer Efficiency (%)	Benefits	Limitations
Electrostatic Spray Guns	90-95	Very high transfer efficiencies. Electrostatic effect can be utilized in conjunction with airspray, airless, air-assisted airless, and HVLP systems to enhance their transfer efficiencies.	Primarily used for metal parts or substrates pre-treated with conductive coatings.

TABLE 7
AVAILABLE PAINT COATING FORMULATIONS

Coating Formulations	% Organic Solvent (by wt.)	Benefits	Limitations
Conventional Coatings	70-80	Knowledge and experience with coating systems.	Uses VOCs and/or HAPs which require add-on controls.
Waterborne Coatings	5-40	Less overspray and improved spray transfer efficiency may be achieved. Less toxic, reduced fire hazard. Potential compliant coatings.	Require spray guns of specific materials, protection from freezing, better temperature and humidity control. Have longer drying times, shorter shelf life.
Higher Solids Coatings	35-50	Greater surface area coverage meaning less coating required. Reduced solvent emissions. Potential compliant coatings.	Have longer drying times than conventional coatings, higher viscosities which may require heating prior to spray application.
Powder Coatings	-0-	Greatly reduced solvent emissions, reduced fire hazard, toxicity, and make-up air requires of the spray booth. Eliminates use of HAPs and VOCs. Eliminates emission fees and compliance demonstration requirements for recordkeeping, reporting and monitoring.	Powder coatings must be applied electrostatically, so they cannot be used on non-conductive parts such as composites. Production must be shut down for color changes; powder must remain dry; high curing temps required.
Radiation-cured coatings	-0-	Eliminates use of HAPs or VOC. Requires no solvents. Eliminates emission fees and compliance demonstration requirements for record-keeping, reporting and monitoring.	Requires energy source to cure coating (ultra-violet or electron-beam). Limited to surfaces reachable by energy source; 3-dimensional surfaces difficult to cure.

TABLE 8**EXAMPLES OF POLLUTION PREVENTION OPPORTUNITIES FOR
PAINTING FOR CLEAN AIR ACT COMPLIANCE**

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Spray Paint Line (Ref 1)	Justrite Manufacturing replaced their solvent-based spray paint line with a powder coating system. This reduced paint-associated waste and volatile organic compound emissions by 100%. They also achieved a higher quality paint finish and improved worker safety.	Reduced Coating Usage	100% VOC reduction	Disposal, operating, energy, and clean-up costs have all been reduced by switching to powder coatings.
Alternative Coatings (Ref 2)	An autobody shop that switched from lacquer to enamel-based coatings reduced its VOC emissions. Lacquer paints typically contain 70 to 90% volume solvent while enamels contain 55 to 75% volume solvent.	Reduced coating usage	Reduced VOC emissions	Enamels are less prone to react with polyester/fiberglass filler to discolor or yellow.
High Volume Low Pressure Spray Guns (Ref 3)	A medium sized commercial/rework aircraft company reduced coating purchases by 22-30% by switching from conventional coating application methods to High Volume Low Pressure (HVLP) spray guns.	22-30% reduction in coating usage	VOC emissions were reduced by 20-40%	HVLP is the preferred technology in the aerospace industry at this time.

TABLE 8 -- continued

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Powder Paint Technology (Ref 4)	By switching to powdered paint technology, Garden Way, Inc. accomplished a 95% reduction in their hazardous waste streams and has experienced sizable treatment savings.	\$25,000 annual sav- ings	100% VOC reduc- tion, 95% hazard- ous waste reduc- tion	System will pay for itself in 5-10 years.
Automated Painting (Ref 5)	General Dynamics replaced manual mixing and hand-spraying of metal parts with computer-controlled robots (a GR OM 500 unit), a proportional paint mixer, electrostatic spray guns, automatic waste cleaning solvent systems which allow for recycle and reuse of waste paint, and solvent stills. Due to these changes, paint waste was reduced by 60%, new paint purchases by 20%, and solvent purchases by nearly 60% in just two years.	\$40,000 annual sav- ings not including savings from new paint purchases	Not known	Though the initial capital investment of \$1.4 million may be too much for small companies, parts of the system such as the electrostatic sprays and solvent stills are inexpensive and very effective.

¹Elimination of regulated compound also provides reduced compliance demonstration expenses for monitoring, recordkeeping and reporting. Regulatory liabilities are also reduced.

TABLE 8 -- continued

REFERENCES FOR POLLUTION PREVENTION EXAMPLES

1. Illinois Hazardous Waste Research and Information Center. "Pollution Prevention: Illinois Industry Success Stories." Champaign, IL. May 1994.
2. United States Environmental Protection Agency, Office of Research and Development. "Guides to Pollution Prevention - The Automotive Refinishing Industry." Publication No. EPA/625/7-91/016, Washington, DC. October 1991.
3. United States Environmental Protection Agency, Office of Air Quality Planning and Standards. "National Emission Standard for Hazardous Air Pollutants (NESHAP) for the Aerospace Industry - Background Information for Proposed Standards." Preliminary Draft, Research Triangle Park, NC. April 1994.
4. United States Environmental Protection Agency, Office of Research and Development. "Achievements in Source Reduction and Recycling for Ten Industries in the United States." Publication No. EPA/600/2-91/051, Washington, DC. September 1991.
5. United States Environmental Protection Agency, Office of Research and Development. "Evaluation of Five Waste Minimization Technologies at the General Dynamics Ponom Division Plant." Publication No. EPA/600/2-91/067, Cincinnati, OH. January 1992.

CHAPTER 7

POLLUTION PREVENTION OPPORTUNITIES IN DEPAINTING

INFORMATION SOURCES

Appendix A also identifies the information sources and reports available on depainting. Recent reports which provide useful information on depainting alternatives are:

- **Guide to Cleaner Technologies: Organic Coating Removal** (2/94, EPA/625/R-93/015) - identifies current and emerging alternative coating removal technologies with emphasis on non-chemical based alternatives (prepared by EPA's National Risk Management Research Laboratory, Cincinnati, Ohio 45268).
- **Paint Removal, An Assessment of Emission Control Options** (3/92, Center for Emissions Control) - a review of alternative approaches to paint stripping with emphasis on chemical alternatives. (Prepared by Center for Emission Control, an industry trade organization).

Although several alternative chemical formulations are available to replace methylene chloride based formulations, the identification of non-chemical based techniques is the focus of this report. Changing from methylene chloride, a HAP, to another solvent, likely a VOC will not foreclose the need to consider further controls. As described below, a wide array of non-chemical based alternatives are available. Federal facilities are encouraged to focus their investigation of depainting alternatives on non-chemical alternatives.

POLLUTION PREVENTION ALTERNATIVES IN DEPAINTING

A variety of technologies are available which can be used to remove coatings. Several blasting techniques exist as well as approaches which thermally destroy (burn) the coating. Table 9 identifies several of the alternative removal techniques available and reported applications. Table 6 summarizes the benefits and limitations associated with the use of these technologies. This information was adapted from the report, Guide to Cleaner Technologies: Organic Coating Removal, previously identified. Additional information on each of these alternatives is available in this report.

Successfully applying one of these techniques as an alternative to a HAP-based formulation, such as one using methylene chloride, will eliminate future compliance concerns under the Clean Air Act, whether to the MACT standard published for the aerospace industry, or future standards for depainting. The future use of methylene chloride paint stripping formulations has the potential to be severely limited under the Clean Air Act because the availability of these alternative techniques.

Some examples are available which document the potential benefits achieved in operations which have replaced methylene chloride formulations with blasting technologies. These examples are presented on Table 7. Significant savings were achieved in each example. In each case, workers no longer needed to be protected from dermal contact or inhalation of vapors from use of chemical strippers. Future compliance burdens with Clean Air Act requirements are also eliminated.

Investing time and effort to identify and implement pollution prevention techniques has the potential to offers benefits that will be realized now and in the future. Federal facilities are encouraged to look hard at preventative techniques, particularly in the development of their Clean Air Act compliance strategies.

TABLE 9**PREVENTION TECHNOLOGIES FOR COATING REMOVAL**

Technology	Reported Application	Waste Products and Emissions	Energy Use	Operations Needed After Stripping
Plastic Media Blasting	Removes paint from a variety of metal and non-metal substrates. Strips aircraft components and ground support equipment. Cleans/strips commercial and industrial parts. Removes powder coatings from sensitive substrates.	Solid coating residue and spent media waste. Airborne particles. Noise.	Compresses air to propel blasting media. Energy for media recovery and recycle, dust collection, and ventilation.	Continuous separation of media from stripped coating particles and spent media during stripping. Remove masking. Dispose of spent media and contained coating residue waste. Some spent thermoplastic media (even with coating residue) can be reused to make plastic parts.
Wheat Starch Blasting	Gentle stripping action suitable for abrasion sensitive fillers and composite materials. Gaining acceptance for thin, soft aluminum in commercial aircraft skins.	Solid coating residue and spent media waste. Airborne particles. Noise.	Compressed air to propel blasting media. Energy for media recovery and recycle, dust collection, and ventilation.	Continuous collection and reuse of spent media during stripping. Remove masking. Dispose of spent media and contained coating residue waste. Spent media can be treated by biodegradation.
Burning Cutoff	Removes thick coatings from a variety of coating line fixtures and tools.	Ash. Offgas.	Electricity or gas supply for heating.	Cool down. Ash removal and collection.

TABLE 9 -- continued

Technology	Reported Application	Waste Products and Emissions	Energy Use	Operations Needed After Stripping
Molten Salt	Removes thick coatings from a variety of coating line fixtures and tools.	Salt/coating by-product sludge. Offgas. Rinse water.	Electricity or gas supply heating.	Cool down. Water rinse.
Sodium Bicarbonate Wet Blasting	Removes paints from a variety of metal substrates. Depaints wood without damaging the substrate. Cleans and depaints brick walls. Removes heavy accumulations of grease and dirt from mechanical equipment.	Liquid waste containing coating residue and spent media. Some airborne particulates. Noise.	Compressed air and water supply to propel blasting media. Ventilation to control particulate.	Remove masking. Dispose of sodium bicarbonate solution and coating residue waste.
Carbon Dioxide Pellet Cryogenic Blasting	Strips surfaces needing high degree of final cleanliness. Useful for equipment where it is desirable to avoid disassembly. Useful when volume of residue must be minimized such as with radioactive-contaminated components or coatings containing hazardous metals (e.g., cadmium or lead).	Solid coating residue waste. Airborne particulates. CO ₂ gas. Noise.	Liquid carbon dioxide supply. Compressed air supply to propel blasting media.	Remove masking. Dispose of coating residue waste.

TABLE 9 -- continued

Technology	Reported Application	Waste Products and Emissions	Energy Use	Operations Needed After Stripping
High-Pressure Water Blasting	Robotic systems for rapid coating removal.	Sludge waste containing paint residue. Wastewater. Some airborne particulates. Noise.	Electricity to drive water pump.	Remove masking. Dispose of coating residue sludge and wastewater.
Medium Pressure Water Blasting	Rapid coating removal.	Sludge waste containing paint residue (and in some systems solvent or abrasive additives). Wastewater. Some airborne particulates. Noise.	Electricity to drive water pump.	Remove masking. Dispose of coating residue sludge and wastewater. If used, dispose of abrasive or sorbent or other treatment medium carrying solvent.
Liquid Nitrogen Cryogenic Blasting	Removes thick coatings of coating from a variety of coating line fixtures and tools.	Solid coating residue and spent media waste. Inert nitrogen gas.	Liquid nitrogen supply.	Vent nitrogen gas from the stripping cabinet. Allow parts to warm for 5 minutes. Dispose of coating residue waste.

Adapted from: Guide to Cleaner Technologies: Organic Coating Removal (2/94; EPA/625/R-93-015).

TABLE 10**PREVENTION TECHNOLOGIES FOR COATING REMOVAL: BENEFITS AND LIMITATIONS**

Technology	Pollution Prevention Benefits	Other Benefits¹	Limitations
Plastic Media Blasting	Eliminates VOCs and HAPs. Uses nontoxic media. Uses a dry process. Spent media are cleaned and reused several times for paint stripping. Some spent thermoplastic media are recyclable to make plastic products.	Provides high-throughput-controlled coating removal. Can selectively remove individual coating layers. Eliminates water use. When stripping is done with thermoplastic media, the waste may be recyclable.	Spent plastic media contain paint chips and so may be hazardous waste. Requires workers to wear respiratory and eye protection equipment. Blasting generates high noise levels. May cause metal substrate damage. More aggressive media types damage fiberglass or composite materials. Contaminants in media can stress substrate. Uses flammable media.
Wheat Star Blasting	Eliminates VOCs and HAPs. Spent media are cleaned and reused several times for paint stripping. Uses a nontoxic, biodegradable medium. Uses a dry process.	Provides controlled coating removal. Can selectively remove individual coating layers. Eliminates water use. Uses inexpensive media. Media are nontoxic and biodegradable.	Spent starch media contain paint chips and so may be hazardous waste. Contaminants in recycled media may damage substrate. Stripping rate is generally slow to moderate. Requires workers to wear respiratory and eye protection equipment. Blasting generates high noise levels. Media are moisture sensitive.

TABLE 10 -- continued

Technology	Pollution Prevention Benefits	Other Benefits¹	Limitations
Burnoff	Eliminates VOCs and HAPs.	Provides rapid removal of thick coatings. Can process complex shapes. Burnoff ovens can remove uncured coating.	Generate coating ash residue that may be hazardous waste. Will damage heat-sensitive materials such as heat-treated aluminum or magnets. Coatings containing halogens (PVC or PTFE) and/or nitrogen will produce corrosive offgas. Must not be used for low-melting metals or alloys. Must not be used with pyrophoric metals. May require offgas treatment, depending on local air permitting regulations. Potential for generation of products of incomplete combustion. Presents possibility of fire.
Molten Salt	Eliminates VOCs and HAPs	Provides rapid removal of thick coatings. Can process complex shapes. Salt bath ensures even heating. Rinsewater waste is compatible with conventional water treatment systems.	Generates by-product sludge that may be hazardous waste. Will damage heat-sensitive materials such as heat-treated aluminum or magnets. Must not be used for low-melting alloys. Must not be used with pyrophoric metals. May require offgas treatment depending on local air permitting regulations. Potential for generation of products of incomplete combustion.

TABLE 10 -- continued

Technology	Pollution Prevention Benefits	Other Benefits¹	Limitations
Sodium Bicarbonate Wet Blasting	<p>Eliminates VOCs and HAPs. Uses nontoxic media.</p>	<p>Provides a controllable process for coating removal. Can selectively remove individual coating layers. Uses inexpensive stripping media. In some cases, liquid waste may be discharged to a conventional wastewater treatment plant. Use of water dissipates heat generated by the abrasion. Eliminates need to prewash surface. Sodium bicarbonate wastestreams are generally compatible with existing water treatment systems.</p>	<p>Uses nonrecyclable stripping media. Generates wet sodium bicarbonate sludge containing coating debris, which may be a hazardous waste. Must collect and treat wastewater containing sodium bicarbonate and paint chips. May require exhaust ventilation system to control particulate. Requires workers to wear respiratory and eye protection equipment. Blasting generates high noise levels. Media can be aggressive so potential for substrate damage exists.</p>

TABLE 10 -- continued

Technology	Pollution Prevention Benefits	Other Benefits¹	Limitations
Carbon Dioxide Pellet Cryogenic Blasting	Eliminates VOCs and HAPs. Uses a dry process so no wastewater is generated. Coating chips collected dry.	Generates low volume or dry waste (none from the media). Eliminates water use. Provides well-defined coating removal pattern. Can selectively remove individual coating layers. Requires limited pre- or poststripping cleanup. No masking needed except for delicate materials such as soft clear plastics. Equipment can be stripped without disassembly. No media separation/recycling system needed. No media disposal cost. Pellets driven into interstitial spaces vaporize, leaving no residue.	Generates coating debris which may be a hazardous. Requires ventilation to avoid potentially dangerous CO ₂ concentrations. Generates airborne particulates that may contain metal from the coatings. Requires workers to wear respiratory and eye protection equipment. Requires workers to wear hearing protection. Possible worker exposure to extreme cold. Potential for worker injury from high-velocity CO ₂ pellet impact. Nonautomated system fatigues workers quickly. Possible static electricity buildup on substrate if no grounding provided. Some coating debris may redeposit on substrate. Low temperatures can cause condensation on substrate. Large local temperature drops can occur in substrate but confined mainly to the surface layer. May damage thermoset composite materials. Difficult to control coating removal on graphite-epoxy composites. Slow coating removal rate. Equipment bulky and capital intensive.

TABLE 10 -- continued

Technology	Pollution Prevention Benefits	Other Benefits¹	Limitations
High Pressure Water Blasting	Eliminates HAPs and VOCs. Water can be processed and recycled during stripping, reducing waste water volume.	High stripping rate. Stripping water can be recycled. Wastewater stream is compatible with existing water treatment systems.	Coating debris sludge may be hazardous waste. System is needed to collect and recycle stripping water. Ultrahigh-pressure systems (>15,000 psi) require expensive robotic operation. Misapplied water jet will damage substrate. Blasting generates high noise levels. Water can enter cavities. Water can penetrate and/or damage joints, seals, and bonded areas.
Medium Pressure Water Blasting	Eliminates HAPs; some systems use VOCs containing softeners. Water can be processed and recycled during stripping reducing wastewater volume.	High stripping rate. Stripping water can be recycled. Wastewater stream is compatible with existing water treatment systems.	Coating debris sludge may be hazardous waste. System is needed to collect and recycle stripping water. Requires workers to wear respiratory and eye protection equipment. Blasting generates high noise levels. Mechanized applications typical due to high reaction forces. Misapplied water jet will damage substrate. Water can enter cavities. Water can penetrate and/or damage joints, seals, and bonded areas.

TABLE 10 -- continued

Technology	Pollution Prevention Benefits	Other Benefits¹	Limitations
Liquid Nitrogen Cryogenic Blasting	<p>Eliminates HAPs and VOCs.</p> <p>Uses a dry process.</p> <p>No dust, fumes, or chemicals released.</p> <p>Coating chips collected dry with small volume of media.</p>	<p>Environmentally clean.</p> <p>No ash residue.</p> <p>Low waste volume.</p> <p>Eliminates water rinse.</p> <p>Very fast cycle times 5 to 15 min. give high throughput rate.</p> <p>Works well on thick coating buildups.</p>	<p>Generates some solid waste containing coating chips and spent plastic media, which may be a hazardous waste.</p> <p>May require ventilation system to prevent nitrogen buildup in confined spaces.</p> <p>Requires worker protection from low temperatures during unloading.</p> <p>Not effective on thin coating films.</p> <p>Less effective on epoxies and urethanes.</p> <p>Existing technology limits part size to less than 5 ft tall and 38 in. diameter, weight less than 400 lb. per stripping cycle.</p>

Adapted from: Guide to Cleaner Technologies: Organic Coating Removal (2/94; EPA/625/R-93-015).

¹ Technologies which eliminate use of VOCs or HAPs, eliminate emission fees and compliance demonstration requirements for monitoring, recordkeeping and reporting.

TABLE 11

**EXAMPLES OF POLLUTION PREVENTION OPPORTUNITIES FOR
PAINT REMOVAL FOR CLEAN AIR ACT COMPLIANCE**

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Plastic Media Blasting (Ref 1)	A study of Plastic Media Blasting (PMB) stripping of C-5 aircraft at Air Force installation concluded that PMB offers significant economic and environmental advantages over solvent stripping. The PMB process at this facility is expected to eliminate 72,000 gallons/year of methylene chloride stripper.	\$4,800,000 annual sav- ings	Eliminated use of HAP. Reduce hazardous waste generation.	PMB eliminate water use. Reduced labor re- quirements over che- mical stripping. Must manage dust generated. Must protect workers from dust, but not vapors and skin contact with chemicals.
Sodium Bicarbonate Wet Blasting (Ref 1)	The NASA Johnson Space Center (JSC) Aircraft Operation Division has used sodium bicarbonate to strip the surface of aircraft wheels prior to inspecting for structural defects. NASA has eliminated the high costs of disposing of solid and liquid wastes generated from their prior use of methylene chloride and other organic solvent strippers.	100% waste reduction	Eliminated use of HAP and VOCs. Eliminated hazard- ous waste.	Must protect workers from dust, but not vapors and skin contact with chemicals.

TABLE 11 -- continued

Process (Ref #)	Pollution Prevention Opportunities	Cost Benefit	Compliance¹ Benefits	Other Issues
Bead-Blast Paint Stripper (Ref 2)	As a result of replacing methylene chloride stripping with a bead-blast paint stripper in its paint shop, General Dynamics has reduced paint-related waste by 50%. The mechanical stripper, which cost \$18,000, will be paid for in just 3.6 years.	\$5,000 annual dis- posal savings	50% hazardous waste reduction. Eliminated use of HAP.	Some fugitive emis- sions occur around the unit. Must protect workers from dust, but not vapors and skin contact with chemicals.

¹ Elimination of regulated compound also provides reduced compliance demonstration expenses for monitoring, recordkeeping and reporting. Regulatory liabilities also reduced.

TABLE 11 -- continued

REFERENCES FOR POLLUTION PREVENTION EXAMPLES

1. United States Environmental Protection Agency, Office of Research and Development. "Guide to Cleaner Technologies - Organic Coating Removal." Publication No. EPA/625/R-93/015, Washington, DC. February 1994.
2. United States Environmental Protection Agency, Office of Research and Development. "Evaluation of Five Waste Minimization Technologies at the General Dynamics Ponom Division Plant." Publication No. EPA/600/2-91/067, Cincinnati, OH. January 1992.

APPENDIX A

INFORMATION SOURCES ON POLLUTION PREVENTION

CONTACTS FOR OBTAINING POLLUTION PREVENTION DOCUMENTS

For EPA Documents:

National Technical Information Service (NTIS)
(703) 487-4650

For EPA Office of Research and Development (ORD) Documents:

Center for Environmental Research Information
26 West Martin Luther King Drive
Cincinnati, Ohio 45268
(513) 569-7562

For Information on ORD Projects:

National Risk Management Research Laboratory
U.S. Environmental Protection Agency
26 West Martin Luther King Drive
Cincinnati, Ohio 45268
(513) 569-7215

For Information and Documents on the Clean Air Act:

Technology Transfer Network (TTN) Bulletin Board System

Operated by the EPA's Office of Air Quality Planning & Standards (OAQPS), the system can be accessed with a computer by calling (919) 541-1447 for 9600 & 19200 bps modems or (919) 541-5742 for 1200 & 2400 bps modems (Data bits=8, parity=N, and stop bits=1). Help Line: (919) 541-5384

For Information on the Significant New Alternatives Policy (SNAP) Program:

Stratospheric Ozone Information Hotline: 1-800-296-1996

For Pollution Prevention Information:

EPA's Pollution Prevention Information Clearinghouse
(202) 260-1023

For Access to Information and Professionals concerning Pollution Prevention and Environmental Compliance:

ENVIRO\$ENSE

Operated by EPA's Office of Research and Development and Office of Enforcement and Compliance Assurance, the system can be accessed by computer modem by calling 703-908-2092 (2,400 to 14,400 bps modems, bits =8, parity =n, stop bits =1, emulation =ANSI or VT-100); or by the World Wide Web via the Internet: <http://wastenot.inel.gov/envirosense/>

For Information on State, Local and Academic Pollution Prevention Programs:

The National Roundtable of State Pollution Prevention Programs
218 D Street, SE
Washington, DC 20003

Phone: 202-543-7272

FAX: 202-543-3844

SOURCES OF INFORMATION ON CLEANING AND DEGREASING

Control of Volatile Organic Emissions from Solvent Metal Cleaning, EPA/450/2-77-022, Research Triangle Park, NC, November 1977. NTIS No. PB-274 557.

United States Environmental Protection Agency, Office of Research and Development. "Guide to Cleaner Technologies, Cleaning and Degreasing Process Changes." Publication No. EPA/625/R-93/017, Washington, DC. February 1994.

United States Environmental Protection Agency, Office of Research and Development. "Guide to Cleaner Technologies, Alternatives to Chlorinated Solvents for Cleaning and Degreasing." Publication No. EPA/625/R-93/016, Washington, DC. February 1994.

United States Environmental Protection Agency, Office of Air and Radiation. "Manual of Practices to Reduce and Eliminate CFC-113 Use in the Electronics Industry." Publication No. EPA/400/3-90/003, Washington, DC, March 1990.

United States Environmental Protection Agency, Office of Air and Radiation. "Eliminating CFC-113 and Methyl Chloroform in Precision Cleaning Operations." Publication No. EPA/400/1-91/018, Washington, DC, June 1991.

United States Environmental Protection Agency, Office of Air and Radiation. "Conservation and Recycling Practices for CFC-113 and Methyl Chloroform." Publication No. EPA/400/1-91/017, Washington, DC, June 1991.

United States Environmental Protection Agency, Office of Air and Radiation. "Alternatives for CFC-113 and Methyl Chloroform in Metal Cleaning." Publication No. EPA/400/1-91/019, Washington, DC, June 1991.

United States Environmental Protection Agency, Office of Air and Radiation. "Aqueous and Semi-Aqueous Alternatives for CFC-113 and Methyl Chloroform Cleaning of Printed Circuit Board Assemblies." Publication No. EPA/400/1-91/016, Washington, DC, June 1991.

United States Environmental Protection Agency, Office of Air and Radiation. "Eliminating CFC-113 and Methyl Chloroform in Aircraft Maintenance Procedures." Publication No. EPA/430/B-93/006, Washington, DC. October 1993.

Pojasek, Robert B. Pollution Prevention Review. "Practical Pollution Prevention - Is Your Quest for Substitute Solvents Preventing You from Evaluating Other Options?" Winter 1991-92. (Available through Pollution Prevention Information Clearinghouse.)

United States Environmental Protection Agency, Office of Research and Development. "Waste Minimization Opportunity Assessment, Naval Undersea Warfare Engineering Station, Keyport, Washington." NTIS Publication No. PB91-216457, Cincinnati, OH. July 1991.

President's Commission on Environmental Quality, Quality Environmental Management Subcommittee. "Total Quality Management, A Framework for Pollution Prevention." Washington, DC. January 1993. (Report available through US Council on Environmental Quality.)

United States Environmental Protection Agency, Office of Air Quality Planning and Standards. "National Emission Standards for Hazardous Air Pollutants: Halogenated Solvent Cleaning Background Information Document." Publication No. EPA/453/R-93/054, Research Triangle Park, NC. November 1993.

United States Environmental Protection Agency, Office of Air Quality Planning and Standards. "Alternative Control Techniques Document--Industrial Cleaning Solvents." Publication No. EPA/453/R-94/015, Research Triangle Park, NC. February 1994.

United States Environmental Protection Agency, Office of Research and Development. "Pollution Prevention Case Studies Compendium." Publication No. EPA/600/R-92/046, Washington, DC. April 1992.

United States Environmental Protection Agency, Office of Research and Development. "Industrial Pollution Prevention Opportunities for the 1990s." Publication No. EPA/600/8-91/052, Washington, DC. August 1991.

United States Environmental Protection Agency, Office of Research and Development. "Guides to Pollution Prevention - The Marine Maintenance and Repair Industry." Publication No. EPA/625/7-91/015, Washington, DC. October 1991.

United States Environmental Protection Agency, Office of Research and Development. "Project Summary - Waste Minimization Opportunity Assessment: Scott Air Force Base." Publication No. EPA/600/S2-91/054, Cincinnati, OH. December 1991.

United States Environmental Protection Agency, Office of Research and Development. "Environmental Research Brief: Waste Minimization Assessment for a Manufacturer of Sheet Metal Cabinets and Precision Metal Parts." Publication No. EPA/600/S-92/021, Cincinnati, OH. May 1992.

United States Environmental Protection Agency, Office of Research and Development. "Environmental Research Brief: Waste Minimization Assessment for a Manufacturer of Military Furniture." Publication No. EPA/600/S-92/017, Cincinnati, OH. June 1992.

United States Environmental Protection Agency, Office of Research and Development. "Environmental Research Brief: Waste Reduction Activities and Options for an Autobody Repair Facility." Publication No. EPA/600/s-92/043, Cincinnati, OH. October 1992.

United States Environmental Protection Agency, Office of Research and Development.
"Opportunities for Pollution Prevention Research to Support the 33/50 Program."
Publication No. EPA/600/R-92/175, Washington, DC. October 1992.

United States Environmental Protection Agency, Office of Research and Development.
"Achievements in Source Reduction and Recycling for Ten Industries in the United States." Publication No. EPA/600/2-91/051, Washington, DC. September 1991.

United States Environmental Protection Agency, Office of Research and Development.
"Pollution Prevention Research Within the Federal Community." Cincinnati, OH.
(Summary paper of pollution prevention opportunity assessments at Federal facilities,
available through EPA's Risk Reduction Engineering Laboratory, Cincinnati, Ohio.)

Illinois Hazardous Waste Research and Information Center, "Pollution Prevention: Illinois
Industry Success Stories", Publication No. TN94-039, Champaign, Illinois, May, 1994.
(Available through Illinois Hazardous Waste Research and Information Center, One East
Hazelwood Drive, Champaign, Illinois 61820, 217-333-8940.)

Industrial Pollution Prevention Handbook by Harry Freeman, Chapter 28; McGraw Hill, 1995.

SOURCES OF INFORMATION ON PAINTING AND DEPAINTING

- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume I: Control Methods for Surface Coating Operations, EPA-450/2-76-028, Research Triangle Park, NC, November 1976. NTIS No. PB-260 386.**
- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume II: Surface Coating of Cans, Coils, Paper, Fabrics, Automobiles, and Light-Duty Trucks, EPA-450/2-77-008, Research Triangle Park, NC, May 1977.**
- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume III: Surface Coating of Metal Furniture, EPA-450/2-77-032, Research Triangle Park, NC, December 1977. NTIS No. PB-278 257.**
- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume IV: Surface Coating of Insulation of Magnet Wire, EPA-450/2-77-033, Research Triangle Park, NC, December 1977. NTIS No. PB-278 258.**
- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume V: Surface Coating of Large Appliances, EPA-450/2-77-034, Research Triangle Park, NC, December 1977. NTIS No. PB-278 259.**
- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VI: Surface Coating of Miscellaneous Metal Parts and Products, EPA-450/2-78-015, Research Triangle Park, NC, June 1978. NTIS No. PB-286 157.**
- Control of Volatile Organic Emissions from Existing Stationary Sources, Volume VII: Factory Surface Coating of Flat Wood Paneling, EPA-450/2-78-032, Research Triangle Park, NC, June 1978. NTIS No. PB-292 490.**
- United States Environmental Protection Agency, Office of Research and Development. "Pollution Prevention Case Studies Compendium." Publication No. EPA/625/R-93/015, Washington, DC. February 1994.**
- Center for Emissions Control. "Paint Removal, An Assessment of Emission Control Options." Washington, DC. March 1992.**
- United States Environmental Protection Agency, Office of Research and Development. "Guides to Pollution Prevention: The Automotive Refinishing Industry." Publication No. EPA/625/7-91/016, Washington, DC. October 1991.**
- United States Environmental Protection Agency, Office of Air Quality Planning and Standards. "National Emission Standard for Hazardous Air Pollutants (NESHAP) for the Aerospace Industry - Background Information for the Proposed Standards." Publication No. EPA/453/R-94-036a. Preliminary Draft, Research Triangle Park, NC. April 1994.**

United States Environmental Protection Agency, Office of Research and Development.
"Evaluation of Five Waste Minimization Technologies at the General Dynamics Ponom
Division Plant." Publication No. EPA/600/2-91/067, Cincinnati, OH. January 1992.

United States Environmental Protection Agency, Office of Research and Development.
"Achievements in Source Reduction and Recycling for Ten Industries in the United
States." Publication No. EPA/600/2-91/051, Washington, DC. September 1991.

United States Environmental Protection Agency, Office of Research and Development.
"Industrial Pollution Prevention for the 1990s." Publication No. EPA/600/8-91/052,
Washington, DC. August 1991.

Hazardous Waste Research and Information Center. "Pollution Prevention: Illinois Industry
Success Stories." Publication No. TN94-039, Champaign, IL. May 1994.

United States Environmental Protection Agency, Pollution Prevention Research Branch.
"Pollution Prevention Research Within the Federal Community." Cincinnati, OH.

United States Environmental Protection Agency, Office of Research and Development.
"Pollution Prevention Case Studies Compendium." Publication No. EPA/600/R-92/046,
Washington, DC. April 1992.

Industrial Pollution Prevention Handbook by Harry Freeman; Chapter 29; McGraw-Hill, 1995.

APPENDIX B

**COMPOSITE SNAP PROGRAM ALTERNATIVES LISTINGS
FOR CLEANING AND DEGREASING**

- Pressure Sensitive Tape and Label Surface Coating - Subpart RR (48 FR 48375, 10/18/83)
- Large Appliance - Subpart SS (47 FR 47785, 10/27/82)
- Metal Coil - Subpart TT (47 FR 49612, 11/1/82)
- Beverage Can - Subpart WW (48 FR 38737 8/25/83)
- Flexible Vinyl and Urethane Coating (49 FR 26892, 6/29/84)
- Magnetic Tape - Subpart SSS (53 FR 38914, 10/3/88)
- Plastic Parts for Business Machines - Subpart TTT (53 FR 2676, 1/29/88)
- Polymeric Coating of Supporting Substrates - Subpart VVV (54 FR 37551, 9/11/89)

VOC limits in NSPSs are generally expressed in terms of mass of VOC per unit volume of applied solids in the coating. Appendix D lists many of the NSPS coating limits. The reader is referred to these specific rules for more information on the NSPSs.

HAP Rules

Several surface coating operations have been identified as major sources of HAPs. These source categories have been targeted for the development of MACT standards. The specific source categories and the date scheduled under the Clean Air Act for completing the MACT standards are shown below. A MACT standard applicable to the aerospace manufacturing and rework industry was published on September 1, 1995 (60FR45948). A MACT standard was also published for magnetic tape production on December 15, 1994 (59FR64580). In addition, MACT standards were proposed on December 6, 1994 addressing surface coating in the shipbuilding and ship repair industry (59FR62681), and in the wood furniture manufacturing industry (59FR62652). These proposed rules should be made final in the 1996 fiscal year.



United States
Environmental
Protection Agency

Office of Air and Radiation August 1995
Stratospheric Protection Rev. 3
Division (6205-J)

Significant New Alternatives Policy (SNAP) Program Substitutes List for Class I Ozone Depleting Chemicals

INTEGRATED LISTS FROM FEDERAL REGISTER NOTIFICATIONS OF: DETERMINATIONS OF ACCEPTABILITY OF ALTERNATIVES FOR CLASS I OZONE DEPLETING CHEMICALS UNDER THE SIGNIFICANT NEW ALTERNATIVES POLICY (SNAP) PROGRAM (Comprehensive as of August 1995)

Section 612 of the Clean Air Act (CAA) requires EPA to review alternatives to ozone depleting substances and to publish lists of acceptable and unacceptable substitutes. It is illegal to replace an ozone depleting chemical with a substitute which has been listed as unacceptable. In addition, any person who produces a substitute must notify EPA at least 90 days before new or existing alternatives are introduced into interstate commerce for significant new use as substitutes.

For further detail on the attached decisions refer to the following Federal Register Notices: 59 FR 13044 (March 16, 1994); and 59 FR 44240 (August 26, 1994); 60 FR 3318 (January 13, 1995); 60 FR 31092 (June 13, 1995); and 60 FR 38729 (July 28, 1995).

FOR MORE INFORMATION ON FEDERAL REGULATIONS UNDER THE STRATOSPHERIC OZONE PROTECTION PROGRAM, PLEASE CALL THE STRATOSPHERIC OZONE PROTECTION HOTLINE AT 1-800-296-1996 (OUTSIDE THE U.S. CALL (202) 775-6677).

**SOLVENT CLEANING
ACCEPTABLE SUBSTITUTES
Updated August 1993**

END USE	SUBSTITUTE	DECISION	COMMENTS
Metals cleaning w/ CFC-113, NCF	Aqueous cleaners	Acceptable	EPA expects to issue effluent guidelines for this industry under the Clean Water Act by as early as 1994.
	Semi-aqueous cleaners	Acceptable	EPA expects to issue effluent guidelines for this industry under the Clean Water Act by as early as 1994.
	Straight organic solvent cleaning (with terpenes, C6-C20 petroleum hydrocarbons, oxygenated organic solvents such as ketones, esters, ethers, alcohols, etc.)	Acceptable	OSHA standards must be met, if applicable.
	Trichloroethylene, perchloroethylene, methylene chloride	Acceptable	OSHA and RCRA standards must be met. EPA expects to issue Maximum Achievable Control Technology requirements under the Clean Air Act for this application by 1994.
	Vanishing oils	Acceptable	Depending on geographic region, may be subject to VOC controls.
	Supercritical fluids	Acceptable	
	Volatile methyl siloxanes	Acceptable	Approval is granted for the whole class of compounds.
	Trans-1,2-dichloroethylene	Acceptable	

END USE	SUBSTITUTE	DECISION	COMMENTS
Electronics cleaning w/ CFC-113, NCF	Aqueous cleaners	Acceptable	EPA expects to issue effluent guidelines for this industry under the Clean Water Act by as early as 1994.
	Semi-aqueous cleaners	Acceptable	EPA expects to issue effluent guidelines for this industry under the Clean Water Act by 1994.
	Straight organic solvent cleaning (with terpenes, C6-C20 petroleum hydrocarbons, oxygenated organic solvents such as ketones, esters, ethers, alcohols, etc.)	Acceptable	OSHA standards must be met, if applicable.
	Trichloroethylene, perchloroethylene, methylene chloride	Acceptable	OSHA and RCRA standards must be met. EPA expects to issue Maximum Achievable Control Technology requirements under the Clean Air Act for this application by 1994.
	No-clean alternatives	Acceptable	Substitutes found acceptable include low solids fluxes and inert gas soldering.
	Supercritical fluids, plasma cleaning, UV/Ozone cleaning	Acceptable	OSHA standards for ozone must be met.
	Volatile methyl siloxanes	Acceptable	Approval is granted for the whole class of compounds.
	Trans-1,2-dichloroethylene	Acceptable	

END USE	SUBSTITUTE	DECISION	COMMENTS
Precision cleaning w/ CFC-113, MCF	Aqueous cleaners	Acceptable	EPA expects to issue effluent guidelines for this industry under the Clean Water Act by as early as 1994.
	Semi-aqueous cleaners	Acceptable	EPA expects to issue effluent guidelines for this industry under the Clean Water Act by as early as 1994.
	Straight organic solvent cleaning (with terpenes, C6-C20 petroleum hydrocarbons, oxygenated organic solvents such as ketones, esters, ethers, alcohols, etc.)	Acceptable	OSHA standards must be met, if applicable.
	Trichloroethylene, perchloroethylene, methylene chloride	Acceptable	OSHA and RCRA standards must be met. EPA expects to issue Maximum Achievable Control Technology requirements for this application by 1994.
	Supercritical fluids, plasma cleaning, UV/Ozone cleaning	Acceptable	OSHA standards for ozone must be met.
	MCF-123	Acceptable	Has an AEL of 30ppm.
	Trans-1,2-dichloroethylene	Acceptable	
	Volatile methyl siloxanes	Acceptable	Approval is granted for the whole class of compounds.

**SOLVENT CLEANING
SUBSTITUTES ACCEPTABLE SUBJECT TO
NARROWED USE LIMITS**

END USE	SUBSTITUTE	DECISION	COMMENTS
<p>Electronics cleaning w/ CFC-113, MCF</p>	<p>Perfluoro-carbons (C5F12, C6F12, C6F14, C7F16, C8F18, C5F11NO, C6F13NO, C7F15NO, and C8F16)</p>	<p>Acceptable for high-performance, precision-engineered applications only where reasonable efforts have been made to ascertain that other alternatives are not technically feasible due to performance or safety requirements</p>	<p>The principal environmental characteristic of concern for PFCs is that they have long atmospheric lifetimes and high global warming potentials. Although actual contributions to global warming depend upon the quantities of PFCs emitted, the effects are for practical purposes irreversible.</p> <p>User must observe this limitation on PFC acceptability by conducting a reasonable evaluation of other substitutes to determine that PFC use is necessary to meet performance or safety requirements. Documentation of this evaluation must be kept on file.</p> <p>For additional guidance regarding applications in which PFCs may be appropriate, users should consult the Preamble for this rulemaking.</p>
<p>Precision cleaning w/ CFC-113, MCF</p>	<p>Perfluoro-carbons (C5F12, C6F12, C6F14, C7F16, C8F18, C5F11NO, C6F13NO, C7F15NO, and C8F16)</p>	<p>Acceptable for high-performance, precision-engineered applications only where reasonable efforts have been made to ascertain that other alternatives are not technically feasible due to performance or safety requirements</p>	<p>The principal environmental characteristic of concern for PFCs is that they have long atmospheric lifetimes and high global warming potentials. Although actual contributions to global warming depend upon the quantities of PFCs emitted, the effects are for practical purposes irreversible.</p> <p>Users must observe this limitation on PFC acceptability by conducting a reasonable evaluation of other substitutes to determine that PFC use is necessary to meet performance or safety requirements. Documentation of this evaluation must be kept on file.</p> <p>For additional guidance regarding applications in which PFCs may be appropriate, users should consult the Preamble for this rulemaking.</p>

**SOLVENT CLEANING
SUBSTITUTES ACCEPTABLE SUBJECT TO
USE RESTRICTIONS**

END USE	SUBSTITUTE	DECISION	CONDITIONS	COMMENTS
Electronics cleaning w/ CFC-113, NCF	HCFC-225ca/cb	Acceptable	Subject to the company- set exposure limit of 25 ppm for the -ca isomer	HCFC-225ca/cb is offered as an isomeric blend. The company-set workplace standard for the cb- isomer is higher--250ppm. The use of the less toxic cb-isomer in the blend suggests that the 25 ppm standard for the ca- isomer can be readily met.
Precision cleaning w/ CFC-113, NCF	HCFC-225ca/cb	Acceptable	Subject to the company- set exposure limit of 25 ppm for the -ca isomer	HCFC-225ca/b is offered as an isomeric blend The company-set workplace standard for the cb- isomer is higher--250ppm. The use of the less toxic cb-isomer in the blend suggests that the 25 ppm standard for the ca- isomer can be readily met.

Precision cleaning w/ CFC-113	HCFC 141b and its blends	Unacceptable	High ODP; other alternatives exist. Effective date: As of 30 days after final rule for uses in new equipment (including retrofits made after the effective date); as of January 1, 1996 for uses in existing equipment. EPA will grant, if necessary, narrowed use acceptability listings for CFC-113 past the effective date of the prohibition.
Precision cleaning w/ NCF	HCFC 141b and its blends	Unacceptable	High ODP; other alternatives exist. Effective date: As of 30 days after final rule for uses in new equipment (including retrofits made after the effective date); as of January 1, 1996 for uses in existing equipment.

**SOLVENT CLEANING
PENDING SUBSTITUTES**

END USE	SUBSTITUTE	COMMENTS
Metals cleaning w/ CFC-113, MCF, and HCFC-141b	HCFC-122	Agency is still reviewing ODP. This HCFC is a new chemical and must also complete Premanufacture Notice requirements under the Toxic Substances Control Act.
	HFC-4310mee	SNAP/Premanufacture Notice review under the Toxic Substances Control Act nearly completed.
Electronics cleaning w/ CFC-113, MCF and HCFC-141b	Perfluoropolyethers	Agency evaluating global warming concerns.
Electronics cleaning w/ HCFC-141b	Perfluorocarbons (C5F12, C6F12, C6F14, C7F16, C8F18, C5F11NO, C6F13NO, C7F15NO, and C8F16)	Agency in process of evaluating global warming concerns.
Precision cleaning w/ CFC-113, MCF	HCFC-122	Agency is still reviewing ODP. This HCFC is a new chemical and must also complete Premanufacture Notice requirements under the Toxic Substances Control Act.
	HFC-4310mee	SNAP and Premanufacture Notice review under the Toxic Substances Control Act is nearly completed.
	Chlorobromomethane	EPA is completing a more detailed analysis on the range of ODP for this substitute and is reviewing updated information on the toxicity of this substitute.
Precision cleaning w/ HCFC-141b	Perfluorocarbons (C5F12, C6F12, C6F14, C7F16, C8F18, C5F11NO, C6F13NO, C7F15NO, and C8F16)	Agency in process of evaluating global warming concerns.

APPENDIX C

SOLVENT INFORMATION DATA SYSTEMS

Hazardous Solvent Substitution Data System

EG&G Idaho, Inc. a management and operations contractor at the U.S. Department of Energy's Idaho National Engineering Laboratory, has been charged with developing a list of products that may be used as substitutes for hazardous solvents.

Because of the dynamic nature of regulatory agency requirements with respect to the risks that chemicals pose to human health and the environment, risk assessments must be conducted before any process changes can be made or any new processes can be initiated. The risk assessment process requires interaction and cooperation between a variety of disciplines. A brief description of the process follows.

To use a particular solvent, the user needs to know the types of soils the product will remove, its base material compatibility and application capability, and any history of use of the product by industry. The industrial hygienist must review the Material Safety Data Sheets (MSDSs) to assess whether the chemical element or compound is on any of the hazardous constituents lists prepared by regulatory agencies and to assess the toxicity, exposure criteria, ecology, and methodology with respect to the proposed use of the product. The process engineer must know if existing equipment can be used or modified, or if the proposed use requires additional capital investment. The process engineer must also know if the product is recyclable and if the spent product is biodegradable. The process manager must be assured that the user's safety will not be at risk, that the process complies with regulatory requirements, and that the life cycle costs are within the budget estimates.

To meet the information needs of the various disciplines, the Hazardous Solvent Substitution Program has developed an unstructured data system. The system allows scanning of the technical product data sheets provided by manufacturers. These are processed by optical character recognition technology, which enables the use of full text retrieval technology. The technology allows the user to query the data system using word and topic searches in conjunction with boolean and context operators. The system also provides a link to vendor-supplied MSDSs for each product. The chemical compound or elements of the product can be compared against the hazardous constituents lists. This capability includes a feature that highlights those products that appear on the lists. Toxicity and biodegradability data may be linked to the product or to the compound or chemical elements of the product. Performance data, test data, and product use references may also be linked to each product. The solid line shows data linkage to product that presently exists, the dotted line shows data that will be linked in the near future.

The following is a description of each type of document available on the Hazardous Solvent Substitution Data System:

- **Product data** - The product data is the base document. It lists the product name and the name, address, and phone number of the manufacturer. The technical data addresses the types of soils that can be cleaned, the applications (immersion, spraying, etc.) and the materials with which the product is compatible or incompatible. In most cases, data required in the MSDS is also listed in the technical data. The text is scanned as American Standard Code for Information Interchange (ASCII) code; it is also scanned as an image because some of the product information sheets contain graphics, tables, or charts that are not available in text-only retrieval.
- **Material safety data sheets** - The MSDSs are scanned as images only because of the poor print quality of many MSDSs. This prevents the processing of undetected errors and eliminates the liability associated with changing an MSDS. The MSDS is linked to the product, making it available for immediate review when a user views the technical data.
- **Chemical elements list** - The chemical elements list is derived from the list of chemical elements and/or compounds in the MSDS. This feature allows a user to query the system on the types of chemicals that make up the product. A comparison can also be made to the chemical elements or compounds contained in the regulatory lists of hazardous constituents.
- **Hazardous constituents list** - This feature lists the chemical elements designated as hazardous under the various worker and environmental protection laws.
- **EPA and other toxicity reports/data** - This feature provides information on toxicology tests and reports that have been generated on various chemical elements, chemical compounds, and chemical families or groups. These reports are also linked to products. An industrial hygienist can immediately review test data for chemicals on which toxicology reports are available.
- **Usage reference** - The usage data describes how the product is used in industry: the application, the process parameters, and any sources of additional information.

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Solvent Alternatives Guide (SAGE)

In 1982, AEERL initiated a program to assist in the selection of nonpolluting industrial surface cleaning alternatives. The objective of the program was to make the identification of cleaning options simple yet based on the latest technical and economic feasibility information available. This objective could be most easily accomplished through the use of electronic equipment and a logic tree format. The resulting system called SAGE for Solvent Alternatives Guide incorporates the speed and ability of the computer to evaluate a large number of operating parameters and conditions to identify the most viable surface cleaning option. The first BETA test version 1.0, of SAGE was released in May of 1993 and placed on the control Technology Center Bulletin for down loading and review. Version 1.0 included only metal surface solvent cleaning and was designed to test the SAGE concept for selecting surface cleaning alternatives. Since its release there have been over 100 down loading of SAGE from the GTC bulletin board and another 100 copies of the system disk was mailed to requestors. Many of the responses from users of the BETA test version indicate that the system in a few minutes confirmed their prior conclusions derived from many hours of study and analysis. The report also gave many users greater insight into the technical considerations and requirements for use of the various options which were previously unknown. The results of the responses have validated the concept used in the SAGE system. The system has been featured in a number of trade magazines including "Product Finishing," and "The Journal of the American Electroplaters and Surface Finishers Society."

SAGE is not a database rather a PC based logic tree system that evaluates the users present operating scenario and then identifies possible surface cleaning alternative solvent chemistries and processes that best suits the defined operating and material requirements. The system asks a series of questions concerning the users existing operation such as: part size, present processing chemistry, part cost, production rate, and contaminants. Based on the answers provided a number of recommended options is provided which represent the most probable alternate cleaning chemistry and/or process. The report generated by SAGE presents the recommended options and important technical parameters. It also provides information on environmental considerations that must be taken into account, regulations that must be addressed when using the alternative, safety requirements, economic considerations, and equipment requirements, and other information that must be considered when implementing the recommended alternative. Finally, the report will include examples of case studies with a similar operating scenario and requirements.

SAGE is designed for use by individuals ranging from shop foremen to regulatory agency personnel, both technical and nontechnical personnel. It requires only a 286 level machine and a printer if a complete report is required. The SAGE system is scheduled for continued upgrade through FY 95 with quarterly release of new versions during this period. Subsequent versions will incorporate into the system additional surface cleaning requirements such as paint stripping, electronic manufacturing, machinery, and printing equipment cleaning. In addition a process and facility design capability, economic and cost projection capability, and a regulation summation by state will be incorporated into the system.

While the final selection of a process alternative must ultimately be made by the user, SAGE will provide the user with the information needed to make that choice.

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NCMS Solvent Database

The NCMS Solvent Database is an electronic database providing access to information on environmental fate, health and safety data, regulatory status, chemical/physical properties, and suppliers. The database includes over 320 pure solvents and trade name mixtures. Each record includes 15 fields of environmental fate, 31 fields of health and safety, 21 fields of regulatory status, 36 fields of chemical/physical properties, and 19 fields of descriptive and supplier data. A relational search capability will enable users to identify potential alternative solvents or mixtures which meet preselected criteria. For example, one can request a list of alcohols exceeding a flash point of 45°C and not regulated under SARA 313. Users can also display and print customized data tables by choosing solvents and properties from pick.

The NCMS Solvent Database is a stand-alone application running under Paradox Runtime. The database is distributed on floppy disks. System requirements are a 100% IBM-PC compatible computer with a 386 or later processor and a hard drive with 6MB of available disk space. You will also need 2MB RAM configured as extended memory, DOS 3.0 or later, and CGA, EGA, VGA, or compatible monitor. The Solvent Database supports the use of a mouse and IBM, HP and Epson-compatible printers.

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APPENDIX D

EXAMPLE LIMITS FOR VOCs FROM SURFACE COATING OPERATIONS

(from EPA Report: Recordkeeping Guidance
Document for Surface Coating Operations and
the Printing Industry 7/89, EPA 340/1-88-003).

ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS

Operation	Pounds VOC per gal coating minus water ^a
<p>1. CAN COATING</p> <p><u>CTG Limits</u></p> <p>a) Sheet basecoat (exterior and interior) and over varnish; two piece can exterior base coat and over varnish</p> <p>b) Two and three piece can interior body spray, two piece can exterior end (spray and roll coat)</p> <p>c) Three piece can side-seam spray</p> <p>d) End sealing compound</p> <p>CTG Reference: EPA 450/2-77-008, Vol. II, May 1977</p> <p><u>NSPS Limits</u></p> <p>From two piece beverage can surface coating operations:</p> <p>Each exterior base coating except clear base coating operation</p> <p>Each over varnish coating and each clear base coating operation</p>	<p>2.8</p> <p>Established based on 25 volume percent solids and 80:20 volume mix of water and VOC</p> <p>4.2</p> <p>Establish based on 18 volume percent solids and 70:30 mix of water and VOC</p> <p>5.5</p> <p>3.7</p> <p>2.4 lb/gal of coating solids</p> <p>3.8 lb/gal of coating solids</p>

ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water ^a
<p>Each inside spray coating operation</p> <p>NSPS Reference: 40 CFR 60 WW; 1983</p> <p>NSPS BID: EPA 450/3-80-036a & b</p>	<p>7.4 lb/gal of coating solids</p>
<p><u>California Limits</u></p> <p>Sheet base coat (exterior and interior) and over varnish</p> <p>Two piece can exterior base coat and over varnish</p>	<p>(1.9)</p> <p>(2.1)</p>
<p>2. PAPER COATING</p> <p><u>CTG Limits</u></p> <p>Coating line (consists of the coatings put on paper, pressure sensitive tapes regardless of substrate (including paper, fabric, or plastic film) and related web coating processes on plastic film such as type-writer ribbons, photographic film and magnetic tape. Also included in paper coating category are decorative coatings on metal foil such as gift wrap and packaging.</p> <p>CTG Reference: The same as for Item 1</p>	<p>2.9 (1.0 California)</p>

ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water ^a
a) Prime application, flashoff area, and oven	1.9 (1.2 Delaware limit)
Prime coat (15.1 lb/gal solids applied--later guidance)	1.2
Guide coat (15.1 lb/gal solids applied--later guidance)	2.8 at baseline TE = 30 percent, Established based on the use of water-borne coatings
b) Topcoat application, flashoff area, and oven	2.8 At baseline TE = 30 percent, Established based on the use of water-borne coatings
c) Final repair application, flashoff area, and oven	4.8
CTG Reference: The same as for Item 1	
<u>NSPS Limits</u>	
Prime coat	1.3 lb/gal solids applied
Guide coat	11.7 lb/gal solids applied at baseline TE = 39 percent
Top coat	12.2 lb/gal solids applied at baseline TE = 37 percent
A requirement of the NSPS is that the operator must conduct a performance test each calendar month and report the results to EPA within 10 days. The calculation of the volume weighted average mass of VOC per volume of applied coating	

ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water ^a
<p>solids during each month constitutes a performance test.</p> <p>While RM 24 is the reference method for use in this performance test to determine data used in the calculation of the volatile content of coatings, provisions have been made to allow the use of coatings manufacturers' formulation data to determine the volume fraction of solids. If an incinerator is used, owner must submit a quarterly report on incinerator performance.</p> <p>NSPS Reference: 40 CFR 60 MM; 1980 NSPS BID: 450/3-79-030a&b</p> <p><u>California Limits</u></p> <p>SCAQMD Rule 1115</p> <p>a) Prime application, flashoff area and oven:</p> <p style="padding-left: 40px;">for electrophoretic primer (1.2 at baseline TE = 95 percent) for primer surfacer (2.8 at baseline TE = 95 percent) for spray primer (2.3 at baseline TE = 95 percent)</p> <p>b) Topcoat application, flash-off area, and oven (2.3)</p> <p>Massachusetts has separate limits for primer application</p>	

ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water ^a
Exemptions in Virginia: Wheel enamels, anti-rust coatings and sealers not associated with prime or top coat application to the vehicle body.	
Exemption in Delaware: Coating lines emitting less than 40 lbs/ day per facility	
7. SURFACE COATING OF LARGE APPLIANCES	
<u>CTG Limits</u>	2.8 at baseline TE = 60 percent
CTG Reference: Vol V.	
<u>NSPS Limits</u>	7.5 lbs/gal of applied coating solids Established based on 62 volume percent solids applied at a TE of 60 percent
NSPS Reference: 40 CFR SS, 1982 NSPS BID: 450/3-80-007a&b	
<u>California Limits</u>	
Air dried or forced air dried coatings	(2.8)
Baked coatings	(2.3)
Industrial machinery:	
Extreme performance coatings	(2.8)
If dried at >90°C	(2.3)