THE U.S. PHASEOUT OF HCFCS:

PROJECTED SERVICING NEEDS IN THE U.S. AIR-CONDITIONING AND REFRIGERATION SECTOR

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PRELIMINARY DRAFT REPORT

Disclaimer

This report presents estimates of the projected quantity of HCFC-22 needed to service air-conditioning and refrigeration equipment and the anticipated installed base of such equipment beyond 2010 in the United States. The objective of this analysis is to provide a resource to assist in the allocation of future HCFC consumption caps. The analyses prepared to date are preliminary in nature and will be revised based on input from stakeholders. A revised report will be prepared.

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Executive Summary

Hydrochlorofluorocarbons (HCFCs) are a class of chemicals that deplete the stratospheric ozone layer, leading to overexposure of ultraviolet (UV) radiation at the earth's surface. Excessive UV radiation damages biological systems and causes malignant melanoma and other skin cancers, cataracts, and harm to certain crops and marine organisms. Reversing the course of ozone depletion is crucial to human and environmental health worldwide. As a Party to the Montreal Protocol, the United States is subject to a cap on the consumption of HCFCs in an international effort to protect the stratospheric ozone layer. Specifically, the United States is obligated to phaseout consumption of HCFCs by 2030 by making graduated reductions in HCFC consumption by certain dates. In order to meet these interim reduction targets, the U.S. Environmental Protection Agency (EPA) began by establishing a schedule for the phaseout of HCFCs with the highest ozone depletion potentials (ODPs), namely HCFC-141b, HCFC-142b, and HCFC-22. The next phaseout milestone occurs on January 1, 2010, when the production and import of HCFC-142b and HCFC-22 (unless for use in equipment manufactured prior to January 1, 2010) will cease. Under the restrictions, between 2010 and 2020, both the production and import of HCFC-142b and HCFC-22 are still permitted to service existing equipment.

In the United States and worldwide, the primary use of HCFC-22 is as a refrigerant (UNEP 2003a). While HCFC-142b is also used as a refrigerant (blended with other constituents), its primary use is as a blowing agent in the foam industry. Estimated consumption of HCFC-22 in the U.S. air-conditioning (AC) and refrigeration industry currently totals approximately 111,510 metric tons, and is by far the largest use of an HCFC by any U.S. industry (EPA 2005a). For this reason, and because the allowable servicing of existing equipment between 2010 and 2020 is applicable primarily to the AC and refrigeration industry, this report presents estimates of the projected quantity of HCFC-22 needed to service AC and refrigeration equipment and the anticipated installed base of such equipment beyond 2010. In quantifying future servicing needs and evaluating how these needs can be met, the objective of this analysis is to provide a resource to assist in the allocation of future consumption caps.

In projecting servicing needs, this report examines the primary sources of R-22[1] to service and maintain equipment after 2010, which include the amounts recovered from converted or retired equipment that are subsequently recycled or reclaimed (i.e., "recovered") and the limited virgin production and import quantities distributed through allowances.[2] It is projected that in 2010, approximately 66,300 metric tons of R-22 will be required to service installed AC and refrigeration equipment, with 29 percent of these needs projected to be met through the use of recovered refrigerant—although 100 percent of the anticipated servicing demand could be met within the U.S. consumption cap if needed. In 2015, 49,600 metric tons of R-22 is projected to be required for servicing, with 61 percent of demand projected to be met through the use of recovered refrigerant supplies. In 2020, the projected quantity required for servicing is 25,600 metric tons, which, because of the phaseout requirements, must be met entirely through the use of recovered material.

Table ES-1 and Figure ES-1 present the overall projected R-22 servicing demand compared to two U.S. HCFC consumption cap scenarios: in the first scenario, it is assumed that 100 percent of the HCFC cap in 2010 and 2015 will be assigned to R-22; in the second scenario, only a portion (i.e., 90 percent) is assigned to R-22 in 2010 and 2015. These scenarios illustrate the amount of leeway available if the projected quantities of recovered supplies are not as robust as anticipated in this analysis, or if actual demand is greater than projected. As shown, in both scenarios, the consumption cap is significantly greater than projected R-22 servicing demand in 2010, including the anticipated demand that can be met through recovered R-22 supplies. Additionally, the table and figure show that, in 2015 through 2020 (and beyond), the total projected R-22 servicing demand is estimated to exceed the consumption cap, and therefore, the use of recovered refrigerant will be necessary to avoid R-22 supply shortfalls.

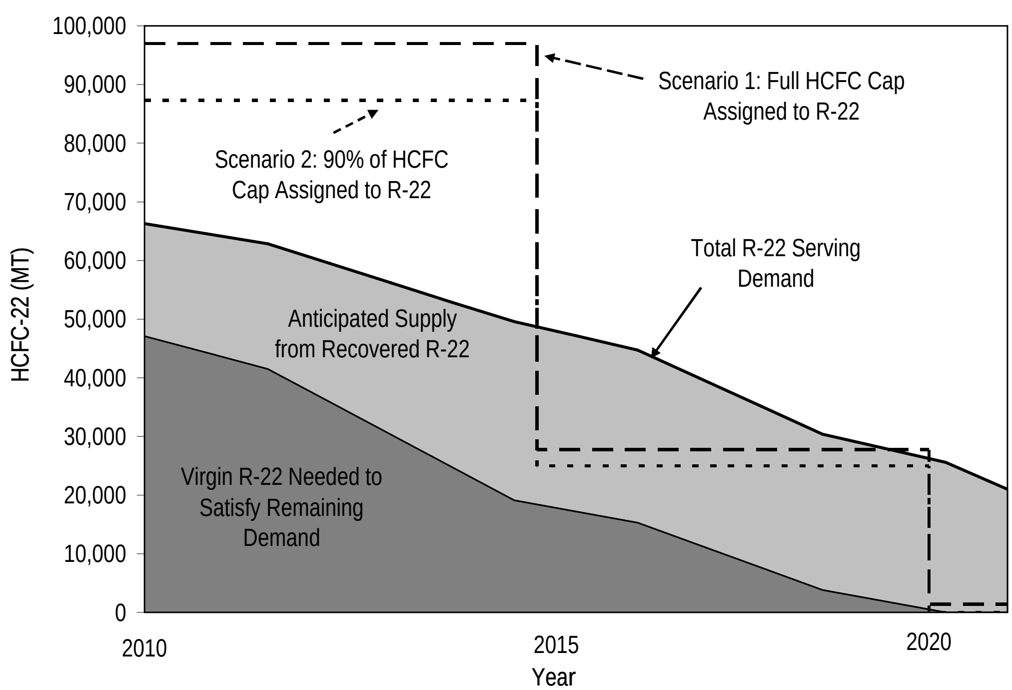
[1] The nomenclature 'R' as used in this report denotes an HCFC and an HCFC blend when it is used as a refrigerant.
[2] The import of used R-22 as approved by EPA is another source; however, this source is not included in the projections of this analysis.

Table ES-1: Summary of Projected R-22 Supply, Demand, and Surplus (R-22 Metric Tons)[a]

Projected R-22 Servicing Demand Summary	2010	2015	2020
Total R-22 servicing demand	66,300	49,600	25,600
Anticipated R-22 supplied from recovery/reuse	19,100	30,400	25,600
Estimated virgin R-22 supply needed to satisfy remaining demand	47,100	19,100	0
Scenario 1: Full HCFC Cap Assigned to R-22			
Virgin R-22 supply available under cap	96,982	27,709	0[b]
Estimated virgin R-22 supply needed to satisfy remaining demand	47,100	19,100	0
Additional virgin R-22 allowable under cap	49,882	8,609	0
Scenario 2: 90% of HCFC Cap Assigned to R-22			
Virgin R-22 supply available under cap	87,283	24,938	0[b]
Estimated virgin R-22 supply needed to satisfy remaining demand	47,100	19,100	0
Additional virgin R-22 allowable under cap	40,184	5,838	0

[a]Quantity expressed in R-22 metric tons, calculated using an ODP of 0.55 for HCFC-22.
[b]In 2020, 0.5 percent of the U.S. consumption cap remains; however, the phaseout schedule in 2020 prevents any allocation of the remaining cap to R-22.

Figure ES-1: Total Projected R-22 Servicing Demand[a]



[a]Scenario 1, as shown in this figure, assumes that 100% of the cap is assigned to R-22. In 2020, 0.5 percent of the U.S. consumption cap remains; however, the phaseout schedule in 2020 prevents any allocation of the remaining cap to R-22.

Under the future scenarios developed in this analysis, the AC and refrigeration industry can satisfy future R-22 servicing needs using both recovered refrigerant and limited amounts of virgin refrigerant without jeopardizing U.S. compliance with the Montreal Protocol. Moreover, it is projected that the U.S. consumption cap will accommodate limited consumption of other HCFCs for use in the AC/refrigeration or other industries (e.g., blends containing HCFC-123 in the fire protection industry, HCFC-225 ca/cb in the solvent cleaning industry). However, the use of significant quantities of recovered refrigerant will be necessary to avoid R-22 supply shortfalls within the AC and refrigeration industry.

This analysis used EPA's Vintaging Model in conjunction with industry collaboration to form the quantitative estimates on projected servicing needs. It is important to note, however, that future R-22 servicing demand and available supply estimates presented in this report are dependent on various market trends, including:

- Changes in equipment charge sizes to accommodate the 13 SEER energy standard;
- Rate of market transition to alternative refrigerants in the United States;
- Assumed equipment leak and servicing loss rates;
- Levels of refrigerant recovery for reuse, reclamation, and/or banking;
- Levels of imports of used R-22; and
- Levels of imports of precharged R-22 equipment.

These factors are addressed in this report, to the extent possible.

The primary use of HCFC-142b is in the U.S. foam industry, where there is no servicing of equipment. Although not thoroughly explored in this analysis, servicing needs for R-142b equipment (currently used mostly in a blend in retail food refrigeration equipment) are not projected to exist beyond 2010 for the AC and refrigeration industry.

The projected scenarios highlighted in this analysis provide a basis for further collaboration with the AC and refrigeration community to gain consensus on future servicing needs and to solidify efforts to maximize supplies (through reuse) in order to achieve the next HCFC phaseout targets.

1. Background: The U.S. HCFC Phaseout Schedule

Title VI of the Clean Air Act (CAA) mandates the development and implementation of regulations to protect the stratospheric ozone layer and ensure U.S. compliance with the *Montreal Protocol on Substances that Deplete the Ozone Layer* (the Protocol). Under the Protocol, the United States and other signatories are obligated to achieve progress toward the total phaseout of the consumption and production of hydrochlorofluorocarbons (HCFCs), which are ozone depleting substances (ODS) widely used as refrigerants, solvents, foam blowing agents, and fire extinguishants.[3] Consumption is defined as "production plus import minus export," and production is defined as the manufacture of a controlled substance from any raw material or feedstock chemical, but does not include production of feedstocks or the reuse or recycling of a controlled substance.

Table 1-1 presents the HCFC consumption cap and the graduated reductions to allowable HCFC consumption for the United States (and all non-Article 5 [developed] countries), as determined for compliance with the Protocol. The first HCFC phaseout milestone was in 1996, when HCFC consumption levels were capped at 1989 ozone depleting potential (ODP)-weighted HCFC consumption levels plus 2.8 percent of the ODP-weighted 1989 CFC consumption. The second phaseout milestone occurred on January 1, 2004, when HCFC consumption limits were reduced by 35 percent of the above cap, which is to be followed by a 65 percent reduction in 2010, a 90 percent reduction in 2015, a 99.5 percent reduction in 2020, and a complete phaseout in 2030.

Table 1-1: U.S. HCFC Consumption Phaseout Targets Under the Montreal Protocol

Date	Consumption Cap	ODP Weighted Quantity	Quantity Expressed in R-22 Metric Tons[a]
Jan 1, 1996	Consumption freeze capped at 2.8% of the 1989 ODP-weighted CFC consumption plus 100% of the 1989 ODP-weighted HCFC consumption	15,240 ODP-metric tons (33.6 mm ODP lbs)	277,091 metric tons (610 mm lbs)
Jan 1, 2004	35% reduction of the cap	9,906 ODP metric tons (21.8 mm ODP lbs)	180,109 metric tons (396 mm lbs)
Jan 1, 2010	65% reduction of the cap	5,334 ODP metric tons (11.8 mm ODP lbs)	96,982 metric tons (214 mm lbs)
Jan 1, 2015	90% reduction of the cap	1,524 ODP metric tons (3.36 mm ODP lbs)	27,709 metric tons (61 mm lbs)
Jan 1, 2020	99.5% reduction of the cap	76.2 ODP metric tons (167,992 ODP lbs)	1,385 metric tons (3.05 mm lbs)[b]
Jan 1, 2030	100% reduction of the cap	0	0

[a]Calculated using an ODP of 0.055 for HCFC-22.
[b]In 2020, only 0.5 percent of the U.S. consumption cap remains; however, the phaseout schedule in 2020 prevents any allocation of the remaining cap to R-22.

Table 1-2 details the U.S. phaseout schedule for HCFCs established under the CAA to comply with the targets set by the Montreal Protocol (as presented in Table 1-1). As shown, the production and import of HCFC-141b, the HCFC with the highest ODP, was banned with limited exemptions beginning January 1, 2003. To meet the next phaseout milestone beginning January 1, 2010, the production and import of HCFC-142b and HCFC-22 (unless for use in equipment manufactured prior to January 1, 2010) will cease. The phaseout for all other HCFCs, such as HCFC-123, begins on January 1, 2015, when production and import is restricted except for use as a refrigerant in equipment manufactured before January 1, 2020. The final phase out for all HCFCs occurs on January 1, 2030.

[3] The production and import of other ODS used by these industries, including chlorofluorocarbons, carbon tetrachloride, and methyl chloroform, were phased out in 1996 – halons in 1994 (with limited exemptions).

Table 1-2: U.S. HCFC Phaseout Schedule Mandated Under the CAA (to Comply with the Protocol)

Date	Affected Substances	Restriction
Jan 1, 2003	HCFC-141b	• No production and no import of HCFC-141b
Jan 1, 2010	HCFC-142b, HCFC-22	• No production and no import of HCFC-142b and HCFC-22, except for use in equipment manufactured before 1/1/2010
Jan 1, 2015	All Other HCFCs	• No production and no import of any HCFCs, except for use as a refrigerant
Jan 1, 2020	HCFC-142b, HCFC-22	• No production and no import of HCFC-142b and HCFC-22 • No production and no import of any other HCFCs except for use as a refrigerant in equipment manufactured before 1/1/2020
Jan 1, 2030	All Other HCFCs	• No production and no import of any HCFCs

Source: EPA (2004a; 2005a)

In 2003, the U.S. Environmental Protection Agency (EPA) established an allowance system to control the U.S. consumption and production of HCFCs, at which time, HCFC allowances were distributed for HCFC-141b, HCFC-22, and HCFC-142b (EPA 2003a).[4] Allowances for other HCFCs must still be distributed by EPA; additionally EPA will re-evaluate HCFC-142b and HCFC-22 allocation levels prior to 2010 to determine whether modifications are necessary to meet the 65 percent consumption reduction required in 2010 by the Protocol.

1.1 Report Objective

The objective of this report is to present quantitative estimates of the projected amount of (a) units of equipment using HCFCs beyond 2010 and (b) HCFCs needed to service equipment beyond 2010. In an effort to prepare for the next phaseout scheduled for the United States, this report presents possible future scenarios on the servicing needs for air-conditioning (AC) and refrigeration equipment that will be in use after 2010. These estimates will aid EPA in allocating future HCFC consumption caps.

This analysis focuses primarily on R-22 servicing needs in the AC and refrigeration industry, the largest HCFC market and the largest industry sector using HCFCs in the United States.

The remainder of the report is organized as follows:

- Section 2 provides a brief overview of the methodology used in this analysis to project servicing scenarios. A further discussion on the methodologies can be found in Appendix A.
- Section 3 provides an overview of the AC and refrigeration industry and presents current consumption and servicing estimates for all HCFCs used in this sector;
- Section 4 provides projected scenarios for units of equipment utilizing R-22 and R-22 servicing needs.
- Section 5 summarizes the key findings of the analysis.
- Appendix A presents the projection methodology and the associated limitations.
- Appendix B provides AC and refrigeration projections by end-use.

[4] The production of one kilogram of HCFC requires the expenditure of one production allowance and one consumption allowance. The import of one kilogram of HCFC requires the expenditure of one consumption allowance. While the import of *used* HCFCs does not require the expenditure of allowances, it does require petition approval by EPA; see Section 4.2.1 for more detail.

2. Methodology Overview

The main tool used to launch the analysis and form the basis for quantitative estimates on current and projected HCFC consumption was EPA's Vintaging Model. The Vintaging Model was developed as a tool for estimating the annual chemical emissions from industry sectors that have historically used ODS, including AC, refrigeration, foams, solvents, aerosols, and fire protection. Within these industry sectors, there are over 40 independently modeled end-uses. The model uses information on the market size and growth for each of the end-uses, as well as a history and projections of the market transition from ODS to alternatives. As ODS are phased out, a percentage of the market share originally filled by the ODS is allocated to each of its substitutes.

The model tracks emissions of annual "vintages" of new equipment that enter into operation by incorporating information on estimates of the quantity of equipment or products sold, serviced, and retired each year, and the quantity of the chemical required to manufacture and/or maintain the equipment. The Vintaging Model makes use of this market information to build an inventory of in-use stocks of equipment and ODS/ODS substitutes in each of the end-uses. A detailed discussion of the Vintaging Model is provided in Appendix A.

As an initial step in this analysis of current and projected HCFC use in the United States, an investigation was conducted into the entire HCFC market, covering all end-uses that utilize HCFCs in the AC and refrigeration, foam, solvents, aerosols, and fire protection sectors. This analysis was conducted by compiling estimates from EPA's Vintaging Model on HCFC consumption for both new manufacturing and the servicing of existing equipment, and the total units of equipment containing HCFCs from 2005 through 2030 by end-use (EPA 2005a). The Vintaging Model data indicate that in 2005, the AC and refrigeration industry represents 96 percent of total HCFC-22 consumption and 86 percent of total HCFC consumption. Therefore, this analysis was narrowed to focus on R-22 servicing needs in the AC and refrigeration industry.

Having established initial estimates, a limited number of industry experts were then contacted to corroborate the findings and market dynamics affecting the servicing needs of the AC and refrigeration industry after 2010. Representatives including those from the Association of Home Appliance Manufacturers (AHAM); Air-Conditioning and Refrigeration Institute (ARI); Carrier Corporation; Heating, Air-Conditioning & Refrigeration Distributors International (HARDI); Hill Phoenix; Honeywell; Raleys; and York were contacted to discuss stationary AC and refrigeration end-uses.[5]

The informal discussions were used to confirm or modify preliminary estimates obtained from the Vintaging Model; information gathered from the discussions was in turn used to refine assumptions and inputs in the Model to improve the estimates provided in this analysis. Additionally, through these efforts, several supplemental analyses were identified and performed to account for several trends expected to affect the AC and refrigeration market and better estimate the projected quantities of R-22 required to service equipment post 2010. Appendix A also includes a discussion of the assumptions and adjustment factors used to develop the supply and demand estimates presented in this report and the limitations and caveats inherent in the analysis.

[5] In order to comply with the Paperwork Reduction Act of 1995, less than ten people were contacted regarding each information category (44 U.S.C. 3502(3)).

3. Current HCFC Use in Air-Conditioning and Refrigeration Equipment

The AC and refrigeration industry encompasses a wide variety of equipment and employs a diversity of HCFC and other refrigerants. This section is organized as follows:

- Sections 3.1 and 3.2 present an overview of AC and refrigeration end-uses, respectively; and

- Section 3.3 provides an overview of HCFC refrigerants used in the AC and refrigeration industry.

3.1 Air-Conditioning End-Uses

AC equipment can be categorized as either mobile or stationary. These broad end-use categories are discussed further below.

Mobile air-conditioning systems include all forms of AC that provide cooling to passenger compartments in all types of moving vehicles. This category can be further broken down into motor vehicle air-conditioning and other mobile air-conditioning systems.

- *Motor vehicle air-conditioning (MVAC)* includes AC in the passenger compartments of light duty vehicles – both cars and trucks (i.e., pick-up trucks, minivans, sport utility vehicles, etc.). A variety of refrigerant blends, many of them including HCFCs, are approved for use in the United States by EPA as replacements for CFC-12 in MVACs. However, these blends have not been endorsed by vehicle or system manufacturers for such use, thereby capturing only a small and declining share of the retrofit market, which consists mainly of HFC-134a. Therefore, the MVAC sector is not discussed further in this analysis.
- *Other mobile air-conditioning* includes AC in the passenger compartments of both buses (including school, transit, and tour buses) and trains (including heavy, light, and commuter rail, and Amtrak trains).[6] Although school bus AC systems converted directly from CFC-12 to HFC-134a, the majority of transit buses, tour buses, and trains continue to use R-22 in their AC systems (Sartin Services 2005; Motorcoach Training 2005; WMATA 2005; Amtrak 2005; NJ Transit 2005).

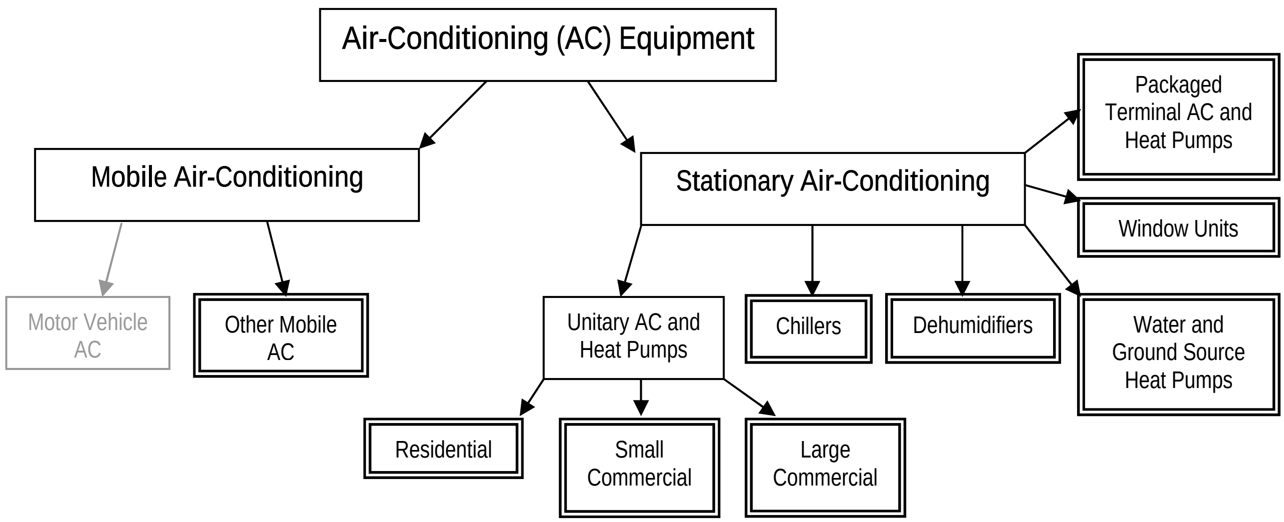
Stationary air-conditioning includes a wide variety of equipment, further categorized into the following six end-uses.

- *Unitary air-conditioners and heat pumps* include both split systems and packaged units and are designed for air circulating, cooling, cleaning, and dehumidifying in residential and small and large commercial applications.
- *Chillers* regulate the temperature and humidity in offices, hotels, shopping centers, and other large buildings. There are four major types of chillers — centrifugal, scroll, reciprocating, and screw — each of which is named for the type of compressor employed. Often, standard AC systems, such as chillers, are customized to be used for industrial applications. Modifications are made to customize the equipment for unusual circumstances (e.g., protection from flammability, high temperatures, or for outdoor use).
- *Dehumidifiers* are mechanical refrigeration systems designed to remove moisture from the air by drawing air first over cold evaporator coils and then warm condenser coils, causing the moisture in the air to condense onto the cold coils. Examples include indoor pool dehumidifiers and portable units used to dehumidify basements.

[6] For the purposes of this report, "other mobile AC" does not include ships, planes, RVs, or construction/farm equipment. In the case of boats, some R-22 is used in AC systems (UNEP 2003a), but this consumption is accounted for in this report under stationary AC equipment, such as packaged terminal units or chillers (Cold Ships 2005).

- *Water and ground source heat pumps* use fluid circulated in a common piping loop as a heat source/sink to cool and heat air. Water-source heat pumps typically use water pumped from a well, lake, or stream as a heat source/sink. Direct expansion geothermal heat pumps circulate refrigerant through piping in the earth.
- *Window units*, also known as room air-conditioners, are small appliances used to condition the air in a single room.
- *Packaged terminal units* are ACs or heat pumps that are mounted on the wall. They are often used in hotel rooms, dormitories, or classrooms.

Figure 3-1: Types of Air-Conditioning Systems[a]



[a]The shaded end-use (MVACs) is assumed to not use HCFC refrigerants; double boxed end-uses are those for which supply and demand projections are estimated in this report.

3.2 Refrigeration End-Uses

Refrigeration equipment can be broken down into four categories: domestic refrigeration, refrigerated transport, industrial process refrigeration, and commercial refrigeration. These categories are described further below.

Domestic refrigeration includes household refrigerators, household freezers, and water coolers. These equipment types are not further analyzed in this report because the refrigerants used for household refrigeration do not typically include HCFCs or blends containing HCFCs.

Refrigerated transport includes refrigeration used in equipment that moves products from one place to another and includes refrigerated ship holds, truck trailers, railway freight cars, and other shipping containers.

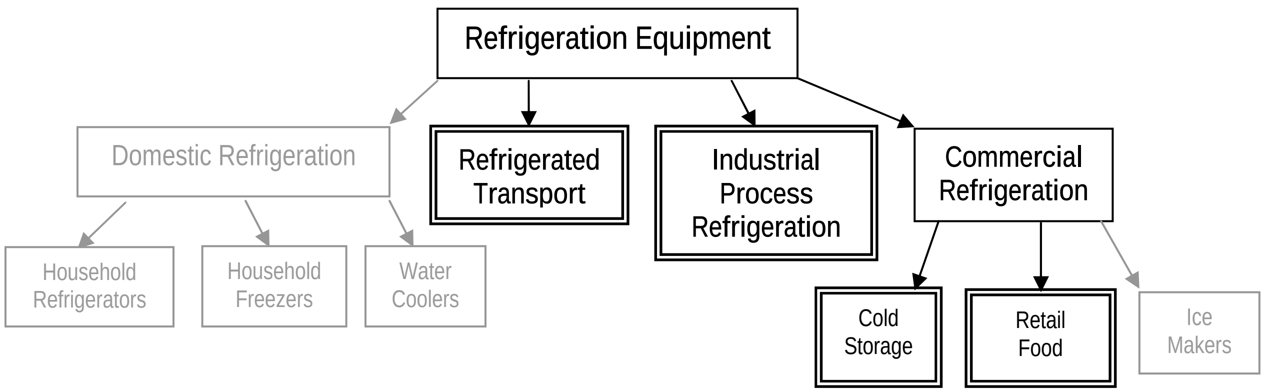
Industrial process refrigeration (IPR) systems are complex, customized systems used to cool process streams in the chemical, food processing, pharmaceutical, petrochemical, and manufacturing industries. This sector also includes industrial ice machines, equipment used directly in the generation of electricity, and ice rinks.

Commercial refrigeration is further broken down into three end-uses:

- *Cold storage warehouses* are refrigeration systems with varying designs and charge sizes. They are used to store meat, produce, dairy products, and other perishable goods before and after food processing.

- *Retail food systems* are used to refrigerate food in commercial retail establishments, such as grocery stores. These systems can be classified as either centralized or self-contained units. Centralized retail food systems, also known as remote systems, consist of a series of compressors and condensers located in a remote machinery room, providing a cooling medium to display cabinets and cold storage rooms in other parts of the building. The most common form of centralized systems circulate refrigerant throughout the store. Alternatives to these types of systems include secondary loop and distributed systems using HFC refrigerant blends. Self-contained retail food units, also referred to as stand-alone systems, are factory produced with all the components integrated. Examples include walk-in refrigerators/coolers/freezers, roll-in refrigerators/freezers, under-counter refrigerators/freezers, reach-in refrigerators/freezers, wine and beer coolers, ice cream machines, beverage vending machines, and all kinds of stand-alone upright or horizontal display cases (e.g., beverage merchandisers, deli cases).
- *Ice makers* are factory-made units used in commercial establishments to produce ice for consumer use (e.g., in hotels, restaurants, and convenience stores). Ice makers are not further analyzed in this report because they do not typically employ HCFCs or blends containing HCFCs.

Figure 3-2: Types of Refrigeration Systems[a]



[a]Shaded areas are assumed to not use HCFC refrigerants; double boxed end-uses are those for which supply and demand projections are estimated in this report.

3.3 HCFC Refrigerants

Historically, chlorofluorocarbons (CFCs) were extensively used as refrigerants in the AC and refrigeration industry; by the 1970s, R-22 and R-502 (a blend of CFC-115 and R-22) were also well established refrigerants. On January 1, 1996, the production and import of CFC refrigerants, classified as Class I ODS under the CAA Amendments of 1990, was phased out. HCFC refrigerants, which also deplete the ozone layer and are classified as Class II ODS under the CAA, were allowed as interim substitutes. Table 3-1 lists the Class II ODS used as refrigerants (or components of refrigerant blends), in descending order according to their ODP.[7] Table 3-1 also lists the phaseout schedule for Class II substances used in both new and existing AC and refrigeration equipment, as required under the CAA.

[7] An ODP value is a measure of a chemical's relative ability to deplete ozone. A reference level of 1.0 is assigned to CFC-11.

Table 3-1: Class II ODS Used as Refrigerants

Class II ODS	CAS Number	Atmospheric Lifetime (years)	ODP[a]	Consumption Phaseout (Starting Jan. 1)	
				New Equipment	Existing Equipment
HCFC-142b (CH_3CF_2Cl)	75-68-3	17.9	0.065	2010	2020
HCFC-22 (CHF_2Cl)	75-45-6	12.0	0.055	2010	2020
HCFC-124 (CF_3CHFCl)	2837-89-0	5.8	0.022	2020	2030
HCFC-123 ($CHCl_2CF_3$)	306-83-2	1.3	0.02	2020	2030

[a]ODP values are taken from the Montreal Protocol (UNEP 2003b).

The remainder of Section 3.3 provides current estimates of the HCFCs and blends containing HCFCs consumed as refrigerants.

3.3.1 HCFC-22

HCFC-22, otherwise known as R-22, was first commercialized as a refrigerant in the 1930s and has been used continuously since that time (UNEP 2003a; Dupont 2005; Calm and Domanski 2004). R-22 is the most common HCFC refrigerant used in AC and refrigeration applications.

Potential non-ODS candidates to replace R-22 vary by application and include HFC-134a, R-404A (composed of HFC-125/HFC-143a/HFC-134a), R-407C (composed of HFC-32/HFC-125/HFC-134a), R-410A (composed of HFC-32/HFC-125) and R-507A (composed of HFC-125/HFC-143a).

Table 3-2 presents current estimates of R-22 consumption and the estimated percent of that consumption that is used to service AC and refrigeration equipment. These estimates were developed based on data from the Vintaging Model (EPA 2005a) and information provided by industry contacts. Appendix A explains the methodology used to develop these estimates and disaggregates servicing estimates by equipment type. As shown in Table 3-2, current estimated consumption of R-22 for both AC and refrigeration equipment totals approximately 111,600 metric tons. Approximately 63 percent of this consumption is for servicing existing equipment, with the refrigeration industry using a higher percentage of its total consumption to service equipment than the AC industry. The majority of R-22 consumption for servicing is currently attributed to residential and small commercial unitary AC equipment and chillers, followed by retail food refrigeration equipment (see Appendix B).

Table 3-2: Summary of U.S. R-22 Consumption (2005)[a]

Equipment Type	Total Consumption for New Manufacturing and Servicing (Metric Tons)	Consumption for Servicing (Metric Tons)	% of Total Consumption for Servicing
Total AC	100,800	60,900	60%
Total Refrigeration	10,800	9,400	87%
Total	111,600	70,300	63%

[a]Quantities of R-22 from blends containing R-22 are factored into these estimates. See Section 3.3.5 for a discussion of blends containing HCFCs.

Since R-22 represents the largest HCFC market in the United States, the projected servicing needs presented in Section 4 focus solely on the use of R-22 and blends containing R-22 in the U.S. AC and refrigeration industry.

3.3.2 HCFC-142b

HCFC-142b, also known as R-142b, is not used as a stand-alone refrigerant but as a constituent of R-409A (composed of HCFC-22/HCFC-124/HCFC-142b). As Table 3-3 presents, only about 100 metric tons of HCFC-142b (used in refrigerant blends) was consumed by the AC and Refrigeration industry in 2005, the majority of which was used to service retail food refrigeration equipment.

The estimates presented in Table 3-3 are drawn directly from the Vintaging Model; this HCFC was not discussed during consultations with industry representatives. The phaseout schedule for HCFC-142b is the same as that for HCFC-22. While the projected servicing needs are not fully explored in the analysis, base estimates from the Vintaging Model indicate that no R-142b will be required to service existing refrigeration equipment beyond 2009.

Table 3-3: Summary of R-142b Consumption (2005)[a]

Equipment Type	Total Consumption for New Manufacturing and Servicing (Metric Tons)	Consumption for Servicing (Metric Tons)	% of Total Consumption for Servicing
Total AC	NA	NA	NA
Total Refrigeration	100	100	100%
Total	100	100	100%

[a]These estimates represent quantities of R-142b from blends containing R-142b. See Section 3.3.5 for a discussion of blends containing HCFCs.

3.3.3 HCFC-123

HCFC-123, also known as R-123, is primarily used as a refrigerant in centrifugal chillers for commercial comfort AC and in industrial process refrigeration. R-123 is the second most commonly used HCFC refrigerant (after R-22), with current overall consumption totaling around 3,200 metric tons—equivalent to about three percent of R-22 consumption. As Table 3-4 indicates, the majority of R-123 is used in AC equipment, specifically for chillers.

The estimates presented in Table 3-4 are drawn directly from the Vintaging Model; R-123 was not discussed during industry consultations. The production and import of virgin HCFC-123 is scheduled for phaseout in 2020 for use in new AC and refrigeration equipment[8] and in 2030 for use in existing AC and refrigeration equipment.

Table 3-4: Summary of R-123 Consumption (2005)

Equipment Type	Total Consumption for New Manufacturing and Servicing (Metric Tons)	Consumption for Servicing (Metric Tons)	% of Total Consumption for Servicing
Total AC	2,600	<50	<1%
Total Refrigeration	600	300	50%
Total	3,200	300	10%

3.3.4 HCFC-124

HCFC-124, otherwise known as R-124, was introduced into the market as a replacement for CFC-114 in specialized centrifugal chillers. Although this use has predominately been phased out, this HCFC is also used in blends, such as R-401A and R-409A, in AC equipment.

As Table 3-5 shows, in 2005, total consumption of R-124 (used in blends) was estimated to be approximately 600 metric tons (or about one percent of total R-22 consumption used in AC and refrigeration applications), all of which was for servicing refrigeration equipment.

[8] In 2015, HCFC-123 production and import will be phased out for all non-refrigerant uses.

The estimates presented in Table 3-5 are taken directly from the Vintaging Model; R-124 was not discussed during industry consultations. The production and import of virgin HCFC-124 is scheduled for phaseout in 2020 for use in new AC and refrigeration equipment[9] and in 2030 for use in existing AC and refrigeration equipment.

Table 3-5: Summary of R-124 Consumption (2005)[a]

Equipment Type	Total Consumption for New Manufacturing and Servicing Demand (Metric Tons)	Consumption for Servicing (Metric Tons)	% of Total Consumption for Servicing
Total AC	NA	NA	NA
Total Refrigeration	600	600	100%
Total	600	600	100%

[a]These estimates represent quantities of R-124 from blends containing R-124. See Section 3.3.5 for a discussion of blends containing HCFCs.

3.3.5 HCFC Refrigerant Blends

Often refrigerants are formulated with several HCFCs and other substances, such as hydrofluorocarbons (HFCs) or propane. R-22 is used as both a stand-alone refrigerant and a component of blends; when used in blends R-142b and R-124 are only used in combination with R-22.[10] Table 3-6 presents the composition of the more common refrigerant blends containing HCFCs.[11]

Table 3-6: HCFC Refrigerant Blend Compositions

Blend	R-22	R-124	R-142b	Other
R-401A	53%	34%		13% R-152a
R-402A	38%			60% R-125, 2% propane (R-290)
R-409A	60%	25%	15%	
R-502	48.8%			51.2% CFC-115

Table 3-7 presents the end-uses in which some of the more common refrigerant blends containing HCFCs are currently used.

Table 3-7: Uses of HCFC-Containing Refrigerant Blends by End-Use

Refrigeration Equipment Type	Refrigerant Type			
	R-401A	R-402A	R-409A	R-502
Retail Food	x	x	x	x
Cold Storage	x	x		x
IPR	x			
Transport	x	x		x

[9] In 2015, HCFC-124 production and import will be phased out for all non-refrigerant uses.
[10] R-123 is only used as a stand-alone refrigerant.
[11] HCFC consumption data presented in this analysis include quantities consumed in blends by employing the percent composition of the corresponding HCFC constituent(s) of that blend. In order to accurately portray the number of units containing HCFC blends, however, blends are not disaggregated when presenting the number of units of equipment (i.e., a unit running on an HCFC-containing blend counts as 1 unit).