6. STATUTORY AND REGULATORY INITIATIVES

6.1 INTRODUCTION

This chapter presents a summary of current and pending federal, state and local controls on the use and emissions of ozone depleting chemicals (ODCs). This summary is an update to the summary prepared by the California Air Resources Board in 1990 (ARB, 1990). As discussed below, the federal 1990 Clean Air Act Amendments (CAAAs), enacted in 1990, provide sweeping authority for additional federal controls. The research for this summary was conducted during 1991 and updated again in 1992, and the data reported are current as of that time.

First, the method for developing the summary is presented. Second, a brief overview of the current status of international controls on ODCs is provided. Then, separate sections are presented for: federal, California and its localities, and other states and localities.

6.2 METHODOLOGY

Several avenues of research were conducted for this summary. First, secondary sources of data were reviewed, including the summary prepared by the ARB (ARB, 1990), on-line data bases (IPA, 1991; BW, 1991), and newspaper indices. These sources, and the on-line data bases in particular, provided a comprehensive list of reported legislative and regulatory efforts ongoing throughout the United States related to ODCs.

After reviewing this list, contacts were made with key industry representatives and trade associations that are tracking the state and local regulatory efforts affecting ODC use and emissions. The initial list developed from secondary sources was supplemented based on these conversations.

Using this expanded list, appropriate individuals in all the states and localities on the list were identified and contacted. In most cases the appropriate individual was employed by the state or local environmental, natural resources, or engineering department. Each individual was contacted by telephone in order to discuss the status of legislation and regulations affecting the use and emissions of the ODCs. The following information was requested in the telephone interviews:

- What legislation and/or regulations have been enacted and/or promulgated?
- If legislation or regulations are in place, what has been the experience to date regarding: implementation; compliance; costs; and emissions reductions?
- Is additional legislation and/or regulations pending?

- If legislation and/or regulations were withdrawn or rejected, what factors led to the withdrawal or rejection?

Copies of proposed or enacted/promulgated legislation and regulations were also requested. In all cases these copies were obtained and reviewed to confirm the information obtained in the telephone interviews. In some cases, additional telephone calls were required to clarify the original information or the information contained in the copies of the legislation and regulations.

Finally, individuals at the U.S. Environmental Protection Agency were contacted and interviewed to obtain information regarding the status of activities required under the CAAAs. This information was recorded and is summarized in the section below.

6.3 INTERNATIONAL REQUIREMENTS

Almost all of the pertinent international controls on ozone depleting compounds (ODCs) are embodied in the Montreal Protocol of 1987, as amended in London in June 1990. The Protocol currently requires each party to phase out all production of CFCs, halons, and carbon tetrachloride by January 2000 (Group I and Group II substances) and to eliminate methyl chloroform production by January 2005 (Group III). Moreover, the Protocol includes a declaration of intent to phase out HCFCs no later than 2040 and, if possible, by 2020. Exhibit 62 lists all of the substances controlled under the Protocol.

The Montreal Protocol does not directly impose compliance requirements on firms and consumers in the U.S. Such requirements are implemented by the Environmental Protection Agency (EPA) using its authority under the Clean Air Act. The U.S. is, however, committed to compliance with the Protocol; under the CAAAs, in cases where the Protocol and the statute conflict, "the more stringent provision shall govern." As described below, there are several instances where the CAAAs impose stricter requirements than are mandated by the Protocol.

Also of note is that the Protocol is not a static set of controls. The discussions at the third meeting of the Parties to the Protocol in June, 1991 in Nairobi, Kenya suggest that additional controls on ozone depleting substances may be imposed at the fourth meeting of the Parties in September 1992, in Denmark. An advisory group is currently working to determine the earliest feasible phase-out date for methyl chloroform and will report to the 1992 meeting on its findings. Stricter controls on halons may also be considered.

The Parties adopted a short list of products containing controlled substances that are banned as imports from non-Parties as of June, 1992. Such products include the following:

- automobile and truck air conditioning units (whether or not incorporated into vehicles);

- domestic and commercial refrigeration and air conditioning/heat pump equipment (e.g., refrigerators, freezers, dehumidifiers, water coolers, ice machines, and air conditioning and heat pump units);
- aerosol products, except medical aerosols;
- portable fire extinguishers;
- insulation boards, panels, and pipe covers; and
- pre-polymers.

Finally, there is some chance that at the fourth meeting of the Parties, the phaseout of ODCs could be accelerated; 13 nations proposed at this year's meeting to adopt a 1997 phaseout date. While the proposal was not adopted, the Parties did agree to study the issue.

Exhibit 62: Substances Controlled by the Montreal Protocol

Group I Substances	Group II Substances	Group III Substances
ANNEX A		
CFC-11 CFC-12 CFC-113 CFC-114 CFC-115	Halon-1211 Halon 1301 Halon-2402	(none)
ANNEX B		
CFC-13 CFC-111 CFC-112 CFC-211 CFC-212 CFC-213 CFC-214 CFC-215 CFC-216 CFC-217	Carbon Tetrachloride	Methyl Chloroform
ANNEX C		
At present, partially halogenated fluorocarbons (i.e., HCFCs), are not considered to be "controlled substances." They are, however, listed as "transitional substances" in Annex C of the Protocol.		

6.4 FEDERAL

U.S. efforts to control ODCs began in 1974. Most recently, the enactment of the CAAAs has expanded EPA's authority to control the use and emissions of ODCs. First a brief review of the initial federal efforts to control ODCs is presented. Then, the major provisions of the CAAAs are presented in detail.

6.4.1 Initial Federal Controls on ODCs

U.S. government restrictions on CFCs were first discussed in Congressional hearings in December 1974. In 1978, the U.S. EPA and the Food and Drug Administration (FDA) banned the use of CFCs as propellants in non-essential aerosol products (43 FR 11301; March 17, 1978). The Consumer Product Safety Commission (CPSC) issued regulations requiring that exempted aerosol products bear a warning label identifying the product as containing CFCs, which may deplete ozone.

In the 1977 Amendments to the Clean Air Act, Congress strengthened EPA's regulatory authority for actions to protect stratospheric ozone. In 1980, EPA issued an Advance Notice of Proposed Rulemaking (ANPRM), "Ozone-Depleting Chlorofluorocarbons: Proposed Production/Restriction" (45 FR 66726; October 7, 1980) that called for limits on non-aerosol uses of CFCs. The Agency announced its objective to freeze current emissions of ozone-depleting compounds.

In 1984, the Natural Resources Defense Council (NRDC) brought suit against the EPA, arguing that the ANPRM constituted a finding of a reasonable threat to the stratosphere, which required the Agency either to issue regulations or to formally withdraw the ANPRM. In 1985, EPA and NRDC were joined by the Alliance for Responsible CFC Policy in filing a joint settlement motion calling for a proposed regulatory decision by May 1, 1987 and a final decision by November 1, 1987. This consent decree was extended in 1987 with deadlines set for December 1, 1987, and August 1, 1988, for proposal and final action, respectively.

Following the U.S. ratification of the Montreal Protocol, the U.S. implemented its obligations under the Protocol by restricting the production and import of CFCs and halons using a two-part quota system of production allowances and consumption allowances (53 FR 30566, August 12, 1988).

- Production Allowances. Manufacturers of the ODCs were required to report their 1986 production to EPA. The manufacturers were allocated production allowances (quotas) based on these reported levels. Allowances for CFCs and halons were kept separate. A total of five companies received production allowances for the CFCs, and three companies received production allowances for the halons.

- Consumption Allowances. Consumption allowances are used to control national consumption of CFCs and halons, as required under the Montreal Protocol.

Consumption is defined as production, plus imports, minus exports. Therefore, EPA required that all import and export data for 1986 be reported. These data were used along with the production levels reported above as the basis for allocating the consumption allowances.

Importers of the relevant ODCs were granted consumption allowances. The manufacturers of the ODCs were granted consumption allowances equal to their production, minus their exports plus their imports. Unfortunately, the parties responsible for a portion of the exports in 1986 could not be identified. These "unallocatable" export quantities were assigned to the manufacturers in proportion to their 1986 market shares of production, thereby reducing their allocations slightly. A total of 14 companies received consumption allowances for the CFCs and six companies received consumption allowances for the halons.

In order for a manufacturer to produce a controlled ODC, it must have valid production and consumption allowances totalling the amount produced. In order to import a controlled ODC, an importer must have a valid consumption allowance equal to the imported amount. To implement this requirement, the manufacturers and importers are required to maintain detailed records of production and other transactions.

In 1988 EPA also published an advance notice of proposed rulemaking to consider further efforts to protect stratospheric ozone (53, FR 30604, August 12, 1988). The EPA also published its risk assessment and regulatory impact analyses that formed the basis for the Agency's actions (EPA, 1987 and EPA, 1988).

6.4.2 The 1990 Clean Air Act Amendments

Future federal efforts to control the ODCs will take place under the framework and authority established by the 1990 CAAAs. A summary of the Clean Air Act Amendments is provided in Exhibit 63. In the exhibit, the eight key provisions of the CAAAs are identified and their regulatory programs are described. Certain requirements established by these provisions include refrigerant recycling, emissions reduction, and the phasing out of all fully-halogenated CFCs and HCFCs by 2000 and 2030, respectively. The eight key provisions of the amendments and their associated regulatory program requirements and activities to-date are as follows.

1. Phaseout of Class I Substances

The CAAAs define Class I substances as all fully-halogenated CFCs, halons, carbon tetrachloride, and methyl chloroform. Production of these substances, except methyl chloroform, is to be phased out by the year 2000. Methyl chloroform is not fully phased out until 2002, which is three years earlier than required by the Montreal Protocol. In the years between 2002 and 2005, EPA can authorize production of methyl chloroform for essential uses. There are also other limited exceptions that allow additional production for national security, aviation safety,

Exhibit 63: The 1990 Clean Air Act Amendments Summary		
Provision	**Summary**	**Effective Date**
Phaseout of Class I Substances	Production and consumption phaseout of all fully-halogenated CFCs, halons, carbon tetrachloride, and methyl chloroform. Phased reductions leading to complete phaseouts: • CFC, halon, carbon tetrachloride: 2000 • Methyl chloroform: 2002 (extension possible) Implemented using production and consumption allowances. Exceptions for authorized additional production include essential methyl chloroform uses between 2002-2005, exports to developing countries through 2010, national security, aviation safety, and medical devices. Phaseout schedule is subject to possible acceleration by EPA.	Currently in place
Phaseout of Class II Substances	Production and consumption phaseout of 33 HCFCs. Freeze in 2015 and phaseout by 2030.	First deadline is 2015
National Recycling and Emission Reduction Program	Limit emissions of Class I/II chemicals during use and disposal to lowest achievable emissions level (LAEL) and maximize recycling. Mandate equipment, training, service/disposal practices: • Servicing/disposal of refrigerant equipment (includes venting prohibition) • All other uses (includes establishing LAELs for refrigeration equipment) • Apply to substitute refrigerants	 July 1, 1992 November 15, 1995 November 15, 1995
Motor Vehicle Air Conditioners	Limit emissions from MAC servicing by mandating equipment, training, and practices. Limit sales of small containers of MAC refrigerant. Allow on-site recovery with off-site reclamation. • "Large" shops servicing more than 100 cars/yr. • "Small" shops servicing less than 100 cars/yr. • Prohibit sale of refrigerant in containers less than 20 lbs. to persons not certified as trained • Extend requirements to replacement refrigerants	 Large: January 1, 1992 Small: January 1, 1993 Cans: November 15, 1992 Repl: January 1, 1995
Nonessential Products	Ban distribution or sale of nonessential products that release Class I or II substances. Congressionally-mandated products include CFC-propelled party streamers and noise horns and CFC-containing cleaning fluids for noncommercial electronic and photographic equipment. EPA has selected additional products using congressional criteria: flexible/packaging foams, CFC-containing aerosols (non-medical), and portable residential halon fire extinguishers.	Class I: November 15, 1992 Class II: January 1, 1994
Labeling	Develop and implement labeling program for products containing or manufactured with Class I or II substances. Labeling program is complex -- see text.	See text.
Safe Alternatives Policy	Limit the use of substitutes for ODCs and ODC-related products based on human health and environmental criteria. Mandate EPA review and approval of existing or near-term ODC substitutes and substitutes for ODC-related products. Future substitutes subjected to EPA review for approval 90 days prior to initial use.	Final rule expected Nov 1992
Coordination With State Laws	Narrow preemption of state or local enforcement of design requirements for new or recalled appliances. Statutory preemption.	Preemption in place from Nov 1990 - Nov 1992

and medical devices. Finally, EPA can authorize production for up to ten years beyond the phaseout date for export of ODCs to developing countries to satisfy basic domestic needs.

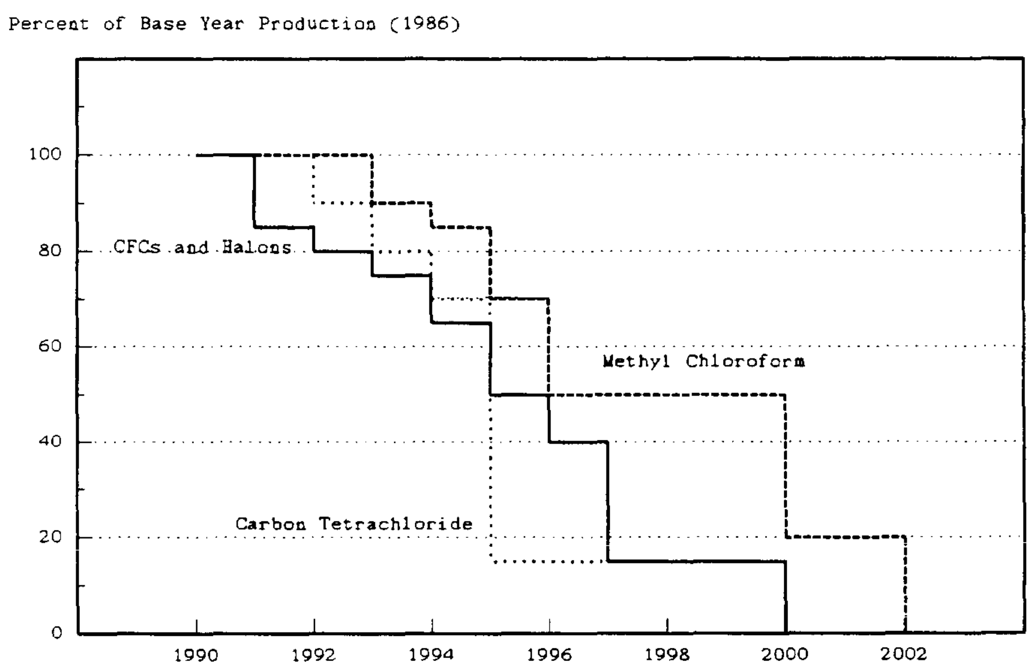
The phaseout schedule for the ODCs is as follows (see Exhibit 64):

- Both fully-halogenated CFC and halon allowable production levels must be reduced by 25 percent of 1986 production levels by 1993, 50 percent by 1995, and 85 percent by 1997. All fully-halogenated CFC production must be eliminated by the year 2000. Production of all halons, except those deemed to be "essential," is eliminated by the year 2000.

- Production of carbon tetrachloride must be reduced by 85 percent of 1986 production levels by 1995 and eliminated by the year 2000.

- Production of methyl chloroform must be reduced 10 percent of 1986 production levels by 1993, 30 percent by 1995, 80 percent by 2000, and phased out completely by 2002 -- three years earlier than required by the Protocol. EPA may allow some production following 2002, but all production will cease by 2005.

Exhibit 64: Phaseout Schedule for Class I Substances



2. Phaseout of Class II Substances

The initial list of Class II substances consists of 33 HCFCs identified in the CAAAs. EPA has the authority to add to the list other substances that may cause harmful effects to the ozone layer. Production of Class II substances is subject to only limited control prior to 2015 under separate sections of the CAAAs. Even though the Montreal Protocol does not yet control HCFCs, the CAAAs call for a freeze in the production of Class II substances in 2015 and a phaseout will begin that will eliminate all production by 2030. As with Class I substances, EPA can grant exemptions for certain specified reasons.

3. National Recycling and Emission Reduction Program

Under section 608 of the CAAAs, EPA must develop regulations that: (1) limit emissions of Class I (CFCs and halons) and Class II (HCFCs) chemicals during their use and disposal to the "lowest achievable emissions level" (LAEL); and (2) maximize recycling. Regulations covering Class I refrigerants used or disposed of during servicing, repair, or disposal of air conditioners and refrigeration equipment are expected to be promulgated in early 1993. Statutorily, the provisions covering these refrigerants took effect on July 1, 1992. Regulations for Class I and Class II substances in other uses are due by November 15, 1994, and take effect by November 15, 1995.

The CAAAs require that EPA's regulations include provisions for the "safe disposal" of Class I and Class II chemicals. The regulations will likely require that the chemicals contained in appliances or machines be removed before disposal of the machine, and that appliances using Class I and Class II chemicals be manufactured with servicing apertures to facilitate recapture of the ODC during service and disposal. The CAAAs also prohibit venting of Class I and Class II refrigerants during servicing and disposal after July 1, 1992.

To comply with the requirements of the CAAAs, EPA is initially focusing on developing rules governing recycling at service and disposal of refrigerants from all air conditioning and refrigeration equipment. The planned program will be similar to the program mandated by the CAAAs for mobile air conditioners (see below). These regulations will likely include: standards for and/or certification of recycling/recovery equipment; standards for and/or certification of off-site reclaimers; certification of technicians; and recordkeeping requirements.

Following its promulgation of the refrigerant recycling rules, EPA plans to focus on developing additional standards or controls for sectors where significant additional emissions reductions are possible. Such regulations could address non-refrigerant uses of the Class I and Class II substances, for example in solvent and fire extinguishing applications. Under the CAAAs, EPA also has the authority to establish LAELs associated with the operation of equipment, including refrigeration and air conditioning equipment. EPA plans to investigate how such LAELs could be established and implemented.

4. Motor Vehicle Air Conditioners

Section 609 of the CAAAs establishes a basic requirement that the servicing of mobile air conditioners (MACs) be performed by a trained technician using approved refrigerant recycling equipment. To implement this basic requirement, the CAAAs also specify procedures for approving refrigerant recycling equipment and defines the training and certification required of service technicians. Finally, the CAAAs restrict the sale of small containers of refrigerant. EPA has published a Notice of Proposed Rulemaking (NPRM) describing its anticipated approach to meeting these requirements of Section 609 (56 FR 43842; September 4, 1991). Each of these issues is discussed in turn.

Basic Requirement. Section 609(c) calls upon EPA to promulgate regulations requiring that, as of January 1, 1992, all establishments servicing more than 100 MACs per year ensure that technicians performing MAC service have been trained and certified and are using approved refrigerant recycling equipment. Entities servicing fewer than 100 MACs are given an additional year to comply. All refrigerants that contain CFCs or HCFCs are covered by these requirements. Effective five years after date of enactment, the statute requires that substitute refrigerants be subject to the same regulations.

Approval of Equipment. Section 609(b)(2) addresses the approval of refrigerant recycling equipment. The statute requires that, at a minimum, the standards promulgated by EPA to evaluate recycling equipment be as stringent as the standards of the Society of Automotive Engineers (SAE) in effect on November 15, 1990. SAE's requirements are included in Standard J-1990, which govern the performance and safety of such refrigerant recycling equipment (SAE, 1989a). The statute also requires that equipment purchased prior to the proposal of regulations under Section 609 can be deemed certified if it is "substantially identical" to certified equipment.

EPA intends to allow two types of approved equipment: "recover only" machines and "recover/recycle" machines. Recover only machines can only capture the refrigerant and store it. This equipment does not purify the refrigerant for re-use. The recover/recycle equipment is capable of purifying the refrigerant for re-use, and is more costly.

EPA is proposing to allow both technologies because it is concerned about the possible adverse economic impact on small businesses if only recover/recycle equipment is allowed. EPA also believes that allowing recover only will increase compliance with Section 609 regulations. In addition, given the present uncertainty about the feasibility of recycling possible refrigerant substitutes (e.g., HFC-134a, ternary blends), EPA feels that recover only machines will be an important component of the refrigerant recycling program in the future.

Many interest groups hold strong views about the issue of whether recover only machines should be allowed. EPA is in the process of working with several technical groups such as the Society of Automotive Engineers to develop a recover only standard that maintains the high level of environmental protection and air conditioning equipment protection achieved by the recycle on-site standard (i.e., SAE J-1990).

EPA is currently proposing to allow the use of recover only equipment in three cases:

- The recovery of refrigerant from discarded vehicles in salvage yards.
- The recovery of refrigerant by MAC service establishments that then send the refrigerant to off-site reclaimers which purify the refrigerant to meet established purity standards.
- The recovery of refrigerant in tandem with recycling by MAC service establishments that have multiple service bays. Such establishments may, for example, use one centralized recycling machine but operate multiple recover only machines (e.g., one recover only machine in each service bay). The used refrigerant extracted by the recover only machines would be transferred to the recycle machine for recycling. Citing increased risks of cross-contamination and a perceived departure from the original voluntary recycling agreement between EPA and the motor vehicle manufacturers, some interest-groups have questioned the prudence of allowing recover and recycle machines to be used in tandem.

Training and Certification of Technicians. Section 609(b)(4) discusses proper training and certification for MAC technicians. The training programs required by EPA must be as stringent as those specified by SAE Standard J-1989 under the certification program of the National Institute for Automotive Service Excellence (ASE) or under the Mobile Air Conditioning Society (MACS) certification program (SAE, 1989b).

EPA has proposed draft criteria to evaluate training and certification programs for technicians. It is anticipated that all programs will have to satisfy the following criteria in order to obtain EPA approval:

- Adequate Training. Each program must provide adequate training for MAC service technicians who wish to obtain certification. "Adequate training" includes one or more of the following components: on-the-job training (e.g., the existing ASE program), training through self-study of instructional material (e.g., the existing MACS program), or on-site training (e.g., the proposed International Mobile Air Conditioning Association (IMACA) program) involving a video, instructor, or hands-on session.
- Certification Test Subject Material. The program must test the technician prior to certification. The material on the certification test must be selected in such a way so as to assess each service technician's knowledge of at least the following subjects:
  - all relevant SAE standards dealing with the servicing and repair of MACs;
  - likely future technological developments (e.g., candidate replacement refrigerants);

-- the general regulatory requirements imposed by EPA under Section 609 of the CAAAs; and

-- the environmental consequences of releases of refrigerants during MAC service and repair and adverse effects of stratospheric ozone layer depletion.

In addition, the subject material may not in any way promote or endorse the product of any refrigerant recycling manufacturer. The training program may, however, include material that references original equipment manufacturers.

- Certification Test Requirements. The certification test should consist of a minimum number of MAC-unique questions that cover in sufficient depth and detail the subject material discussed above. To safeguard the integrity of the test, EPA requires that the following factors be considered in administering each certification test:

  -- Completed tests must be sent to an independent testing authority for grading.

  -- Each test must provide a means of verifying the identification of the individual taking the test (e.g., social security number and signature).

  -- The test may be taken as an open-book test and without the supervision of a proctor.

  -- If a program allows a non-English speaking technician to use a translator in taking the test, the certificate received by the technician must indicate that translator assistance was required.

  -- Sufficient measures must be taken at the test site to ensure that the tests are completed honestly by each technician. For example, in some situations, multiple versions of a test for a single test site might be appropriate.

- Technical Revisions. The director of each certification program will be required to conduct a periodic review (e.g., biennially) of its test subject material and provide EPA with a written assurance that it has taken the necessary steps to update its material based upon the latest technological developments in the MAC service and repair sector.

- Technician Recertification. At present, EPA does not intend to require recertification of MAC technicians. However, based upon the technical revisions described by the directors of certification programs and its own understanding of technological developments in the MAC service and repair sector, the Agency reserves the right to specify the need for technician recertification at some future date.

- Proof of Certification. Programs must provide each technician who has fulfilled the necessary training and certification requirements with an individual proof of certification. Suitable examples of proof include the following: certificate, wallet-sized card, or display card.

In evaluating the adequacy of any training and certification program, EPA reserves the right to consider other factors it deems relevant to ensuring the effectiveness of the program.

Small Containers. Section 609(e) restricts, as of November 15, 1992, the sale or distribution, to persons other than those who are trained and certified, of any refrigerant containing CFCs or HCFCs suitable for use in a MAC in containers of less than 20 pounds.

5. Nonessential Products

Section 610 of the CAAAs directs EPA to ban the distribution or sale of certain "nonessential" products that release Class I or Class II substances during manufacture, use, or disposal of the product. Congress defined several products as nonessential and established guidelines for EPA to identify additional products that are nonessential. EPA plans to promulgate regulations banning emissions of Class I substances from nonessential products to become effective November 15, 1992. Similar regulations for emissions of Class II products are planned to become effective January 1, 1994. Products identified to date as nonessential are as follows.

Products Specified by Congress. Congress specified that the following products be considered nonessential and prohibited from sale or distribution:

- CFC-propelled plastic party streamers. The only product EPA has found that fits the description of a "CFC-propelled plastic party streamer" is "string confetti" commonly known as "silly string."

- CFC-propelled noise horns. A noise horn is generally regarded as a product from which the high dispensing pressure of a propellant produces a loud piercing sound that can travel long distances. Two types of consumers have been found to use these noise horns: boaters use them to warn each other of their whereabouts while on the water, and others use them to draw attention (e.g., as a alarm device or a noisemaker at sporting events).

- CFC-containing cleaning fluids for noncommercial electronic and photographic equipment. EPA has found three types of products that appear to meet this description:

-- Liquid packaging and solvent wipes such as tape head cleaner, computer disk head cleaner, and film cleaner. These products may contain CFC-113.

-- Solvent sprays such as contact cleaners, flux remover, circuit cleaner, and film and negative cleaner. These products typically contain CFC-113 and/or CFC-11.

-- Gas sprays such as lens and keyboard dusters. These products typically contain CFC-12 or HCFC-22.

To distinguish between commercial and noncommercial cleaning fluids, EPA plans to require that purchasers of CFC-containing cleaning fluids provide a "commercial identification" as a means of identifying themselves as commercial entities. The commercial identification number requirement could be fulfilled by one of several options, including a federal Employer Identification Number (EIN), a state sales tax exemption number, or a local business license number. Under this option, consumers without a commercial identification number would be unable to purchase CFC-containing cleaning fluids.

The distributor would be required to retain identification information for each customer buying CFC-containing cleaning fluids. The information could be kept as part of tax exemption paperwork, computer files or other existing records, or on a short form developed by EPA. New forms would not have to be completed for every transaction, but commercial use information would have to be renewed every year in order to be considered valid.

Other Nonessential Products That Release Class I Substances. In addition to the products specified by Congress, EPA plans to use its authority under Section 610(b)(3) to identify other products that release Class I substances and are nonessential. To determine whether a product is nonessential, the CAAAs direct EPA to consider "the purpose or intended use of the product, the technological availability of substitutes for such product and for such Class I substance, safety, health, and other relevant factors."

Using the criteria for identifying nonessential products, to date EPA has identified three products as being nonessential:

- Flexible and packaging foams. The product "flexible and packaging foam" includes the following foam types: open cell polyurethane slabstock, molded, and poured foams where the blowing agent is mixed with chemicals which react to form the plastics; and closed cell thermoplastic extruded polystyrene, polyethylene, and polypropylene foams where the blowing agent is injected into a molten plastic resin which hardens upon cooling.

- Non-medical aerosols or pressurized dispensers containing CFCs. Although most uses of CFCs as aerosol propellants were banned in 1978, several uses were exempted as essential uses and others were excluded by the definition of "propellant." Since 1978, substitutes have become available for most of these uses (including household, automobile, industrial, and pesticide products).

- Portable residential halon fire extinguishers. "Residential halon fire extinguishers" includes two product types: self-expelling factory sealed (so called "aerosol") fire extinguishers (including those with crimped valves) containing halon-1211 alone or in mixture with halon-1301 (90 percent of residential market), and "noncommercial" portable fire extinguishers containing halon-1211 (10 percent of residential market).

Other Nonessential Products That Release Class II Substances. Under Section 610(d) Congress directed EPA to ban the sale or distribution of two types of products releasing Class II substances effective January 1, 1994, including the following:

- Any aerosol or pressurized dispenser that contains a Class II substance. Exemptions may be granted under two conditions: (1) use of the product is essential as a result of flammability or worker safety concerns; and (2) the only available alternative is use of a Class I substance.

- Any non-insulating plastic foam product that contains or is manufactured with a Class II substance. Exemptions may be granted for foams used for motor vehicle safety.

6. Labeling

Section 611 of the CAAAs directs EPA to develop and implement a labeling program for products containing or manufactured with class I or II substances. EPA promulgated regulations on May 4, 1992 to become effective by May 15, 1993.

The CAAAs define three types of products that must be labeled and specifies the time frame by which products must be labeled:

Containers of Class I or Class II Substances and Products Containing Class I Substances. Containers in which a Class I or Class II substance is stored or transported, and products containing a Class I substance, must bear a clearly legible and conspicuous label stating:

> "Warning: Contains [*insert name of substance*], a substance which harms public health and environment by destroying ozone in the upper atmosphere."

Products Manufactured with Class I Substances. EPA generally considers the phrase "manufactured with" to mean a product that uses a controlled substance in its manufacturing process but no longer contains the controlled substance. Examples include those products cleaned with solvents, products made with adhesives or coatings, open celled flexible foam, and certain food or tobacco products. Effective May 15, 1993, products manufactured with Class I substances must bear a clearly legible and conspicuous label stating:

> "Warning: Manufactured with [*insert name of substance*], a substance which harms public health and environment by destroying ozone in the upper atmosphere."

To establish a reasonable definition of "manufactured with," EPA intends to exclude incidental uses where the controlled substance does not have physical contact with the product in question. Examples of incidental uses could include fresh produce stored in a warehouse refrigerated by a CFC-using refrigeration system or clothes from a textile mill where the machinery is maintained with methyl chloroform but the clothes do not have physical contact with the substance.

EPA also intends to exclude from the definition of "manufactured with" products which result from the transformation of a controlled substance such that the controlled substance no longer poses a threat to the ozone layer. Examples of transformation include the production of chlorinated rubber, vinyl chloride, and automobile and airplane fuel using carbon tetrachloride.

Products Containing or Manufactured with Class II Substances. No later than January 1, 2015, products containing or manufactured with a Class II substance must be labeled with the appropriate label described above. EPA will require labeling after May 15, 1993 of such products that it determines, after notice and opportunity for public comment, have substitute products or manufacturing processes available that meet the criteria stated above. EPA is not planning to include requirements for labeling products containing or manufactured with Class II substances in the proposed rule.

Section 611(e) of the CAAAs allows for petitions to be submitted to EPA to apply the requirements of Section 611 to products containing Class II substances or a product manufactured with Class I or Class II substances which are not otherwise subject to the requirements. This petition process will operate between May 15, 1993 and January 1, 2015. For products manufactured with Class I substances, a successful petition would result in the labeling of a product previously determined by EPA to be exempt. For products containing or manufactured with Class II substances, the petition process could lead to labeling of a product that had been left unlabeled by default.

To guide its development of an approach for implementing Section 611 of the CAAAs, EPA began by delineating its fundamental objectives in requiring warning labels on products. The EPA's goal is:

"To implement the labeling requirements of Section 611 in a way that: (1) informs all consumers at the point of purchase of the threat posed to the ozone layer by the product; (2) informs service technicians and disposers of recoverable substances; and (3) does not significantly affect the aesthetics of the product."

In order to achieve these stated goals, EPA is planning to propose the following requirements:

Basic Label Characteristics. EPA is planning to propose that the warning label be placed on the *Principal Display Panel* (PDP) of the products. The PDP is defined as "the portion(s) of the surface of the immediate container, and of any outer container or wrapping, which bear(s) the labeling designed to be most prominently displayed, shown, presented, or examined under conditions of retail sale." EPA is also planning to specify the type size that must be used for different size PDPs so that the warning statement is proportional to the size of the existing label.

EPA is also planning to require that the statutory language be accompanied by a symbol (e.g., a pictogram or shape). EPA has developed several examples of symbols that it might propose.

Products Without a PDP. For products that do not have an obvious PDP, or where a consumer is likely to make a purchase decision without seeing the actual product, EPA is planning to propose that the labeling information be made available to the consumer through informational or promotional materials prepared by the manufacturer.

Stream of Commerce. EPA plans to require that the labeling information provided by the manufacturer of a product that is used as a component of another product be passed through to the ultimate purchaser, even if the manufacture of the final product does not use ODCs.

Recoverable Substances Label for Products Containing Recoverable Class I and Class II Substances. EPA is also planning to require a permanent label on all products containing recoverable ozone-depleting substances that states the name of the substance contained by the product and possibly states that federal law prohibits venting and requires recovery or recycling. Many products containing recoverable Class I and Class II refrigerants, including home refrigerators and automobile air conditioners, already have a permanent label indicating which refrigerant is used. To the extent that these existing labels provide the specified information, they may be considered sufficient to fulfill any recoverable substances labeling requirement.

Petitions. EPA plans to propose guidelines for the petition process to ensure that data submitted are sufficient to evaluate petitions. The guidelines will be applicable to petitions both to add products containing or manufactured with Class II substances to the labeling requirement and petitions to temporarily exclude products manufactured with a Class I substance from the labeling requirement.

7. Safe Alternatives Policy

EPA has initiated a program under Section 612 of the CAAAs to evaluate substitute products and manufacturing processes that do not use ODCs. The purpose of the program is to develop an overall strategy for moving from the use of ODCs to other, safer, products. EPA can prohibit or restrict the use of substitutes that it finds cause adverse effects on human health or the environment.

EPA plans to evaluate substitutes based on a range of parameters, including occupational risks to workers, potential consumer exposures, ambient releases to air and water, solid and hazardous waste risks, stratospheric ozone depletion, and global warming. EPA has indicated that it will not attempt to quantify all of these parameters. Instead, the Agency will make a qualitative judgment about the relative advantages and disadvantages of each substitute.

The evaluation of substitutes will occur in two phases. The first phase of the program will involve a series of risk characterizations. Each characterization will focus on a general end-use sector (e.g., foams, solvents, or refrigeration) and will assess substitutes that are already available or likely to be available in the next two years. EPA will then decide which, if any, of these near-term substitutes should be subjected to regulatory control.

The second part of the process involves the Significant New Alternatives Program (SNAP). Under the SNAP process, any manufacturer who develops a substitute for an ozone-depleting chemical must notify EPA 90 days prior to its initial use. EPA will then determine whether use of the substitute should be restricted. To minimize the burden on the regulated community, the Agency intends to integrate the SNAP process with the Pre-Manufacturing Notice (PMN) requirements imposed under the Toxic Substances Control Act.

EPA currently plans to publish a proposed rule describing the Safe Alternatives Program in early 1993. The Agency will then consider public comments on the proposal.

8. Coordination with State Laws

Section 614(e) of the 1990 CAAAs imposes a two-year moratorium any state or local government activities to enforce any requirement related to the design of any new or recalled appliance for purposes of protecting the stratospheric ozone layer. "Appliance" in this case refers to any refrigeration or air conditioning equipment that contains Class I or Class II substances. The moratorium is intended to prevent states and localities from adopting inconsistent design requirements relating, for example, to the specification of purge devices or service apertures.

The limits imposed by the CAAAs on state and local activities are considered to be quite narrow. To date there has been no indication that states or localities were contemplating enacting design requirements prohibited by the amendments. Additionally, the amendments do not preempt other state and local efforts to control ODC use and emissions. Therefore, states and localities are permitted to undertake initiatives such as restricting specific uses of ODCs and requiring recycling of ODCs.

6.5 CALIFORNIA

6.5.1 State of California Statutory and Regulatory Activity

In 1990, five bills were introduced affecting the use and emissions of ODCs. A.B. 3994 (Scher), signed by the Governor September 27, 1990, was the only one of the five bills that was enacted. A.B. 3994 restricted the use of "ozone friendly" labels to products whose production or use does not accelerate stratospheric ozone depletion. The bill defined the conditions needed to be considered "ozone friendly" as meaning "any chemical or material released into the environment as a result of the use or production of a product, will not migrate to the stratosphere and cause unnatural and accelerated deterioration of ozone."

In 1991, two bills pertaining to ODCs were introduced:

- AB 691 (Hayden). This bill requires businesses with more than two service bays or three employees that service or install mobile air conditioners (MACs) to acquire Underwriter Laboratory (UL) or Society of American Engineers (SAE) certified refrigerant recycling equipment by January 1, 1993. All businesses must comply by January 1, 1994. The Bureau of Automotive Repair would have responsibility for drafting and enforcing regulations. Operators must receive Automotive Service Excellence (ASE), Mobile Air Conditioning Society (MACS) or equivalent training. Violations are punishable by fines of $50, not to exceed $1,000 a day.

- AB 859 (Vasconcellos). This bill bans the sale of 1995 or later model-year motor vehicles using CFC-based MACs after January 1, 1995. A phase out period begins January 1, 1993 through January 1, 1994 during which not more than 90 percent of the model-year vehicles sold or certified for sale that are equipped with MACs may have CFC-based MACs. During 1994, not more than 75 percent of the new 1994 model year or later may utilize CFC-based MACs. On or after September 1, 1994, not more than 10 percent of all model year 1995 may utilize CFC-based MACs. Substances with an ozone depletion potential (ODP) of 0.1 or greater and covered under the Montreal Protocol are considered to be CFC-based products. Automotive manufacturers must also file annual and quarterly reports on their compliance. Each phase-down deadline may be extended for up to two years upon a determination by the Air Resources Board that the original deadline cannot be met.

AB 859 was enacted into law October 12, 1991.

6.5.2 Local Statutory and Regulatory Activity

Seventeen cities, counties and districts in California have enacted ordinances, promulgated regulations or issued policies directed at reducing ODC use and emissions. Exhibit 65 lists these localities and summarizes their main provisions. Based on discussions with local representatives, one factor leading to the adoption of these policies is the hope of prompting state or federal action. Many of the local restrictions have very similar provisions. Exhibit 65 summarizes the existing ordinances and regulations as follows:

- Foam Restriction: Thirteen localities restrict the manufacture and use of one or more types of ODC-containing foam products. Packaging foams are generally restricted.

- Recycling Required: Twelve localities require some type of ODC recycling when air conditioner and refrigeration systems are serviced or disposed. Most commonly recycling is required for MAC servicing and disposal.

- Refrigerant Sales Restriction: Eleven localities have restrictions on the sale of ODC refrigerant in small containers. In most cases sales are permitted in containers of a specified size (e.g., 20 pounds or more) to certified technicians or those with recycling equipment.

- Halon Restriction: Seven localities have enacted restrictions on halon emissions. Most commonly these restrictions involve recycling and reclamation of halon during servicing. In some cases the sale of portable halon fire extinguishers is prohibited, and testing of total flooding systems is regulated.

- Policy Statement Only: Three localities have enacted ordinances that are restricted to being a policy statement only. These localities are not enforcing restrictions on ODCs at this time.

Although Exhibit 65 shows that many California localities have enacted restrictions on ODC use and emissions, most of these restrictions are very similar to the requirements of the CAAAs. Exhibit 66 shows how the restrictions enacted by the State of California and localities within the state exceed the CAAAs requirements in two ways:

- In most cases, the restrictions are essentially identical to the CAAAs requirements, except that the local restrictions have an earlier effective date. These situations are shown in Exhibit 66 with an "A."

- In some cases, the local provisions include restrictions that are not currently required under the CAAAs. These situations are shown in Exhibit 66 with a "B."

Exhibit 65: California Localities with ODC Policies					
Locality	**Foam Restriction**	**Recycling Required**	**Refrig. Sales Restriction**	**Halon Restriction**	**Policy Statement Only**
BAAQMD		X	X		
Berkeley	X	X	X	X	
Highland	X[a]				
Irvine	X	X	X	X	
Los Angeles	X				
Newport Beach					X
Rancho Cucamonga	X				
Redlands	X[a]				X
San Diego	X	X[b]			
San Francisco		X	X		
San Jose	X	X	X		
San Ramon	X	X	X	X	
Santa Cruz County	X	X	X	X	
Santa Monica	X	X	X	X	
Sonoma[c]		X	X		X
South Pasadena	X	X	X	X	
SCAQMD	X	X	X	X	

a Compliance is voluntary.
b Recycling only required for MAC servicing of city-owned vehicles.
c The ordinance is a policy statement only and will not be enforced until Sonoma County adopts similar restrictions.

Exhibit 66: Incremental Impact of CA State and Local ODC Policies Relative to CAAAs Requirements

State or Locality	National Recycling & Emission Reduction Program		Motor Vehicle Air Conditioners			Nonessential Products				Labeling
	Refrigerant Recycling	Halon Recycling	MACs Recycling	Model Years	Small Cans	Foam	Building Insulation	Cleaning Fluids	Halon Extinguishers	
California				B						B
BAAQMD			A		B					
Berkeley	A	A	A		A	A	B		A	
Highland						A[1]				
Irvine	A	A	A		A	A	B			
Los Angeles						A				
Newport Beach										
Rancho Cucamonga						A				
Redlands						A[1]				
San Diego			A[2]			A				
San Francisco			A		A					
San Jose			A		A[3]		B			
San Ramon	A	A	A		A[4]	A	B	A		
Santa Cruz County										
Santa Monica		A	A		A	A	B	A		
Sonoma										
South Pasadena	A	A	A		A	A	B	A		
SCAQMD	A	A	A		B	A			A	

A -- Refers to earlier effective date than required in CAAAs or anticipated EPA rules.
B -- Refers to provision beyond that of CAAAs.
1 -- Compliance is voluntary.
2 -- City-owned vehicles only.
3 -- Applies to containers of 10 pounds and smaller.
4 -- Applies to containers of 15 pounds and smaller.

As shown in the exhibit, many of the local requirements differ from the CAAAs requirements only in terms of the expected effective dates. For example, the CAAAs require recycling during MAC servicing by January 1, 1992 for large shops and January 1, 1993 for all shops (large and small). Many of the local ordinances require recycling at all shops by January 1, 1992, thereby having an earlier effective date than the CAAAs.

The primary area in which the local restrictions exceed the CAAAs restrictions is in the case of ODC-based building insulation. Six localities have restricted the use of banned ODC-based building insulation, whereas the CAAAs do not currently require that such insulation be banned as a nonessential product. EPA has the authority to ban these products, but has not yet indicated that it will. Even if EPA does not ban these products directly, federal restrictions will eventually result in their elimination because over the long term EPA is mandating a phase-out of ODCs, so ODC-based building insulation will necessarily be replaced by non-ODC-based products.

The State of California's two requirements both exceed the CAAAs restrictions: (1) the state will be restricting the use of ODC-based air conditioners in specific automobile model years; and (2) the state has defined the conditions under which "ozone friendly" labels can be used. Finally, the SCAQMD and BAAQMD restrictions on the sale of small containers of MAC refrigerant exceed the CAAAs requirements: the SCAQMD bans such sales while the CAAAs restrict such sales to properly certified technicians that operate certified recycling equipment; the BAAQMD bans sales of containers of any size to non-certified persons, while the CAAAs restrict sales of containers of 20 pounds or less.

Many of the local representatives contacted attribute the effectiveness of their programs to the significant resources committed to educate the public and businesses of the issues and the compliance requirements. Each of the requirements is summarized below.

Bay Area Air Quality Management District (BAAQMD)

The Board of BAAQMD adopted a "Stratospheric Ozone Policy" on November 6, 1991, encouraging the reduction and minimization of ODC emissions and prohibiting the substitution of toxic air contaminants for ODCs. Included in the Policy is a 1992 schedule for the BAAQMD to review and develop rules that eliminate current ODC exemptions and require refrigerant recovery and recycling when servicing mobile and stationary air conditioners and refrigeration equipment. The only rule to have been developed and adopted to date by the BAAQMD requires refrigerant recovery and recycling when servicing, salvaging or dismantling MACs.

On June 17, 1992, the BAAQMD adopted Rule 7 Motor Vehicle Air Conditioner Refrigerant establishing guidelines for refrigerant recovery and recycling when servicing MACs in accordance with Title 40 of the Code of Federal Regulations Part 82 (40 CFR 82). The Rule also modifies some of the standards set forth in 40 CFR 82 with the following provisions:

- No person may either add refrigerant to a MAC that has a detectable leak or operate MAC recovery, recycling, or charging equipment that has a detectable leak. Leak inspection must include an external examination of the system and an internal test using an electronic leak detector. Effective June 17, 1993, electronic leak detectors must meet SAE-J standards.

- Effective November 15, 1992, the sale of CFC refrigerants in containers of any size is prohibited.

- The provisions for MAC servicing as set forth in 40 CFR 82 will also apply to MAC salvaging or dismantling until similar restrictions are adopted at the federal level.

Berkeley, California

Commercial use of ODCs is prohibited, except for use in refrigerators and air-conditioners, research on the effects of ODCs, medical applications for which non-ODC alternatives do not exist, and manufacturing performed under specifications for the U.S. Armed Forces. Foam packaging and building insulation containing ODCs is banned. Firms who service or dispose of refrigeration or air-conditioning systems must ensure that ODC coolant is recaptured and recycled with SAE or UL equivalent equipment and trained personnel. The sale of ODCs to individuals or in containers intended for use by individuals is prohibited. Retail establishments may not sell halon fire extinguishers and firms servicing halon extinguishers must use reclamation systems. All the above provisions are effective March 11, 1991 except for the ban on commercial ODC use which became effective June 11, 1991.

When filing building permits, applicants must certify that no ODC-containing insulation will be used. Regulations and a plan for implementation are being drafted. The following ODCs are covered by the ordinance: CFCs (CFC-11, 12, 113, 114, 115); HCFC-22; Halon-1301, Halon-1211, Halon-2402; Methyl chloroform and carbon tetrachloride.

Highland, California

Highland banned the use of CFC-processed food packaging as of January 1, 1989. Compliance is voluntary.

Irvine, California

The city of Irvine enacted a comprehensive package of restrictions on ODC use and emissions in 1989 (Ordinance 89-21). Technical corrections were enacted in 1990 (Ordinance 90-13). The following regulations became effective July 1, 1990:

- CFCs are banned, except for use as a refrigerant in refrigerators or air conditioners, research on the effects of ODCs, medical applications for which non-ODC alternatives do not exist, and manufacturing performed under military specifications for the U.S. Armed Forces.

- CFC-containing packaging is banned.

- Rigid or flexible foam (including building insulation) containing or utilizing ODCs is banned.

- Recovery and proper handling of CFC-containing building insulation from existing buildings are required during remodeling or demolition.[18]

- CFC refrigerants in refrigeration or air conditioning units must be recovered and/or recycled during service or disposal and CFC refrigerants can only be sold to persons possessing a recycling system.

- Permits must be acquired for testing halon fire extinguishing systems. Hardship exemptions are available.

- Halons must be recovered when servicing portable fire extinguishers.[19]

An Environmental Program (EP) Coordinator position is created to supervise activities related to the ordinance and a Science Advisory Committee is created to assist the Coordinator. The following substances are covered by the ordinance: CFCs (CFC-11, 12, 113, 114, 115); Halon-1301, Halon-1211, Halon-2402; Methyl chloroform and carbon tetrachloride.

In 1991 Irvine enacted two additional related ordinances (Ordinance 91-49 and Ordinance 91-50). Filing fees were set at $50 for a permit/exemption and $25 for a de minimis exemption. Late filing fees are levied for certification/exemption application of $25, $50 and $100 if the applicant is 1-15, 15-30 or more than 30 days late, respectively. Applicants are also billed when their applications require significant time to process.

The EP Coordinator reported that the city mailed information and held workshops to educate affected parties about the regulations. They took a "help people comply" attitude. Violators are issued notices of non-compliance. Persistent non-compliance may result in court action.

Irvine has undertaken a fairly active enforcement program. Building permit applicants must sign a statement that no ODC materials will be used. Out of approximately 50 mobile air conditioning (MAC) service stations and car dealers, 25-30 have recycling equipment. The rest are occasionally contacted regarding MAC servicing to determine compliance. It was reported that verifying proper equipment use is difficult because staff to verify equipment use are not available.

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[18] Effective thirty days after the publication of notice that a reclamation facility capable of safely disposing ODCs has become operational in the city.

[19] Effective thirty days after the publication of notice that a reclamation facility capable of safely disposing ODCs has become operational in the city.

The restrictions on air conditioning and refrigerator servicing are reported to be among the hardest to enforce because not all firms servicing the equipment are located in the city. About 25-30 firms are currently permitted under the Irvine ordinance to service this equipment. The ban on ODC coolant sales to persons without recycling certificates has been difficult to enforce. Irvine residents can go outside the city to purchase refrigerant putting local merchants at a disadvantage to competitors.

Los Angeles, California

The Los Angeles City Council passed an ordinance supporting federal and state efforts to reduce use of and recover and recycle CFCs. They have also asked internal agencies to review their use of ODCs and required the use of recycling equipment when servicing city-owned vehicles.

In 1988 the City of Los Angeles enacted Ordinance No. 163,918 restricting the use of polystyrene plastic manufactured with ODCs. As of July 1, 1989 it is unlawful to manufacture, sell, or distribute any product containing polystyrene plastic manufactured with ODCs with an ODP of 0.05 or greater.

Newport Beach, California

Newport Beach passed a resolution supporting international, federal, and state legislation regulating and banning CFC use. Newport has not passed and is not considering additional legislation.

Rancho Cucamonga, California

CFC-processed food packaging is prohibited as of September 1, 1989. Rancho Cucamonga has not passed and is not considering additional ODC legislation.

Redlands, California

Redlands enacted an ordinance encouraging vendors to stop using CFC-processed food packaging by June 1989, and requires the city to purchase acceptable alternatives when available. Redlands has not passed and is not considering additional legislation.

San Diego, California

The City of San Diego has enacted an ordinance requiring MAC refrigerant recycling for city-owned vehicles and bans CFC processed food packaging.

San Francisco, California

The City of San Francisco passed an ordinance July 1991, effective August 1991, "prohibiting the sale of small chlorofluorocarbon containers, and prohibiting the repair of motor vehicle air conditioning systems without a permit from the Department of Public Health (DPH)." The sale of CFC refrigerant in less than twenty pound containers to persons not permitted by DPH is banned. Approved recycling equipment must be used when repairing or dismantling any MACs, including when MACs are being disposed. The fully-halogenated CFCs (CFC-11; CFC-12; CFC-113; CFC-114; and CFC-115) and any other "substance listed under Section 602 of the Clean Air Act" are covered.

The ordinance was publicized through a mass mailing to businesses identified through Board of Auto Repair filings. The city has maintained close contact with industry organizations and has conducted workshops.

The city will inspect applicants when permits are issued. Two year permits for MAC servicing must be obtained from the Department of Health ($150 processing fee). Permitting requires applicants to certify ownership of recycling equipment meeting UL and SAE standards and that personnel are properly trained. Violations will result in a notice being served, a hearing, and possible revocation of the violator's permit and fines not to exceed $5,000. Fines per violation cannot exceed $500. The Health Department has the authority to inspect at the owner's expense (at a rate of $75 per hour) business premises if a violation is suspected.

San Jose, California

Effective July 1, 1990, Ordinance 23438 requires CFC recycling during the servicing or disposal of MACs and prohibits the sale of MAC refrigerant in less than 10 pound containers. Annual permits must be acquired from the Director of Neighborhood Preservation. Equipment must meet "nationally recognized standards". Reportedly, the bill initially included HCFCs and prohibited the use of ODC-containing building materials. HCFCs were removed from the bill and actions regarding the building material provision were postponed until 1994. Currently, the fully-halogenated CFCs are covered.

To educate businesses, the city obtained a list of service stations from the California Association of Auto Repairers. These businesses were sent material on the new law. In addition, the city sponsored two free training workshops on the use of recycling equipment. Service stations must be permitted, which requires a $100 application fee and proof of ownership of UL approved equipment. Inspectors occasionally check on equipment use. Reportedly, within two months of enactment most businesses had paid the $100 for a permit. Presently 131 of 135 applicable businesses have permits.

It is planned to restrict the use of ODC-containing building foam by modifying the applicable building code (by January 1993) and enforcing the provision through the existing building permit process.

San Ramon, California

In 1989 San Ramon enacted ordinances 166 and 194 establishing a wide range of restrictions on the use and emissions of ODCs. Ordinance 166, effective September 7, 1989, specifically prohibits the use of food packaging manufactured with fully-halogenated CFCs. Ordinance 194, effective July 26, 1990, bans the use of all fully-halogenated CFCs, with specified exceptions:

- research on the effect of ODCs on the environment;
- use as a refrigerant in air conditioning or refrigeration equipment;
- health care providers and drug manufacturers may continue to use CFCs until safe and effective alternatives are available; recycling equipment must be used in conjunction with sterilization equipment;
- use of CFCs as required under contract to the U.S. armed forces and as required under military specifications; and
- use may continue if the applicant demonstrates that no technically or economically feasible alternative exists.

Ordinance 194 also bans the use of CFC-containing building insulation and requires that such insulation be recovered and disposed of properly when buildings are remodeled or demolished. Refrigerant recycling is required during the disposal of refrigeration or air conditioning units. Halons must also be recovered and recycled when servicing portable fire extinguishers.

In 1991 San Ramon adopted Ordinance 202 regulating the manufacture, distribution, sale, and recycling of products which use ozone depleting compounds. The following provisions were enacted:

- effective March 12, 1991 MAC refrigerant sales must be in containers of at least 15 pounds; and
- effective January 1, 1992 recycling is required during MAC installation, servicing, and disposal.

MAC refrigerant recycling equipment must be certified by UL to meet SAE J standards.

Mail notification was sent to relevant parties. Present enforcement is reportedly complaint driven.

Santa Cruz County, California

In June 1990 Santa Cruz County enacted Ordinance No. 4068 with the following provisions becoming effective on January 1, 1992:

- all manufacturing, producing, cleansing, degreasing, and sterilizing uses of ODCs are prohibited;

- all sale and use of packaging, insulating, or foam-containing products containing or utilizing ODCs are prohibited;
- the use of ODC-containing insulating foams in buildings is prohibited;
- the use of refrigerant recapture and recycling equipment is mandated when servicing or disposing of refrigeration and air conditioning units;
- refrigeration and air conditioning service technicians must be properly trained and certified;
- steps must be taken to employ practices that prevent venting and emissions of ODCs from air conditioners and refrigeration systems;
- all refrigerant must be removed prior to disposal of any refrigeration or air conditioning unit;
- reclamation of halons when servicing fire extinguishers is required;
- retail sales of portable halon fire extinguishers are prohibited; and
- refrigerants for MACs can only be sold in refillable containers which hold 15 pounds or more.

The recycling equipment must meet SAE standards, and service technicians must receive proper training in the use of this equipment in a program similar to that offered by MACS or the Bureau of Auto Repair. Each day of violation is punishable by a fine of up to $250. The compounds covered by the ordinance include the fully-halogenated CFCs (CFC-11; CFC-12; CFC-113; CFC-114; and CFC-115); the halons (halon-1211; halon-1301; and halon-2402); methyl chloroform; and carbon tetrachloride.

The ordinance was amended in June of 1992 to conform with the U.S. EPA restrictions promulgated under the CAAAs. Those affected by the county ordinance may delay compliance until the effective dates of the EPA rules, and the county requirements will be no more stringent than the EPA rules.

Santa Monica, California

June 12, 1990, Santa Monica City enacted Ordinance No. 1530 regulating the manufacture, distribution, sale, and recycling of products which use ozone depleting compounds. The following provisions were enacted:

- effective January 1, 1991 food and foam packaging using ODCs are banned and it is unlawful to recharge an air conditioning unit, refrigeration unit, or halon fire extinguisher that contains a leak;

- effective January 15, 1991 recapture and recycling equipment is required when servicing MACs and businesses servicing MACs must submit recycling plans to the city;

- effective January 1, 1992:

  -- rigid or flexible foam containing ODCs is prohibited in building construction;

  -- refrigerant ODCs cannot be sold to persons who do not possess evidence of operating a recycling system as required by the ordinance;

  -- halon reclamation systems must be used by those servicing halon fire extinguishing systems;

  -- the use of ODCs to manufacture, produce, cleanse, degrease, or sterilize any substance is prohibited, with the following exceptions: research on the effect of ODCs on the environment; health care providers and drug manufacturers may continue to use ODCs until safe and effective alternatives are available (recycling equipment must be used in conjunction with sterilization equipment); through January 1, 1996 persons may apply for an exemption if no technically or economically feasible alternative exists.

- effective January 15, 1992 halon recycling plans must be submitted.

The compounds covered by the ordinance include the fully-halogenated CFCs (CFC-11; CFC-12; CFC-113; CFC-114; and CFC-115); the halons (halon-1211; halon-1301; and halon-2402); methyl chloroform; and carbon tetrachloride.

Reportedly, implementation to date has taken an educational approach. The city has mailed flyers to affected businesses and held several workshops. While no formal certification/verification process exists yet, field inspections will be carried out by the existing field force that enforces hazardous waste regulations. The ordinance relies on the building permit process to implement the ban on ODC-containing construction materials.

Sonoma, California

The city council adopted an ordinance in 1990 with the following provisions:

- refrigerant recycling during the service and disposal of any air conditioning and refrigeration systems is required; and

- the sale of ODCs for refrigerants would be restricted to persons who own and operate recycling systems.

The compounds covered by the ordinance include the fully-halogenated CFCs (CFC-11; CFC-12; CFC-113; CFC-114; and CFC-115); methyl chloroform; and carbon tetrachloride. The Fire Chief would be responsible for enforcement and authorizing exemptions.

The ordinance is designated as a "policy statement" -- enforcement of the ordinance is deliberately deferred until the County of Sonoma adopts a similar ordinance. As of this writing the county had not yet enacted such an ordinance.

South Pasadena, California

Ordinance No. 1969 was adopted in 1989 with the following provisions that became effective on January 1, 1991:

- food and foam packaging using ODCs are banned;
- the use of ODC-containing building insulation is banned;
- recovery and proper handling of CFC-containing building insulation from existing buildings are required during remodeling or demolition;[20]
- refrigerant recycling during the service and disposal of any air conditioning and refrigeration systems is required;
- the sale of ODCs for refrigerants is restricted to persons who own and operate recycling systems;
- reclamation of halons when servicing fire extinguishers is required and a permit is required for releasing halons during testing; and
- the use of ODCs is banned, with specified exceptions: research on the effect of ODCs on the environment; use as a refrigerant in air conditioning or refrigeration equipment; health care providers and drug manufacturers may continue to use ODCs until safe and effective alternatives are available (recycling equipment must be used in conjunction with sterilization equipment); use of ODCs as required under contract to the U.S. armed forces and as required under military specifications; and use may continue if the applicant demonstrates that no technically or economically feasible alternative exists.

The compounds covered by the ordinance include the fully-halogenated CFCs (CFC-11; CFC-12; CFC-113; CFC-114; and CFC-115); the halons (halon-1211; halon-1301; and halon-2402); methyl chloroform; and carbon tetrachloride.

[20] Effective thirty days after a finding by the Public Works Director that a reclamation facility capable of safely disposing ODCs has become operational in the city.

The Director of Public Works is responsible for drafting implementing regulations for the ordinance; as of this writing the Director of Public Works position is vacant. Reportedly, copies of the ordinance have been mailed to about 30 businesses considered affected parties based on their SIC codes. One business has received a military-contract exemption. No organizations have been certified as complying, although some service stations in the area reportedly have the required equipment.

South Coast Air Quality Management District (SCAQMD)

In response to the Governing Board of the SCAQMD's adoption of a "Policy on Global Warming and Stratospheric Ozone Depletion," two rules were adopted in 1991 (1411 and 1415) and one was adopted in 1992 (1418). In addition to these rules, several older rules have been amended and now contain provisions affecting ODC use. SCAQMD policies on ODC control are as follows:

Rule 1411: This rule, adopted March 1991, requires recovery and recycling of fully-halogenated CFC refrigerant when servicing or disposing of MACs as of January 1, 1992. Recycling equipment must be UL and SAE equivalent. Service technicians must be trained and certified by the manufacturer or an equivalent program. Owners/operators of equipment must check for leaks in any serviced equipment and, semi-annually, in recovery and recycling equipment. Sale of refrigerant in less than 20 pound containers is prohibited.

Regulated facilities will be audited by existing inspectors. Records of the amount of refrigerant bought and used, units serviced and operator training must be maintained for 2 years. Non-compliance penalties are punishable by fines up to $25,000 a day. Information about the rule and compliance procedures has been mailed to affected businesses.

Rule 1415: As of January 1, 1992 this rule requires that approved recovery and recycling equipment be used when servicing or disposing of any non-vehicular refrigerator, freezer or air conditioning systems containing more than 50 pounds of fully-halogenated CFC refrigerant. The operation of these refrigerant systems is prohibited unless they pass annual leak inspection by a Certified Auditor. Any leaks uncovered during inspection must be fixed within 14 days.

Auditors will be certified by the Executive Officer of the SCAQMD. Records of a system's inspection and maintenance must be kept for two years by the owner/operator. Non-compliance penalties are punishable by fines up to $25,000 a day. Information notifying affected businesses of the rule was mailed in August, 1991.

Rule 1175: This rule, adopted November 3, 1989 and amended January 5, 1990, regulates the manufacture of foam products.

- Manufacturing operations, excluding expanded polystyrene (EPS) molding operations, shall reduce annual fully-halogenated CFC emissions from 1988 levels by 40 percent in 1991 and 100 percent in 1994.

- As of July 1, 1991 EPS manufacturers must certify total emissions from their products are less than 2.4 pounds per 100 pounds of raw material processed.

By July 1, 1990 foam manufacturers must submit a plan demonstrating compliance with the above requirements. If the above requirements cannot be met, air pollution control devices may be installed as a means of achieving compliance.

SCAQMD staff report that by providing a maximum emission level this rule gives the foam industry flexibility to install emissions equipment or use substitute materials or processes to meet regulation requirements. Records of daily raw material use, equipment and blowing agent type(s) must be kept beginning January 1, 1990. Fully-halogenated CFCs, VOCs, and methylene chloride are covered by this rule.

Rule 1122: This rule, originally adopted in 1979 and amended several times, requires owners and operators of solvent cleaning equipment to take measures to control emissions. The rule requires equipment covers, immediate repair (1 day) of leaks and dictates how the equipment is to be operated. Fully-halogenated CFCs have been exempt from this rule. This exemption is now reportedly under review.

Rule 1151: This rule, adopted July 8, 1988, governs the use and emissions of VOCs in the motor vehicle and mobile equipment refinishing industry. This rule was recently amended to eliminate the exemption for fully-halogenated CFCs and methyl chloroform.

Rule 1418: This rule, adopted January 10, 1992, restricts the use of halons in portable and total flooding fire extinguishing systems as of July 1, 1992. Recycling systems are mandated with specified recovery efficiencies. Discharge tests of total flooding systems are restricted. Reporting requirements are listed for owners of total flooding systems, and service personnel must be licensed. The sale of halon portable fire extinguishers for residential, non-commercial use is also prohibited.

6.6 OTHER STATES AND LOCALITIES

A total of 34 states and localities outside California have undertaken actions to address ODC use and emissions. As was found within California, many similar ordinances have been enacted. For example, six communities in Colorado have coordinated their efforts and enacted virtually identical restrictions.

Exhibit 67 summarizes the review of these actions. As shown in the exhibit:

- Foam Restriction: Nineteen states and localities restrict the manufacture and use of one or more types of ODC-containing foam products. Packaging foams are generally restricted.

Exhibit 67: Non-California States and Localities with ODC Policies

State or Locality	Foam Restriction	Recycling Required	Refrig. Sales Restriction	Halon Restriction	Other
Arkansas					Policy Statement only
Colorado		X			
Boulder, CO	X	X	X	X	
Denver, CO	X	X	X	X	
Ft. Collins, CO	X	X	X	X	
Greenwood, CO	X	X	X	X	
Littleton, CO	X	X	X	X	
Wheat Ridge, CO	X	X	X	X	
Connecticut	X	X	X		
Florida	X	X			
Dade Co., FL[a]	X	X	X	X	
Hawaii		X	X		
Iowa	X				
Louisiana					Exempted CFCs from hazardous waste rules
Maine	X	X	X	X	New car[b]
Maryland					Nothing enacted
Boston, MA[a]	X	X	X	X	

a Proposed ordinance only.
b Bans ODC based MACs in new cars.

Exhibit 67: Non-California States and Localities with ODC Policies (Continued)

State or Locality	Foam Restriction	Recycling Required	Refrig. Sales Restriction	Halon Restriction	Other
Cambridge, MA	X	X	X	X	
Michigan					Nothing enacted
Minnesota		X	X	X	
Minneapolis, MN		X	X	X	
Missouri	X				
Nashua, NH	X	X	X	X	
Newark, NJ	X	X	X	X	
Albuquerque, NM		X	X		
New York		X	X	X	Preempts local ordinances
North Carolina	X				
Ohio					Aerosol propellant ban only
Oregon	X	X	X		
Rhode Island		X			Ban on all CFCs in 1995
Vermont		X	X	X	New car[b]
Virginia	X				
Washington		X			
Wisconsin		X	X		New car[b]

b Bans ODC based MACs in new cars.

- Recycling Required: Twenty five states and localities require some type of ODC recycling when air conditioner and refrigeration systems are serviced or disposed. Most commonly recycling is required for MAC servicing and disposal.

- Refrigerant Sales Restriction: Twenty one states and localities have restrictions on the sale of ODC refrigerant in small containers. In most cases sales are permitted in containers of a specified size (e.g., 20 pounds or more) to certified technicians or those with recycling equipment.

- Halon Restriction: Sixteen states and localities have enacted restrictions on halon emissions. Most commonly these restrictions involve recycling and reclamation of halon during servicing. In some cases the sale of portable halon fire extinguishers are prohibited, and testing of total flooding systems are regulated.

Although Exhibit 67 shows that many states and localities have enacted restrictions on ODC use and emissions, most of these restrictions are very similar to the requirements of the CAAAs. This situation is very similar to the situation described above for the localities in California. Exhibit 68 shows how the restrictions enacted by the states and localities exceed the CAAAs requirements in two ways:

- In most cases, the restrictions are essentially identical to the CAAAs requirements, except that the state and local restrictions have an earlier effective date. These situations are shown in Exhibit 68 with an "A."

- In some cases, the state and local provisions include restrictions that are not currently required under the CAAAs. These situations are shown in Exhibit 68 with a "B."

As shown in the exhibit, many of the local requirements differ from the CAAAs requirements only in terms of the expected effective dates. As described above for the localities in California, many state and local requirements for recycling during MAC repair have an earlier effective date than the CAAAs requirements.

As was found in California, the primary area in which the local restrictions exceed the CAAAs restrictions is in the case of ODC-based building insulation. Ten localities have banned ODC-based building insulation, whereas the CAAAs do not currently ban such insulation. Additionally, three states will restrict ODC-based automobile air conditioners in specific model years. Finally, several localities ban the sales of small cans of MAC refrigerant, which exceeds the CAAAs restrictions on such sales.

Arkansas

In 1991 the Arkansas legislature passed four resolutions regarding CFC use and supporting the Montreal Protocol and Clean Air Act. These resolutions are statements of policy

Exhibit 68: Incremental Impact of Other State and Local ODC Policies Relative to CAAAs Requirements										
State or Locality	National Recycling & Emission Reduction Program		Motor Vehicle Air Conditioners			Nonessential Products				Labeling
	Refrigerant Recycling	Halon Recycling	MACs Recycling	Model Years	Small Cans	Foam	Building Insulation	Cleaning Fluids	Halon Extinguishers	
Arkansas										
Colorado										
Boulder, CO	A	A	A		A	A	B		A	
Denver, CO	A	A	A		A[1]	A	B		A	
Ft. Collins, CO	A	A	A		A[1]	A	B		A	
Greenwood, CO	A	A	A		A[1]	A	B		A	
Littleton, CO	A	A	A		A[1]	A	B		A	
Wheat Ridge, CO	A	A	A		A[1]	A	B		A	
Connecticut	A				A	A				
Florida			A			A				
Dade Co., FL		A	A		A	A				
Hawaii	A		A		A[1]					
Iowa						A				
Louisiana										
Maine			A	B	A[1]	A		A	A	A
Maryland										
Boston, MA	A	A	A		A	A	B		A	
Cambridge, MA	A		A		A[1]		B	A	A	A

A -- Refers to earlier effective date than required in CAAAs or anticipated EPA rules.
B -- Refers to provision beyond that of CAAAs.
1 -- Applies to containers of 15 pounds and smaller.

Exhibit 68: Incremental Impact of Other State and Local ODC Policies Relative to CAAAs Requirements (Continued)

State or Locality	National Recycling & Emission Reduction Program		Motor Vehicle Air Conditioners			Nonessential Products				Labeling
	Refrigerant Recycling	Halon Recycling	MACs Recycling	Model Years	Small Cans	Foam	Building Insulation	Cleaning Fluids	Halon Extinguishers	
Michigan										
Minnesota	A	A			B	A				
Minneapolis, MN	A	A			B	A				
Missouri						A				
Nashua, NH	A	A	A		B		B	A	A	
Newark, NJ	A	A	A		A	A	B			
Albuquerque, NM			A		A					
New York	A		A		A[1]			A	A	
North Carolina						A				
Ohio										
Oregon			A		B	A		A	A	
Rhode Island										
Vermont			A	B	B			A	A	A
Virginia						A				
Washington			A		B			A		
Wisconsin			A	B	B					

A -- Refers to earlier effective date than required in CAAAs or anticipated EPA rules.
B -- Refers to provision beyond that of CAAAs.
1 -- Applies to containers of 15 pounds and smaller.

and do not include binding restrictions or regulations. The resolutions do require that the state identify CFC substitute products in procurement procedures, provide training for proper handling, recycling and disposal of CFCs in vocational-technical schools and incorporate the CAAAs standards into policies for new and existing state buildings.

Colorado

In 1989 the Colorado legislature enacted S.B. 77 requiring the recycling and reuse of CFCs from refrigeration and air conditioning systems with over 100 pounds of refrigerant in retail stores, cold storage warehouses, or commercial or industrial buildings. Intentional refrigerant venting is also prohibited from these systems. Regulations are being drafted and will have both registration and reporting requirements for refrigeration system owners and servicers. Although S.B. 77 became effective January 1, 1990, implementing regulations must go through public hearings before adoption, which is expected in early 1993.

Six communities in Colorado's Front Range have regular meetings to discuss progress on ODC related legislation, enforcement and other issues: Boulder, Denver, Fort Collins, Greenwood, Littleton, and Wheat Ridge. Their goals include working toward a consistent set ofregulations for their region. They also work together on public information/education materials that can be shared, such as videos and mailers. These six communities have enacted similar, and in some cases identical, ODC restrictions. Each is described in turn.

Boulder, Colorado

Boulder has enacted Ordinance No. 5361 which became effective on July 1, 1991. The following provisions are included:

- recycling is required during MAC installation, servicing and disposal;
- MAC refrigerant sales must be in containers of at least 20 pounds unless sold to those that having recycling equipment;
- recycling is required during refrigeration system installation, servicing and disposal;
- ODCs are prohibited as aerosol propellants, with the exception of medical products;
- ODC-containing building materials are prohibited as of January 1, 1994;
- ODC-based packaging materials are prohibited;
- retail sales of halon-1301 and halon-2402 fire extinguishers are limited to those with a permit; and

- halon recycling is required and halon release during testing is restricted.

Industrial and commercial users of 1,000 pounds or more of any combination of ODCs are required to submit emissions reports annually.

To implement this ordinance the city manager may issue regulations. Draft regulations have been published covering the following: the registration of CFC recovery and recycling equipment; the issuance of registration receipts to allow purchases of refrigerant in containers under 20 pounds; the issuance of permits for purchasing halon-1301 and halon-2402 fire extinguishers.

Denver, Colorado

Ordinance No. 211-90 was adopted March 16, 1990 and sets forth restrictions on ODC use and emissions. To implement this ordinance, regulations were adopted May 20, 1991 by the City and County of Denver with the following provisions:

- Recovery and recycling are required as of January 1, 1991 during the installation, service, or disposal of MACs, refrigeration, and air conditioning systems.

- Effective January 1, 1991: intentional venting of ODCs from MACs, refrigeration, or air conditioning systems is prohibited; the sale of MAC refrigerant in containers of less than 15 pounds is prohibited; and the use of ODCs as aerosol propellants is prohibited (with the exception of medical products).

- Effective July 1, 1991 the use of ODC-produced packaging foam is prohibited.

Also included in the ordinance, but not yet included in the regulations, is a restriction on the manufacture or installation of ODC-containing building insulation as of January 1, 1994. Also effective January 1, 1991 but not written into the regulations are restrictions on the use of halon fire extinguishers. The release of halon from fire extinguishers for testing or training is prohibited except where required by law. Halon must be recaptured and recycled when servicing halon fire extinguishing systems. Retail sales and purchase of halon fire extinguishers is prohibited without a permit.

To implement the ordinance, the regulations require that building owners with major refrigeration systems and businesses that manufacture, install, service, or dispose of MACs, refrigeration systems, and air conditioning systems register with the city.

Reportedly compliance with the ban on CFC container sales was initially poor. A mailing went out to affected businesses followed by inspectors who issued fines. The existing Air Quality inspection personnel will have the responsibility for visiting MAC servicing establishments. Because violators servicing MACs with improper equipment or procedures must be "caught in the act," enforcement of this provision has reportedly proven to be quite challenging.

Fort Collins, Colorado

The City Council of Fort Collins enacted Ordinance No. 93 in 1990 with the following provisions:

- recycling is required during MAC, refrigeration, and air conditioning installation, servicing and disposal (effective March 1, 1991);
- MAC refrigerant sales must be in containers of at least 15 pounds (effective March 1, 1991);
- ODCs are prohibited as aerosol propellants, with the exception of medical products (effective March 1, 1991);
- ODC-containing building materials are prohibited (effective January 1, 1994);
- ODC-based packaging materials are prohibited (effective July 1, 1991);
- retail purchase and installation of halon-containing fire extinguishing systems require a permit (effective March 1, 1991); and
- halon recycling is required and halon release during testing is restricted (effective March 1, 1991).

Industrial and commercial users of 1,000 pounds or more of any combination of ODCs are requested to voluntarily submit emissions reports. MAC refrigerant recycling equipment must be certified by UL to meet SAE J standards.

To date the city has reportedly taken an education oriented approach toward enforcement. Brochures and copies of the regulations have been mailed to individuals and industry. A mail and phone survey was taken which indicated about 70 percent of affected businesses had bought recycling machines.

Greenwood Village, Colorado

In June 1990 Greenwood Village enacted Ordinance No. 18 regulating the use and emissions of ODCS. Draft regulations implementing the ordinance have been published. The ordinance becomes effective in three phases: January 1, 1991, July 1, 1991 and January 1, 1994.

Effective January 1, 1991 recovery and recycling is required during the installation, service, and disposal of MACs, refrigeration, and air conditioning equipment. The sale of MAC refrigerant in less than 15 pound containers is prohibited. The use of any ODC as propellant or source of energy is prohibited except for medical purposes. The release of halon from fire extinguishers for testing or training is prohibited except where required by law. Halon must be recaptured and recycled when servicing halon fire extinguishing systems. Retail sales and purchase of halon fire extinguishers is prohibited without a permit.

Effective July 1, 1991, packaging produced with ODCs is banned. Effective January 1, 1994, the manufacture or installation of ODC-containing building insulation is banned.

Littleton, Colorado

The City of Littleton enacted Ordinance No. 37 in 1990 regulating the use and emissions of ODCs. The provisions of the ordinance include:

Effective January 1, 1991 recovery and recycling is required during the installation, service, and disposal of MACs, refrigeration, and air conditioning equipment. The sale of MAC refrigerant in less than 15 pound containers is prohibited. The use of any ODC as propellant or source of energy is prohibited except for medical purposes. The release of halon from fire extinguishers for testing or training is prohibited except where required by law. Halon must be recaptured and recycled when servicing halon fire extinguishing systems. Retail sales and purchase of halon fire extinguishers is prohibited without a permit.

Effective July 1, 1991, packaging produced with ODCs is banned. Effective January 1, 1994, the manufacture or installation of ODC-containing building insulation is banned.

The ordinance designates the City Manger responsible for administering it and providing informational and implementation assistance to the general public and affected businesses. Enforcement will reportedly be "complaint driven." Most service station managers have been contacted by the city. Large MAC servicing organizations readily complied while smaller shops claim the cost of equipment is overburdensome. No fines have been levied to date.

Wheat Ridge, Colorado

The City of Wheat Ridge enacted Ordinance No. 852 in 1990 regulating the use and emissions of ODCs. The provisions of the ordinance include:

Effective January 1, 1991 recovery and recycling is required during the installation, service, and disposal of MACs, refrigeration, and air conditioning equipment. The sale of MAC refrigerant in less than 15 pound containers is prohibited. The use of any ODC as propellant or source of energy is prohibited except for medical purposes. The release of halon from fire extinguishers for testing or training is prohibited except where required by law. Halon must be recaptured and recycled when servicing halon fire extinguishing systems. Retail sales and purchase of halon fire extinguishers is prohibited without a permit.

Effective July 1, 1991, packaging produced with ODCs is banned. Effective January 1, 1994, the manufacture or installation of ODC-containing building insulation is banned.

Present enforcement is reportedly complaint driven and also includes periodic inspections to ensure compliance. In the event violations are found, they will result in verbal notification and a compliance deadline followed by official written notification of the violation and eventual prosecution. The maximum fine for non-compliance is $999/day.

Connecticut

The Connecticut legislature has enacted House Bill No. 5630 that addresses the use and emissions of fully-halogenated CFCs. The statute has the following provisions:

- Effective July 1, 1992 polystyrene manufactured using ODCs is prohibited.
- Recycling of refrigerants is required (see below for effective dates).
- The state shall not purchase polystyrene foams manufactured with ODCs as of January 1, 1991 (July 1, 1992 for building materials).
- The sale of refrigerant for recharging is permitted only to properly licensed individuals as of October 1, 1989.
- By January 1, 1991 recycling of ODCs during MAC service is required for state agencies and businesses with ten or more cars in their fleet.
- As of January 1, 1990 stationary sources emitting annually more than ten tons of any controlled substance must submit a plan to reduce those emissions by 50 percent by January 1, 1994.

To implement the statute, regulations have been published that define terms and articulate the statutory requirements. The regulations include the following provisions. Effective January 1, 1992, businesses servicing 100 or more motor vehicles a year must discharge any controlled substance into a "recovery device" certified by the EPA. By January 1, 1993, businesses servicing less than 100 vehicles annually must also use recovery devices. By July 1, 1992, recovery devices must also be used when servicing stationary "cooling devices." Entities operating disposal sites must submit a plan by January 1, 1993, for the recovery of controlled substances. Disposal sites must be using recovery devices by July 1, 1992.

All entities emitting more than 10 tons of controlled substances in 1989 must reduce emissions by 50 percent by January 1, 1994. Additionally, by January 1, 1993, ethylene oxide sterilizers that use ODCs must be equipped with "best available control technology" that reduces emissions by at least 90 percent.

The statute and draft regulations were publicized through two press releases and a comprehensive mailing. There is presently no enforcement or audit mechanism. Reportedly, enforcement will be complaint driven.

Florida

Florida has banned the sale of ODC-manufactured foam products and the Department of Environmental Regulation (DER) approved regulations requiring the recovery and recycling of MAC refrigerant. Reportedly, no other regulations have been promulgated because federal regulations will adequately address other areas.

Effective July 1, 1991, establishments with more than two service bays, more than one bay dedicated to MAC repair, or more than five employees on any one shift must use approved refrigerant recycling equipment and check for MAC leaks. All businesses servicing MACs must comply by June 1, 1992. Equipment must be either UL or SAE-J approved.

Business establishments must have certified equipment and service technicians. Certification must be renewed annually. Acceptable training requires MACS or IMACA procedures and operations and maintenance training from the manufacturer or alternate program(s) approved by the DER. Effective June 1, 1992, persons installing or servicing MACs must also be certified in "Heating and Air Conditioning" from the National Institute for Automotive Service Excellence (NIASE).

Business owners were notified by the mailing of about 50,000 registration cards. Compliance will be monitored using tax rolls and an inspection team. Violations are punishable by fines up to $100 per incident with a $1,000/day ceiling.

Dade County, Florida

On September 16, 1991 Dade County enacted an ordinance governing ODC use with the following provisions:

- recycling and recovery equipment must be used when servicing any MAC, refrigeration or air conditioning system, and venting from such systems is prohibited (effective September 26, 1992);
- reclamation systems must be used when servicing halon fire extinguishing systems (effective September 26, 1992);
- halon release during testing is restricted (effective September 26, 1991);
- the sale of refrigerant in less than 20 pound containers is prohibited (effective September 26, 1991);
- aerosol products using ODCs as propellants or sources of energy are banned (effective September 26, 1991); and
- food service items manufactured with ODCs are banned (effective September 26, 1991).

Violations are punishable by a civil penalty of $500. The ordinance covers all the CFCs, HCFCs, halons, carbon tetrachloride, and methyl chloroform.

Hawaii

Hawaii's legislature has enacted a statute requiring recovery and recycling during MAC and other air conditioning servicing and disposal. UL certified recycling equipment must be used. The sale of ODC refrigerant in less than 15 pounds containers is also prohibited. The requirements took effect January 1, 1991.

The Health Department is responsible for enforcing the restrictions on the sale of ODC refrigerants. Compliance has been monitored through spot checks and to date no violations have been identified.

The Motor Vehicle Repair Industry Board is responsible for enforcing the MAC recycling requirements and the Contractors Licensing Board is responsible for enforcing recycling of ODCs from other air conditioning equipment. Reportedly, these organizations are not actively enforcing the regulations. Implementing regulations have not been promulgated. In the event motor vehicle regulations are violated, fines are set at $75 for the first offense, and $150 to $1,000 for subsequent offenses. In addition, the Board may suspend, revoke or refuse to renew the registration of a business for a violation.

Iowa

Foam packaging and food service items manufactured with CFCs were banned effective January 1, 1990. This ban is extended to all plastic foam products manufactured with fully-halogenated CFCs as of January 1, 1998. Reportedly, additional ODC legislation is not under consideration.

Louisiana

Two State Senate bills dealing with CFCs were introduced in 1991, SB 405 and SB 444. Neither was enacted. SB 405 would have created a tax credit on the purchase of CFC recovery and recycling equipment. SB 444 required State procurement to find alternatives to CFC processed products and restricted consumer non-essential CFC use. Recently, the Department of Environmental Quality proposed to exempt used CFCs being recovered from MACs and other refrigeration and air conditioning systems from hazardous waste rules.

Maine

The Maine legislature has enacted several statutes controlling ODC use and emissions. During 1991, a bill banning the sale of halon residential fire extinguishers, CFC cleaning sprays, party streamers and noise makers was enacted with an effective date of January 1, 1992. A separate bill addressing home refrigeration was not passed as the proposed time-frames were longer than expected federal requirements.

Other statutory requirements enacted include the following:

- Sales of polystyrene foam products made with CFCs were banned effective January 1, 1989. The commercial use of foam board is being phased out according to manufacturers' estimates of their ability to do so and substitute availability.

- Extraction and reclamation of CFCs during MAC servicing becomes mandatory January 1, 1992. Equipment must be UL approved or meet SAE-J standards. No permit will be required, however, organizations servicing MACs must keep records of the number of cars serviced and the amount of CFC bought and used. There are no specific training requirements.

- Effective October 1, 1991 containers of CFC refrigerant lighter than 15 pounds must carry warning labels. As of January 1, 1992 CFC refrigerant can only be sold in containers greater than 15 pounds and must be for commercial use. 1994 or later model year motor vehicles with CFC air conditioning cannot be registered or sold in the state.

- Effective January 1, 1979 fully-halogenated CFCs are banned from non-medical aerosol propellant applications.

Maryland

State legislation was introduced in Maryland to restrict the production, use, and emissions of ODCs. Provisions proposed included requirements for recycling, restrictions on foam production and use, and reporting requirements. To date no legislation has been enacted.

Massachusetts

The State of Massachusetts has no statutory or regulatory restrictions on ODC use and emissions, although some restrictions are proposed in a comprehensive clean air bill currently under consideration.

Boston, Massachusetts

A comprehensive ordinance was introduced in 1991 to control ODC use and emissions with the following provisions:

- Effective January 1, 1992 production of ODCs is prohibited except for HCFC-22 and for use in research on the effect of ODCs on the environment.

- Effective January 1, 1993 commercial use of ODCs is prohibited except for HCFC-22 and for use in research on the effect of ODCs on the environment, medical applications, and air conditioning and refrigeration equipment.

- Effective January 1, 1992 foam containing ODCs is prohibited except for HCFC-22 and as of January 1, 1993 any CFC processed food packaging material is banned. Exemptions include ODC use in air conditioning and refrigeration equipment and for research on the effect of ODCs on the environment.

- Effective January 1, 1995 ODC-containing building insulation is banned.

- Effective June 1, 1992 ODCs except for HCFC-22 must be recaptured and recycled during servicing and disposal of both mobile and stationary air conditioning and refrigeration systems.[21]

- Effective June 1, 1992 sale of CFC refrigerant in less than 20 pound containers is prohibited.

- Effective January 1, 1991 the retail sale of halon fire extinguishers or use of such units when not mandated by law is prohibited.

- Within six months of the ordinance's passage, reclamation systems must be used when servicing halon fire extinguishing systems.

Within six months of the ordinance's passage, the Commissioner of Health must adopt reporting requirements and regulations for affected businesses. Building permit applicants must certify compliance with the ban on ODC building insulation. Violations of this ordinance would be punishable by a fine of $50 to $100 for the first and $200 to $500 for the second violation.

Cambridge, Massachusetts

In May 1990 the City of Cambridge adopted Ordinance 1101 on the Protection of the Stratospheric Ozone Layer. Effective immediately, CFC plastic party streamers, noise horns and CFC cleaning solutions for consumer photographic or electronic equipment are banned. Additional provisions include:

- Effective March 17, 1991 businesses that produce, sell, or use ODCs must file a report on annual ODC use "setting forth the amount, by weight" of any of the regulated substances used or sold for 1989 and each calendar year thereafter.

- Effective January 1, 1991 recovery and recycle equipment must be used to recover refrigerant when servicing or disposing of any air conditioner or refrigerator. The equipment must be UL approved and meet SAE or ARI standards for mobile or stationary equipment respectively.

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[21] HCFC-22 is exempt from this provision until June 1, 1993.

- Effective January 1, 1991 the sale of CFC refrigerant in less than 15 pound quantities or to persons not owning recycling equipment is prohibited.

- Effective January 1, 1991 halon fire extinguishers are prohibited from home use and restricted to applications where required by law.

- Effective January 1, 1991 warning labels are required for products containing or manufactured with "CFC, Halon or other ozone-depleting substance(s)."

- Effective January 1, 1992 foam insulation containing ODCs is prohibited from use in new construction or repair. Existing stock must be serviced according to recovery and disposal procedures established by the Commissioner of Health and Hospitals.

- Effective January 1, 1992 the sale, manufacture, or distribution of CFC-113, methyl chloroform, or carbon tetrachloride in annual quantities greater than fifty percent of their respective 1989 levels is prohibited. Effective January 1, 1994 the sale, manufacture, or distribution of CFC-113, methyl chloroform, or carbon tetrachloride is prohibited except for use in medical applications.

The Commissioner of Health and Hospitals, who is responsible for enforcement, has promulgated implementing regulations. Mail notification was sent out to relevant parties. Presently, no audit or enforcement mechanism has been established, however, periodic checks will reportedly begin soon.

Michigan

A Michigan task force prepared a report on CFCs which was shelved following the enactment of the U.S. Clean Air Act Amendments. Presently House Bill 4939 is pending which mandates CFC refrigerant recycling when state-owned vehicles are serviced.

Minnesota

The Minnesota legislature has enacted three statutes regarding ODCs. The first statute, enacted in the 1970s, banned the use of CFCs in non-medical aerosol propellant applications. The second statute was enacted in 1988 and prohibited the use of CFC processed packaging as of January 1, 1990. There is a civil penalty of up to $500 for each violation. Industry was notified when the laws passed. Present enforcement is reportedly complaint driven.

The third and most comprehensive statute was adopted in 1990 with the following provisions:[22]

[22] ODC use in medical applications is exempt.

- Effective July 1, 1991 auto salvagers must remove CFCs for recycling. Scrap refrigerators, central air conditioners and freezers must also have CFCs removed for recycling or proper disposal.

- Effective July 1, 1992 businesses servicing refrigerators, central air conditioners or freezers must capture CFCs for recycling or proper disposal.

- Effective January 1, 1993 MAC CFCs must be recaptured for recycling when servicing. In addition, CFC coolants can only be sold to those with proof of ownership of recycling equipment.

- Effective January 1, 1993 halons must be reclaimed during servicing.

- Effective January 1, 1993 the sale of CFC solvents or CFC refrigerants in containers of 15 pound or less containers is prohibited. The sale of CFC propelled party streamers and CFC noise horns is also prohibited.

Minneapolis, Minnesota

The Minneapolis city council adopted on July 27, 1990, restrictions on ODC use and emissions that are equivalent to the state statute enacted in 1990.

Missouri

Missouri House Bills 438, 440, 96 and 97 prohibit the purchase and sale of expanded polystyrene foam food packaging containing CFCs. Effective January 1, 1992 the law expands to include all thermoformed or extruded polystyrene made with CFCs.

New Hampshire

Nashua, New Hampshire

March 26, 1991, the Board of Aldermen for the City of Nashua enacted an ordinance regulating "commercial establishments handling, using or selling ozone depleting compounds" with the following provisions:

- The sale, manufacture or distribution of ODCs is prohibited as of September 26, 1991, with the following exceptions: research on the effects of ODCs; refrigerant applications in refrigerators, freezers, and air conditioners; medical applications for which non-ODC alternatives do not exist; and manufacturing performed under military specifications for the U.S. Armed Forces.

- ODC refrigerant recycling is required during the manufacture, installation, and servicing of all air conditioning and refrigeration equipment, including MACs, as of January 1, 1992.

- ODC refrigerant recycling is required during the disposal of all air conditioning and refrigeration equipment, including MACs, as of May 26, 1991.

- Sale of ODC refrigerant in less than 20 pound quantities is prohibited as of May 26, 1991.

- Party streamers, noise horns and cleaning sprays for photographic and electronic equipment are banned as of May 26, 1991.

- ODC-containing building insulation is banned as of January 1, 1995.

- Halon containing fire extinguishers can only be sold to persons with permits and halon releases for testing and training are restricted as of April 26, 1991. In addition, recycling and recovery systems must be used when servicing halon fire extinguishers.

Reportedly, additional staff has not been retained for the implementation of the new ordinance. A citizen volunteer group was instrumental in passage of the legislation and indicated they would take an active role in its implementation. Enforcement will be complaint driven. To date there has reportedly been significant voluntary compliance.

New Jersey

Newark, New Jersey

Newark Municipal Council adopted an ordinance regulating the use of ozone depleting compounds, October 4, 1989. The following provisions became effective April 22, 1990:

- The sale, purchase or use of food-packaging materials made with any ozone-depleting substance is prohibited.

- The sale, manufacture or distribution of ODCs is prohibited with the following exceptions: research on the effects of ODCs; refrigerant applications in refrigerators, freezers, and air conditioners; medical applications for which non-ODC alternatives do not exist; and manufacturing performed under military specifications for the U.S. Armed Forces.

- Building insulation containing any ozone-depleting substance is banned.

- Refrigeration and air-conditioning repair and disposal facilities must use recapture and recycling equipment.

- Retail sale of ODC refrigerants is prohibited except to owners of recycling equipment.

- The use of halon in fire extinguisher testing or training is restricted to instances required by law or where city permits have been issued. Fire extinguisher service and repair facilities must collect/recycle halons.

To educate the public about the new ordinance, all Newark businesses were sent a copy of the ordinance. In addition, the city held seminars to explain the new recycling requirements. A survey has been mailed out to all relevant parties to gather information about the ordinance's impact. Enforcement has consisted of spot checks and responses to complaints. Fines are a minimum of $100 and up to $1000 for each violation. Each day of non-compliance is considered a violation.

New Mexico

Albuquerque, New Mexico

The City of Albuquerque enacted Air Quality Control Regulation No. 37 on March 13, 1991. The regulation became effective October 1, 1991 with the following provisions:

- Auto service centers must use CFC recycling/recovery equipment.

- MAC refrigerants can only be sold to persons with approved recycling or recovery equipment.

- Automobile wreckers must remove ODCs from units before wrecking.

Reportedly, additional regulations are not under consideration.

Implementation consisted of a mass mailing and the absorption of verification responsibilities by existing field staff. Recycling equipment must meet SAE-J standards. No certification of technicians will be required; it is assumed people who buy the equipment will be properly trained.

New York

New York state passed CFC legislation in 1990 superseding any local actions. Regulations for the implementation of the law are currently being drafted and should be completed in early 1993. The legislation takes effect in two phases with the following provisions:

- By January 1, 1991 automotive repair shops with 4 or more covered bays must capture and recycle CFC during the servicing and disposal of all MACs. MAC refrigerant recycling equipment must be certified by UL to meet SAE J standards. The sale of CFC containing non-essential products like air horns, toys and photographic cleaning products is prohibited. The sale of hand held halon fire extinguishers is prohibited.

- Effective January 1, 1992 all businesses servicing MACs must have purchased CFC recapture and recycling equipment. CFCs must also be recaptured and recycled during the repair and disposal of refrigeration systems (chillers and refrigerators in retail stores and cold storage warehouses). Vehicle dismantlers must certify to the DMV purchase of approved recycling equipment upon license renewal. The sale of CFCs in less than 15 pound containers to entities without approved MAC recycling equipment is prohibited.

Violations are punishable by a civil penalty not to exceed $100.

North Carolina

North Carolina has enacted two statutes regarding ODCs: one regulates CFCs as toxic compounds and a second banned the use of CFC containing packaging material as of October 1, 1991.

Several state legislative proposals were introduced which have not yet passed either the state House or Senate. The most comprehensive is Senate Bill 781. It would require recycling equipment when servicing MACs, effective January 1, 1992. Stationary refrigeration devices would also be required to have recycling equipment by July 1, 1992. The sales of CFCs in quantities under 15 pounds and CFC containing party streamers, noise horns, cleaning fluids or other non-essential consumer products would also be prohibited as of January 1, 1992.

Ohio

The State of Ohio enacted H. 232 in the 1970s which banned CFC aerosol propellant applications. A recent bill (H.B. 700), which was not enacted, would have required refrigerant recycling equipment for MACs servicing. To facilitate recycling, CFCs have been excluded from hazardous waste regulations.

Oregon

In 1989 Oregon enacted Senate Bill 1100 with the following provisions:

- Effective July 1, 1990 for wholesalers and January 1, 1991 for retailers, MAC refrigerant containers smaller than 15 pounds, party streamers, noise makers and polystyrene food packaging containing CFCs are banned. Also, hand held halon fire extinguishers and CFC containing electronic and photographic equipment cleaners are prohibited from home use.

- By August 10, 1991 shops which work on MACs and have four or more employees or three or more covered bays must have equipment to recover and recycle MAC coolant.

- All shops working on MACs must have the required equipment by August 10, 1992. Equipment must be UL approved and meet SAE-J standards. There are no specific training requirements.

In addition to the above, tax credits on the purchase of recovery and recycling equipment are available from either the Department of Energy (35%) or the Department of Environmental Quality (up to 50%). Only one can be taken.

A brochure was sent to 13,000 retail shops notifying them of the new regulations on the retail and wholesale distribution of CFC bearing products. In addition, a trial run was performed with electronic supply stores. Reportedly, businesses have little incentive or ability to distinguish between "wholesale" or "retail" customers. Consequently, the ban on the sale of products to homeowners (while sales are permitted to businesses) is not being enforced.

Automotive shops will be surveyed on a random basis by an existing DEQ field force out of regional offices. First violations will result in a letter with subsequent violations resulting in fines. Violations are punishable by civil penalties up to $10,000 per day.

In addition, to the above statute, there are three bills pending before the legislature:

- Senate Bill 613 changes the definition of CFCs to include "any Chlorofluorocarbon that contributes to stratospheric ozone and depletion" including some potential CFC substitutes (HCFCs).

- House Bill 2970 contains the following provisions, for which no implementation dates are given:

  -- The use of ozone depleting substances without obtaining specific exemptions is prohibited. CFC research and medical and military products are exempt until suitable alternatives are available.

  -- The mandatory use of recapture and recycle equipment is expanded to all refrigeration and air conditioning equipment during service or disposal.

  -- The sale of ozone depleting building insulation and food packaging with CFCs is banned.

  -- Halons must be reclaimed and recycled when repairing fire extinguishers.

- House Bill 3337 requires a study on the effectiveness of the above law with attendant recommendations.

Rhode Island

In 1988 the State of Rhode Island enacted legislation (Chapter 18.10 of the Health and Safety Code) prohibiting the purchase or manufacture of CFC-11 and/or CFC-12 "processed products." Exemptions for products with no adequate substitutes were allowed. In 1990 Chapter 18.10 was amended to postpone its effective date to January 1, 1995.

An amendment to Rhode Island Rules and Regulations for Solid Waste Management facilities was promulgated February 1991. The amendment effectively requires removal and recycling of CFCs from all items entering solid waste management facilities (transfer stations and landfills). Operating plans providing for CFC recovery and recycling must be filed by August 26, 1991. After a transition period, spot checks will be absorbed into the existing monthly inspection program.

Vermont

In 1989 the State of Vermont enacted H. 260 to control the use and emissions of ODCs as follows:

- UL or SAE-J approved recycling equipment must be used during MAC servicing or disposal as of January 1, 1991.
- The sale of CFC refrigerant in containers of less than 15 pounds requires a warning label after October 1, 1989 and is banned as of January 1, 1991.
- The registration of 1993 model year and later motor vehicles containing CFC based MACs is prohibited.
- The sale of CFC containing plastic party streamers, noise horns, and non-commercial cleaning sprays are prohibited as of January 1, 1990.
- Halon fire extinguishers are banned from home use, effective January 1, 1990.

Implementing regulations for these requirements have been promulgated. In 1991 H. 71 was enacted changing the model year when autos are prohibited from registration with CFC based air conditioning to 1995. In addition, CFC MAC equipped cars offered for sale must carry warning placards by July 1, 1991.

To date most efforts have been made on education, primarily through working with the State Automobile Association. Due to a lack of funds, no real enforcement efforts have been initiated. Reportedly there have been complaints about discount and auto part stores selling refrigerant for MACs and small service stations failing to use the required recycling equipment.

Virginia

House Bill 763, enacted in the 1991 session, bans the use of CFC processed packaging materials as of January 1, 1992.

Washington

May 15, 1991 the State of Washington enacted a comprehensive air quality bill with a section on "Global Warming and Ozone Depletion" effective July 1, 1992. Persons servicing, repairing or disposing of MACs, refrigeration systems, commercial or industrial air conditioning, heating or refrigeration systems and consumer appliances must use refrigerant extraction equipment to recover regulated refrigerants. The sale of refrigerant in "containers designed for consumer recharge of a MAC or consumer appliance" is banned. Also banned are non-essential CFC or other ODC containing products like party streamers, tire inflators, air horns, noise makers and electronic and photographic cleaning sprays. Regulations for implementing the requirements will be written in 1993.

Wisconsin

In April 1990, the Wisconsin Legislature enacted 1989 Wisconsin Act 284 regulating ODC use and emissions from air conditioning and refrigeration equipment. The Act requires that ODC refrigerants be recovered and recycled by trained service technicians using certified equipment. The provisions of the statute include the following:

- As of February 28, 1991 ODC refrigerant recapture and recycle equipment must be used when servicing MACS. Equipment must meet SAE- J 1990 standards or a substitute approved by the state. Equipment operators must have at least 2 hours training that meets state guidelines. By November 1, 1991, businesses must register ($80) and certify they meet equipment and training requirements.

- As of January 1, 1994, new automobile sales in Wisconsin are banned unless at least 25 percent of a distributor's/manufacturer's national new car sales do not have ODC containing MACs. The percentage of national sales that must be free of ODC containing MACs increases to 50 percent in 1995. Effective January 1, 1996 no new car sales are permitted with ODC-containing MACs.

- Effective December 31, 1991 refrigerant recapture and recycling equipment must be used when installing or servicing refrigeration equipment with 5 pounds or more of ODC refrigerant. Operators must also meet training guidelines similar to those for MACS.

- Effective December 31, 1992 refrigeration equipment with less than 5 pounds of ODC refrigerant must also be serviced with recapture and recycling equipment.

- Effective December 31, 1990 refrigerant cannot be sold in less than 15 pound containers. Recycled refrigerant must have less than 15, 4000 and 330 ppm of moisture, refrigerant oil and non-condensable gases, respectively.

Direct mailing and trade associations were used to inform businesses of their new responsibilities. Training programs have been established through manufacturers and technical colleges. Fines have not yet being levied. Most violations are punishable by $50 to $1,000 fines.

In December 1991, the Wisconsin Legislature amended 1989 Wisconsin Act 284 by creating 1991 Wisconsin Act 97 regulating ODC emissions from the salvaging, dismantling, and transporting of refrigeration equipment. The Act requires that ODC refrigerants be recovered and transferred into storage tanks by trained service technicians using certified equipment. The statute has the following provisions effective June 30, 1992:

- Refrigerant must be removed and transferred to storage tanks before the salvaging or dismantling of refrigeration equipment. Service technicians must be trained using certified equipment.

- Effective June 30, 1992, any person who sells, gives, or transports refrigeration equipment to a scrap metal processor must provide documentation to the processor that the refrigerant has been recovered and transferred to a storage tank unless the scrap metal processor agrees in writing to perform the recapture process.

- Release of refrigerant from storage tanks or from the salvaging, dismantling, and transporting of refrigeration equipment to the environment is prohibited except for minimal releases that occur during the recovery and transfer process. Certification that refrigerant is not released to the environment is required for any person who transports refrigeration equipment to a scrap metal processor.

Violations are punishable by fines ranging from $100 to $1,000.

To implement the Act, the Wisconsin Department of Natural Resources has proposed a rule which is currently being reviewed and should be adopted in early 1993. It is planned that the rule will become effective May 1, 1993. The rule includes the following provisions. Annual registration and fees are required for any person salvaging, dismantling, or transporting refrigeration equipment. Any person salvaging or dismantling refrigeration equipment must also keep a record of their refrigerant recovery activities for three years. Training programs which certify service technicians to operate refrigerant recovery equipment must be approved and pay a specified fee every three years.

6.7 REFERENCES

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7. CONCLUSIONS

This report presents an overview of latest information on ozone depleting chemical (ODC) emissions and opportunities for control. The primary conclusions are as follows:

Overview of the Problem: Stratospheric ozone depletion has been measured at all latitudes using a combination of ground station and satellite measurements. Emissions of ODCs, principally fully-halogenated CFCs and halon compounds, are believed to be the principal cause of the observed depletion.

International Action: Through the Montreal Protocol and its subsequent amendments, production of key ODCs is being phased out. Current plans are that partially-halogenated HCFCs, which are less damaging than CFCs, will be controlled and eventually phased out over the next 30 to 40 years.

U.S. Action: The U.S. has ratified the Montreal Protocol and its subsequent amendments, and through the Clean Air Act Amendments (CAAAs) of 1990 is phasing out ODC production. Additional CAAAs requirements include, *inter alia*: recovery and recycling of refrigerants from air conditioners and refrigeration systems; prohibition on the venting of refrigerant; and a ban on the use of CFCs and HCFCs in selected applications. The CAAAs authorize the Administrator of EPA to control ODC uses and substitutes for ODCs as well.

State and Local Action: States and localities have enacted ordinances and regulations to reduce ODC emissions within their jurisdictions. In most cases, these ordinances do not exceed the requirements of the CAAAs. In California, AB 859 exceeds the CAAAs requirements by phasing out the sale of ODC-based mobile air conditioners (MACs) by model year 1995.

1990 Emissions: As the result of existing and anticipated federal restrictions on ODC production and use, ODC use and emissions declined in the late 1980s in the U.S. In particular, use in foam production and in solvent cleaning declined. The 1990 emissions estimate reflects these trends, with total ozone depleting potential (ODP) weighted emissions for the U.S. estimated at about 264 million kilograms. Based on the U.S. estimates and California-specific activity levels, California ODP-weighted 1990 emissions are estimated at nearly 35 million kilograms, or about 13 percent of the U.S. total.

Key Sources: The largest sources of emissions both nationally and in California are MACs, solvent cleaning, and foams. In California, these three sources accounted for about 70 percent of ODP-weighted emissions in 1990.

Uncertainties in the Emissions Estimates: Historical total annual production and consumption of the ODCs is reasonably well known from industry data. The manner in which the ODCs have been used over time is more uncertain, and is based on estimates of the products manufactured and serviced with ODCs over the years. The largest uncertainties are in the amounts of ODCs used and emitted during the servicing of various types of refrigeration and air conditioning systems. Although there is uncertainty regarding the distribution of ODC use among system types, estimates of total annual emissions are relatively insensitive to this uncertainty because most refrigeration and air conditioning systems have similar leakage characteristics during operation and servicing.

A second major source of uncertainty is the emissions rate from insulating foams. These foams, found in buildings and appliances, slowly release their ODCs. The emissions estimates for any individual year such as 1990 are sensitive to the assumed rate of release from these foams, including the portion released during product disposal. However, because virtually all the ODCs in the foams will be released eventually, there is much less uncertainty regarding the eventual cumulative emissions from this source.

Future Emissions: Over time, ODC emissions will be limited by the ODC production phaseout. Estimating the time profile of emissions during and shortly following the phaseout is complex because the estimates must consider the inter-relationships among the various ODC uses and the costs of eliminating ODC use in each. The estimates must also consider the rate at which new chemical substitutes will become available and penetrate the market. Based on a range of assumptions about the rate of the phaseout and the availability and use of new chemical substitutes, U.S. ODP-weighted emissions in 2005 are estimated to range from about 48 to 54 million kilograms. This represents about an 80 percent reduction from 1990 levels.

Based on the national emissions estimates, California ODP-weighted emissions in 2005 are estimated to range from about 7.5 to 8.5 million kilograms. This is about 16 percent of national emissions, and represents nearly an 80 percent reduction from 1990 levels.

Control Measures: There are a large number of control measures for reducing ODC use and emissions. New chemical substitutes and processes are anticipated to be available for all new air conditioning and refrigeration systems. Alternative blowing agents are available for most types of foam production. Proven alternatives are available for all solvent cleaning needs, in particular the printed circuit board and electronics cleaning industries that are important in California.

Many of the control measures are expected to be relatively low cost, and some measures appear to be profitable given recent increases in the prices of ODCs. HCFCs are expected to play an important transitional role, enabling the use of fully-halogenated CFCs to be eliminated quickly. Simultaneously, researchers are developing product, process, and chemical substitutes to replace the HCFCs as well in the long term.

Enforcement: In addition to phasing out the production of ODCs, the federal rules being promulgated under the CAAAs cover a wide range of services and products found throughout the country. Based on discussions with EPA representatives, enforcement of the requirements is expected to be "complaint driven." Given the very large number of businesses and individuals affected by the rules (e.g., all MAC repair shops and all air conditioning and refrigeration service professionals), additional enforcement efforts may be appropriate. The enforcement area may be one in which state and local entities could make an important contribution by publicizing the requirements and checking for compliance as part of existing inspection and information collection programs. The cost and effectiveness of adding these responsibilities to existing programs should be examined.

The Need for a Market in Recycled ODCs: A market for recycled ODCs is needed. While the production of ODCs is phased out, existing air conditioning and refrigeration equipment will require ODCs for servicing. "Drop-in" substitutes are not expected to be available, and the retrofits required to accept the new refrigerants appear to be costly. Consequently, ODCs recovered from equipment being disposed must be made available to enable existing ODC-based equipment to be used for its expected useful life. The CAAAs require ODC recovery and recycling at both service and disposal. These requirements will help to create a supply of recycled ODCs.

Potential Control Gaps: Over the next 10 to 15 years, steps should be taken to ensure that the remaining available ODCs are used most effectively. By doing so, emissions will be minimized and the usefulness of existing ODC-based equipment will be maintained. The market for recycled ODCs should be monitored to assess whether interventions are needed to ensure the maximum possible recovery of ODCs during product servicing and disposal. In the event that the supply of recycled ODCs does not develop as currently expected, low-cost options for maintaining the usefulness of existing ODC-based equipment will require increased attention.

Additional Research Needs: By phasing out the production of ODCs, all ODC emissions will be eliminated. Currently, however, there are no provisions for preventing all the ODCs that were produced from being emitted eventually. In particular, ODC-based foams in buildings and appliances are expected to continue to emit ODCs slowly over many years. No cost-effective method of capturing these ODCs, even during product disposal, is currently available.

It is possible that recycled ODCs will remain available after ODC-based equipment is retired. In the event that more recycled ODCs are available than required, options for safely disposing of the chemicals may be to be developed. Over the long term, replacements for the transitional HCFCs will also be required. Demonstration projects for innovative cooling systems may be particularly valuable, as a variety of new chemical and process options are under development.

APPENDIX A: MODEL OVERVIEW

This Appendix describes the analytic framework used to estimate the emissions and control costs of the phaseout of ozone depleting compounds (ODCs) in the United States.[1] The phaseout restricts the availability of compounds required for manufacturing and operating ODC-based equipment. The emissions and costs resulting from the phaseout depend on:

- the types of controls that are adopted to eliminate ODC use in equipment that is manufactured and operated with these compounds;
- the costs of these controls (including energy costs) and their effectiveness at reducing the demand for ODCs; and
- the rate at which controls are adopted over time.

The last factor is particularly important. A large fraction of ODC use in the U.S. goes to manufacturing and servicing long-lived capital equipment. An example is industrial building chillers with an average life of 20 years or more. The analysis must therefore consider whether a phaseout will cause premature retirement of equipment due to the reduced availability of ODCs needed to service the equipment stock.

The possibility of early equipment retirement depends upon:

- the speed at which the existing equipment stock will turn over to be replaced by alternative equipment;
- the extent to which existing equipment can be retrofitted to use chemical replacements for ODCs; and
- the feasibility of using recycled ODCs to maintain the stock of equipment past the production phaseout.

The approach is called the "Vintaging Framework" because it analyzes these factors by simulating the adoption of controls in the stock of ODC-based equipment over time. For this purpose, the stock is divided into equipment types (e.g., mobile air conditioners) and year of manufacture, or "vintage."

The Vintaging Framework is an extension of previous cost analyses performed by EPA. The economic principles that underlie the Framework are presented in Appendix I of the August

[1] In practice, the Vintaging Framework is a system of computer models. For purposes of description, however, the models are presented here as a single framework.

1988 Regulatory Impact Analysis (EPA, 1988). Some assumptions for calculating the social and private costs of ODC alternatives also come from that study.

The remainder of this Appendix is organized is follows:

- Section 1 provides an overview of the steps performed by the Vintaging Framework to estimate costs and emissions.
- Section 2 describes the baseline analysis of equipment that is developed to establish a benchmark for assessing the impacts of the phaseout.
- Section 3 presents the methods used to specify the impacts of controls on ODC use and emissions.
- Section 4 describes how the timing and market penetration of controls is defined in control plans.
- Section 5 outlines the methods and assumptions used to simulate the selection of control plans for each equipment type.
- Section 6 summarizes the calculation of aggregate costs of a phaseout.
- Section 7 describes the methods used to estimate emissions of chemical substitutes.

A.1 OVERVIEW

The Vintaging Framework estimates the emissions and costs under an ODC phaseout by simulating the introduction of controls in the current and expected future stock of ODC-based equipment. These controls may include chemical substitutes, product substitutes, and process changes (e.g., recycling). While reducing demand for ODCs, these controls may change the costs of manufacturing and operating the equipment stock. The amount of energy required to operate the stock may also change.

The Framework identifies these cost and energy impacts by undertaking the following steps:

- estimating ODC use, energy use, and life-cycle costs in baseline (i.e., uncontrolled) equipment;
- specifying the impact that individual controls, such as a chemical substitute, may have on ODC use, energy use, and costs in the equipment;

- defining alternative groups of controls, referred to as "control plans," for each equipment type that may be implemented over time to meet regulatory restrictions on ODCs;
- selecting a least cost control plan for each equipment type that may be adopted in response to a phaseout;
- summarizing total costs for the U.S. associated with the implementation of these control plans; and
- estimating emissions of chemical substitutes for the selected control plans.

Each step is summarized briefly.

A.1.1 Baseline Analysis

The Framework starts by evaluating ODC equipment in the absence of restrictions on the production of these compounds. The purpose of this analysis is to establish a baseline of ODC use, emissions, and life-cycle costs against which the ODC reductions and incremental costs of controls can be assessed. Current and projected future stocks of ODC equipment are evaluated in terms of:

- size of the equipment stock;
- ODC consumption and emissions, including compound use required to service the equipment stock;
- energy requirements; and
- life-cycle costs (i.e., costs of operation and servicing).

These factors are estimated by: (1) defining the characteristics of the equipment stock over time; and (2) simulating the manufacturing, operation, and retirement of current and projected equipment stocks.

Equipment characteristics evaluated include the ODC charge size, ODC emission rates, energy consumption per piece of equipment, and life-cycle costs. Given these characteristics, equipment is simulated to undergo various "emission events," each of which occur at some probability over time. ODC use and emissions, energy use, and costs are calculated at each event.

For example, the first event, manufacturing, may require an initial ODC charge. Subsequent events, such as leakage, can cause ODC emissions. Both ODC use and emissions can occur when equipment is serviced to replace leakage. The Framework tracks the amount of ODCs residing in the equipment after each event over time. The final event, equipment retirement, results in emissions of any remaining ODC charge (unless it is simulated to be recycled).

A baseline analysis is performed for 36 equipment types for 1989-2010. Exhibit A-1 summarizes the equipment types evaluated. The data used to develop these analyses are differentiated to the extent possible by vintage (i.e., the year in which the equipment was produced). For example, refrigerators produced ten years ago consume more energy than refrigerators manufactured today. The amount of CFCs required to operate automobile air conditioners (MACs) has declined over time as the equipment has been down-sized. The Framework tracks these vintage-specific characteristics and uses them to estimate ODC use, emissions, and life-cycle costs.

A.1.2 Specification of Controls

After establishing a baseline for each equipment type, the Framework defines controls that reduce the use and/or emissions of ODCs. For each equipment type, controls are specified in terms of:

- reductions in use and emissions;
- impacts on energy consumption; and
- impacts on costs.

To define these factors, each control is specified to change compound use, energy, and cost characteristics in the relevant equipment stocks. For example, recycling controls can prevent venting of CFC charges that routinely occurs when CFCs are refilled in equipment. The costs of performing refills may also increase to reflect the costs of purchasing recycling equipment.

A wide range of controls was specified for each equipment type. The controls include chemical substitutes, product substitutes, and changes in the manner in which equipment is operated and/or serviced. The impacts of each control on compound use, energy use, and costs were defined in engineering data developed for EPA. The primary source of information on these impacts is EPA (1988), although much of the information has been updated for this analysis.

For some equipment types, controls were included that involve recycling of ODCs out of equipment that is retired. That is, ODCs remaining in equipment at the end of its useful life may be recovered and reused. In addition, some controls include retrofitting existing equipment to use chemical substitutes. The possibility of recovering ODCs out of the converted equipment is included as a control. The availability of recycled ODCs creates an opportunity to operate ODC-based equipment after production of these compounds is phased out.

Exhibit A-1: Equipment Types Evaluated

Refrigeration

Centrifugal Chillers (CFC-11, CFC-12, CFC-114, CFC-500)
Reciprocating Chillers
Household Refrigerators
Freezers
Dehumidifiers
Vending Machines
Ice Makers (CFC-12, CFC-500)
Water Coolers
Commercial Ice Machines (Medium, Large, and Extra Large)
Ice Rinks
Process Refrigeration (Petroleum Refineries and Chemical Industry)
Retail Food Storage (CFC-12, CFC-502)
Refrigerated Transport (CFC-12, CFC-500)
Mobile Air Conditioners
Cold Storage Warehouses (CFC-12, CFC-502)
Miscellaneous Refrigeration

Solvent Cleaning

Cold Cleaning
Open Top Vapor Degreasing
Conveyorized Vapor Degreasing

Sterilization

Hospital
Commercial
Medical Equipment
Pharmaceutical

Halon Fire Extinguishing

Portable Civilian
Portable Military
Total Flooding Civilian
Total Flooding Military

For purposes of analysis, the equipment types are divided by compound. For example, centrifugal chillers are split into four types of equipment corresponding to CFC-11, CFC-12, CFC-114, and CFC-500 chillers.

A.1.3 Definition of Control Plans

The implementation of controls in response to a phaseout is defined in control plans. A number of control plans were developed for each equipment type. Each represents alternative groups of controls that may be undertaken over time in response to the reduced availability of ODCs. A plan specifies: (1) the types of controls undertaken; (2) the expected start date of the controls; (3) the speed with which the controls are implemented; and (4) the extent to which the controls can be applied to the existing stock of equipment.

The purpose of these control plans is to define sets of controls that are internally consistent and likely to be adopted by industry. They are constructed to represent as closely as possible the timing and manner in which controls will be put in place. Each plan specifies one complete set of controls implemented during 1989-2010 in response to a phaseout. Because the selection of controls is uncertain, many alternative plans were developed for each equipment type. These alternative plans vary the types and timing of the controls that may be implemented.

Most of the control plans were specified to eliminate the use of CFCs in equipment by the final year of the phaseout (phaseouts by both 1996 and 2000 were examined). Some plans were constructed, however, to allow for continued use after the phaseout. The source of CFCs after the phaseout would be amounts recycled out of retired and retrofitted equipment. Control plans also were developed that include early retirement of equipment. These plans generally were not selected in the analysis, however, because of their high cost.

A.1.4 Selection of Control Plans

The emissions and costs under the phaseout are computed by simulating the adoption of control plans. For this purpose, increases in ODC prices are assumed to drive the selection of controls. As industries compete for a dwindling supply of ODCs, they are assumed to choose control plans in a least cost manner. The following procedure is used:

- The controls included in each control plan are applied to the baseline equipment stock. ODC use and emissions, energy use, and life-cycle costs are computed over time for the equipment after the imposition of controls. Costs of early equipment retirement, if applicable, are included as part of the costs of the control plans.

- The incremental costs of each control plan are identified by comparing the costs of manufacturing and operating the equipment stock before and after the controls are applied. Incremental costs represent the difference between the costs of the control plan and costs for the baseline equipment.

- Reductions in ODC use and emissions are calculated by comparing use and emissions over time in baseline equipment and controlled equipment.

- Control plans for each equipment type are selected in order of least cost. The least cost plans are found by comparing incremental costs per kilogram of ODC reductions across control plans.

The selection starts with the least cost plan for each end use, and moves to successively more expensive plans until the schedule of reductions in regulated compounds is satisfied. The costs used to determine the least cost control plans are the private (financial) costs borne by firms, with appropriate adjustments for tax liabilities and costs of capital.

The selection of control plans is governed by two rules: (1) a single control plan is selected for each equipment type for the entire analysis period (i.e., 1989-2010); and (2) once selected, the control plan is effective for the entire period. These conditions are designed to portray more accurately the manner in which controls will be implemented by industry. Each control plan continues a complete transition from ODCs during 1989-2010 because industries are unlikely to shift from one control to another (e.g., install a long-term chemical substitute into new equipment and then subsequently convert this new equipment to a different substitute).

In selecting control plans, the Vintaging Framework also considers the controls that are available to reduce ODC use in end uses that are not listed in Exhibit A-1. These other end uses typically represent uses of ODCs in products that do not need to be refilled with the compounds after production. An example of such an end use is foam used to insulate houses. The costs of controls for these end uses is evaluated using the cost framework developed described in EPA (1988). Controls for these end uses are merged with Vintaging control plans during the control selection process.

A.1.5 Aggregate Costs

The Framework selects a control plan for each end use so that together, the selected controls satisfy the production phaseout. Having made this selection, the Framework then reports two types of costs: (1) social costs -- the actual costs of the controls undertaken; and (2) transfer payments -- payments from the users of ODCs to producers of the compounds due to increases in ODC prices.

Social costs are the sum of all increases in capital, operating, and energy costs for the selected controls. Transfer payments are calculated by multiplying remaining ODC use quantities by the estimated price increases for each compound. Social costs and transfer payments are computed for each year and discounted for reporting purposes. All costs reported in this study are in 1990 dollars.

A.1.6 Emissions of CFC Substitutes and Greenhouse Gases

As a final step, the Framework provides estimates of the emissions of chemical substitutes and energy-related greenhouse gases. Emissions of some substitutes, particularly partially-halogenated chlorinated compounds (HCFCs), may contribute to stratospheric ozone depletion and global warming. Changes in the energy efficiency of equipment may also lead to changes in the emissions of greenhouse gases (such as carbon dioxide) due to increases or decreases in fuel consumption.

The remainder of this Appendix describes the data and analysis underlying each of the steps summarized above. Because the data requirements for performing the analysis are substantial, the full data set cannot be presented here.

A.2 BASELINE ANALYSIS

As indicated above, the Vintaging Framework begins by establishing a baseline of the following factors for each equipment type over time:

- size of equipment stock;
- ODC consumption and emissions;
- energy requirements; and
- life-cycle costs.

This section reviews the data and calculations developed to perform this baseline analysis.

A.2.1 Equipment Stock

To estimate the size of the current and projected equipment stock, the following data were collected for each equipment type:

- historical equipment production in the United States;
- historical domestic equipment consumption;
- the rate of expected future growth in domestic production and consumption; and
- a retirement function.

Equipment production refers to the number of pieces of equipment manufactured annually in the U.S., including production for export. Equipment consumption is defined as the number of pieces of equipment put into domestic operation. Equipment consumption roughly equals equipment production, minus exports, plus imports. Equipment production is differentiated from consumption to account for international trade. Some equipment is exported and thus may receive its initial ODC charge in the U.S., but will not be refilled with ODCs domestically. The reverse is true for imported equipment.

Initially, historical production and consumption data were collected for each equipment type so that a complete equipment stock could be estimated for 1985. Equipment with a 20 year maximum lifetime, for example, would require production and consumption data beginning in 1965. This assessment was updated to describe the equipment stock in 1990.

Stocks of equipment can be expected to change over time. In the Vintaging Framework, this change is determined in part by variation in annual equipment production and consumption. For most equipment types, growth rates are used to project equipment production and consumption after 1989. For others, available forecasts of future production and consumption were used. Future production and consumption of automobile air conditioners, for example, are driven by a published cyclical forecast of motor vehicle demand.[2]

The Framework uses a retirement function to calculate the length of time each piece of equipment is expected to survive after initial production. A retirement function defines the probability of survival as a decreasing function of age. These retirement functions are a critical part of the Vintaging Framework because they determine the speed at which the stock of equipment can be turned over and be replaced by alternative equipment.

Estimates of retirement functions that vary survival as a function of age were available for several equipment types (e.g., refrigerators, freezers, and mobile air conditioners). For other equipment types, a retirement function was constructed based on available data regarding the average and maximum expected lifetimes of the equipment.[3] For most equipment types, however, only point estimates of the expected average lifetime of the equipment were available. The retirement functions for these equipment types assume 100 percent survival up to this average age and zero percent survival thereafter.

Given these data, the equipment stock in one year is estimated as the equipment stock in the previous year, plus equipment consumption, minus retirements. The Framework tracks the age of each piece of equipment and applies the retirement function to retire the appropriate fraction of the equipment stock each year.

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[2] Projections of motor vehicle demand are combined with estimates of the fraction of motor vehicles that will be installed with air conditioners to forecast future production and consumption of the air conditioners.

[3] A beta function was used to construct these retirement functions. The functions were developed to retire one-half of the equipment by the average age and all equipment by the maximum age.

A.2.2 ODC Use and Emissions

Annual ODC use and emissions are estimated for each equipment type during 1989-2010. Because controls can reduce particular kinds of ODC use, the estimates are further broken down by type of use or emissions (e.g., manufacturing use versus servicing use). Baseline estimates of use and emissions are based on the following data collected for each type of equipment:

- Charge size. Charge size refers to the number of kilograms of ODCs initially installed in the equipment.

- Compounds used. The compounds used in the equipment are specified. For some equipment types, combinations of CFCs are used. Also, a variety of compounds may be used at different points in the equipment life-cycle (e.g., CFC-11 may be used as a working fluid in refrigeration equipment but CFC-12 used in testing the equipment for leaks). The ODCs used are specified by each point in the life-cycle.

- Emission events. A set of emission events is defined for each equipment type that characterizes the types of events that generate use, emissions, and costs. At a minimum, these emission events include the following:

  -- manufacturing;

  -- operation (including leakage if any);

  -- service to replace ODCs lost from leakage; and

  -- retirement.

  Other emission events are defined if appropriate. For example, vehicle accidents are included as an emission event that can cause use and emissions of CFC-12 in mobile air conditioners. The following characteristics are specified for each emission event:

  -- the compounds (e.g., CFC-12) used at each event if the event results in a fill of the equipment;

  -- the probability of the event as a function of: (1) the age of the equipment (e.g., manufacturing only occurs at age zero); or (2) the quantity of ODCs remaining in the equipment (e.g., service to replace lost ODCs may be triggered when the remaining charge falls below a specified level); and

  -- the manner in which the probabilities interact -- some events are "exclusive" (i.e., they affect a portion of the equipment stock) whereas others are "interactive" (i.e., they can affect the entire equipment stock regardless of the occurrence of other events).

- ODC use and emissions per event. The quantity of ODC used and emitted at each emission event is defined. These quantities are specified either as: (1) a fraction of the quantity residing in the equipment; or (2) as an absolute quantity in kilograms. In addition, the mechanism by which each event leads to ODC use and emissions is characterized. Some events, such as leakage, result only in compound emissions that are not replaced immediately. Other events, particularly servicing, cause the equipment to receive a recharge.

- Recharge practices. For emission events that result in recharge, current and expected future recharge practices are defined. These practices include:

  -- leak testing (the quantity of ODC used to test the equipment for leaks); and

  -- service waste (the quantity of ODC lost during the recharge process).

  Not all equipment types are simulated to undergo leak testing. In addition, to the extent that data allow, these factors are specified over time. Available data suggest, for example, that automobile service shops have reduced the amount of CFCs lost when servicing MACs.

- Use and emissions of ODCs in foam insulation. Certain types of refrigeration equipment are insulated with CFC-blown foam. Examples include refrigerators, vending machines, and refrigerated transport units. Use and emissions of CFCs in foam insulation are specified in terms of: (1) the quantity of CFCs used to manufacture the foam; and (2) the rate at which CFCs are emitted from the foam.

Each of these factors is defined by equipment vintage. For example, MACs produced ten years ago have a larger charge size than do air conditioners made today. The rate at which CFCs leak from MACs has also been declining due to improvements in engineering design and hose materials.

With these data, baseline ODC use and emissions are estimated as follows. The Framework starts with the first year of equipment production, say 1965. Units produced in that year are estimated to be filled with an ODC charge. Additional ODC consumption may occur if some of these compounds are wasted during the fill process. In the next year, the equipment consumed in the U.S., representing the domestic equipment stock, is examined. The emission events described above are applied to this equipment, one at a time.

With each emission event, the following calculations are made:

- The fraction of the equipment stock undergoing the event is estimated based on the event probabilities.

- For those pieces of equipment that experience the event, a portion of the ODC charge residing in the equipment is emitted.

- If it is a characteristic of the emission event, the equipment is refilled. Both this refill and the emissions that arise due to recharge waste and leak testing are counted as use of the compounds used for refill.

- The charge remaining in the equipment is calculated. The Framework tracks this remaining charge, or "charge state," after each event.

- If the emission event results in equipment retirement, the entire remaining charge is emitted from the equipment (unless recycling is simulated).

After the above steps are performed for the first event, the next emission event is evaluated. The process continues until all of the emission events are exhausted. At each event, the Framework records the amount of ODC use and emissions.

When all emission events are completed, the charge levels in the affected equipment have changed. The modified equipment stock is then simulated to age by one year. The Framework again applies the emission events to the modified equipment stock. It then cycles through the remaining life of the equipment until the equipment produced in the relevant vintage (e.g., 1965) is fully retired.

After the equipment consumed in this first year are evaluated, the Framework performs the above analysis for the next vintage of equipment (e.g., equipment produced in 1966). Subsequent equipment vintages are then simulated, one at a time, through the equipment produced in 2010. The results of this simulation are estimates of ODC use and emissions for the equipment stock. The estimates are tracked by: (1) equipment vintage; (2) compound; and (3) type of use or emissions (e.g., initial fill versus service waste).

A.2.3 Energy Consumption and Costs

A baseline of energy consumption and costs also was evaluated for each type of equipment. Some of these equipment types, such as portable fire extinguishers, do not consume energy in their operation. For energy-consuming equipment types, the following data were developed to estimate energy use and costs:

- Energy consumption per unit. The amount of energy consumed by each piece of equipment per year was estimated. The energy evaluated is related only to the operation of the equipment. For example, the energy requirements for MACs were identified as the increase in fuel needed to operate the air conditioner, not energy to drive motor vehicles. Energy expended in manufacturing the equipment (e.g., making and installing the air conditioners) also was ignored.

- Fuel types. The types of fuels used in each equipment type were identified. When multiple fuel types are used (e.g., gasoline and diesel fuel for MACs) the fraction of energy supplied by each fuel type also was estimated. These fractions may vary over time to reflect expected shifts among fuel types (e.g., switches to methanol powered automobiles). The following fuel types were considered in the analysis:

  -- Electricity: residential, commercial, industrial;

  -- Natural Gas: residential, commercial; and

  -- Oil: gasoline, residential heating oil, commercial heating oil, diesel.

- Energy prices. Energy prices were estimated for each fuel type for each year during 1989-2010.

Estimates of energy consumption per unit of equipment were differentiated to the extent possible by equipment vintage. Energy consumption in newly-manufactured refrigerators, for example, has been declining due in part to U.S. energy efficiency standards for appliances.

Using these data, the Framework estimates baseline energy consumption by multiplying annual energy consumption per unit by the number of units in operation, accounting for the vintage of each unit. The cost of this energy consumption is then calculated by multiplying energy consumption by energy prices for the appropriate fuel types.

A.2.4 Life-Cycle Costs

Estimates of baseline life-cycle costs were developed from the following data for each type of equipment:

- ODC compound cost. The cost of each compound per kilogram was included to capture the costs of purchasing and using the compounds.

- Operating costs. Costs that occur each year to operate the equipment, including the energy costs described above, are included.

- Event-specific costs. Other life-cycle costs were specified around the emission events that are simulated to trigger ODC use and emissions. Capital costs associated with manufacturing the equipment are included with the manufacturing emission event. Similar costs may be specified for other emission events (e.g., leakage, servicing, and retirement).

Where possible, estimates of these costs vary by the vintage of equipment.

Estimates of life-cycle costs are driven by the simulation of ODC use and emissions described above in Section A.2.2. The costs of ODCs used in equipment are estimated by multiplying compound use by the cost of the compounds. (Emissions do not give rise to compound costs.) Operating costs are tabulated for each year for which the equipment is in service. Other life-cycle costs are determined from the simulation of emission events. These costs are estimated by multiplying the number of pieces of equipment undergoing the event by costs estimated per each event.

A.2.5 Summary

The results of the baseline analysis are estimates of equipment stocks, ODC use and emissions, energy consumption, and life-cycle costs for equipment that consume ODCs. Estimates are provided for each equipment type and for each year during 1989-2010. This analysis drives the evaluation of the phaseout.

A.3 SPECIFICATION OF CONTROLS

Having established a baseline for ODC equipment, the Framework next defines controls that may be undertaken for purposes of reducing ODC use within each equipment type. The following types of controls were identified for the phaseout cost analysis:

- Chemical substitutes -- replace ODCs used in the manufacturing or operation of equipment with less ozone depleting chemicals.

- Process/product substitutes -- replace ODC-based processes with alternative processes. An example is the use of aqueous cleaning to replace solvent cleaning with CFC-113.

- Engineering/recycling controls -- modify the operation and servicing of ODC equipment to reduce emission rates (e.g., recycling of CFCs from existing equipment or avoiding emissions through improved housekeeping).

A large database of alternative controls was developed for each equipment type. Not all of the controls are simulated to be undertaken, and simulated controls do not necessarily all start immediately. The types and timing of controls simulated in the cost analysis are defined in control plans (see Section A.4 below).

For the controls identified, estimates were prepared concerning the costs of the control and the potential reduction in ODC use achievable with the control. The manner in which these factors are defined is described below.

A.3.1 Effects on CFC Use and Emissions

The potential effectiveness of each control to reduce ODC use and emissions was estimated based on the following factors:

- Compound types. Controls may change the compounds used to operate equipment. These compound changes may apply to some or all portions of the equipment life-cycle. For example, "drop-in" chemical substitutes may be used only for servicing equipment.

- Impact on ODC use and emissions. The impact of each control on use and emissions may be defined by emission event. For example, recovery equipment may reduce CFC use and emissions during MAC servicing. Other recycling controls may be applied separately to recover CFCs from retiring MACs. In this way, controls can be specified for all or part of the equipment life-cycle. The impacts of controls on ODC use and emissions are expressed as: (1) percent reductions (e.g., 35 percent less servicing emissions); or (2) absolute reductions (e.g., reduction in emissions of 2.5 kilograms).

The reduction effectiveness is generally less than 100 percent for engineering controls such as recycling. The reduction effectiveness of chemical substitutes is assumed to be 100 percent (for the applicable emission events and equipment types). Similarly, the reduction potential for product substitutes is 100 percent.

A.3.2 Effects on Energy Consumption and Energy Costs

The controls that are undertaken to reduce ODC use may increase or decrease the energy efficiency of affected equipment. These energy efficiency changes may also lead to energy savings or costs. In the Vintaging Framework, the energy impacts of each control are specified as: (1) percentage changes in the energy consumed by the equipment per year; or (2) absolute changes in the number of Btus required to operate the equipment.

The energy costs or savings associated with controls are estimated using the analysis of fuel types and energy prices described for the baseline analysis. Changes in energy consumption are translated into savings or costs by multiplying these changes by energy prices for the types of fuels required to operate each type of equipment.

A.3.3 Effects on Costs

The implementation of controls may change the cost of manufacturing and operating the equipment stock. To enable the controls to be evaluated in terms of costs, the Vintaging Framework defines the costs of each control in terms of:

- Conversion costs -- transitional, one-time costs associated with introducing the control as a means of reducing ODC use (e.g., research and development costs, training costs, and costs of industry retooling of production lines to manufacture ODC-free equipment);

- Compound costs -- savings from reducing the use of ODCs, plus costs of using chemical substitutes (if any); and

- Life-cycle costs -- increases or decreases in the costs of manufacturing or operating the equipment stock.

The impact of the controls on life-cycle costs are expressed as: (1) percentage changes in baseline costs; or (2) absolute changes in baseline costs. These cost changes may be defined for each emission event that gives rise to costs.

A.3.4 Costs of Early Equipment Retirement

The phaseout could cause some of the existing stock of ODC-consuming equipment to be retired before the end of its expected useful life. This situation is referred to as "early" or "premature" equipment retirement. The Vintaging Framework computes a cost associated with early retirement. This section presents the equations and assumptions that underlie the calculation.

Early retirement involves the replacement of equipment with non- or less-ODC consuming equipment. This replacement occurs before the end of the expected useful life of the original equipment. For example, a building chiller may have a 25-year useful life but be retired at age 20 due to the phaseout. This replacement has two effects: (1) the equipment owner buys new equipment to replace the equipment in year 20; and (2) the owner avoids the capital expenditure that would have been incurred to replace the equipment at the end of its useful life, as well as all future replacements of the equipment.

The equipment that is purchased to replace the original equipment will need to be replaced at the end of its useful life. As a result, early retirement results in a one-time shift in the cycle of capital expenditures. In this example, the one-time shift is five years, as follows:

	Pattern of Capital Expenditures (Years of Equipment Purchase)						
Equipment Purchase Without Early Retirement	1	25	50	75	100	125	150...
Equipment Purchase With Early Retirement in Year 20	1	20	45	70	95	120	145...

The costs of early retirement are therefore calculated as:

- the present value of expected future capital expenditures for the capital equipment that replaces the ODC-based equipment; minus

- the present value of avoided future capital expenditures for the ODC-based equipment.

These present values are calculated in perpetuity, assuming that early equipment retirement results in a permanent shift in the pattern of capital expenditures in the ODC-consuming industry.

A.4 DEFINITION OF CONTROL PLANS

Section A.3 described how the impacts of individual controls on ODC use, emissions, energy use, and costs are defined in the Vintaging Framework. For purposes of estimating the aggregate costs of a phaseout, however, these individual controls must be aggregated in a proper manner, so that compatible controls are simulated over time. To specify the set of compatible controls, the database of controls for each equipment type was examined and subsets were identified. These subsets are referred to as control plans.

Control plans specify the types, timing, and penetration rates of controls for each equipment type. The plans also define how individual controls will interact over time. For example, a control plan may include recycling CFCs in 100 percent of equipment as of 1991 and the introduction of a chemical substitute in new equipment only as of 1995. In this case, the recycling could be simulated to occur also in the equipment using the chemical substitute. The control plans are specified so that such control interactions are internally consistent and likely to be adopted by industry.

Each control plan represents an alternative transition path out of CFCs or halons for each equipment type. In essence, each plan "tells a story" about the types and costs of controls that may be implemented over time. As explained below, the costs of a phaseout are determined by selecting a least cost control plan for each equipment type. For this purpose, only one control plan is chosen for each type of equipment.

The following information is defined for each control plan:

- the types of controls included (e.g., chemical substitutes and recycling controls);

- interactions among the controls (e.g., applying recycling controls to both CFC equipment and equipment using chemical substitutes);

- the applicability of controls to existing equipment (i.e., not all controls can be used in the existing equipment stock);

- the maximum penetration of each control, defined as the percentage of the relevant equipment simulated to undertake the control;
- the control start year;
- the year that the control reaches its maximum penetration; and
- whether the implementation of the control requires early retirement of existing equipment.

The Framework uses linear interpolation to calculate the penetration of controls between the control start year and the year the control reaches maximum penetration.

The specification of controls in the control plans is uncertain and somewhat subjective. The key factors considered in developing control plans for the phaseout analysis were:

- Expected Feasibility. Control plans were defined to simulate as closely as possible the expected implementation of controls in each end use.
- Range of Plans. A large number of plans were developed so that the Framework would have many from which to select a least-cost control plan. These plans vary the types and timing of controls included.
- Phaseout Target. Most of the plans were configured to achieve a complete phaseout by 1996 or 2000. Such plans generally require a mixture of: (1) recycling controls; (2) chemical substitutes for the existing equipment stock; and (3) new, currently unavailable chemical substitutes in new equipment (i.e., equipment manufactured after 1993).
- Recycling Plans. Plans were developed for several equipment types that allow for continued operation of equipment after the phaseout. After the phaseout, equipment is simulated to draw its ODC use from an accumulated pool of banked production and amounts recycled out of equipment that is retired in previous years. Recycling may reduce the cost of a phaseout because it supplies ODCs after the phaseout, which may prevent the need to retire equipment early.
- Retirement Plans. A "backstop" control plan was included that specified early equipment retirement. These plans are guaranteed to achieve the phaseout by the specified dates, but at a large cost.

Although numerous control plans were developed for the phaseout cost analysis, many more control plans could have been created. Also, the aggregation of controls into control plans required many assumptions and judgments. Alternative assumptions and judgments would lead to alternative estimates of the costs of a phaseout.

A.5 SELECTION OF CONTROL PLANS

This section describes the methods used by the Vintaging Framework to simulate the adoption of control plans in response to a phaseout. The selection starts by calculating regulatory targets over time (i.e., the quantity of CFCs and halons allowed to be produced during 1989-2000). Because ODC consumption must respond to this production phaseout, control plans are then selected to achieve the required reductions in compound consumption.

A.5.1 Regulatory Targets

The phaseout requires reductions in the production of regulated compounds. These reductions are calculated following methods outlined in the U.S. EPA regulations that implement the requirements of the Montreal Protocol, its amendments, and the Clean Air Act Amendments of 1990. Consequently, reductions are computed by: (1) separating CFCs and halons into two groups; (2) calculating ozone-depletion weighted production for each group in 1986;[4] and (3) specifying allowable production of each group over time as a percent of 1986 levels.

Because the level of CFC and halon production would be expected to increase in the absence of regulatory requirements, reductions for these compounds also increase over time. Thus, the difference between CFC and halon production before and after the imposition of a phaseout is taken as the amount of reduction that must be achieved by adopting control plans.

A.5.2 Analysis of Control Plans

The control plans defined for each equipment type are applied to the relevant equipment stock, one at a time. The controls specified within each control plan are simulated to penetrate and change the characteristics of the equipment stock. Then, the equipment life-cycle is simulated after the imposition of controls. ODC use and emissions, life-cycle costs, and energy consumption are calculated for each control plan using the methods described above for the baseline analysis. The cost of early equipment retirement also is calculated as a cost of control plans if applicable.

A.5.3 Incremental Costs of Control Plans

The incremental costs of each control plan are identified by subtracting costs incurred under the plan from baseline costs during 1989-2010. Incremental costs are divided into two types: (1) capital costs, which are considered depreciable for tax purposes; and (2) operating costs.

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[4] For this calculation, production of each CFC or halon is multiplied by each compound's ozone-depletion weight as reported in the Montreal Protocol.

Capital costs were assumed to include increases in the costs of purchasing equipment plus the costs of converting the equipment to use alternatives, if any. Operating costs include changes in the costs of compounds required to service the equipment, energy costs, and other changes in annual operating costs such as labor.

A.5.4 Social and Private Costs

The incremental capital and operating costs of each control plan are adjusted over time to express these costs as social and private costs. Social costs reflect total resource costs to society. Private costs reflect the costs faced by firms, including adjustments for tax liabilities and costs of capital.

Private costs are estimated in order to assess the potential reactions of individuals and firms to restrictions on ODC production. Private costs differ from social costs because of tax effects, differences in discount rates, and possible differences in the kinds of costs incurred.

A.5.5 Weighted Compound Reductions

The reductions in compound use potentially achievable with each control plan are computed. The reductions are found by subtracting ODC use for the baseline analysis from compound use from the control plans. The estimates are prepared for each year and are weighted to reflect the relative ozone-depletion of the CFCs or halons that are reduced.

A.5.6 Trigger Prices

Trigger prices are computed for each control plan. They are estimated by dividing the incremental private costs of the control plans by the ozone-depletion weighted compound reductions achieved by the plans. A trigger price indicates the increase in weighted ODC prices at which the controls within the control plan become cost effective. Thus, at this price increase the controls are assumed to be "triggered."

In some equipment types, many controls designed to reduce ODC use already have been implemented or are expected to be adopted in the near future as the result of regulatory requirements (e.g., recycling). Hence, control plans eligible to be selected include these controls. In the phaseout analysis, the costs of required controls are left out of trigger prices because these costs do not influence the selection of controls.

A.5.7 Least Cost Plans

Based on the analysis of trigger prices, the range of control plans available to each equipment type is examined to find the least cost plan. The order in which successive control plans would be undertaken is then determined, should the least cost plans not be sufficient to achieve a phaseout. This ordering is achieved by calculating the discounted marginal private costs (per kilogram of ODC use reduction) of moving from the least cost plan to each successive plan.

For example, the least cost plan is first identified. The present value of the marginal private costs of moving from this control plan to each of the remaining control plans is computed. The control plan with the lowest marginal cost is ranked after the least cost plan. The marginal costs of moving from this second control plan to remaining plans are then calculated, and so on until the control plans are ordered for each equipment type.

A.5.8 Control Plan Selection

As a final step, control plans are selected and tested until the production phaseout over time is achieved. Several factors affect this selection:

- A single control plan is selected for each equipment type.

- The control plan is effective for the entire analysis period (1989-2010).

- Control options for non-equipment end uses (e.g., foams) are included in the selection process.

- CFCs or halons simulated to be recaptured out of existing or retired equipment are allowed to be used to extend the life of equipment after the production phaseout in 2000.

- Because the control plans represent collections of fixed technologies that replace ODCs, the selected plans may "over-control" consumption of these compounds in some years. That is, the plans may reduce consumption more than is required to satisfy regulatory restrictions on production. The difference between regulated production and consumption during 1989-2010 is allowed to accumulate as a pool of ODCs that can be used to service the existing equipment stock.

Finally, the set of control plans and options jointly ensure that CFC production over time does not exceed the allowable phaseout schedule.

A.6 AGGREGATE COSTS

Given the set of control plans selected to meet the production phaseout and the selection criteria, social costs, transfer payments, and other consequences of the controls are computed. Social costs are the incremental costs of the technologies and activities that are required under the control plans and options for each equipment type. Transfer payments are equal to the remaining ODC use in each year multiplied by the price increases estimated for the compounds each year.

ODC price increases are determined by examining the incremental costs of the most expensive control plans adopted in response to the phaseout. The costs of these control plans per kilogram of reduction are reported as the increase in prices.

A.7 EMISSIONS OF SUBSTITUTES AND GREENHOUSE GASES

As a final step, emissions of substitutes and fuel-related greenhouse gases are estimated. Emissions are computed so that the impacts of control selection on stratospheric chlorine and greenhouse warming can be assessed.

Estimates of the emissions of chemical substitutes for CFCs and halons are reported directly by the Framework. The estimates are obtained by simulating the manufacturing and operation of the CFC and halon equipment after the CFCs and halons have been replaced by substitutes. Use and emissions of the chemical substitutes are calculated at each step in the equipment life-cycle.

Emissions of energy-related greenhouse gases are evaluated by identifying changes in energy consumption associated with the selected control plans. The types of fuels used in each type of equipment are examined, along with the quantity of each greenhouse gas potentially emitted due to marginal changes in fuel use ("emission factors"). Greenhouse gas emissions are then computed by multiplying changes in energy consumption by the emission factors estimated for the appropriate fuel types.

A.8 REFERENCES

EPA (U.S. Environmental Protection Agency) (1988), Regulatory Impact Analysis: Protection of Stratospheric Ozone, Office of Air and Radiation, Washington, D.C., August 1, 1988.

APPENDIX B: MODEL ASSUMPTIONS FOR REFRIGERATION AND AIR CONDITIONING END USES

This appendix presents the model assumptions for the refrigeration and air conditioning end uses analyzed within the Vintaging Analysis Framework. The full data set is too large for presentation in a report of this type. Consequently, this appendix provides a summary of the major assumptions and data used. Each end use is discussed separately.

B.1 MOBILE AIR CONDITIONING

This section presents data on the use of CFC-12 in motor vehicle air conditioners (MACs). The data were derived from trade associations, contacts with manufacturers, dealers, and servicing agents of automobiles, relevant literature and the regulatory impact analysis prepared by EPA (EPA, 1988).

Charge Size

The charge size of factory installed mobile air conditioners for automobiles produced before 1980 range from 0.98 kg to 1.73 kg (IRT, 1979c). The charge size for aftermarket mobile air conditioners is between 0.86 kg and 0.91 kg (IRT, 1979c). Charge size since 1980 is declining, with an average charge size of about 0.85 kg for factory installed units in 1990.

Manufacturing Emissions

Original equipment units are installed at the factory. It was assumed that an amount of refrigerant equivalent to approximately 32 percent of the initial charge was emitted during leak testing for MACs installed between 1965 and 1980 (IRT 1979c). For the years 1981 through 2000, the leak testing emission rate was assumed to drop to six percent of the initial charge (Radian, 1987). An additional 20 percent of the charge is released during charging of the MAC (Radian, 1987). Thus manufacturing and installation emissions are between 0.51 kg and 0.90 kg for MACs produced from 1965 to 1980, and between 0.22 kg and 0.34 kg for MACs produced after 1981, depending on their age.

Aftermarket Installation Emissions

Aftermarket units are installed, charged, and leak tested at the dealership. Installation emissions are about 0.22 to 0.23 kg for aftermarket MACs installed after 1981.

Servicing Emissions

MACs servicing emissions are based on the following assumptions (Radian, 1987):

- 70 percent of the charge remains in a MAC when it is brought in for recharge only.
- 55 percent of the charge remains in the MAC when it is brought in for service.
- 20 percent of the initial MAC charge is released during recharging after servicing.
- Recycling efficiency is 95 percent.

Based on the above assumptions, average servicing emissions for the 1990 MAC fleet are estimated to be between 0.77 kg and 1.16 kg per event when no recycling takes place. Emissions from older (newer) cars with larger (smaller) than average charge sizes are simulated to be higher (lower). Average servicing emissions are estimated to be between 0.038 kg and 0.06 kg when recycling takes place.

Leakage Emissions

Two different types of leakage may occur during normal operation -- design leakage and abnormal leakage. Design leakage refers to emissions that occur when the MAC is operating normally, while abnormal leakage refers to emissions that exceed normal amounts. Abnormal leakage may result from equipment problems not detected at the factory, or problems that develop during the MACs operation. Many equipment problems are detected and repaired, but if undetected, these problems may contribute to leakage over the life of the unit.

Design leakage was estimated to be 0.085 kg per year, and abnormal leakage was estimated to be 0.043 kg per year for all years prior to 1976 (Palmer et al., 1980). Because of technological improvements that occurred in 1985, design and abnormal leakage emissions were reduced to 0.06 kg and 0.033 kg respectively after this date.

Automobile accidents can result in a partial or complete discharge of the CFC-12 contained in a MAC. The analysis assumes that 2.5 percent of all vehicles on the road will be in such accidents each year (IRT, 1979c). This estimate excludes cases in which the entire vehicle must be disposed of due to damage received in an accident.

B.2 REFRIGERATED TRANSPORTATION SYSTEMS

This section presents data on CFC-12, CFC-500, and CFC-502 based refrigerated transportation systems used to transport perishable goods. These units consist of two different classes of systems -- refrigerated railway freight cars and other mobile refrigeration vehicles including trucks, trailers, and vans. Most of the data presented in this section are derived directly from EPA (1988).

A critical assumption underlying these data is that the capital stock and life cycle data (e.g., charge size, capital cost, emissions during manufacturing, servicing, and leakage, and energy use) for these two classes of refrigerated systems are the same due to similarities in their sizes and the types of cargo transported.

Charge Size

The average charge of refrigerant in refrigerated transportation systems is 8.1 kilograms. This estimate was based on a Radian (1988) calculation that divided the total quantity of CFC used to charge new refrigerated transportation systems in 1985 (364,000 kilograms) by the total number of systems produced in 1985 (45,000 units).

Manufacturing/Installation Emissions

Approximately 12.4 percent of the charge is emitted during the manufacturing of new refrigerated transportation systems. This was calculated by dividing the total quantity of CFCs emitted during manufacturing in 1985 (56 metric tons) by the total quantity of CFCs used to charge new refrigerated transportation systems in 1985 (364 metric tons) (Radian, 1987). This calculation assumes that the quantity of CFCs emitted during manufacturing in 1985 also applies to refrigerated transportation systems manufactured between 1973 and 2010.

Radian (1987) estimated that approximately three percent of the total charge of refrigerant is emitted during the leak testing of new equipment at the manufacturing plant. The total emissions during manufacturing are estimated to be approximately 15.4 percent of the charge, or 1.25 kg. No leak testing or charging emissions occur during installation.

Servicing Emissions

Refrigerated transportation systems are assumed to emit 13.6 percent of their total charge due to servicing each year. This was calculated by averaging two different estimates of CFC emissions during servicing. First, based on Radian (1987) data, it was estimated that 2.25 percent of the total charge is emitted annually during servicing. This was derived by dividing the estimated 63 metric tons of CFC emitted during servicing by the total number of refrigerated transportation systems (345,000) in use in 1985 and the average charge of CFC in such systems (8.1 kilograms). Second, an industry expert estimated that refrigerated transportation systems are vented once every four years, which indicates annual servicing emissions of 25 percent of the total charge (Heffurn, 1988). Averaging these two results gives an emission rate of 13.6 percent due to servicing, or approximately 1.1 kg per year. Assuming that servicing occurs once every four years, servicing emissions per event are estimated to be approximately 4.4 kg.

For the refrigerated transportation end use, we estimated a recycling efficiency of 95 percent, meaning that 95 percent of the refrigerant that would normally be released during servicing is captured when recycling is performed. Servicing emissions assuming recycling takes place are therefore estimated to be approximately 0.06 kg per year, or 0.22 kg per event.

Leakage Emissions

Approximately 2.25 percent of the total charge was estimated to leak from refrigerated transportation systems on an annual basis. This assumes that one-half of the 126 metric tons of CFC emitted during "use and servicing" in 1985 (as reported by Radian, 1987) is attributable to leaks. The leakage rate was calculated by dividing the 63 metric tons of CFC loss due to leakage by the total number of refrigerated transportation systems (345,000) in use in 1985 and the average charge of CFC in such systems (8.1 kilograms).

B.3 MEDIUM AND LARGE ICE MAKERS

This section describes medium and large ice makers. The emission estimates are derived from data presented in EPA (1988).

Charge Size

The average charge size for medium ice makers is 2.27 kg. This estimate is an average of the charge size of medium ice makers with capacities of 100 pounds per 24 hours (0.91 kilogram charge) and the charge size of machines with a capacity of one ton of ice per 24 hours (3.636 kilogram charge) (Beverley, 1988).

The average charge size for large ice makers is 34.1 kg The estimate is an average of the charge size of large ice makers having a capacity of one ton of ice per 24 hours (27.23 kilogram charge) and those having a capacity of three tons of ice per 24 hours (45.45 kilograms) (Beverley, 1988), taking into account the distribution of ice makers across these two sizes.

Manufacturing/Installation Emissions

Approximately 6.3 percent of the total charge of medium and large ice making equipment is emitted during the manufacture of new equipment (Radian, 1987). This amounts to approximately 0.14 kg for medium ice makers and 2.15 kg for large ice makers.

No information was available on leak testing undertaken during manufacturing or servicing of ice making equipment. Ice makers are assumed to be charged at the factory with no emissions occurring during installation.

Servicing Emissions

Ice machines are typically serviced for routine mechanical problems two to three times each year. During servicing, the unit is recharged if needed. Ice machines are typically fully vented and recharged twice in their lifetime of 20 years (Beverley, 1988). When recycling is not performed, servicing emissions are estimated to be approximately 2.1 kg per event for a medium ice maker and 32.2 kg per event for a large ice maker. Assuming a recycling efficiency of 95 percent, servicing emissions are 0.1 kg per event for medium ice makers and 1.6 kg per event for large ice makers when recycling is performed.

Leakage Emissions

Ice machines lose approximately 5.5 percent of their charge annually due to leakage during normal operation (Radian, 1987). Thus, medium ice makers leak approximately 0.125 kg per year and large ice makers approximately 1.88 kg per year.

B.4 HOUSEHOLD REFRIGERATORS AND FREEZERS

This section presents data on household refrigerators and freezers. The refrigerator category includes units that have freezer compartments or self-contained freezers. Although refrigerators and freezers differ in terms of the size of their CFC charge, they are produced and operate in a similar manner. As a result, many of the life cycle characteristics associated with refrigerators and freezers (e.g., fraction of charge emitted during manufacturing, leakage, and servicing) are the same.

The data presented in this section were collected through contacts with trade associations, industry experts, research labs, firms that manufacture, service, and dispose of refrigerators and freezers, and by a review of the relevant literature and EPA (1988).

Charge Size

The average charge of CFC-12 in refrigerators and freezers is shown below by year of manufacture:

Period of Refrigerator Production	
1957-1978	0.33 kg
1979-1984	0.21 kg
1985-2010	0.19 kg

Period of Freezer Production	
1957-1978	0.44 kg
1979-1984	0.28 kg
1985-2010	0.31 kg

Estimates for the period 1957 to 1978 were calculated by averaging the typical charge size for refrigerators operating in 1946 (0.45 kilograms as reported by IRT, 1979b) with a Rand (1982) estimate of the average charge size for refrigerators and freezers operating in 1979 (0.21 and 0.43 kilograms, respectively). The charge size for refrigerators and freezers manufactured between 1979 and 1984 was provided by Rand (1982). Finally, the charge size for equipment manufactured between 1985 and 2010 was provided by Radian (1988).

Manufacturing/Installation Emissions

An amount of refrigerant equivalent to 6.4 percent of the total charge of refrigerant is emitted during the manufacture of a new unit (IRT, 1979b; Stamos, 1988). It was estimated that 1.6 percent of the total charge is emitted as a result of leak testing, while the balance occurs when the unit is charged (Radian, 1988). Manufacturing emissions for units manufactured after 1985 are, therefore, approximately 0.015 kg for refrigerators and 0.025 kg for freezers. No emissions occur during equipment installation as the appliances are charged at the factory.

Servicing Emissions

Industry experts report that 1.5 percent of all refrigerators and freezers are serviced each year and that the CFC-12 charge is completely vented and refilled at that time (IRT, 1979b). Servicing emissions assuming no recycling are, therefore, between 0.19 kg and 0.33 kg per servicing event for refrigerators and 0.31 to 0.44 kg for freezers. For refrigerators and freezers, a recycling efficiency of 90 percent was assumed, meaning that 90 percent of the refrigerant that would normally be released during servicing is captured when recycling is performed. Multiplying the range of servicing emissions assuming no recycling presented above results in a range of 0.02 to 0.03 kg per servicing event for refrigerators and 0.03 kg to 0.04 kg for freezers.

Leakage Emissions

Approximately 0.2 percent of the total charge of refrigerant leaks from a refrigerator or freezer during normal operation each year (IRT, 1979b; Stamos, 1988). Therefore, leakage emissions range between 0.0004 to 0.0006 kg per year for refrigerators and 0.0006 to 0.0008 kg per year for freezers.

B.5 OTHER HOUSEHOLD REFRIGERATED APPLIANCES

This section presents data on dehumidifiers, vending machines, water coolers, and small ice machines. These appliances are assumed to have operating characteristics similar to refrigerators and freezers. The data presented in this section were collected through contacts with trade associations, industry experts, research labs, firms that manufacture, service, and dispose of household appliances, and through a review of the relevant literature and EPA (1988).

Charge Size

The CFC charges in small refrigerated units are estimated as follows:

Dehumidifiers:	0.41 kilograms (Radian, 1987)
Vending Machines:	0.21 kilograms (Radian, 1987)
Water Coolers:	0.10 kilograms (Radian, 1987)
Ice Cube Makers CFC-12:	0.49 kilograms (Beverley, 1988; Radian, 1987)
Ice Cube Makers CFC-502:	0.49 kilograms (Beverley, 1988; Radian, 1987)

Manufacturing Emissions

During manufacturing of small refrigerated units 6.4 percent of the total charge of refrigerant is emitted. This estimate was based on estimates for refrigerators and freezers (IRT, 1979b). It was estimated that an amount equivalent to 1.6 percent of the total charge is emitted during leak testing performed during the manufacture of a new unit (Radian, 1988).

Servicing Emissions

Based on estimates for refrigerators and freezers, it was assumed that the entire charge remaining in the unit is vented during servicing. Servicing emissions, therefore, are estimated to be between 0.1 and 0.49 kg per event per unit. It was assumed that recycling efficiency would be 90 percent, meaning that 90 percent of the refrigerant that would otherwise be released during servicing would be captured by recycling equipment. Multiplying the range of 0.1 to 0.49 kg for CFC released during servicing assuming no recycling (calculated above) results in a range of 0.01 to 0.05 kg per servicing event assuming recycling occurs. As with refrigerators and freezers, about 1.5 percent of the units are serviced each year.

Leakage Emissions

It is assumed that 0.2 percent of the charge per year is emitted during normal operation each year, or approximately 0.0002 to 0.001 kg per year.

B.6 CENTRIFUGAL CHILLERS

This section describes the data for centrifugal chillers. The emissions estimates are derived primarily from information obtained during a May 2, 1991 industry meeting conducted by EPA, and from responses to a questionnaire developed at that meeting (ARI, 1991), EPA (1988), and IRT (1979a).

Charge Size

The average cooling capacity of a centrifugal CFC-11 chiller was reported to be 400 tons, with an average charge size of approximately 2.5 lbs per ton, indicating an average charge size of 1,000 lbs, or approximately 450 kg.

Manufacturing Emissions

Manufacturing emissions occur at the factory and result primarily from leak testing and run-in testing. Purging of hoses, valves, and fittings were cited as specific sources of emissions at manufacturing plants. Quantitative estimates were provided by the manufacturers for emissions during leak testing and run-in testing.

Industry representatives reported that all CFC-11 chillers were leak tested at the manufacturing facility, resulting in the release of approximately 2 lbs., or 1 kg of CFC-12 per chiller. Representatives also reported that "run-in" testing is performed at the factory on all CFC-11 chillers, resulting in the release of approximately 12.5 lb, or approximately 6 kg of CFC-11 per chiller.

Installation Emissions

Installation emissions occur at the installation site, and result from leak testing and charging. As with manufacturing-related emissions, installation emissions can be traced to purging of hoses, valves, and fittings, and evaporation from improperly sealed refrigerant drums left sitting on the job site

Industry sources reported that leak testing is performed at the installation site and results in the release of approximately 200 lbs., or 91 kg, of CFC-11. CFC-11 chillers are charged on-site during installation, resulting in the release of approximately 20 lbs, or 9 kg, of CFC-11.

Servicing Emissions

The servicing frequency for a well maintained chiller was reported to be approximately four times per year, including one oil change and three maintenance calls. The minimum servicing frequency for a chiller that receives any regular service was reported to be once per year for an oil change.

Annual servicing emissions from a chiller receiving service once per year were reported to be approximately 60 lbs., or 27 kg per event. This was assumed to be the amount of refrigerant released during an annual oil change. Emissions from a well-maintained chiller that receives an annual oil change and three other scheduled maintenance calls are reported to be approximately 120 lbs., or 54 kg, per year. The balance of 27 kg is the amount of refrigerant likely to be released from a well maintained CFC-11 chiller during the three servicing events when the oil is not changed, or nine kg per event as a lower bound for servicing emissions. The upper bound is estimated to be 27 kg per event for CFC-11 chiller servicing emissions.

For the CFC-11 chiller end use, a recycling efficiency of 95 percent was assumed, meaning that 95 percent of the refrigerant that would otherwise be released during servicing was assumed to be captured. Multiplying the range of 9 to 27 kg for releases during servicing with no recycling yields a range of 0.45 to 1.35 kg per servicing event assuming recycling occurs.

Leakage Emissions

Annual leakage was reported to be approximately 113 kg per year for a poorly maintained chiller, 36 kg per year for a chiller receiving average maintenance, and 23 kg for a well maintained chiller.

B.7 RECIPROCATING CHILLERS

This section describes reciprocating chillers that use CFC-12 and HCFC-22. Most of the data used in updating the Vintaging Model data was obtained during industry meetings and from contacting industry representatives.

Charge Size

The average cooling capacity of a CFC-12 or HCFC-22 reciprocating chiller was estimated to be approximately 90 tons, and the charge size to be approximately 1.78 lb (0.807 kg) per ton, or approximately 73 kg per unit (ARI, 1991).

Manufacturing Emissions

Manufacturing emissions result from run-in testing (4.0 kg), leak testing (1.0 kg), and from the charging operation (0.1 kg), all of which take place at the factory (ARI, 1991).

Servicing Emissions

Servicing emissions with no recycling were estimated by industry to be approximately 4.0 kg to 5.0 kg per year for a reciprocating CFC-12 or HCFC-22 chiller (ARI, 1991). These emissions result from the release of refrigerant at the time of service (0.9 to 1.15 kg), plus recharge emissions of 0.1 kg. Servicing occurs, on average, four times per year. Thus, the servicing emissions per unit per event are estimated to be approximately 1.0 to 1.25 kg.

The recycling efficiency for reciprocating chillers is assumed to be 95 percent. Thus, servicing emissions per event with recycling are assumed to be approximately 0.045 to 0.058 kg, plus 0.1 kg for recharging, or approximately 0.145 to 0.0158 kg in total.

Leakage Emissions

The average annual leakage emissions were reported to be approximately 3.0 kg per year for a well-maintained chiller, 14.0 kg for a chiller receiving average maintenance, and 23.0 kg for a chiller receiving no maintenance (ARI, 1991).

B.8 CHEMICAL PROCESSING AND REFINERY UNITS

This section presents documentation of the process refrigeration data used in the updated Vintaging Model. The Vintaging Model tracks the life cycle emissions of ten types of process refrigeration equipment: built-up centrifugal equipment using CFC-11, CFC-12, CFC-500, and HCFC-22; built-up reciprocating equipment using CFC-12 and HCFC-22; CFC-11 packaged equipment; and CFC-12, CFC-502, and HCFC-22 packaged equipment.

Most of the data used to calculate average charge size, capacity, emissions, and energy usage was obtained at an industry meeting and through surveys prepared by ICF and completed by industry representatives after the meeting (Industrial Chiller Services, 1991; DuPont, 1991; Lewis Energy Systems, 1991).

Charge Size

Built-up Systems: Built-up systems typically consist of a compressor and condenser unit supplied by one manufacturer, and an evaporating unit built by the same or another manufacturer to specifications provided by the plant engineer or an engineering design company. The system components are assembled on site to meet the specific design criteria of a particular application.

The charge sizes reported for typical built-up systems having centrifugal compressors were from 680 kg for a CFC-11 unit to approximately 9,100 kg for an HCFC-22 unit. The charge sizes for typical positive displacement built-up equipment were reported to be approximately 1,800 for a CFC-12 unit to 4,550 kg for an HCFC-22 unit.

Packaged Systems: Packaged systems typically consist of a compressor, condenser, and evaporator on a single skid, supplied in standard capacities by refrigeration equipment manufacturers. Charge sizes for typical CFC-11 packaged systems with centrifugal chillers were reported to be approximately 680 kg. Charge sizes for reciprocating equipment were reported to range from approximately 145 kg for a typical CFC-502 unit to approximately 180 kg for a typical CFC-12 unit.

Manufacturing Emissions

Built-up Systems: Manufacturing emissions for built-up systems are estimated to be approximately 2.0 percent of the initial charge for built-up equipment, or 13.6 kg to 182 kg.

Packaged Systems: Manufacturing emissions for packaged systems are estimated to be approximately 10 percent of the initial refrigerant charge, plus 10 kg for leak testing at manufacture (except for CFC-11 packaged units), plus 1.0 kg for charging emissions (except for CFC-11 units, which are leak tested and charged at installation).

Installation Emissions

It was reported that all built-up process refrigeration equipment is charged and leak tested on site. Leak testing emissions were reported to be approximately 10 kg, and charging emissions were reported to be approximately 1 kg for all but CFC-11 packaged systems. Leak testing and charging emissions for CFC-11 packaged systems was estimated to be approximately 21 kg.

Servicing Emissions

It was reported during the ICF industry meeting on process refrigeration that most high pressure process refrigeration systems are equipped with receivers into which most of the refrigerant charge can be pumped at the time of service. It was also reported that, typically, all of the refrigerant charge within a CFC-11 process refrigeration system that can be recovered as a liquid is removed before the system is opened for service. Because process refrigeration equipment is typically the largest and most expensive of any in the refrigeration sectors, and because the charge sizes are the largest, it is assumed that service technicians in this sector adhere to service practices that minimize the loss of refrigerant, short of recycling. It is also assumed that the servicing frequency is four times per year for this equipment.

Built-up Systems: Servicing emissions assuming no recycling are between 94 kg per year, or 23.5 kg per event, for a CFC-12 centrifugal system and 914 kg per year, or 229 kg per event, for an HCFC-22 centrifugal system. This includes emissions of approximately 1 kg during system re-charging. With a recycling efficiency of 95 percent, servicing emissions are between 8.5 kg and 49.5 kg per year, or 2.12 kg to 12.4 kg per event.

Packaged Systems: Servicing emissions for packaged systems assuming no recycling are between 12 kg per year, or 3 kg per event, for a CFC-502 unit and 140 kg per year, or 35 kg per event, for a CFC-11 unit. This includes emissions of approximately 1 kg during system re-charging. With a recycling efficiency of 95 percent, servicing emissions are between 1.06 kg and 2.7 kg per year, or 4.24 to 10.8 kg per event, for packaged systems.

Leakage Emissions

Built-up Systems: Leakage was reported to be between 5 percent and 20 percent per year of the initial equipment charge, as shown below. Leakage emissions for built-up systems are between 68 and 1,820 kg per year.

Equipment type	Annual leakage (%)	Annual leakage (kg)
CFC-11 centrifugal	10	68
CFC-12 centrifugal	20	360
HCFC-22 centrifugal	20	1,820
CFC-500 centrifugal	5	110
CFC-12 positive displacement	20	360
HCFC-22 positive displacement	15	680

Packaged Systems: Leakage emissions for packaged systems were reported to be between 10 percent to 15 percent per year of the initial equipment charge, as shown below. Leakage emissions for packaged systems are estimated to be between 15 kg and 68 kg per year.

Equipment type	Annual leakage (%)	Annual leakage (kg)
CFC-11 centrifugal	10	68
CFC-12 positive displacement	15	27
HCFC-22 positive displacement	15	27
CFC-502 positive displacement	10	15

B.9 ICE RINKS

This section documents the data used for ice rink refrigeration equipment in the updated Vintaging Model. The data used in the Vintaging Model was obtained through an industry meeting held at ICF, and through contacts with industry representatives. The Vintaging Model tracks the life cycle emissions of CFC-12, CFC-502, and HCFC-22 ice rink refrigeration equipment.

Charge Size

The following typical charge sizes were reported by an industry representative (Andersen, 1991)[1]:

CFC-12 systems	360 kg
CFC-502 systems	340 kg
HCFC-22 systems	1,360 kg

Manufacturing Emissions

Manufacturing emissions were reported only for HCFC-22 equipment, and were estimated to be approximately 1 kg per unit.

Installation Emissions

All systems are leak tested and charged during installation. Installation emissions were reported to be approximately 10 kg of HCFC-22 for leak testing and 1 kg of the specific refrigerant for system charging for each type of equipment.

Servicing Emissions

All equipment is assumed to be serviced once per year. Annual servicing emissions were reported to be approximately 8 percent of the system charge for CFC-12 and CFC-502

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[1] In cases where a range was reported, a weighted average was used based on the equipment population.

equipment, plus 1 kg attributed to recharging. Thus, servicing emissions are estimated to be approximately 30 kg per event (30 kg per year) for CFC-12 equipment, and 28.2 kg per event (28.2 kg per year) for CFC-502 equipment. Servicing emissions were reported to be approximately 2 percent of the equipment charge for HCFC-22 equipment, plus 1 kg attributed to equipment recharging, or approximately 28.2 kg per event (28.2 kg per year).

Assuming a recycling efficiency of 95 percent, servicing emissions with recycling for all types of equipment are approximately 2.45 kg per event (2.45 kg per year).

Leakage Emissions

CFC-12 and CFC-502 systems are estimated to leak approximately 50 kg per year, and HCFC-22 systems are estimated to leak approximately 57 kg per year.

B.10 HOME HEAT PUMPS AND RESIDENTIAL AIR CONDITIONING

This section documents the emissions from HCFC-22 home heat pumps and residential central air conditioning (A/C) systems. The emission estimates are derived primarily from a May 16, 1991 industry meeting conducted by EPA, and industry responses to a questionnaire developed at that meeting (ARI, 1991).

Charge Size

The average cooling capacity of a residential A/C unit was reported by manufacturers to be approximately 3 tons, with a typical charge size of approximately 0.97 kg per ton of cooling capacity. The average charge size is therefore estimated to be approximately 2.9 kg for a residential A/C unit.

The average cooling capacity for a home heat pump was reported to be approximately 3 tons, with a charge size of approximately 1.26 kg per ton of cooling capacity. The average charge size is therefore estimated to be approximately 3.8 kg for a home heat pump.

Manufacturing Emissions

Manufacturing emissions result from leak testing and charging at the factory. For both home heat pumps and residential A/C units, the quantity of refrigerant released during leak testing was reported to be 1 percent of the total equipment charge, or approximately 0.029 kg for residential A/C, and approximately 0.04 kg for home heat pumps.

The losses during charging of home heat pumps and residential A/C equipment occur during disconnection of the charging hoses, repairing faulty units on the assembly line, and leakage through the charging hoses. Charging emissions were reported to be between 1 percent and 2 percent of the equipment charge for both home heat pumps and residential air conditioners, or between 0.029 kg and 0.058 kg for a residential A/C unit, and between 0.038 kg and 0.076 kg for home heat pumps. Thus, charging emissions are between 0.029 kg and 0.076 kg for this end use.

Servicing Emissions

Service industry representatives reported that approximately 2 percent of the installed home heat pumps and residential A/C units require servicing in any year, and that the entire refrigerant charge remaining in the unit is released during the service event. During the industry meeting, industry representatives estimated that approximately 20 percent of the refrigerant charge will leak from a home heat pump or residential A/C unit before a degradation in performance is noticed and a service technician is called.

In the no recycling case, it was assumed that the remaining 80 percent of the full charge is vented at the time of servicing. In addition, 1 percent of the charge, or approximately 0.04 kg, is assumed to be released from hoses and fittings during recharging of the equipment after servicing. Service emissions, assuming no recycling, are thus calculated to be approximately 3.08 kg for a home heat pump, and approximately 2.35 kg for a residential A/C unit. We assumed that no additional refrigerant is used to leak test the equipment during servicing because adequate system pressure remains to allow use of leak detection equipment.

The recycling efficiency for residential A/C and home heat pumps is assumed to be 95 percent; i.e., 95 percent of the refrigerant charge remaining in the equipment can be recovered before the equipment is serviced (ICF, 1991). Assuming that recycling equipment is employed during servicing, the servicing emissions are estimated to be approximately 0.16 kg for a residential A/C unit, and approximately 0.19 kg for a home heat pump per servicing event. This estimate also assumes that approximately 0.04 kg of refrigerant is lost during recharging.

Leakage Emissions

A typical home heat pump or residential air conditioning unit is estimated to leak approximately 20 percent of its charge before requiring service. Industry representatives reported that between 2 percent and 5 percent of the installed equipment requires service each year. On a per-unit basis, it is estimated that leakage emissions are between 2 percent and 5 percent of the charge in one year, or approximately 0.06 kg to 0.19 kg per unit per year. There is no leakage associated with normal operation of this type of equipment, however, and it is more likely that units either leak and are serviced or do not leak at all.

B.11 COLD STORAGE WAREHOUSES

The Vintaging Model tracks three different types of equipment in the cold storage sector: CFC-12 cold storage warehouses, CFC-502 cold storage warehouses, and HCFC-22 cold storage warehouses. The life cycle emissions are tracked by the model as kg per cubic foot of warehouse space.

Charge Size

The average warehouse was calculated to contain approximately 1,000,000 cubic feet of refrigerated space (IARW, 1991). The average charge size was calculated to be approximately 1,000 kg for a typical warehouse, or approximately 0.001 kg per cubic foot.

Manufacturing Emissions

An amount of refrigerant equal to approximately 6 percent of the charge is released during manufacturing, or approximately 60 kg per warehouse (Krack, 1991).

Installation Emissions

Leak testing was reported to take place at the warehouse site and to account for approximately 5 kg per warehouse, or approximately 1.25 kg per unit. Fill related emissions are approximately 1 percent of the charge (2.5 kg for a single unit, 10 kg for an entire warehouse).

Servicing Emissions

It was reported that approximately 10 percent of the remaining refrigerant charge is released during a single servicing event, and that a typical warehouse refrigeration unit is serviced twice per year (Krack, 1991). In addition an amount equivalent to approximately 1 percent of the initial charge is assumed to be released each time the unit is recharged after servicing. Thus, servicing emissions are estimated to be approximately 89 kg per service event (10 percent x remaining charge of 790 kg + 10 kg). Annual emissions are 178 kg year per warehouse, or 44.5 kg per unit. Note, however, it is unlikely that all four refrigeration units at a "typical" warehouse would be serviced simultaneously.

The recycling efficiency is assumed to be 95 percent. Therefore, servicing emissions per event are estimated to be approximately approximately 14 kg per warehouse when recycling is performed (10 percent x remaining charge of 790 kg x (1.0 - 95 percent recycling efficieny) + 10 kg), or about 3.5 kg per unit. Annual emissions, assuming two servicing episodes per year, are 7 kg per unit or 28 kg per warehouse.

B.12 RETAIL FOOD STORAGE

The Vintaging Model tracks two different types of retail food storage equipment, "single" and "parallel" systems, and three refrigerants, CFC-12, HCFC-22, and CFC-502. Single, stand alone systems modeled are those using CFC-12 or CFC-502; parallel systems modeled are those using CFC-12, HCFC-22, and CFC-502. Parallel systems are found in larger supermarkets, while stand alone systems are typically used in restaurants, convenience stores, small grocery stores, and cafeterias.

Charge Size

Parallel Systems: One industry representative estimated that the refrigerant used in its parallel systems was 50 percent CFC-12, 20 percent HCFC-22, and 30 percent CFC-502, and that the average total refrigerant charge for a single supermarket is approximately 2.3 kg (5 lb) per 100 ft^2 of selling area (Kroger 1991). It was also noted that stores tend to have either two parallel systems (both CFC-12 or one CFC-12 and one CFC-502) or a single HCFC-22 system. The average floor space for a typical supermarket is estimated to be approximately 20,550 ft^2 (Progressive Grocer, 1990); thus the charge size for parallel systems in a typical store is estimated to be approximately 466 kg. On average for the industry, this breaks down into 291 kg of CFC-12 (466x50/(50+30)) and 175 kg of CFC-502 (466x30/(50+30)), or 466 kg of HCFC-22.

Because data on the typical or average number of parallel systems or the number of compressors per parallel system were not available from industry sources, the Vintaging Model tracks supermarkets rather than the equipment for the parallel systems.

Stand Alone: Because production data were not available from industry sources for smaller retail food equipment, the Vintaging Model tracks convenience stores, restaurants, and other eating establishments instead of individual equipment. Each convenience store, restaurant, cafeteria, or other eating establishment is estimated to have one medium temperature CFC-12 system and one low temperature CFC-502 system installed.

Representatives from companies that service refrigeration equipment in restaurants and convenience stores reported that a CFC-12 stand-alone unit typically has a 10.5 kg charge, and a CFC-502 stand-alone unit has a 19 kg charge.

Manufacturing Emissions

Manufacturers test compressor units before they leave the factory. It was assumed that 2 kg of refrigerant are emitted during manufacturing stand alone systems and 4 kg for parallel systems.

Installation Emissions

Emissions during installation result from leak testing and charging. One industry representative reported that approximately 90 kg of HCFC-22 are used to leak test a single supermarket (Kroger, 1991). Assuming that the amount of refrigerant emitted during leak testing is proportional to the equipment charge, approximately 56 kg are emitted in leak testing a CFC-12 system, 34 kg in leak testing a CFC-502 system, and 90 kg in leak testing an HCFC-22 system. It was also reported that 2.0 kilograms of HCFC-22 are emitted in leak testing stand alone systems at installation.

Servicing Emissions

One industry representative reported that approximately 1 percent of the refrigerant is vented from a single supermarket in one year during servicing of parallel systems (Kroger, 1991). An additional 3.0 kilograms of refrigerant per store are lost as a result of leakage from hoses and servicing fittings during recharging. Thus, servicing emissions are estimated to be approximately 5.9 kg per year for a CFC-12 parallel system, 4.8 kg for a CFC-502 system, and 7.6 kg per year for an HCFC-22 system.

Stand alone systems are assumed to be serviced when 20 percent of the refrigerant charge has leaked. All of the remaining refrigerant charge is vented at the time of servicing. Approximately 8.4 kilograms of CFC-12 and 15.2 kilograms of CFC-502 are vented at a single servicing event during servicing of stand alone systems. Another 1.0 kg is emitted during recharging.

Recycling efficiency is assumed to be 95 percent. Thus, servicing emissions with recycling are estimated to be between 1.04 kg to 2.16 kg for parallel systems, and between 0.42 and 0.76 kg for stand alone units per servicing event.

Leakage Emissions

The annual refrigerant leakage for a single supermarket is estimated to be either 84 kg of CFC-12 and 51 kg of CFC-502, or 135 kg of HCFC-22 (Kroger, 1991). Stand alone systems leak approximately 2 kg per system per year.

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APPENDIX C: DISPOSAL OF APPLIANCES IN CALIFORNIA

Under the Clean Air Act Amendments of 1990 (CAAAs), refrigerant recovery and recycling will be required when refrigeration and air conditioning systems are serviced or disposed. Additionally, venting of refrigerants will be prohibited.

This appendix describes the manner in which consumer appliances, refrigerators, freezers, and individually packaged air conditioner units ("window" air conditioners), are disposed. A variety of entities are involved, potentially making the implementation and enforcement of the refrigerant recovery and recycling requirements difficult. This description is based on discussions with industry personnel in Southern California. However, the general picture of the disposal process is similar to data collected in other parts of the country.

C.1 METHODOLOGY

This section describes the method used to gather information about the appliance disposal industry. The term "disposal," as used in "appliance disposal industry," describes the point at which an appliance is either crushed or buried. When an appliance is disposed, it becomes either recyclable metal or metal waste. A disposed appliance can neither be bought or sold again as an appliance nor ever be restored to working condition. Disposal, therefore, represents the final stage in an appliance's life cycle. The term "appliance disposal industry" refers to the various entities that enable an appliance to be disposed. In addition to the entities involved in the actual crushing or burying of appliances, the appliance disposal industry includes those entities involved at any level of the disposal process.

None of the entities involved in the appliance disposal industry, however, are solely devoted to disposing appliances. Appliance disposal is only one of the several services that these entities either perform or require. There is no single entity that specializes at all levels in disposing appliances. The appliance disposal industry consists of many different entities from a broad range of industries. Because these several entities also operate within various levels of the disposal process, the appliance disposal industry is complex and difficult to define.

A phone survey was conducted to gather information about the appliance disposal industry. Because of the segmented nature of the industry, a phone survey approach was adopted to allow for several different entities across the various industries to be contacted. These entities were unknown at the beginning of the survey, however, due to the lack of published information on the appliance disposal industry. The objectives of the phone survey, therefore, were to identify the entities involved in appliance disposal as well as to describe their function within the industry.

The phone survey strategy involved a step-by-step information gathering process. The strategy was based on the assumption that an interview with one specific entity would expose other entities within the appliance disposal industry. During the interviewing of these other entities, even more entities within the industry would be exposed. This process would then repeat itself until all of the entities in the industry were discovered. After all of the entities and their roles were known, an overall picture of the appliance disposal industry could be formed.

The first step of the survey was to contact the individual entities within the appliance disposal industry. The phone survey focused on the appliance disposal entities located only in Southern California. These entities were chosen randomly from telephone directories. The first entities that were contacted were those involved in the actual crushing and burying of appliances: metal recycling yards and landfills. These two entities were initially known to be involved in the appliance disposal industry, and were a logical point from which to begin working backwards gathering information about the industry.

The questions that were asked during the phone interviews followed a standard format, and included the following:

- From whom do you purchase or receive your appliances?
- To whom do you sell or give your appliances?
- How are your appliances disposed?
- What services do you perform on the appliances once they are in your possession?
- What services are performed on the appliances before you purchase or receive them?
- What becomes of the appliances after you give or sell them to another entity?
- What are the services that you perform, if any, that require the appliances' refrigerants to be vented?
- Do you make any attempt to recover and/or recycle these refrigerants? Why or why not?
- Do you consider your operating procedures to be standard within your segment of the industry? If not, how do they differ?
- How many appliances do you purchase or receive/sell or give/dispose in a given time period?
- What percent of appliances that you purchase or receive requires refrigerant venting? What percent requires disposal?

Answers to these questions identified the entities involved in appliance disposal and explain their functions within the industry. The information also defined the relationships among the various entities.

The number of phone interviews varied among the many entities of the appliance disposal industry. Exhibit C-1 lists the contacts that provided the most comprehensive and useful information. Others contacted gave limited opinions but did not contribute significantly to our understanding of the industry.

The phone survey produced information about the appliance disposal industry from various entities across several different industries. Although no individual entity could provide an overall summary of the appliance disposal industry, the combined information gathered from all of the entities provides an overall picture of the industry. The phone survey, therefore, was used to create an organizational model of the segmented appliance disposal industry.

Exhibit C-1: Organizations Contacted

Organization	Telephone #	Contact
A-1 Scrap Metal	818/767-4388	Bill Thompson
Central Los Angeles Recycling & Transfer Station	213/746-9700	John Silver
City of Burbank Public Works Department	818/953-3152	Hope McAloon
City of Irvine Environmental Affairs	714/724-6252	Michael Brown
City of Los Angeles Department of Water & Power	213/481-3401	Larry Chacon
City of Los Angeles Refuse Collection	213/485-4906	Linda Jordan
Goodwill Industries of Southern California	213/435-7741	Rudy Vokun
King of the Valley Appliances	818/985-8966	Bill Williams
Mack Metals Company	818/768-6922	Dennis Fogel
Mid-City Iron & Metal Corp.	213/747-4281	Les Cline
Sanitation Districts of Los Angeles County	213/245-9865	Jaime Navaro
Sunset Appliance	310/395-2414	Carl Noravian
The Salvation Army	800/472-2379	Walter O'Neill
Vick's Disposal Co.	213/268-9034	Hutch Stepanian

C.2 ENTITIES OF THE APPLIANCE DISPOSAL INDUSTRY

This section introduces the concept of "appliance disposal paths" and identifies and defines the major entities involved in the disposal process. Explanation of the entities includes a description of their function within the appliance disposal industry. Before the entities are discussed, the idea of disposal paths is first be explained.

Disposal paths are different combinations of entities through which appliances travel before being disposed. All of these paths begin at a single starting point, consumers, and terminate at two end points, landfills and metal recycling yards.

Consumers that initiate the process are those that for any reason, possess certain appliances that they no longer want. To dispose of these appliances, consumers are faced with several different options. Each option represents at least one separate disposal path for the appliance. The entities that determine the disposal path for these appliances include retail stores, used appliance and repair stores, non-profit resell organizations, transfer stations, private haulers/junkmen, and public haulers. These entities operate at stages between the initial disposal level of consumers and the final level of landfills and metal recycling yards. Each of the entities is described in one of three categories: initial entities, intermediate entities, and final entities.

C.2.1 Initial Entities

Consumers

Consumers represent the starting point for appliances in the disposal process. Consumers initiate the disposal process when they act to no longer possess their appliances. Consumers are faced with several options for disposing their appliances. Each option will lead to at least one different disposal path for a given appliance, with two exceptions. First, consumers can resell their appliances to other consumers. Second, consumers can store their appliances on their own private property. In both of these cases, consumers exercise an option that will not lead to the disposal of their appliances. If any of the other options are chosen by consumers, however, the first step of the appliance disposal process will have been completed.

C.2.2 Intermediate Entities

Retail Stores

Retail stores are independent stores or chains that are involved in the selling of new merchandise. These stores range in size, and might have several different locations or departments through which new appliances and other merchandise are sold. Retail stores become involved in the appliance disposal process by accepting customer trade-ins of used appliances. Generally, retail store do not sell these used appliances directly back to consumers. Instead they sell them to used appliance and repair stores.

Some of the retail stores that were interviewed do not routinely accept trade-ins of used appliances. Other retail stores allow used appliance trade-ins to induce potential customers to purchase new appliances. One retail store's trade-in policy offers a customer a monetary incentive in the form of a discount off the price of a new appliance. A trade-in option also provides the customer with a convenient outlet for the disposal of a used appliance.

One used appliance and repair store reported having several contracts to purchase traded-in appliances from retail stores. Additionally, used appliances are purchased from the independent contractors that deliver new appliances for some retail outlets. Under this arrangement, the delivery companies pick-up the used appliances while delivering and installing the new appliances. These independent delivery companies then sell the used appliances to used appliance stores.

Used Appliance and Repair Stores

Used appliance and repair stores are usually smaller, individual stores involved in the selling and/or repair of used appliances. The services offered by these stores vary; some stores only sell or repair used appliances, while other stores perform both functions. Regardless of their services, virtually all used appliance and repair stores send used appliances that cannot be sold to metal recycling yards.

Used appliance and repair stores play a primary role in the appliance disposal industry. The stores receive their used appliances from several sources including consumers, retail stores, private haulers/junkmen, and non-profit resell organization auctions. The stores buy used appliances from these sources and sell the items to consumers. If the appliances require servicing before they can be sold, the stores will usually attempt to repair them. When the repairs are too costly or difficult, the store disposes of the appliance. Based on the information gathered through phone interviews with used appliance and repair stores, the used appliances that are to be disposed will first be stripped of any parts deemed valuable and then given or sold to contracted private haulers/junkmen. Refrigerant recovery or recycling was not common during servicing or before disposing of the appliances.

Private Haulers/Junkmen

Private haulers and junkmen are private companies or individuals that offer hauling services, including curbside pick-up of disposed appliances. Private hauling companies might be a large or small operation, while junkmen usually operate on a smaller level. Junkmen are often single individuals who offer free curbside hauling services. Private haulers, on the other hand, generally charge a fee. Appliances represent only one of numerous items that private haulers or junkmen transport. It is possible, however, for private haulers or junkmen to specialize in the transport of appliances.

Private haulers and junkmen are involved in transporting appliances between entities at all levels of the disposal industry. These haulers transport appliances among the following entities: consumers, used appliance and repair stores, non-profit resell organizations, transfer stations, and metal recycling yards. Besides simply transporting the disposed appliances, private haulers and junkmen will sometimes strip the appliances of valuable parts before the appliances are delivered to metal recycling yards. These parts (e.g., the compressor, motor, copper tubing) are usually sold to used appliance and repair stores. The stripping of these parts is sometimes required by certain metal recycling yards before the appliances will be accepted.

Private haulers generate revenue mainly from the transportation fee that they charge their customers. Because private haulers operate on a relatively larger level than junkmen, they usually will haul other items in addition to appliances in one given pick-up. Junkmen, on the other hand, usually haul for free and might only haul one appliance per pick-up. Junkmen earn their income from selling the appliance to either a used appliance store or metal recycling yard. Junkmen also make money from selling the stripped appliance parts to appliance repair stores. Both private haulers and junkmen provide convenient disposal options for consumers as well as for other entities.

Public Haulers

Public haulers are county or city sanitation hauling services that offer curbside pick-up of appliances. Typically these "bulky item" pick-ups are made once per month and usually at no charge. Each public hauler provides services only for their designated county or city.

Public haulers are a convenient and relatively cheap method for consumers to dispose their appliances. Public haulers transport disposed appliances from consumer households to county or city transfer stations. After the appliances reach the transfer station, they are separated from the other materials and sent to metal recycling yards. Non-recyclable materials are sent to the local landfill. Parts of this process are sometimes simplified in cases where a metal recycling yard and transfer station will be located on the same site.

Public haulers are generally a government service funded by tax revenues. Some revenues, however, may be generated if the appliances are sold to metal recycling yards. Public hauling services are attractive to consumer households because of the convenience and relative low price for pick-up of appliances, in contrast especially to private hauling services.

Transfer Stations

Transfer stations are county or city sanitation "holding" sites. These stations typically operate in conjunction with public hauling services and/or metal recycling yards. Transfer stations offer their services exclusively within their county or city. Transfer stations primarily facilitate public hauling services, although in many cases, consumers can also leave an appliances at a transfer station for a fee. At the transfer station, appliances are generally separated from other discarded materials. The appliances are then transferred to a metal recycling yard which is sometimes located on-site.

Non-Profit Resell Organizations

Non-profit resell organizations provide free curbside pick-up of appliances and other items and offer the eventual resell of these items through their own thrift stores. These organizations might be either smaller, local groups or larger, nation-wide operations such as the Salvation Army and Goodwill. Because the Salvation Army and Goodwill are two of the larger, more influential organizations in the southern California area, the following discussion will pertain to their particular operating procedures.

Non-profit resell organizations collect appliances from households and transport them to a central location. At this central site, the appliances' working condition and ability to be repaired are assessed. Appliances that are in working condition are sent to one of the organization's thrift stores for resale. If the appliances require relatively low cost, minor repairs, they are serviced and then transferred to thrift stores for resell.

On the other hand, if the appliances require relatively costly, major repairs, they will be included in the organization's daily auction. At these auctions, several used appliance and repair stores are allowed to purchase the items. Some of the appliances, however, will remain unsold after the auction. These appliances are usually first stripped of any valuable parts and then picked up by private haulers or junkmen who then deliver the items to transfer stations, metal recycling yards, or used appliance and repair stores. These non-profit resell organizations do not attempt at any stage to recover or recycle refrigerants from the appliances.

Some differences, however, exist between the operating procedures at the Goodwill and Salvation Army. The Goodwill's disposal operations for appliances that remain unsold after an auction differ from the procedure described in the preceding paragraph. At the Goodwill's central processing location, an on-site compactor will crush any remaining appliances before they are transported to a metal recycling yard by private haulers or junkmen. The Salvation Army, on the other hand, does not have an on-site compacting facility. The Goodwill also deviates from the Salvation Army through its policy of not including room air conditioners as a part of its appliance collection service. At the Salvation Army, however, room air conditioners are handled in the same manner as refrigerators.

C.2.3 Final Entities

Landfills

Landfills represent an end point in the appliance disposal process. Consumers self-haul their appliances to these sites. These sites generally charge a fee per pound for disposal. Appliances are allowed to be disposed in landfills in Los Angeles county. In certain other counties and cities, however, appliances are banned from landfills for two primary reasons. First, an appliance disposed at a landfill is not recycled. Second, there is no attempt to recover and/or recycle refrigerants before the appliance is buried or crushed.

Generally, appliances are hauled to landfills only by individual consumers. The disposal fee discourages other transporters of appliances such as private haulers and junkmen from using the landfills for appliance disposal. It is more economical for private haulers and junkmen to deliver appliances to metal recycling yards, used appliance and repair stores, and transfer stations at which they could instead receive payment for their items.

Landfills are usually a county or city operation funded by local tax revenue. The sites facilitate trash disposal within a given community. Landfills, however, represent a relatively expensive and inconvenient solution for individual consumers disposing their appliances. Not only do consumers have to self-haul their appliances, but they also must pay a fee to dispose their items. Although private haulers or junkmen require a payment, they do provide curbside pick-up of appliances. Public haulers and non-profit resell organizations offer free curbside pick-up of appliances. Individual consumers could also haul their appliances to a transfer station or used appliance and repair store. Of all of the appliance disposal paths faced by the individual consumer, landfills are probably the least utilized option.

Additionally, AB 1760 (enacted in 1991) prohibits the disposal of major appliances which contain enough metal to be economically feasible to salvage in landfills as of January 1, 1994. As a result, refrigerators and freezers will essentially be banned from disposal in landfills at that time.

Metal Recycling Yards

Metal recycling yards are various-sized operations involved in the recycling of metals. These yards represent an end point in the appliance disposal process. Metal recycling yards usually operate independently. In some cases, these yards will be contracted with specific transfer stations and located together. Only some metal recycling yards will accept appliances, however, due to the environmental risks involved with disposing the items.

Metal recycling yards purchase appliances on a per pound basis from transfer stations, used appliance and repair stores, and private haulers and junkmen. These yards will usually only accept appliances if they are stripped of certain environmentally harmful parts including motors, refrigerants, and components containing PCBs. In addition to these parts, any other valuable parts are stripped prior to delivery to the yards if delivered by a junkman or used appliance and repair store. As of January 1, 1994 AB 1760 requires that "materials which require special handling" be removed from major appliances and vehicles prior to crushing. AB 1760 defines these materials to include "CFCs injected in air-conditioning.refrigeration units," as well as other hazardous wastes and substances.

After purchasing the appliances, the yards crush the units in large compactors. (The yards contacted report that shredding is not performed by metal recyclers.) The compacted metal is eventually sold to steel mills in the United States and abroad. The yards make no attempt to recover and recycle refrigerants before the appliances are compacted. By requiring appliances to be stripped of environmentally harmful parts before purchasing the units, metal recycling yards have attempted to no longer be identified as a source of refrigerant emissions.

Metal recycling yards purchase appliances at relatively low prices ("$.01/lb") with the incentive to resell the appliances for a higher price in their recycled form to domestic and foreign steel mills. Because appliances only represent a relatively small portion of the items being recycled at the yards, the demand for appliances at metal recycling yards is low. The price offered for appliances by the yards therefore is also low. Metal recycling yards represent the only entity in the appliance disposal industry, however, that considers appliances at this stage to be of monetary value. Metal recycling yards thus provide a market for disposed appliances from transfer stations, used appliance and repair stores, and private haulers and junkmen.

C.3 FLOW CHART OF APPLIANCE DISPOSAL STREAM

Exhibit C-2 presents a summary flowchart of the appliance disposal industry. The various entities involved in the appliance disposal industry are shown in the boxes of the flowchart. The lines between the boxes represent the possible movement of an appliance while the arrows indicate the direction of the movement. Some of the entities have several options for disposing an appliance, all of which are demonstrated on the chart.

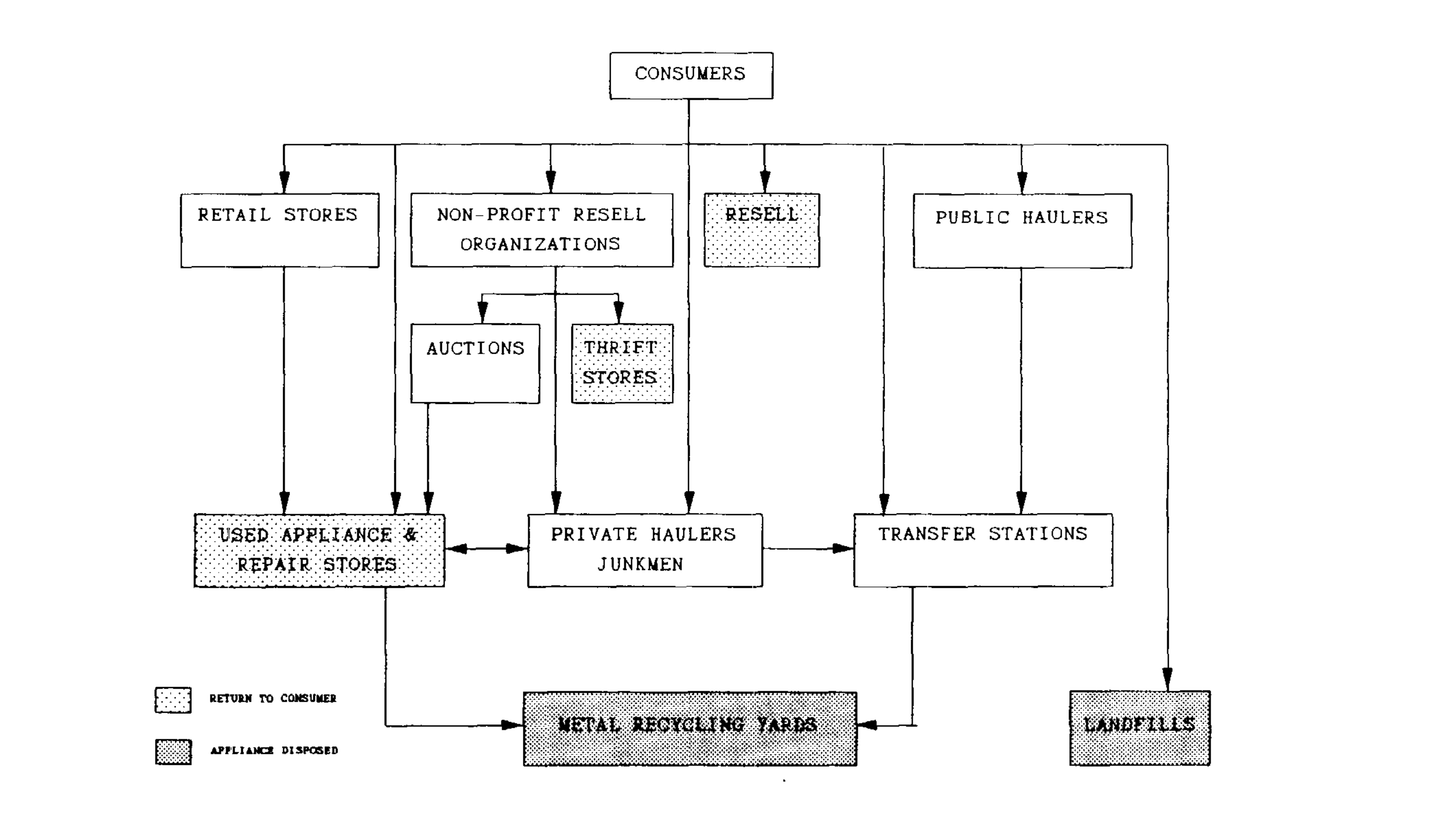
The three levels of entities, initial, intermediate, and final, are arranged in descending order on the chart. The appliance initially enters the disposal stream via individual consumers, located near the top of the chart. The two end points in the disposal stream, landfills and metal recycling yards, are shown at the bottom of the chart and indicated by the darker shading. The points in the disposal stream at which an appliance can be returned to the consumer (resell, thrift stores, used appliance and repair stores) are identified on the chart by the lighter shading.

C.4 CONCLUSIONS

The information collected indicate that the appliance disposal industry is very decentralized. No one organization controls the flow of used appliances from consumers to disposal at metal recycling yards or landfills. However, the qualitative picture of the industry provided by interviewees indicates that most used appliances flow through used appliance stores and non-profit resell organizations. These entities usually perform some level of servicing or repair to the merchandise. Consequently, it is these entities that would likely be responsible for complying with refrigerant recovery and recycling requirements.

Private haulers and junkmen appear to play an important role as well. These entities may strip parts from appliances for resale, but generally do not have the facilities or resources for recovering refrigerant. The extent of the involvement of the junkmen in the system was difficult to ascertain precisely. However, indications are that they play a significant role, indicating that refrigerant recovery may be difficult to enforce for this portion of the disposal process.

Exhibit C-2: Flowchart of Disposal Process



APPENDIX D: METHOD USED TO ESTIMATE COST PER KILOGRAM OF EMISSIONS REDUCED

This appendix describes the method used to estimate the costs of reducing the emissions of ozone depleting compounds (ODCs). The approach focuses on estimating the private costs of reducing emissions, which are the cost faced by industry. Social costs, which reflect real resource costs to society, can also be estimated, as described in EPA (1988). However, private costs are used in the analysis to asses potential industry responses to the ODC phaseout.

D.1 ANNUALIZED COSTS

For each control option, private annualized costs were estimated. These annualized costs reflect the capital, operating, and other costs that are incurred when the control is undertaken. These costs are based on engineering estimates and are defined as the costs that are incremental relative to continuing to use and emit ODCs in their current form. The private costs reflect the costs faced by firms, including appropriate adjustments for tax liabilities and costs of capital.

To enable the controls options to be compared and analyzed in relation to a policy of restricting the production of ODCs, the annualized costs are expressed on a per kilogram of emissions avoided basis. This "per kilogram" estimate is made by dividing the annualized cost of undertaking the control by the amount of emissions that may be reduced by the control. The resulting value (based on private costs) is taken as an indication of the increase in the price of ODCs that would be required in order for firms to be indifferent between undertaking the control or continuing to use and emit the ODCs. If the price of the ODCs exceeds this annualized value, the firm would be better off to reduce its use and emissions of ODCs and undertake the control. Consequently, the cost estimates are designed to be used in the analysis framework described in Appendix A.

The following types of costs were obtained (where applicable) for each control possibility:

- capital costs -- such as the acquisition cost of equipment. Capital costs are one-time costs that are subject to depreciation.
- non-recurring costs -- transitional, one-time costs such as research and development, or training required to implement a control. For purposes of computing private annualized costs, non-recurring costs were considered not to be depreciable.
- annual operating costs -- incremental materials, energy, and labor required to implement the control.

All of these reported engineering-based cost estimates are on a before-tax, real basis in 1990 U.S. dollars.

D.2 PRIVATE ANNUALIZED COSTS OF INDIVIDUAL CONTROL OPTIONS

To estimate private costs, a discounted cash flow analysis was used. This cash flow analysis: (1) computes annualized before-tax costs using a before-tax private discount rate; (2) estimates incremental cash flows incurred by private entities including the effects of depreciation and taxes on cash flows; and (3) computes an annual cost as the net of all annualized cash flows.

The methods used to estimate private annualized costs are comprised of the following steps:

1. The magnitude and timing of pre-tax costs (i.e., capital and operating costs) were specified. Assumptions regarding the timing of the costs and expenses (relative to the initiation of the control) are:

   -- capital and non-recurring costs occur in year 0;

   -- depreciation expense occurs over five years; and

   -- operating costs are incurred each year.

2. Total pre-tax costs were estimated for each year over the control's operating life.

3. Tax implications were calculated as: cost after taxes = cost x (1-marginal tax rate).

4. Depreciation was "added back" to net after-tax costs to account for the tax savings attributable to this non-cash expense.

5. The stream of after-tax cash flows was discounted using the private cost of capital to compute a net present value of the costs of the control over its entire life.

6. The present value of the after-tax costs was annualized using the private cost of capital as the discount rate. This present value is then divided by the total reduction in ODC use (or emissions) that can be achieved by the control to produce an annualized private cost per kilogram of use (or emissions) avoided.

Taxes were calculated using a marginal total tax rate of 44 percent. Investment Tax Credits (ITCs) were assumed not to be available. A tax loss would be included on un-depreciated capital whenever the depreciable life exceeded the operating life of capital (however, this did not occur).

Annual depreciation expense was calculated using the straight line method over five years. This assumption is conservative because depreciation expenses occur uniformly over the depreciation period, whereas accelerated depreciation methods produce tax benefits in earlier years. Because depreciation is based on initial acquisition costs, annual depreciation expense was deflated by an inflation index to calculate real depreciation. An inflation rate of 4 percent was used.

To select the appropriate rate of private discount, the rate recommended in EPA (1988) was used. As discussed in EPA (1988), the available literature was surveyed, and little consensus was found among the experts who have studied this problem.[1] The range of estimated values for the real rate of return on private investments was from 4 to 9 percent. Accordingly, 6 percent was selected as a median estimate.

D.3 LIMITATIONS

The methods used to estimate the private costs of proposed restrictions on ODC use are limited in terms of the data available and the manner in which the method is applied. The primary limitations of the data include:

- Identification of Control Options. By definition, only those control options that are currently known are included in the analysis.
- Individual versus Aggregation of Controls. The method is applicable to both individual controls and to any aggregation of controls. The manner in which controls are aggregated to construct "control plans" is subjective (see Appendix A).
- Uncertainty Surrounding New Chemical Substitutes. There is uncertainty surrounding the cost and availability of some of the new chemical substitutes.

The method also assumes that the primary mechanism driving the allocation of ODCs across competing uses is price. Although this is a standard assumption for analyses of this type, other factors (such as the relationship between producers and their customers) may influence the allocation.

D.4 REFERENCES

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[1] Studies that address this issue include: Holland and Myers (1980); Fraumeni and Jorgenson (1980); Brainard, Shoven and Weiss (1980); and Lind (1982).

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APPENDIX E: INDUSTRY CONTACTS

This appendix lists the industry contacts made during the conduct of this study in the summer and fall of 1991. These contacts were made to confirm information that had been collected under previous studies for the U.S. Environmental Protection Agency. In particular, the focus of this data collection effort was to assess whether firms in California were responding to current and expected future limitations on ozone depleting chemical (ODC) production in the same manner as other firms throughout the U.S. had indicated.

Also, given that ICF staff have been and continue to be in contact with many large users of ODCs, this data collection effort also focused on the activities of smaller firms. It had been suggested by some that small firms were responding to the ODC phaseout in the same manner as larger firms. The data collected in this study supports this viewpoint.

ODC use in foam production and solvent applications have changed most rapidly in the late 1980s and early 1990s. Consequently, this effort was directed at these two industries. The following sections summarize the contacts made with printed circuit board manufacturers, other solvent users, and foam producers and formulators. The following summaries of actions reportedly taken and planned are relative to the summar and fall of 1991 when the information was collected.

E.1 PRINTED CIRCUIT BOARD (PCB) MANUFACTURERS

Accu-sembly
4123 Roweland
El Monte, CA 91731-1008
((818)350-5994
John Shimmin
General Manager
Sales: $1-5MM
Assembly of electronic components onto printed circuit boards.

Accu-sembly changed from CFCs to a non-ODC spray cleaner made by Chemtronics two years ago. The new cleaner costs about $1.00 more per can than CFCs and is somewhat disadvantageous in that it attacks some plastics. About 12 cases of the spray are used annually. The change was made for environmental reasons and was facilitated by the fact that CFCs were not a major part of the product or cost. The core manufacturing process uses water soluble paste.

Arxe Inc.
1280 Piper Dr
Milipitas, CA 95035
(408)945-6622
Jerry Brown
Owner
Sales: $5-10MM
Printed Circuit Board Assembly

The use of methyl chloroform (MC) was replaced with water soluble paste 6 months ago. This resulted from 2 years of looking at MC alternatives. While HCFCs were considered, they would have been much more expensive, requiring all new equipment. The change to water soluble paste required equipment adjustments and convincing customers it was effective. Prominent reasons for the change are:

- Tax increases.
- Environmental concern
- Less hassle - treatment and reporting requirements.

The only ODC use now is occasional aerosol spray cleaning for tests.

The paste, which uses terpene or EC-7, is a medium term solution which will eventually be replaced with no-clean fluxes which burn off in the oven.

Asemtec Inc.
1528 Montague Expressway
San Jose, CA 95131
(408)434-0552
Allan Moore
Sales & Technical
Sales: $5-10 MM
Electronics Parts Assembly

Asemtec uses about 250 gallons of CFC solvents annually as a dissolving agent for surface mounts. They are in the process of testing water soluble paste and should changeover shortly, replacing all CFC use. Research into alternatives has taken 1.5 years and changing the processes is expected to take 4 months. The change is primarily driven by two factors: economics (the increasing cost of CFC solvents) and the impending phase-out. Relative to the cost of CFCs and rosin, water soluble paste will save money.

ASMD Inc. (Advanced Surface Mounted Devices)
12000 Brookprinter Place
Poway, CA 92064
(619)486-3304
Brian Silanno
Quality Manager
Sales: $1-5MM
Surface mount printed circuit board assembly, memory modules, commercial & military.

ASMD is close to completely phasing out all substances controlled under the Montreal Protocol. Initial research of alternatives took about 5 to 6 months. They are switching to water soluble paste. This switch influences the entire production process. New equipment was purchased at a cost of about $90,000. The old equipment will be sold if possible. The driving force to this change was economics; MC was becoming prohibitively expensive. Customers were not concerned one way or the other.

Cableco Technologies Corp
1941 Las Plumas Ave
San Jose, CA 95133
(408)259-0800
Harjan Singh
Supervisor
Sales: $5-10MM
Assemble electronic parts

Cableco only uses water soluble paste. This is standard for firms that assemble cable and harnesses only.

Cirtex Inc.
2330 Calle Del Mundo
Santa Clara, CA 95054-1007
(408)727-9123
Warren Leard
Supervisor
Sales: $5-10MM
Printed Circuit Board manufacture

Cirtex changed 3-4 years ago from methyl chloroform to synthetic solvents. The synthetic solvents are less effective, but do not require reporting. In Santa Clara County, reporting requirements for methyl chloroform are too expensive to comply with, prompting the switch.

Cottage Industries
3698 Haven Ave, #B
Redwood City, CA 94063
(415)365-0227
Mary Lu Bishop
Owner
Sales: $1-5MM
Electronic parts assemblers

Cottage Industries use no ODCs; they clean with deionized water. About 8 years ago they changed from methyl chloroform. They changed because Kester brought out new water lines which were easier to use and not hazardous. The cost was about the same.

Dawn VME Products
47073 Warm Springs Blvd
Fremont, CA 94539-7454
(415)657-4444
Ron Richter
Manufacturing Manager
Sales: $1-5MM
Printed Circuit Board manufacture

Dawn VME originally used a water and acid mix solvent cleaner. About a year ago they changed to DFX Genesolve (CFC-113) and acquired a Barron Blakely vapor degreaser which recaptures vapors. Recycled vapor is kept in a 55 gallon drum, which is not yet full, and will be sent to a recycler. With the transition to DFX Genesolve, a new tank was purchased which will readily accept HCFC based Genesolve when it becomes available.

Delta Assembly Technology Inc
1181 N Fourth
San Jose, CA 95112-4945
(408)292-0773
Tom Nader
VP Operations
Sales: <$1MM
Printed Circuit Board assembly

Delta uses no ODCs. They changed from CFCs 8 years ago for environmental reasons. Switching costs resulted in retiring equipment costing $20-25,000, but has proven cheaper as the price of CFCs has risen.

Efco Systems
9030 Owensmouth Ave
Canoga Park, CA 91304-1416
(818)882-7171
Gerald Fitzgerald
Owner
Sales: $1-5 MM
Printed Circuit Board assembly

Efco uses about 250 gallons of methyl chloroform vapor degreaser annually. They have tried no-wash and other systems finding them all unacceptable. Some other manufacturers have gone to water wash systems. Boards are porous material and need to be heat baked to remove all water, ensuring product integrity. Vapor residues are recaptured and recycled. Captured residue amounts to an estimated 40% of original material. Many competitors moved out of state and many customers take business out of state because it is cheaper, in large part due to stringent environmental regulations.

E.2 OTHER SOLVENT USERS

Ardrox Inc.
16961 Knott Ave
La Mirada, CA 90638-6015
(714)739-2821
Doug Pomeroy
Safety & Environmental Manager
Sales: $25-100MM
Aircraft cleaning products, chemicals for making printed circuit board

Ardrox makes custom cleaning agents with both CFCs and methyl chloroform. CFCs are used in small quantities for special orders where specified by the customer. This is most often in the non-destructive test area for aerospace and high performance cars.

Methyl chloroform is formulated for use as a degreaser. It is not considered a very important part of Ardrox's portfolio of products. MC use over the last year has declined about 25% due to Ardrox pushing substitutes and customers changing specifications. In the future, Ardrox will continue to discourage methyl chloroform use and expects costs to be a driving force for industry change.

Blue Coral Division of McKay Chemical Co.
Division of McKay Chemical Co
1920 Randolph St
Los Angeles 90001-1438
(213)582-7477
Gerald Martin
VP Operations
Sales: $10-25MM
Automotive additives cleaners, polishes, greases and oils

Blue Coral has eliminated CFCs and methyl chloroform from its products. Instead, propane is used as propellant and methylene chloride and perchloroethane are used as degreasers. The big reason for changes were RCRA requirements which banned chlorinated solvents in landfills and required incineration or recycling of chlorinated solvents waste. Some customers, like service stations, do not want to touch chlorinated solvents since the cost of oil disposal is $0.40/Gallon versus $3.50 for oil contaminated chlorinated solvents. They are looking at replacing methylene chloride with HCFCs or aromatics but find these alternatives very expensive. They maintain close contact with major chemical manufacturers (e.g., DOW and DuPont) who are working on substitutes.

Cal-Pac Chemical
6231 Maywood Ave
Huntington Park, CA 90255-4530
(213)585-2178
Charles F Duane
General Manager, Owner
Sales: $1-5MM
Plating cleaners; cleaning compounds; private label cleaners

Over the past 5 years Cal-Pac's use of methyl chloroform has declined about 90% from 6,000 - 12,000 to 600 - 1,200 gallons annually. They make electrical, metal and furniture cleaners. The decline in use is due to falling demand. Automotive repair shops no longer want the product for cleaning carburetors and furniture manufacturers are moving out of the state. It was stated that: "Half of the companies making these cleaners are going out of business."

Detrex Corp(500 Employees)
3027 Fruitland Ave.
Los Angeles, CA 90058
(213)588-9214
Darrell Croft
Branch Manager
Sales: $25-100MM
Degreasers, degreasing solvents dry cleaning equipment, hazardous waste management

Detrex primarily distributes MC (about 200,000 lbs/month). They sell about 10,000 pounds of CFC a month. Use of both chemicals has declined 30-35% over the last two years. While there is definitely a big regulatory component in this drop, the economy is also a factor. In addition to distributing solvents, they recycle MC. Recycling has been going on for years. The percent of MC returned for recycling has been increasing the last few years.

DuBois Chemical
15010 E Don Julian Road
City of Industry, CA 91746-3301
(213)961-6305
Fred Larson
Environmental Manager
Sales: $10-25MM
Polishes & sanitation goods.

In California, Dubois primarily runs a warehousing operation. They receive 20-25,000 gallons of MC annually and repackage it from bulk into small containers. The MC is used in electronics and "wipe on/wipe off" cleaners. MC volumes are estimated to be about the same now as in the past. To alleviate some of the regulatory burden, the repackaging of MC is now contracted out, resulting in zero emissions for this location.

Metal Surfaces Inc.
6060 Shull St
Bell Gardens, CA 90201
(213)927-1331
Bruce Nielsen
Plant Engineer
Sales: $10-25MM
Clean and plate all types of metal

One year ago Metal Surfaces Inc. put plastic straps on a door next to one of two vapor degreasers to prevent the wind from blowing the vapor, reducing emissions about 9%. Six months ago, they installed cooling coils on top of both vapor degreasers, reducing emissions a further 81%. As a consequence, MC use has declined from 178,000 pounds annually to about 18,000 pounds. Residue is captured on the vapor degreasers and sent out for reclamation. The cooling coils cost $35,000. The primary reasons for the change were economics and regulations. MC was costing them $33,000 annually. For the future they are looking at soap cleaners, but can't find anything that does it all.

M & R Plating
10939 Magnolia Blvd
North Hollywood, CA 91601
(818)506-4316
Andre Randa
Account Executive
Sales: $1-5MM
Clean and plate precious metals

M & R plating uses about 600 gallons of MC annually. The MC is used to degrease and clean plated precious metals and is considered a key part of the process. Degreaser residue is sent out for reclamation. While they have looked into alkalines, there are no changes planned now or in the future.

Surtex Inc
29334 Pacific Street
Hayward, CA 94544-6018
(415)582-7800
Chris Van Veen
Chemical Production Manager
Sales: $1-5MM
Industrial & commercial floor polishes, cleaners, degreasers.

Surtex uses about 100,000 pounds of MC annually. They have been looking into substitutes for 4-5 years with little success. MC volumes have been constant the last few years when they would have normally grown. Lost MC sales (est. 33%) have been compensated for by substitute products.

Surtex customers are primarily small industrial metalworking companies. Some customers have changed from MC to water or citrus cleaning systems. While type of industry is not indicative of ability to change to MC substitutes, the size of company and plant type are. Large companies have been more able to invest in the expensive equipment and R & D to change to water or other substitute processes. Plants with fixed cleaning equipment can more readily change to aqueous cleaning systems. Plants with mobile cleaning systems or businesses that do field work need MC systems as substitutes lack portability.

In the future, Surtex will change to next best alternatives as MC is phased out. The initial search for alternatives was fueled by the changing laws and public opinion. They would prefer to sell less hazardous chemicals.

E.3 FOAM PRODUCERS AND FORMULATORS

Carpenter CO
7809 Lincoln
Riverside, CA 92513
(714)354-7550
Arlen Roll
Technical Director
Sales: $100MM
Systems house; Polyurethane and slabstock fabrication

Carpenter is both a systems house and foam manufacturer. They deal solely in packaging and slabstock polyurethane (PU) foam. CFCs were phased out a little over a year ago. However, "insignificant" amounts of CFCs are still used in systems which are exported tax free. CFC use has declined gradually for 8 years going from 100% of foam production to 75% CFCs and 25% methylene chloride 5 years ago to no CFCs today. The main drivers for change have been prices and customer demands.

The final phase out took about a year and required process changes. Instead of CFCs, methylene chloride and MC are used. The use of these two chemicals is being curtailed dramatically. Carpenter does not use recovery equipment but has always had a closed production process.

Foamex Corporation
Subsidiary of Koll International Holdings Inc
1400 E. Victoria Ave
San Bernardino, CA 92408-2924
(714)824-8981
Dan C. Dobratz
Plant Manager
Glen Kieler
Sales Manager
Sales: >500MM
Flexible open cell polyurethane foams

Foamex is the largest slabstock foam producer in the U.S. with over $500MM in sales and 49 plants. They phased out CFC use 100% about 1 year ago. This change was due to pending regulations, costs, environmental concern, and customer requests. Instead of CFCs, current systems use water-blown, MC and methylene chloride technologies. Blowing processes should progress to HCFC and eventually all water blown systems - no auxiliary chemicals. Given the fragmented nature of the business, recovery systems are not an option due to cost. Contacts believe that the Foamex experience is typical of the whole polyurethane foam industry.

Company-wide R & D and change over costs were over $100,000. The most difficult changes to make were for medical applications where products had to be completely reformulated and approved by customers.

Marko Foam Products
725 Harrison St
Corona, CA 91720
(714)272-4700
Richard Peterson
Account Manager
Sales: $10-25MM
Foam fabricating and molding

Marko makes expanded polystyrene sheet (EPS), polyethylene (PE) and polyurethane (PU) foams. The EPS never used CFCs and presently uses pentane. The PE used CFCs until a year ago when suppliers, Dow and ARCO, phased it out. The PU foams still use CFCs.

Much of the EPS is used in building insulation. The PE is laminated onto corrugated materials. The PU foam is rigid and used for insulation. Marko is in the process of moving their plant; the new facility will have pentane recapture systems.

Polymer Development Labs, Inc.
212 Taft Ave
Orange, CA 92665-4220
(714)921-2300
Mike Badgett
Technical Sales Rep
Titus Lai
Quality Control Chemist
Sales: $10-25MM
Plastics foam products & insulation foam

PDL is a systems house - they buy polyols and isocyanate which are then mixed to create foaming systems and sold to foam manufacturers. They produce over 1,000 systems. To reduce CFC use, some product formulations have changed to HCFC or non-ODC agents and closed instead of open mixing containers are used. Most changes are in the rigid polyurethane (PU) foams and froth foams.

Rigid foams go into building insulation. Froth foams are used in buildings and refrigeration panels. Some of PDL's rigid systems have changed from CFC to water-blown systems. PDL's chemist has tried to remove CFCs from systems wherever possible. Some froth foams now use HCFC-22 instead of CFC-12. About 1-2% of both the number and volume of PDL's systems have changed to non-CFC or HCFC agents.

While additional substitutes exist, it is difficult getting them to work in the manufacturing process. All the work on basic materials is being done by the major chemical manufacturers (Dow, Union Carbide, ARCO), and PDL focuses on applying the results of their research. To date, process changes have been limited to equipment adjustments. Changes to decrease emissions include the use of closed instead of open mixing tanks and pressurized containers instead of open drums. The impetus for change has been high costs for CFCs and increased customer/supplier awareness. Customers often want the product that is easiest to apply even at a higher cost.