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Refrigerant Mission Statement

A-10.1 Objective

To detail how Williams College complies with Sections 608 and 609 of the Clean Air Act Amendments as codified in 40 CFR Part 82 rules and regulations.

A-10.2 Mission Statement

Williams College's site management is committed to providing a safe, healthful, and environmentally sound workplace for its tenants, employees, and contractors while complying with all environmental regulatory requirements.

We will emphasize:

- ☑ Providing a business environment, which fosters professionalism, team effort and personal responsibility for service quality.
- ☑ Providing environmentally responsible solutions.
- ☑ Minimizing Williams College's "risk" exposure through proactive management policies and action programs designed to meet and/or exceed federal, state, and local requirements.
- ☑ Insuring all responsible employees and contractors are aware of and will comply with all applicable environmental regulations.
- ☑ Replacement or retrofit of Ozone Depleting Substance (ODS) equipment, such as CFC equipment, at the end of its service life or when economically feasible.

Williams College's refrigerant compliance program encompasses a strategic approach and general guidance for managing building air conditioning and refrigeration equipment and refrigerant service tools. In brief, the program is to properly recover/recycle refrigerants, repair leaks, document all activities and to safely handle, store and dispose of refrigerants.

Refrigerant Overview

B-10.1 Background

A refrigerant is a fluid (liquid or gas), which transfers heat away from one point to another. In a typical vapor compression system, the refrigerant changes phase. That is, it changes from a liquid to a gas when it absorbs heat and changes back to a liquid when it gives up heat. Most chemicals have the ability to change from a liquid to a gas, but only a few chemicals do so in a manner that makes them good refrigerants.

Most refrigerants used today for vapor compression air conditioning are called halocarbons. A halocarbon is a hydrocarbon molecule containing one or more halogens. The halogen elements most commonly used in refrigerants are chlorine (Cl) and fluorine (F). Refrigerants used in centrifugal chillers are halocarbons based on methane and ethane molecules.

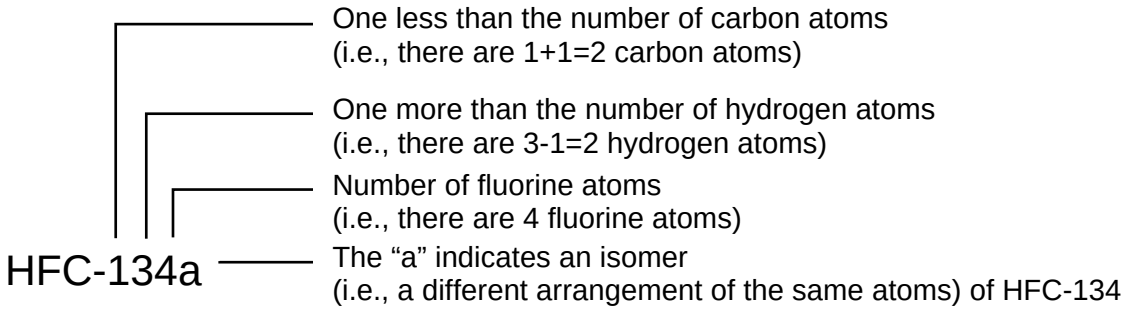
B-10.2 Refrigerant Nomenclature

Most refrigerants in common use *are* single chemicals.

Single component refrigerants have an "R-" designation of two or three numbers, which reflect its chemical composition.

- The first digit (of a refrigerant with three numbers) is one unit lower than the number of carbon atoms in the molecule. If the molecule contains only one carbon atom, the first digit is omitted.
- The second digit is one unit greater than the number of hydrogen atoms in the molecule.
- The third digit is equal to the number of fluorine atoms in the molecule.

For example: HFC-134a - 1,1,1,2-tetrafluoroethane (CH_2FCF_3)



Some refrigerants, however, are comprised of two or more chemicals. R-500 and R-502 are two examples. R-502 is composed of 48.8% (by weight) of HCFC-22 and 51.2% of CFC-115. When formulated in those proportions these chemicals take on the characteristics of a single refrigerant. Combinations of chemicals that act as a single refrigerant are called azeotropes.

Azeotropes are designated by a three digit number beginning with the number "5", such as R-502.

Combinations of chemicals that maintain some of their original characteristics are called zeotropes. For example, unlike single refrigerants and azeotropes, which boil at a single temperature, zeotropes boil over a range of temperatures determined by the boiling points of their individual components. A zeotrope is also sometimes referred to as a blend. Zeotropes are designated by a three digit number beginning with the number "4". The designation ends with a letter to differentiate between compositions of the same chemicals such as in R-401A.

The below chart details the refrigerant, chemical name, CAS number and UN# wherever applicable:

Refrigerant	Chemical Name	CAS number	UN #
11	trichlorofluoromethane (CCl_3F)	75-69-4	N/A
12	dichlorodifluoromethane (CCl_2F_2)	75-71-8	UN1028
13	chlorotrifluoromethane ($CClF_3$)	75-72-9	UN1022
22	chlorodifluoromethane ($CHClF_2$)	75-45-6	UN1018
23	trifluoromethane (CHF_3)	75-46-7	UN1984
113	1,1,2-trichloro-1,2,2-trifluoroethane (CCl_2FCClF_2)	76-13-1	N/A
114	1,2-dichloro-1,1,2,2-tetrafluoroethane ($CClF_2CClF_2$)	76-14-2	UN1958
123	2,2-dichloro-1,1,1-trifluoroethane ($CHCl_2CF_3$)	306-83-2	N/A
134a	1,1,1,2-tetrafluoroethane (CH_2FCF_3)	811-97-2	UN1956
401A	(53/13/34) chlrodifluoromethane/1,1-difluoroethane/2-chloro-1,1,1,2-tetrafluoroethane	N/A	UN1956
401B	(61/11/28) chlorodifluoromethane/1,1-difluoroethane/2-chloro-1,1,1,2-tetrafluoroethane	N/A	UN1956
402A	(60/2/38) pentafluoroethane/propane/chlorodifluoromethane	N/A	UN1956
402B	(38/2/60) pentafluoroethane/propane/chlorodifluoromethane	N/A	UN1956
404A	(44/52/4) pentafluoroethane/1,1,1-trifluoroethane/1,1,1,2-tetrafluoroethane	N/A	UN1956
406A	(55/4/41) chlorodifluoromethane/2-methyl propane (isobutene)/1-chloro-1,1-difluoroethane	N/A	UN1956
407C	(23/25/52) difluoromethane (methlyene fluoride)/pentafluoroethane/1,1,1,2-tetrafluoroethane	N/A	UN1956
408A	(7/46/47) pentafluoroethane/1,1,1-trifluoroethane/chlorodifluoromethane	N/A	UN1956
409A	(60/25/15) chlorodifluoromethane/2-chloro 1,1,1,2-tetrafluoroethane/1-chloro-1,1-difluoroethane	N/A	UN1956
410A	(50/50) difluoromethane (methylene fluoride)/pentafluoroethane	N/A	UN1956
500	(73.8/26.2) dichlorodifluoromethane/1,1-difluoroethane	N/A	UN2602
502	(48.8/51.2) chlorodifluoromethane/chloropentafluoroethane	N/A	UN1973
503	(40.1/59.9) trifluoromethane/chlorotrifluoromethane	N/A	UN2599
507	(50/50) pentafluoroethane/1,1,1-trifluoroethane	N/A	UN1956

B-10.3 Physical and Environmental Properties of Refrigerants

Even small changes in the makeup of these refrigerants can make a large difference in their physical and environmental properties. The following table shows some thermophysical and environmental properties of some common refrigerants.

Refrigerant	Boiling Point (ºF)	Specific Heat @ 86ºF (Btu/lb. ºF)	ODP	GWP	Atmospheric life (years)
R-11	74.7	0.21	1.000	4600	45
R-12	-21.6	0.24	.82	10600	100
R-22	-41.4	0.31	0.034	1900	11.8
R-123	82.0	0.21	0.012	120	1.4
R-134a	-15.0	0.36	0	1600	13.6
R-404A	-51.9	0.37	0	4540	(13.6-53.5)
R-410A	-60.9	0.41	0	2340	(5.6-32.6)
R-502	-49.5	0.30	0.221	6200	(11.8-1700)
R-507	-52.8	0.35	0	4600	(32.6-53.5)

B-10.4 Health and Safety Considerations

Many chemicals, including refrigerants, can be harmful if used improperly. Three important categories of health and safety concerns are toxicity, flammability, and O_2 displacement (asphyxiation hazard).

An international group of refrigerant manufacturers, through the Program for Alternative Fluorocarbon Toxicity (PAFT) testing, have conducted extensive toxicology tests on some HCFC and HFC refrigerants. With these results, manufacturers have recommended concentrations that humans can tolerate for a given time without harmful effects, called Allowable Exposure Limits (AELs). These values are given in parts per million (ppm), indicating the maximum amount of refrigerant that can be safely tolerated. Other toxicity indicators include Threshold Limit Values (TLVs) and Permissible Exposure Levels (PEL) values. Refrigerant manufacturers indicate the AEL, TLV, and PEL of a refrigerant on the Materials Safety Data Sheet (MSDS). ASHRAE Standard 34, *Number Designation and Safety Classification of Refrigerants*, classifies toxicity into two groups:

Class A: Refrigerants with low toxicity, with a weighted TLV over time higher than 400 ppm. That is, only concentrations over 400 ppm, over sustained periods of time are of concern.

Class B: Refrigerants with higher toxicity with a weighted TLV over time lower than 400 ppm.

Flammability, the ability of a chemical to support combustion, is also measured in a laboratory. Refrigerants are generally classified as being non-flammable, of low flammability, or high flammability.

ASHRAE Standard 34 assigns each refrigerant into one of three flammability groups. There are various scientific definitions for these groups, but generally they can be categorized as:

Group 1: No flammability

Group 2: Low flammability
Group 3: High flammability

By combining toxicity and flammability criteria, a matrix is obtained which classifies a refrigerant into class A1, A2, A3, B1, B2, or B3.

	A	B
3	R-600a (isobutane) R-290 (propane)	R-1140 (vinyl chloride)
2	HFC-32 HFC-143a HFC-152a	R-717 (ammonia)
1	CFC-11 CFC-12 HCFC-22 HFC-125 HFC-134a	HCFC-123

ASHRAE 34 Matrix with Some Refrigerant Examples

ASHRAE Standard 15, 1994, *Safety Code for Mechanical Refrigeration* treats the subject of how refrigerants that have been classified in ASHRAE Standard 34 may be used. It points out the need for refrigerant vapor sensors and self-contained breathing apparatus in certain situations because all fluorocarbon refrigerants are heavier than air and can cause asphyxiation.

CFCs and Ozone Depletion

The theory linking chlorofluorocarbons (CFCs) to stratospheric ozone depletion and environmental concerns was first proposed in the 1970s. Scientific studies provided an understanding of the chemical processes and physical mechanisms. Mathematical models predicted the effects of ozone-depleting substances (ODS) released into the atmosphere and transported by air currents to the stratosphere. The models predicted that continued use of these substances would lead to substantial ozone depletion in the next 50 to 100 years.

The stratospheric ozone layer protects the earth's surface from excessive quantities of harmful ultraviolet (UV-B) radiation. After evaluating scientific evidence, an international consensus resolved that certain identified volatile man-made, chemical substances containing chlorine and bromine are causing the depletion of the thin, fragile ozone layer. The conclusion was to reduce these releases and restrict their use.

ODS chemicals are widely used in many processes and products. Previously, ODS were used as refrigerants in buildings, household appliances, and automobiles; as foam blowing agents for insulation; as degreasers for metals and as propellants in containers. Currently, existing equipment, which utilizes CFCs, can continue to be used. New refrigerant equipment, however, is designed to use CFC alternative refrigerants, which minimize or eliminate their ODP.

There are several exemptions to the continued use of CFCs. The largest "essential use" exemption authorized under the Montreal Protocol includes medical devices such as metered-dose inhalers used in the treatment of asthma. List of common substances regulated by the Montreal Protocol.

Common Substances Covered by the Montreal Protocol and Amendments

CLASS I - CFCs	CLASS II - HCFCs
CFC-11*	HCFC-22*
CFC-12*	HCFC-123*
CFC-13	HCFC-124*
CFC-111	HCFC-141
CFC-112	HCFC-142
CFC-113	
CFC-114	
CFC-115*	Others
	Carbon Tetrachloride
Halons	Methyl Chloroform
Halon-1211	Methyl Bromide
Halon-1301	
Halon-1202	

*NOTE: These chemicals are used extensively, either alone or in a blend, for air-conditioning and refrigeration applications.

Environmental Concerns

The environmental concerns associated with refrigerants fall into two categories: stratospheric ozone depletion and global warming or climate change. CFC and HCFC refrigerants contain chlorine which, when released into the stratosphere – an upper layer of the atmosphere, depletes the ozone layer.

As stratospheric ozone depletion occurs, the quantity of UV-B radiation reaching the earth's surface increases. The ozone levels in the stratosphere also vary naturally due to climate, latitude, and airborne particles but ozone depleting chemical emissions would reduce the mean levels.

This radiation increase results in potential health and environmental risks including increased incidents of certain skin cancers and eye cataracts, suppression of the body's immune system, damage to plants and food crops, and reduced aquatic life growth. Radiation also causes an increased weathering of man-made plastic and rubber products.

Scientific research on ozone depletion is advanced enough and the problem serious enough that legislation is now in place which requires Williams College to take immediate action.

Global warming is likely to be contributed to by the emission of certain man-made "greenhouse" gases (many refrigerants are greenhouse gases). These gases are said to collect and hold in the earth's heat that would normally radiate out into space. This heat may cause the temperature in the atmosphere to rise and other effects on climate. It is probable that climate change could cause a number of effects including damage to crops, or even the melting of polar ice caps. There is less scientific consensus on the extent to which CFCs, HCFCs, and HFCs actually contribute to global warming. But scientists agree that we must consider not only the refrigerants' direct impact on global warming, but also the indirect impacts, such as the impacts of using a refrigerant that results in a chiller that is less energy efficient. Such an occurrence causes higher emissions of carbon dioxide, which is also a greenhouse gas and in this way also affects global warming.

U.S. Federal Rules and Regulations

C-10.1 Objective

To detail the U.S. Federal regulatory requirements which affect Williams College operations in the performance of service work, maintenance, repair, or disposal of air-conditioning or refrigeration equipment. It is the responsibility of each site to obtain and comply with state and local regulations.

C-10.2 Summary of 40 CFR Part 82 Requirements

- ☑ Requires service practices that maximize recycling of ozone-depleting compounds (both chlorofluorocarbons [CFCs] and hydrochlorofluorocarbons [HCFCs] and their alternatives) during the servicing and disposal of air-conditioning and refrigeration equipment.
- ☑ Sets certification requirements for recovery and recycling equipment.
- ☑ Restricts the sale of refrigerant so that it is only sold to certified technicians and appliance manufacturers.
- ☑ Requires persons servicing or disposing of air-conditioning and refrigeration equipment to certify to the EPA on OMB Form #2060-0256 that they have acquired recycling or recovery equipment and are complying with the requirements of the rule.
- ☑ Requires the repair of substantial leaks in air-conditioning and refrigeration equipment with a charge of greater than 50 pounds.
- ☑ Establishes safe disposal requirements to ensure removal of refrigerants from goods that may enter the waste stream with the charge intact (e.g., motor vehicle air conditioners, home refrigerators, and room air conditioners).
- ☑ Sets certification for technicians and reclaimers.

Enforcement Authority

C-20.1 External Enforcement of Violations

Any violation of the Clean Air Act may result in civil or criminal action against the individual and the company. Any conviction or penalties assessed for a violation of any state or local provision will be the responsibility of the named individual and his or her site.

Federal environmental laws provide various enforcement options that the EPA and state agencies can take against alleged violators.

The specific provisions for civil and criminal penalties vary according to the statute. Fines can range up to $27,500 per day per violation and prison terms can extend from one to 5 years for a violation. If a company is found to have violated the law in a civil action, it may suffer adverse

publicity in addition to substantial financial penalties. In criminal cases, in addition to the potential for financial penalties to be imposed on a company in violation of the law, individual managers and officers of the company may face prosecution and imprisonment. Senior administration of the company, even if they are not directly involved in the alleged violations, could be subject to prosecution. This may occur if such administrators consciously screened themselves from a matter that they had the power to prevent or correct.

In addition, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) imposes "no fault" liability on site owners, operators, generators responsible for the release, threatened release or any failure to notify the National Response Center of a release of a listed hazardous substances in more than a reportable quantity. Some ODCs and their alternatives may be listed by CERCLA.

C-20.2 Types of Enforcement Actions

This plan is based on enforcement activities generally taken by the EPA. States generally have similar enforcement techniques. There are four basic types of enforcement actions, differing in severity and in the amount of agency resources required. In order of increasing severity, these actions are the following:

Informal Administrative Actions

Informal administrative actions are advisory in nature, such as a notices of noncompliance or warning letters from the agency. In such an action, the EPA will provide notice of the alleged violation to the site, define required corrective measures and set a deadline for compliance. If the site fails to comply, the EPA may institute more severe actions.

Formal Administrative Actions

Formal administrative actions take the form of legal orders. They require the alleged violator to take corrective action within a specified period and to refrain from certain behavior, and order future compliance. Fines also may be imposed through an administrative action. The EPA uses administrative actions extensively in environmental programs that provide authority for them. The EPA handles such administrative actions through its internal administrative litigation system. This system is similar to any court system, with the exception that the EPA's administrative law judges (ALJs) preside over it. You may appeal an ALJ's ruling to the EPA administrator and the administrator's final decision to federal court.

Civil Actions

Civil actions frequently take the form of lawsuits initiated by the U.S. Department of Justice (DOJ) at the EPA's request. The EPA normally uses civil judicial actions against the more serious violators or to enforce corrective actions of imminent hazards. These suits generally result in monetary penalties and court orders requiring corrective or remedial actions or specific actions to prevent future violations.

Criminal Prosecution

Criminal actions are initiated by DOJ at the request of the EPA against an alleged violator, and seek criminal sanctions including fines and imprisonment. The EPA uses criminal actions to respond to flagrant, intentional disregard of applicable law. *In addition, the CAA gives the EPA authority to pursue criminal actions in response to deliberate falsification of documents or records and knowing and willful violations.*

C-20.3 Enforcement Authority Under the Clean Air Act

The EPA, and states where applicable, generally receives its enforcement authority from the particular statute being enforced. The Clean Air Act is the federal regulation of the greatest concern to managers in charge of refrigerant compliance.

The Clean Air Act authorizes a nationwide program to reduce air pollution through air quality planning, regulation, enforcement, and research. The act consists of a series of interrelated programs designed to protect health and the public welfare from emissions polluting the ambient air. Subchapter VI of the CAA "Stratospheric Ozone Protection" contains the provisions regarding refrigerants that are Class I and II ozone depleting substances.

Administrative Penalties

The CAA gives the EPA the Authority to issue administrative orders assessing civil administrative penalties of up to $27,500 per day of violation whenever EPA finds that a company has violated or is violating air regulations, including Stratospheric ozone protection requirements.

Civil Actions

Under the CAA, the EPA may initiate civil actions in court to obtain injunctive relief requiring the violator to achieve compliance and to recover penalties in amounts up to $27,500 per day per violation.

Criminal Actions

The EPA may bring criminal actions for knowing violations, which may result in a substantial fines and imprisonment.

Knowingly making false statements or representations in records or reports required under the CAA, or knowingly failing to notify or report may be punishable by fine and imprisonment up to two years.

Knowingly making false statements or representations in records or reports required under the CAA, or knowingly failing to notify or report may be punishable by fine and imprisonment up to two years.

Under the CAA, federal agencies cannot contract to procure goods, materials and services with a person convicted of a criminal offense if that contract will be performed at the facility at which the violation that gave rise to the conviction occurred, and the convicted person owns, leases or supervises the facility. If the court convicts the site owner for criminal violation of a provision, or any other federal air standard or order, listing of the firm is mandatory and automatic. The

EPA might also extend the prohibition to other facilities owned or operated by the convicted person. Removal from the list requires certification by the EPA that the violator has corrected the conditions giving rise to the listing.

Significant New Alternatives Program

C-30.1 Background

Under authority of Section 612 of the Clean Air Act (CAA), regulations promulgated on March 18, 1994, effective April 18, 1994, the EPA has established a program in which they will evaluate applications for use of substitute chemicals and technology to replace ozone depleters in specific uses.

C-30.2 EPA's Significant New Alternatives Program (SNAP) Rule

- ☑ SNAP requires the manufacturer or importer of a proposed substitute for an ozone-depleting chemical to provide the EPA notification 90 days before introducing the substitute into interstate commerce. During the 90-day period, the EPA will evaluate company studies and other information and decide whether the substitute is either acceptable or unacceptable for a specific use, based on whether the substance may have adverse effects on human health or the environment. Some of the criteria the EPA will consider in the risk screening include flammability, chemical toxicity, global warming potential and exposure of workers, consumers, the general population and aquatic life.
- ☑ If the EPA places a substance on the unacceptable list, it becomes unlawful to use it as a substitute for an ozone depleter.

Obtain a current SNAP list and keep the list updated by contacting the EPA Hot line at 800-296-1996 or print directly from the EPA web site http://www.epa.gov/ozone/title6/snap.

Responsibilities

D-10.1 Objective

To describe the responsibilities of Williams College personnel who are responsible for refrigerant compliance management.

D-10.2 Background

Williams College has acknowledged the federal and local regulations for refrigerants. Williams College has provided guidelines, requirements, best practices, and training on specific processes to manage refrigerants.

D-10.3 Manager of Environmental Health and Safety

Williams College has established a chain of command for refrigerant management. The Manager of EH&S has responsibility for overall operations and has the budget and authority to implement refrigerant management compliance. The responsibility for refrigerant compliance is delegated to the Foreman and the Safety Coordinator.

The Manager of EH&S has the ultimate responsibility for implementation of this plan and shall communicate the refrigerant compliance issues to all affected Williams College employees, technicians and contractors.

Responsibilities

- ☑ Implements the Refrigerant Compliance Plan.
- ☑ Conducts biannual refrigerant management site audits and refrigerant service training.
- ☑ Identifies risks associated with refrigerant issues and communicates to management.
- ☑ Ensures training of all technicians.
- ☑ Assists in safety equipment deployment.

D-10.4 Safety Coordinator

The Safety Coordinator serves as a resource to provide assistance in meeting Williams College's obligations for refrigerant compliance management.

Responsibilities

- ☑ Maintains the Williams College, technician and contractor records of refrigerant inventories, usage and disposals.
- ☑ Maintains contact with refrigerant suppliers and service contractors.
- ☑ Assists in the transportation and disposal of used refrigerant, used oil and parts.
- ☑ Provides input to budget planning process for refrigerant management.

- ☑ Identifies equipment and services required to comply with regulations.
- ☑ Provides input to site compliance budget planning process.

D-10.5 Foreman

The Foreman shall delegate the daily responsibility of refrigerant management to a selected individual who shall be referred to as the HVAC Technician. The Foreman will support the Manager of Environmental Health and Safety in their efforts. Guidelines for support include:

Responsibilities

- ☑ Supports the Manager of EH&S in implementing the Refrigerant Management Plan.
- ☑ Mitigates risks associated with refrigerant issues when identified.
- ☑ Procures equipment and services required to comply with regulations.

D-10.6 Refrigerant/HVAC Technician

Each technician is responsible for becoming informed on the federal and local requirements and the Williams College Refrigerant Management Plan requirements. Each technician is responsible for complying with federal regulations and the requirements of the Refrigerant Management Plan.

Responsibilities

- ☑ Complete required records for all refrigerant related activities per plan requirements.
- ☑ Ensure recovery units meet EPA evacuation requirements.
- ☑ Maintain, leak test and document recovery unit maintenance per manufacturer's recommendations.
- ☑ Follow procedures to eliminate refrigerant contamination and mixing.

Self-Audit Survey Checklist

D-20.1 Objective

To provide a tool for the Safety Coordinator to verify continued compliance with federal regulations and the Refrigerant Management Plan requirements.

D-20.2 The Self-Audit Checklist

The self-audit checklist is designed to assess the effectiveness of a site's Refrigerant Management Plan. A survey should be performed annually by the Safety Coordinator, with the results sent to the Manager of Environmental Health and Safety and Foreman. The Safety Coordinator is responsible for resolving any deficiencies that are identified during the self-audit process in a timely manner.

The following activities shall be implemented and managed by the Safety Coordinator:

- ☑ Complete the self-audit, correct deficiencies and document results.
- ☑ Maintain required documentation regarding the management and handling of refrigerants (i.e., training record, maintenance records, refrigerant use, etc.).
- ☑ Provide suggested revisions or updates for improving the refrigerant management plan to the Manager of Environmental Health and Safety and Foreman for consideration.
- ☑ Determine applicable state and local requirements and verify compliance with those requirements.

SELF-AUDIT CHECKLIST

General Record-keeping Requirements

Perform for each technician/truck and site operation

Inspection Topic –Record keeping	Yes	No	N/A	Comments
Note: All records must be maintained for 3 years				
In general are service records available for inspection for **all** service, maintenance, repair, or disposal performed on refrigerant equipment?				
Do the service records contain the following details:				**Rate quality for each and rate % of records which comply**
The amount of refrigerant **added** during the maintenance or repair of all refrigerant equipment?				
The amount of refrigerant **recovered** or recycled during the maintenance, repair, or disposal for all refrigerant equipment?				
Description of service or repairs performed and details of where leaks were and what was done to repair				
Which **recovery/recycle unit** was used (or other method) to recover or recycle refrigerant during maintenance, repair, or disposal?				
What **vacuum level** was achieved during refrigerant recovery for a major service or equipment disposal?				
Are all leaks repaired and documented within the 30 days allowed?				
Has a retrofit/replacement plan been written for systems that were not repaired within 30 days?				
Are initial leak verification tests being documented after leak repairs? Is method used documented?				Mandatory for Industrial Process refrigeration systems
Are follow-up leak verification tests being conducted & documented, within 30 days of initial test, for units (circuits) which contain refrigerant of 50 pounds or greater? *Note: perform for all ≥ 50 pound units.*				Mandatory for Industrial Process refrigeration systems
Are refrigerant purchase records **easily** available showing dates, quantity, refrigerant type, and supplier				
Are records available, for refrigerant sent to a refrigerant reclaimer, distributor or contractor:				
To whom (Name / Phone)?				
Date sent and date returned?				
Gross weight sent? \ Net weight returned as reclaimed?				

SELF-AUDIT CHECKLIST

Refrigerant Management Issues

Inspection Topic	Yes	No	N/A	Comments
Is the Refrigerant Compliance Plan being utilized?				
Has refrigerant compliance training for your technicians been conducted?				
Has a refrigerant inventory audit been conducted recently? Date & results:				
Have you contacted all refrigerant suppliers to remove inactive technician names from their records				
Is used refrigerant oil being disposed of properly				
Is your equipment inventory 100% complete and properly categorized by EPA type?				
Are disposal labels being used and placed on all disposed of refrigerant equipment? *(Rate for equipment abandoned in place and for equipment staged for disposal)*				

Service Technician Issues

Inspection Topic	Yes	No	N/A	Comments
Are all technicians EPA certified to proper level?				
Are copies of EPA certification cards on file? Including contractors?				
Are any technicians EPA cards from programs decertified by the EPA?				
Do all EPA certification cards have a level listed and the words "*as required by 40CFR, Part 82, subpart f"?*				
Are technicians documenting accidental refrigerant release incidents? *(non-mechanical)*				
Can technicians quote the EPA >50 lbs. equipment types and their leak trigger rates?				
Are charging scales accurate; calibrated?				
Are technicians reaching the required vacuum levels for correct recovery and documenting information?				
Can technician demonstrate proper use of recovery units and can they quote the EPA required recovery vacuum levels?				
Are contractors documenting refrigerant service work on the RCM Service Order input form?				
Is each technician accurately documenting each leak found and repaired? *Rate quality & % of time details are included*				

SELF-AUDIT CHECKLIST

Recovery Unit Issues

Inspection Topic	Yes	No	N/A	Comments
Is a list of model numbers, serial numbers and date purchased for all recovery units available?				
Is a copy of the recovery unit acquisition certification form, sent to the EPA showing at least one recovery unit is on site, available?				
Have periodic leak/vacuum checks of recovery units been conducted and documented?				
Is there evidence recovery unit filters are being changed as required?				
Are automotive Section 609 recovery units being used for Section 608 stationary equipment?				
Are contractor recovery units EPA approved and model and serial numbers on file?				
Has a copy of the evacuation chart been laminated and attached to each recovery unit?				

Refrigerant Cylinders

Inspection Topic	Yes	No	N/A	Comments
Are DOT 39 (disposable) cylinders being evacuated to 4 psig and punctured before disposal?				
Do you have an accurate inventory of all recovery and virgin refrigerant cylinders with serial numbers or ID numbers?				
Are recovery cylinders correctly color-coded to ARI-K (gray with yellow top)?				
Are all recovery cylinders current with the 5-year re-testing date?				
Are all cylinders properly labeled with a refrigerant specific tag/label and non-flammable gas tag/label attached?				
Are you using dedicated cylinders for each refrigerant type?				

General Safety Issues

Inspection Topic	Yes	No	N/A	Comments
Do technicians have access to refrigerant MSDS?				
Do technicians have access to personal protective equipment for refrigerants?				
Do technicians wear proper personal protective equipment when handling refrigerants?				

Technician Requirements

D-30.1 Objective

To define the requirements for persons who perform refrigerant services.

D-30.2 Who Must Be Certified

EPA approved certification testing is required for any person who may perform service, maintenance, repair or recovery work on a refrigerant containing circuit. Williams College technicians and Contractor technicians shall service only equipment for which they are certified.

D-30.3 EPA Certification

The required type of certification testing depends on the type of refrigerant being used and the size of the system being serviced. The four types of certification identified by the Clean Air Act Amendments Section 608, stationary equipment are presented in the following table:

Type of equipment serviced	Level of required certification
Small appliances (<5lbs.)	Type I
High- and very-high-pressure equipment	Type II
Low pressure equipment	Type III
All types	Universal*

**Type IV Universal does not include motor vehicles.*

It is recommended that the Safety Coordinator provide an annual refresher training session for technicians. Obtain technician input on subjects, utilize manufacturer's training and at a minimum cover safety issues, alternative refrigerants, servicing procedures, federal, state and local regulations.

D-30.4 EPA Inspection Questions

The EPA routinely asks:

1. If technicians have their certification cards available.
2. For copies of all technician cards or certificates.
3. If technicians can recite the required recovery vacuum levels.
4. If technicians know the leak trigger rates for the four over 50 pound EPA equipment classifications.
5. If technicians perform leak tests, on recovery units, calibrate their gages and can demonstrate the proper use of a recovery unit.

D-30.5 Technician Certification Card Review

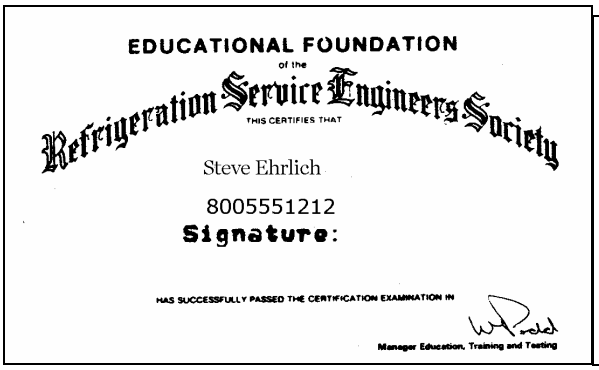
Review each employee and all contractor cards or certificates to ensure it has a level listed from the table above and has the following statement: **"as required by 40CFR, Part 82, Subpart f."** If the card does not have the 40CFR statement or an EPA level listed the card is not valid and the technician must get re-certified by an approved program. To verify if the Technician certification program listed on the card is EPA approved or no longer approved by EPA check

the following website and compare the certifying program name with the EPA list. The list is in constant change approved and not approved programs can be found at:

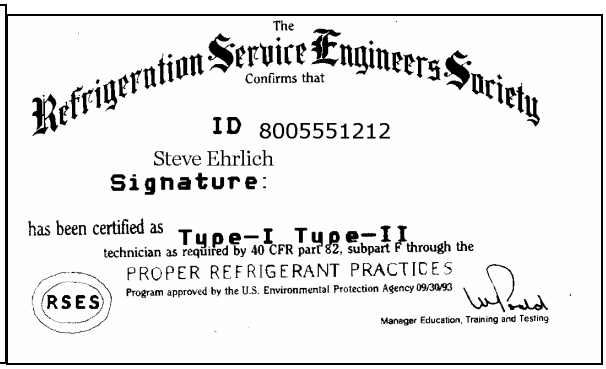
http://www.epa.gov./ozone/title6/608/608certs.html

Certification Card Samples

Not Approved Card



Approved Card



Refrigerant Recovery Equipment Requirements

D-40.1 Objective

To define the requirements which users of recovery equipment for Williams College will follow to ensure compliance with EPA regulations.

D-40.2 Recovery Unit Registration

The Safety Coordinator shall assure that an EPA Recovery Unit Acquisition Certification Form (OMB #2060-0256) has been submitted to the appropriate EPA region.

D-40.3 Responsibility

The Safety Coordinator is responsible for entering each piece of recovery equipment into the Refrigerant Compliance Manager™ (RCM) software.

D-40.4 Recovery Unit Labeling

EPA required that manufacturers must obtain certification from an EPA approved testing agency, for each model of recovery/recycle equipment, sold after November 15, 1993. Units must be properly labeled by the manufacturer. The approved agencies are the Air Conditioning and Refrigeration Institute (ARI) and Underwriters Laboratories (UL). The label should be similar to the following:

"This equipment has been certified by ARI/UL to meet EPA's minimum requirements for recycling and/ or recovery equipment intended for use with [appropriate category of appliance--e.g., small appliances, HCFC appliances containing less than 200 pounds of refrigerant, all high-pressure appliances, etc.]."

Units manufactured before November 15, 1993 are considered grandfathered and may not have the ARI or UL label. Technicians need to know if they are using a grandfathered or ARI/UL certified unit to ensure proper recovery vacuum is achieved for the type of recovery unit they are using. See EPA Evacuation Chart D-40.7.

D-40.5 Maintenance Responsibility

Each certified technician shall have access to recovery equipment. The care and maintenance of this equipment will be their responsibility. If unit does not function properly, the service technician shall notify their supervisor and replace the non-functioning recovery unit with one that functions before proceeding with the service.

Technicians and contractors shall service and maintain recovery/recycling equipment per manufacturer's specifications. Periodic leak testing of recovery units shall be performed and the results recorded in the Refrigerant Compliance Manager™ (RCM) software input forms.

D-40.6 EPA Inspection Questions

1. The EPA will always ask to see a copy of your EPA Recovery Unit Acquisition Certification Form (OMB #2060-0256).
2. They will always ask for list of all your recovery units or ask you to go find them to record the nameplate data.
3. The EPA will routinely ask you to demonstrate if your recovery units can achieve the required vacuum levels. Ensure technicians perform the leak tests, calibrate gages and can demonstrate the proper use of a recovery unit.

D-40.7 EPA Evacuation Level Chart

Type of Appliance	Recovery Units Manufactured Date	
	Before Nov. 15, 1993 Grandfathered Unit	**After Nov. 15, 1993 ARI/UL Unit**
R-22, R-402A/B, R-407A/B/C appliance, or isolated component of such appliance, normally containing less than 200 pounds of refrigerant.	0	0*
R-22, R-402A/B, R-407A/B/C appliance, or isolated component of such appliance, normally containing 200 pounds or more of refrigerant.	4	10
Very High Pressure Appliance **R-410A/B, R-13, R-23, R-503**	0	0
Other high-pressure appliance, or isolated component of such appliance, normally containing less than 200 pounds of refrigerant. **R-12, R-114, R-134a, R-401A/B/C, R-500, R-502**	4	10
Other high-pressure appliance, or isolated component of such appliance, normally containing more than 200 pounds of refrigerant. **R-12, R-114, R-134a, R-401A/B/C, R-500, R-502**	4	15
Low-Pressure Appliance **R-11, R-113, R-123**	25	25 mm Hg absolute
*** Inches of Hg vacuum relative to standard atmospheric pressure of 29.9 inches of Hg, except where noted.**		

For small appliances (less than 5 pounds), evacuation levels are as follows:

- ☑ for "grandfathered" recovery equipment, recover 80 percent.
- ☑ for new recovery equipment when the compressor is working, recover 90 percent.
- ☑ for new recovery equipment when the compressor is not working, recover 80 percent.
- ☑ for all appliances, evacuate to 4 inches of mercury vacuum.

Record-keeping Requirements

D-50.1 Objective

To detail the records which shall be kept to ensure compliance with the U.S. EPA regulations.

D-50.2 Importance of Record-keeping

The U.S. EPA has established record-keeping requirements for owners and operators of air conditioning and refrigeration equipment containing CFC and HCFC refrigerants. The EPA can request detailed reports of refrigerant usage, service, maintenance and disposal for the past three years. Failure to comply with these regulations can result in fines up to $27,500 per day per violation.

D-50.3 Record-keeping Method

Williams College requires that records be kept to comply with the laws, and to establish data for compiling accurate refrigerant asset management information. Refrigerant Compliance Manager™ (RCM) software is used to maintain records. The input forms from RCM are contained in the appendix. It is the responsibility of the Williams College technician or the maintenance contractor technician to fill out and route the appropriate RCM input forms to the Safety Coordinator.

D-50.4 Required Plant/Site and Technician Records

Pursuant to Section 114(a) (1) of the Clean Air Act, 42 U.S.C. Section 7414(a) (1) and 40 CFR 82.166 (j) & (k), Williams College is required by the EPA to document the following information. The Safety Coordinator will maintain the following records in the RCM software for at least three (3) years.

1. Complete site refrigerant equipment inventory with equipment categorized as under 50 pounds or over 50 pounds, comfort cooling, commercial refrigeration, industrial process refrigeration or other refrigeration. *RCM Equipment input form.*
2. The equipment database must include refrigerant type and operating charge data. If charge is unknown (split system, not listed on nameplate) then it must be calculated. Consult manufacturer data sheets, measure piping length, component capacity and detail calculations. Alternate method is to establish a charge by total circuit or system tonnage times a value of 2 to 2.5 pounds per ton. On next major service when unit is totally pumped down, amend equipment notes (with date, new charge value and service order ID #) and equipment charge detail with actual charge.
3. Complete refrigerant inventory for all cylinders and drums of refrigerant on site including on going purchases of refrigerant. *RCM Cylinder input form.*
4. Records of all Williams College and contractor technicians who perform any service, maintenance, repair, or disposal on refrigerant containing equipment. RCM technician and *Contractor input forms.*

5. Recovery / recycle unit information and maintenance history. *RCM Recovery unit input form.*
6. Complete service records for all refrigerant related work including: date of service, technician/contractor name, quantity and type of refrigerant added, recycled or removed, description of service and leak repair procedure, leak testing method and result, vacuum level achieved during recovery. *RCM Service Order Form.*
7. Leaks must be documented. Report leaks that cannot be repaired to the (Refrigerant Coordinator). In every case, Williams College has the responsibility to eliminate the leak. If the leak exceeds the regulatory leak-rate limit, Williams College shall do one of the following: have the leak repairs completed within 30 calendar days of the original leak notification, produce a written plan that details the equipment retrofit, or replacement within one year of the original leak notification. See Leaking Systems Section D-70 for specific equipment types.
8. Equipment Disposal Records. When equipment is removed from service the refrigerant and oil must be removed. Record the following information: date of recovery, technician name, equipment ID number, model number and serial number, refrigerant type and amount recovered, recovery unit used, vacuum level, record that oil was recovered, and disposal location (dumpster, scrap, etc.). *RCM Service Order Form.*

Refrigerant is Williams College's property. Any refrigerant added which is not Williams College's property must be documented. No refrigerant may leave the Williams College site without first being reviewed and documented by the Safety Coordinator.

D-50.5 EPA Inspection Questions

1. The EPA will always ask for a list of your technicians (with their certification information), contractors, new refrigerant vendors, recovered refrigerant reclaimer/disposer, recovery units and your over 50 pound equipment.
2. They will ask you what type of over 50 pound equipment you have (comfort cooling, industrial process refrigeration, commercial or other refrigeration).
3. They will ask to see records of the amount of refrigerant you have purchased and added to the over 50 pound systems. They may even want to take an inventory of your new and recovered refrigerants.
4. They will ask how you determine when you have a leaking system.
5. They will ask for leak repair records on your over 50 pound systems.
6. They will ask for records of initial and follow-up verification testing on industrial process equipment leak repairs.

Disposal of Refrigerant, Lubricants and Equipment

D-60.1 Objective

To define the requirements and documentation for disposal and transfers of ownership of refrigerant, used lubricants and refrigeration equipment from Williams College.

D-60.2 Refrigerant Ownership Transfer

When transferring refrigerant ownership to another company, document the transaction. Provide a service record of refrigerant recovered from equipment disposed of or from a contaminated system. This transfer of the refrigerant shall be noted on the Refrigerant Compliance Manager™ (RCM) software Refrigerant Cylinder input form for input into the RCM database.

D-60.3 Used Lubricant Disposal

Refrigerant oil is considered a hazardous waste if it contains more than 4,000 parts per million (ppm) of dissolved refrigerant or 1 percent (10,000 ppm) of any F500 classified waste or acid contaminant *and* if it is not headed for reclamation. Most refrigerant oil that has been exposed to a refrigeration system or a recovery process still contains greater than 5,000 ppm of dissolved refrigerant and acid gas.

The toxicity characteristic (TC) rule of 1990 subjected many more wastes to federal hazardous waste regulations. The TC rule sets regulatory limits on lead, benzene, and other contaminants. It is the contracted disposal service's responsibility to determine if used oil does or does not exceed the regulatory limits for TC constituents. Used oil that fails the TC must be disposed according to hazardous waste regulations.

Used oil from refrigeration equipment may contain appreciable levels of contaminants. It is important to maintain records that document the source of the oil and its ultimate disposal.

Caution: Do not mix refrigerant lubricants with other types of wastes!

Waste Oil Environmental Contacts

Cyn Environmental Services 1-800-242-5818

D-60.4 Equipment Disposal Guidelines

The EPA has established refrigerant equipment (appliance) disposal requirements in 40 CFR, 82.156, to ensure refrigerant is removed from equipment prior to scraping, shredding or landfill burial. Requirements exist for small appliances (< 5 pounds) and over 5-pound equipment.

Technicians and owners disposing of any refrigerant-containing equipment or small appliances must maintain records that show proper evacuation occurred. For appliances with less than 5 pounds there are several options. For large equipment with over 5 pounds, such as retail food refrigeration, cold storage warehouse refrigeration, rooftops, packaged units chillers, and industrial process refrigeration, the refrigerant shall be recovered in accordance with the EPA's evacuation requirements prior to dismantling or salvaging.

For small appliances a choice can be made to recover onsite or send the units to an EPA approved Scrap/recycling Company that has refrigerant removal capability.

When any refrigerant equipment is disposed, the refrigerant and oil must be removed from the equipment before its final disposal.

D-60.5 Equipment Disposal Record-keeping

The following information shall be documented for each on-site disposed of unit.

- ☑ Date of recovery.
- ☑ Equipment ID # or serial number(s).
- ☑ Refrigerant type and amount recovered.
- ☑ Technician's name & shop address
- ☑ Vacuum level achieved
- ☑ Organization receiving equipment.

No >5-pound equipment will be disposed of without removing the charge. A disposal tag similar to the following will be applied to the equipment after the recovery is complete. Without the tag, equipment may be refused at a landfill or scrap recycler.

An Environmental Disposal Tag similar to the following shall be attached to equipment being disposed. Without the tag, equipment may be refused at a landfill or scrap recycler.

ENVIRONMENTAL DISPOSAL TAG

ENVIRONMENTALLY HARMFUL REFRIGERANTS AND OIL HAVE BEEN REMOVED FROM THIS UNIT IN COMPLIANCE WITH SECTION 608 OF THE CLEAN AIR ACT

REMOVED BY: (PRINT)_____

COMPANY NAME: (PRINT)_____

ADDRESS: (PRINT)_____

_____

TELEPHONE:_____DATE:__/__/__

SIGNATURE_____

D-60.6 Small Appliances Sent Off-site with Charge Intact to Salvage Company

Small appliances, < 5 pounds, may be sent to an EPA approved salvage company with all systems intact (even if refrigerant leaked out).

Prior to sending any small appliances to salvage, you must determine in advance and receive a signed statement that the salvage yard has certified to the EPA that they recover the refrigerant before final disposal. Handle units with care to ensure none of the unit's systems or circuits is damaged during loading/off loading and in transit. Keep the signed statement from the Salvager on file.

Prepare a letter with the following information for appliances sent with the charge intact and provide a copy to the final disposer.

- ☑ Your company name, address, contact name
- ☑ Salvager's name and contact.
- ☑ Date of transaction.
- ☑ Unit model and serial numbers of all units sent.
- ☑ Refrigerant type.
- ☑ Include the following statement on the letter: "**This equipment or appliance containing refrigerant is subject to the "safe disposal requirements" of the Clean Air Act of 1990 as implemented by 40 CFR Part 82, Subpart F, 82.150-166, requiring that refrigerants be removed from equipment and appliances prior to final disposal.**"

Leaking Systems Requirements

D-70.1 Objective

To define a leaking system and describe the procedures which will be followed by technicians servicing such systems (40 CFR Part 82.156, Final Rule Summary and Refrigerant Leak Repair Flow Chart).

D-70.2 Statement of Intent

Williams College employees or contractors shall not charge refrigerant into a known leaking system.

D-70.3 Definition of a Leaking System

A system is defined as a "known" leaking system when one of the following conditions occurs:

- ☑ A review of readily available documentation determines that the system has a leak.
- ☑ Williams College or contractor technician has added refrigerant to the same system during a recent service visit.
- ☑ The service technician can readily determined upon arrival for servicing the equipment that the system has a refrigerant leak.

If a substantial leak is discovered, and cannot be repaired within thirty days, the leaking equipment must either be repaired, or a retrofit or retirement plan developed. Notify the Safety Coordinator and Foreman on systems that cannot be repaired within the thirty-day limit.

Since July 1, 1992 it has been against the law to intentionally vent refrigerants to the atmosphere while maintaining, servicing, repairing, or disposing of air conditioning or refrigeration equipment. Units under 50 that have chronic leaks (weekly top off) should also be repaired or replaced because the EPA can claim you are knowingly venting per the above law Since July 1, 1992 it has been against the law to intentionally vent refrigerants to the atmosphere while maintaining, servicing, repairing, or disposing of air conditioning or refrigeration equipment. Since July 1, 1992 it has been against the law to intentionally vent refrigerants to the atmosphere while maintaining, servicing, repairing, or disposing of air conditioning or refrigeration equipment.

D-70.4 Substantial Leak Limits for Equipment Over 50 lb.

A substantial leak is currently defined as a leak rate corresponding to 15% for comfort cooling and other refrigeration systems, 35% for industrial process and commercial refrigeration of the total system charge in a one (1) year period. The Refrigerant Compliance Manager™ (RCM) software automatically calculates equipment leak rates of all equipment. To manually determine if a system is above the federal regulatory level rate use the following formula:

$$\text{Annualized refrigerant leak rate} = \frac{365}{} \times \frac{RC}{} \times 100$$

$$\frac{NOD}{NRC}$$

Annualized refrigerant leak rate maximum = 15 % for comfort cooling & other refrigeration
35 % for industrial process & commercial

NOD = Number of days since most recent system charge
RC = Amount of refrigerant charged into system
NRC = Normal refrigerant capacity of system being charged

NOTE: Failure to make this calculation or enter the service work order into RCM promptly is not acceptable.

D-70.5 Leak Repairs in Less Than 30 Days

If a unit cannot be shut down to make leak repairs and it requires refrigerant to be charged into the leaking system, a technician should first obtain authorization from their supervisor and/or the Safety Coordinator. The authorization shall be documented on the RCM Service Order form along with the contributing factors delaying the repair of the leak and when and how the permanent repairs will be completed. The Service Order shall be entered into the RCM software promptly and identified as a leaking system on the Service Record screen. **NOTE: Do not fail to follow up on the repairs within 30 days.**

D-70.6 Leak Repairs in Greater Than 30 Days

Systems, which cannot be repaired in thirty days, must have a written repair/retrofit/replacement plan developed within 30 days of the date the unit exceeded its trigger rate. This plan should be entered in the RCM Equipment notes screen with the date and details of the reasons why the leak cannot be repaired. The plan must also include the plan of action for the repairs/retrofit or replacement and must be completed in one year from the plan date.

Industrial process refrigeration systems have up to 120 days before this plan is required if and only if a process must be shut down, but the reasons delaying the repairs beyond 30 days must also be documented.

Leak Testing Requirements

D-80.1 Objective

To describe when leak testing is to be conducted, documented and the approved methods.

D-80.2 Leak Testing

When leak testing new installations or systems after repair, the technician shall use approved testing methods. Use RCM Service Order Form to document all leak tests.

- ☑ Include leak testing during scheduled preventative maintenance inspections. Annually leak test each system with greater than 50 lbs of refrigerant as a best practice. (Mandatory in SQAQMD –Los Angeles)
- ☑ **Initial Leak Verification Test:** Leak test all equipment on the conclusion of major repairs and **prior to recharging** the unit with refrigerant.
- ☑ Document the results of the initial verification leak tests on RCM *Service Order Form*
- ☑ **Follow-up Leak Verification Test:** Schedule, conduct and document a 30-day follow-up verification leak test for all systems with over 50 lbs of refrigerant. This test must be completed within 30 days after the initial leak verification test was completed and with the unit operating at its normal load**.**
- ☑ Leak test all new contractor installed equipment prior to acceptance.

D-80.3 Acceptable Leak Testing Methods

All new equipment including: packaged equipment – factory charged, field charged, split systems or field-constructed systems with field installed refrigerant piping shall be leak tested during startup. On new equipment, leak testing should be performed with nitrogen set at a minimum of 150 psi and left standing for a predetermined amount of time.
The following are acceptable leak testing methods.

- ❑ Ultrasonic Leak detector
- ❑ Pressurizing system to 10 psig with HCFC-22 then increasing pressure to safe level with dry nitrogen.
- ❑ Soap bubbles
- ❑ Halide torch detector
- ❑ Deep Vacuum - Low-pressure chiller (pull to 1mm hg. Ok if rise is < 2.5 mm hg in 12 hours)
- ❑ Hydrostatic Tube test kit - Low pressure chiller water tube
- ❑ Electronic Leak detector
  Note: In order to leak test with an electronic detector, a trace gas must be mixed with the nitrogen. This is a last resort method of leak testing.

  Safety notice: Never use oxygen, high-pressure air or a flammable gas for leak checking. Oxygen and oil form an extremely explosive mixture.

Refrigerant Inventory Process

D-90.1 Objective

To define the processes on how refrigerant assets shall be managed and accounted.

D-90.2 EPA Purchase Records

The EPA requires that owner/operators track purchases of refrigerants used in units with over 50 pounds charge and maintain purchase records for five years. See Recordkeeping Requirements.

D-90.3 New Purchases

The following defines accountability for each administration level.

The Safety Coordinator is responsible for tracking current refrigerant inventory and new refrigerant purchases and refrigerant disposals. The Safety Coordinator shall develop a method to label/mark all refrigerant containers with a unique identification number that will be placed on the containers and into the RCM software.

Certified HVAC Technicians may sign out refrigerant cylinders by ID number per the methods defined by the Safety Coordinator for use in Williams College equipment. Fill out RCM Cylinder input forms or other documents as directed by the Safety Coordinator.

The HVAC Technicians will survey inventory every six months to assure purchases and usage are being properly recorded.

D-90.4 Storage of Refrigerants

The National Fire Protection Association (NFPA) codes and standards and local codes and standards along with ASHRAE Standard 15 – 1994 provide standards for storing refrigerants.

Do not store over 330 pounds of refrigerant in a mechanical equipment rooms (motors > 50 horse power).

Refrigerant stored in any room shall be secured to limit access to certified technicians only.

For storage in non-mechanical rooms ensure adequate ventilation. If poor ventilation is a concern change storage location or have a registered mechanical engineer review and perform ASHRAE Standard 15 calculations to determine if refrigerant sensors and alarms are necessary in storage rooms.

Preferred storage is in a large volume ground level warehouse type location within a securely fenced, locked area.

Contractor Requirements

To define requirements for managing refrigerant service contractors and contractors installing new equipment.

Contractor shall be responsible and accountable for compliance with the EPA Clean Air Act (CAA) Section 608, 40 CFR part 82 and any state and local codes for all refrigerant-related work. Contractor shall ensure that all contractor employees are made aware of the content of these practices prior to beginning work on refrigerant containing equipment.

Contractor shall provide only proper level EPA certified technicians using EPA certified and registered recovery/recycle units to perform work on new and existing Williams College refrigerant equipment.

Contractor shall submit the following information to the College Safety Coordinator or Project Manager prior to starting any work.

- ☑ A list of all service technicians' names and EPA certification numbers and level of certification (copies of EPA Certification Cards are acceptable).
- ☑ A list of all recovery/recycling units to be used and a signed statement that an EPA Recovery Unit Acquisition Certification form has been sent to the EPA (a copy of the form is acceptable).

Documentation and Record-Keeping

Contractor shall provide service records with all required information to the Safety Coordinator.

- ☑ Manufacturer and Model number
- ☑ Serial number
- ☑ Location of equipment
- ☑ Refrigerant type and Unit Charge
- ☑ Date of service or installation
- ☑ Service, repair or disposal description
- ☑ Quantity of refrigerant added
- ☑ Quantity of refrigerant removed, recovered, recycled, reclaimed or disposed of
- ☑ Quantity of lubricant disposed of, and method of disposal
- ☑ Detailed information on any leaks discovered and repaired
- ☑ Name(s) of EPA certified service technicians who performed work
- ☑ EPA Certified and registered recovery/recycling units used on equipment

Consequences for Non-Compliance

Williams College shall have the right to stop work under any contract at any time if the work fails to meet the EPA regulations.

Williams College shall have the right to withhold payment for services if the proper documentation of refrigerant work or related work is not completed.

New Equipment Guidelines

All new equipment installed shall utilize non-CFC-refrigerants. The goal is to limit the number of new alternative refrigerants utilized on site. Maintenance and inventory costs will be reduced by standardizing and limiting refrigerant types. The College Mechanical Maintenance Supervisor, and HVAC Foreman shall work as a team to determine what refrigerants are presently in use and set standards for all future refrigerant equipment purchases. In addition, further maintenance and parts inventory cost savings can be achieved by standardizing on equipment manufacturers. Service history and existing parts inventory shall be considered in this analysis and the recommendations presented to Project Managers.

New Equipment Leak Testing

All new equipment including: packaged equipment – factory charged, field charged, split systems or field-constructed systems with field installed refrigerant piping shall be leak tested prior to or during startup. The leak testing process shall utilize the appropriate method determined by the College Foreman and shall be witnessed by the College Foreman or a designated HVAC technician.

The HVAC Technicians and Safety Coordinator shall work with Williams College Project Managers and contractors to assure all new equipment is properly tagged and equipment data is provided to be entered into RCM.

New equipment shall be leak tested during startup and a report given to the Safety Coordinator. If detected, leaks shall be repaired before acceptance of the system. A thirty-day follow-up leak test shall be performed on systems which have had a leak detected during startup procedures.

Leak Testing

All new equipment including: packaged equipment – factory charged, field charged, split systems, or field-constructed systems with field installed refrigerant piping shall be leak tested during startup. On new equipment, leak testing should be performed with nitrogen set at a minimum of 150psi and left standing for a predetermined amount of time.

Note: - In order to leak test with an electronic detector, trace gas must be mixed with the nitrogen. This is a last resort method of leak testing.

The contractor or installing party shall submit a RCM Service Order form with notes verifying the leak testing and results to the Safety Coordinator or Project Manager.

If a leak is detected the following shall occur:

1. Notify the HVAC Technician.

2. Document the leak on a RCM Service Order input form.
3. Repair the leak.
4. Document the action and procedures taken on the RCM Service Order form.
5. Leak test to verify the leak was repaired.
6. Schedule and provide a 30-day follow-up verification leak test with a HVAC team member.
7. Document follow-up leak testing on the RCM Service Order form.
8. Repeat the above process if follow-up leak is detected.

Demolition Procedure for Equipment Removed by Contractors

Requirement for contractor to provide names of EPA certified technicians with their certification number and certification level who will be performing the refrigerant equipment demolition and refrigerant recovery. An *RCM Service Order Form* shall be filled out by the certified contractor technician and forwarded to the Safety Coordinator.

Note: *If a properly certified contractor technician removes the refrigerant, the unit tagged as such and the RCM Service Order form has been submitted then a non-certified person may perform the actual demolition.*

In all cases the contractor technician shall tag the unit that the refrigerant was removed. Tags can be obtained from the Office of Environmental Health & Safety.

ENVIRONMENTAL SAFETY NOTICE

ENVIRONMENTALLY HARMFUL REFRIGERANTS AND OIL HAVE BEEN REMOVED FROM THIS UNIT IN COMPLIANCE WITH SECTION 608 OF THE CLEAN AIR ACT

REMOVED BY: (PRINT)_____

COMPANY NAME: (PRINT)_____

ADDRESS: (PRINT)_____

_____

TELEPHONE:_____DATE:__/__/__

SIGNATURE_____

1. The contractor, in contractor provided refrigerant recovery cylinders shall take ownership of the recovered refrigerant and transport off site to a proper disposal company or certified reclaimer (**Unless other wise directed by the Project Manager**). The quantity removed from each unit and from the site shall be documented on the *RCM Service Order form* used for the actual recovery procedure.

Refrigerant Recovery Procedure

E-10.1 Objective

To define the procedures for recovering refrigerant; guidelines for proper filling of recovery cylinders and drums; recommended safety precautions; and an applicable evacuation levels chart.

E-10.2 Refrigerant Recovery Procedure

Follow the instructions for the specific recovery unit you are using and follow the general guidelines below where applicable.

Before Beginning Recovery:

1. Label all recovery cylinders with a refrigerant ID label for the type of refrigerant that it contains or will contain. Color-code all recovery cylinders as required: yellow top, gray body. Do not accept any exchange or new cylinders that are not color-coded or have an expired re-test date.
2. Maintain recovery equipment in proper working order. Change filter/dryers: a) after 200 lbs. of recovered refrigerant, b) when changing to a different refrigerant type, c) after refrigerant is recovered from a compressor burn-out, d) according to manufacturer's recommendations.
3. Leak-test each piece of recovery equipment every six months or per local regulations to ensure all units must meet the EPA mandated evacuation levels. **Note:** Certified technicians can be asked during an EPA inspection to demonstrate proper operating procedures of a recovery unit.
4. Follow the manufacturer's operating procedures for the equipment being used. Make sure that copies of the operating and maintenance procedures are attached to the equipment. Original operating instructions should be maintained in a file.
5. Install filters, if necessary.
6. Pull a five-to-ten minute vacuum on the system using a micron gauge to ensure refrigerant parity and to evacuate non-condensables.
7. Check safeties.
8. Evaluate if the unit or interconnection hoses trap any refrigerant that might mix and contaminate refrigerant.
9. Using quick connect fittings on the refrigerant hoses, connect the recovery equipment and cylinder to the equipment being serviced. Evacuate refrigerant hoses.

Start the Recovery Procedure:

1. Begin to withdraw liquid or vapor or both. Not all mechanical equipment is designed for access to the liquid refrigerant. It is the responsibility of the technician to determine this and make the proper decision.

Note: The ability to withdraw liquid is preferable for these reasons:

- ☑ Liquid withdrawal removes many contaminants in suspension.
- ☑ Water-charged heat exchangers will not freeze as readily.
- ☑ Withdrawal may be quicker, though processing may not be.
- ☑ Liquid withdrawal will pull all system contaminants into the recovery unit, while vapor recovery leaves them in the serviced system if the machine recovers by pulling refrigerant through its internal circuitry.

2. If able to recover in the liquid mode, monitor the recovery process until all liquid is recovered, then change to vapor-recovery mode. At all times monitor the weight of refrigerant in the recovery cylinder.
3. Ensure that the EPA mandated vacuum levels are reached and record levels achieved.
4. Use a digital scale to record the amounts of refrigerant recovered. When recovering large amounts of refrigerant, use a drum or hanging scale.
5. Drain the oil separator to ensure no contamination of the refrigerant occurs.
6. After reaching the required vacuum level, isolate the equipment, turn off the recovery unit, and watch the gauges. An increase in pressure may indicate additional refrigerant in the equipment system requiring additional recovery.
7. When recovery is complete, secure all equipment and proceed with the repair.

If using:	Then:
An empty recovery cylinder	Evacuate to ensure no contamination occurs.
An unknown/unlabeled recovery cylinder that already contains refrigerant	Determine or test refrigerant quality and type.
A recovery unit equipped with an automatic low pressure shutoff	Wait and watch for at least five minutes after the unit shuts off when system goes into vacuum to determine whether all liquid and residual vapors have been withdrawn. A rise in pressure from a vacuum indicates more refrigerant to recover.
A recovery unit which automatically restarts on system pressure rise	Let it cycle until all possible refrigerant has been recovered. This type of unit must not be operated unattended.
A refrigeration unit with a suspected air-side or water-side leak	Recover only to atmospheric temperature to prevent air from entering the system and document this action.

E-10.3 Applicable Evacuation Levels

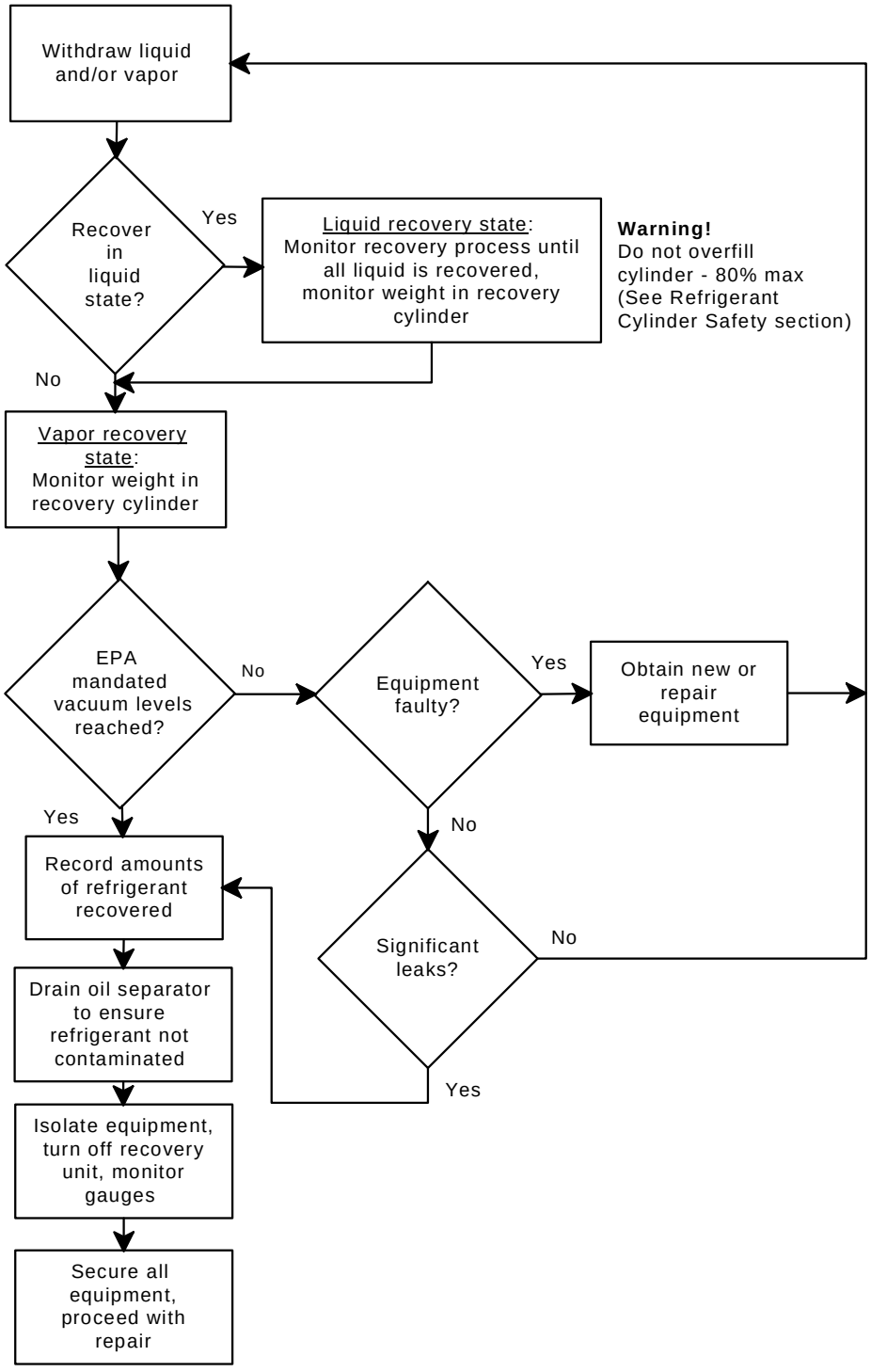
When servicing or disposing of equipment, certified technicians must evacuate the refrigerant with an approved recovery unit. Applicable evacuation levels specified in the chart below must be met.

Type of Appliance	Recovery Units Manufactured Date	
	Before Nov. 15, 1993 Grandfathered Unit	**After Nov. 15, 1993 ARI/UL Unit**
R-22, R-402A/B, R-407A/B/C appliance, or isolated component of such appliance, normally containing less than 200 pounds of refrigerant.	0	0*
R-22, R-402A/B, R-407A/B/C appliance, or isolated component of such appliance, normally containing 200 pounds or more of refrigerant.	4	10
Very High Pressure Appliance **R-410A/B, R-13, R-23, R-503**	0	0
Other high-pressure appliance, or isolated component of such appliance, normally containing less than 200 pounds of refrigerant. **R-12, R-114, R-134a, R-401A/B/C, R-500, R-502**	4	10
Other high-pressure appliance, or isolated component of such appliance, normally containing more than 200 pounds of refrigerant. **R-12, R-114, R-134a, R-401A/B/C, R-500, R-502**	4	15
Low-Pressure Appliance **R-11, R-113, R-123**	25	25 mm Hg absolute
*** Inches of Hg vacuum relative to standard atmospheric pressure of 29.9 inches of Hg, except where noted.**		

For small appliances (less than 5 pounds), evacuation levels are as follows:

- ☑ for "grandfathered" recovery equipment, recover 80 percent.
- ☑ for new recovery equipment when the compressor is working, recover 90 percent.
- ☑ for new recovery equipment when the compressor is not working, recover 80 percent.
- ☑ for all appliances, evacuate to 4 inches of mercury vacuum.

E-10.4 Refrigerant Recovery Procedure Process Diagram



Refrigerant Cylinder Identification

E-20.1 Objective

To describe the color and labeling procedure for refrigerant cylinders.

E-20.2 Refrigerant Container Color

Containers for recovered refrigerant should be colored according to ARI Guideline K-1997, Containers for Recovered Fluorocarbon Refrigerants. This guideline requires a color scheme of gray with a yellow cap. Since it applies for all recovered refrigerants, it is imperative that recovered refrigerant containers be marked or tagged to avoid recovering different refrigerants into the same cylinder.

- ☑ Cylinders with non-removable collars: the body shall be gray, the collar shall be yellow.
- ☑ Cylinders with removable caps: they body shall be gray, the shoulder and cap shall be yellow.
- ☑ Drums: the drum shall be gray, the top head shall be yellow.
- ☑ Tons: the body shall be gray, the ends and chimes shall be yellow.

E-20.3 Virgin Refrigerant Container Color and Class Matrix

Refrigerant	Color	PMS #	Class
11	Orange	021	I
12	White	None	II
13	Light Blue (Sky)	2975	III
13B1	Pinkish-Red (Coral)	177	III
14	Yellow-Brown (Mustard)	124	III
22	Light Green	352	II
23	Light Blue-Grey	428	III
113	Dark Purple (Violet)	266	I
114	Dark Blue (Navy)	302	II
116	Dark Grey (Battleship)	424	III
123	Light Blue-Grey	428	I
124	Deep Green (DOT Green)	335	I
125	Medium Brown (Tan)	465	I
134a	Light Blue (Sky)	2975	II
401A	Pinkish-Red (Coral)	177	II
401B	Yellow-Brown (Mustard)	124	II
401C	Blue-Green (Aqua)	3268	II
402A	Light Brown (Sand)	461	III
402B	Green-Brown (Olive)	385	III
404A	Orange	021	III
407A	Lime Green	368	III
407B	Cream	156	III
407C	Medium Brown (Brown)	471	III
408A	Medium Purple (Purple)	248	III
409A	Medium Brown (Tan)	465	II
Refrigerant	**Color**	**PMS #**	**Class**
410A	Rose	507	III

Source:
ARI Guidelines N-1995,
ARI Guidelines K-1997

PMS =
Pantone® Matching System, an international printing, publishing and packaging color language.

410B	Maroon	194	III
500	Yellow	109	II
502	Light Purple (Lavender)	251	II
503	Blue-Green (Aqua)	3268	III
507	Blue-Green (Teal)	326	III
717, NH_3	Silver		
Any Recovered	Yellow/Gray		

E-20.4 Refrigerant ID Labels and Usage Tags

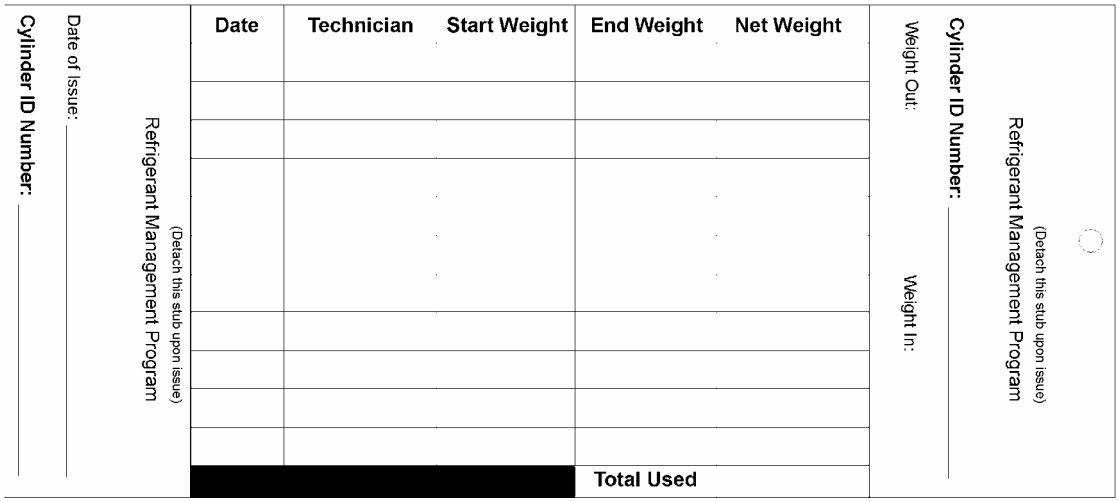
It is essential to know what refrigerant is in a given cylinder. Therefore, recommended guidelines have been established for labeling refrigerant cylinders. ARI Guideline N-1995, Assignment of Refrigerant Container Colors, sets color standards for existing, new and reclaimed refrigerants. Purchase and place an appropriate color coded refrigerant ID labels for each refrigerant recovery cylinder, tank or drum (available from most local distributors). For each recovered refrigerant type, mark the cylinder with refrigerant condition (good, unknown, contaminated). If you have mixed refrigerants mark it as mixed and do not use.

E-20.5 Sample Refrigerant Identification Labels

Each container shall be marked will a DOT proper shipping name and an appropriate UN identification number. Refer to Refrigerant Transporting/Shipping section for more information.

E-20.6 Sample Cylinder Usage Tag

Utilize a refrigerant usage tag when multiple users/shifts utilize a refrigerant cylinder, tank or drum. The following is a sample.



Refrigerant Management Program
(Detach this stub upon issue)
Date of Issue: _____
Cylinder ID Number: _____

Date	Technician	Start Weight	End Weight	Net Weight
			Total Used	

Refrigerant Management Program
(Detach this stub upon issue)
Cylinder ID Number: _____
Weight Out: _____ Weight In: _____

Contamination Avoidance

E-30.1 Objective

To define the practices which shall be followed to avoid contaminating a recovery container.

E-30.2 Statement of Intent

Refrigerant shall not be mixed. Refrigerant that is contaminated can cause future service problems. Every effort to avoid contamination shall be made. Reclamation centers will not accept mixed refrigerants. Williams College can be charged for disposal of the mixed gases.

E-30.3 Standard Procedures

Remove and dispose of recovery/recycling filters when changing refrigerants. Filters include Cartridge Filter cartridges, Inline filters (both suction and liquid), and Bullet filters.

Properly label refrigerant cylinders in accordance with ARI Guidelines K. Refer to the Refrigerant Cylinder Identification for specifics.

Recover residual refrigerant from the service gauge set and hoses after each service procedure *or* have a gauge set for each type of refrigerant.

Properly prepare the recovery/recycling machine to receive each refrigerant per manufacturer's specifications. This includes completely removing the residual refrigerant left in the machine. Before changing refrigerant types, draw a vacuum to assure that all contaminates in the equipment have been removed.

Properly prepare the recovery cylinder to receive each refrigerant per manufacturer's specifications. This includes completely removing the residual refrigerant left in the cylinder. Before changing refrigerant types, draw a vacuum to assure all possibility of contaminants in the refrigerant has been removed.

Used Refrigerant Handling

E-40.1 Objective

To define which of the following three options should be used when dealing with refrigerant that has been recovered from a system.

Option 1: Put refrigerant back into the system without recycling it.

Option 2: Recycle refrigerant and put it back into the system from which it was removed or return to inventory for use in Williams College owned equipment.

Option 3: Send refrigerant to a certified reclaimer or vendor.

E-40.2 Introduction

If the refrigerant is put back into the system it was removed from, or saved for use in an other system, the recovered refrigerant contaminant levels shall not exceed the levels in the Maximum Containment Level Table. If the contaminant levels are exceeded, the refrigerant should be recycled or reclaimed, or new refrigerant used. Since it is not always practical or feasible to confirm that a recovered or recycled refrigerant meets these levels by test, these guidelines have been written to give the servicing personnel some criteria to help determine which of the three options covered in the "Objective" should be chosen.

There are several factors that need to be considered when deciding what to do with recovered refrigerant. These factors include:

1. Reason system is being serviced,
2. Condition of refrigerant and system,
3. Equipment manufacturers' policies,
4. Refrigerant cleaning capability of recycling equipment.
5. Feasibility and Maintenance departments' preference.

After all of these factors have been evaluated, the service technician should be able to make a decision.

General Comments

Regardless of whether recycled refrigerant or new/reclaimed refrigerant is put into a system, the system must be properly cleaned and evacuated prior to putting refrigerant back into the system. Manufacturer's recommended service procedures should be followed to ensure that the system is free of contamination before any refrigerant is put into the system. At a minimum, all driers in the system should be replaced and systems with compressor burnouts should have a suction line filter/drier added to assist in removing acids that will be in the oil that remains in the system.

If the refrigerant is removed from a system, recycled and returned to a system, there are several other things to keep in mind. Recovery cylinders must be kept clean so that refrigerant that has been recycled does not become contaminated again when it enters the recovery cylinder.

Cleaning and maintaining recycling and recovery equipment regularly, especially after the equipment has been used on jobs with very contaminated refrigerants, is very important to ensure that the contamination from the previous job does not transfer to the next job.

E-40.3 Recycled Refrigerants

Refrigerants that are recovered and recycled should not exceed the Maximum Contaminant Levels before reuse as shown in the following table:

Maximum Contaminant Levels of Recycled Refrigerants in Same Owner's Equipment			
Contaminants	**Low Pressure Systems**	**R-12 Systems**	**All Other Systems**
Acid Content (by wt.)	1.0 PPM	1.0 PPM	1.0 PPM
Moisture (by wt.)	20 PPM	10 PPM	20 PPM
Non-Condensable Gas (by Vol.)	N/A	2.0%	2.0%
High Boiling Residues (by Vol.)	1.0%	0.02%	0.02%
Chlorides by Silver Nitrate Test	No turbidity	no turbidity	no turbidity
Particulates	Visually clean	visually clean	visually clean
Other Refrigerants	2.0%	2.0%	2.0%
Note: To insure that the recycling equipment maintains its demonstrated capability to achieve the above levels, it must be operated and maintained per the equipment manufacturer's recommendations.			

Laboratory testing is your only sure assurance that contaminant levels are not exceeded, but it may be accomplished if the recycle unit is capable of recycling refrigerants to the levels in the table.

E-40.4 Mixed Refrigerants

Mixed refrigerants refer to the situation where refrigerants become unintentionally mixed as opposed to commercially available zeotropic or azeotropic blends. Mixed refrigerants:

- ☑ Have adverse impact on operating systems performance and capacity.
- ☑ Affect lubrication, equipment life operating costs and warranty costs.
- ☑ Have a higher cost for disposal.

Determining the Presence of Mixed Refrigerants

Determine the presence of mixed refrigerants with a laboratory test; or check the saturation pressure and temperature of the refrigerant in the system and compare with the published values for this refrigerant in a pressure-temperature chart.

Blend Refrigerants

E-50.1 Blend Refrigerants/Retrofits

Only use a retrofit refrigerant, which has been approved by the original air conditioning manufacturer and as approved by the EPA's "SNAP" list.

System modifications may include hoses, a high-pressure cutout device, seals, desiccant, lubricant, refrigerant control replacement, increased condenser capacity and other modifications as determined by the equipment manufacturer. Not following the OEM recommendation may result in system damage, loss of performance and affect the warranty.

It should be noted that blend refrigerants may not be compatible with CFCs, HCFCs, or HFCs and may require separate service equipment.

There are two situations that a technician may encounter when working with blends:

Blend Fractionation

Blend fractionation is when one or more refrigerants of the same blend leak at a faster rate than the other refrigerants in the same blend. This different leakage rate is caused from the different partial pressures of each constituent in the near-azeotropic mixture. Fractionation also occurs because the blends are near-azeotropic mixtures and not pure compounds, or pure substances like CFC-12. Fractionation was initially thought of as a serviceability barrier because the original refrigerant composition of the blend's constituent may change over time from leaks and recharges.

To avoid fractionation, charging of a refrigeration system incorporating a near-azeotropic blend should be done with **liquid** refrigerant whenever possible. To ensure that the proper blend composition is charged in the system, it is important that only liquid be removed from the charging cylinder. Cylinders containing near-azeotropic blends are equipped with dip tubes, allowing liquid to be removed from the cylinder in the upright position. When adding liquid refrigerant to an operating system, make sure liquid is throttled, thus vaporized, into the low side of the system to avoid compressor damage. A throttling valve can be used to ensure that liquid is converted to vapor prior to entering the system.

Blend Temperature Glide

Near-azeotropic ternary blends have temperature glides (a range of condensing or evaporating temperatures for one pressure) when they evaporate and condense. A pure compound like CFC-12, boils and condenses at a constant temperature for a given pressure. Since the blends are near azeotropic, they will have some "temperature glide" or a range or temperatures in which they will boil and condense. The amount of glide will depend on system design and blend makeup. Temperature glide can range from 2 to 12 degrees Fahrenheit. Since the saturated liquid temperature and the saturated vapor temperature for a given pressure are not the same, the constituent in the blend with the highest vapor pressure (lowest boiling point) will reach 100 percent saturated vapor before the other constituents. Sensible heat will not be gained by this

refrigerant while the other constituents in the blend are still evaporating. This same phenomenon happens during the condensing cycle.

Some systems will not be affected by this temperature glide because it is design dependent. System design conditions must be evaluated when retrofitting with a blend. Because of the high percentage of HCFC-22 in some blends, the compressor may see higher condensing saturation temperatures and pressures when in operation. Because HCFC-22 has a relatively higher heat of compression when compared to other refrigerants, a higher discharge temperature may be experienced.

E-50.2 Refrigerant Blend Nomenclature

Refrigerant blends are designated by their refrigerant numbers and weight proportions. The refrigerants will be listed first in order of increasing boiling points, followed by their respective weight percentages.

The blends also have refrigerant "R" numbers:

The 400 series blends represent the near-azeotropic refrigerant blends.
The 500 series blends represent the azeotropic blends.

For example:

R-401 would indicate that the blend is a near-azeotrope, and the 1 would indicate that it is the first 400 series blend commercially produced.

R-502 would indicate that the blend is an azeotrope, and the 2 would indicate that it is the second 500 series blend commercially produced.

E-50.3 SNAP Approved Refrigerant Replacement Blends

Blend	Producer	Base	Lubricant	Application
R-401A 22/152a/124 (53/13/34% wt.)	Dupont MP39	HCFC	Alkylbenzene	Medium Temperature R-12
R-401B 22/152a/124 (61/11/28% wt.)	Dupont MP66	HCFC	Alkylbenzene	Transportation Refrigeration and Low Temperature R-12
R-402A 22/125/290 (38/60/2% wt.)	Dupont HP80	HCFC	Alkylbenzene & some Ester	Low and Medium Temperature R-502
R-402B 22/125/290 (60/38/2% wt.)	Dupont HP81	HCFC	Alkylbenzene	Low and Medium Temperature R-502
R-403B 22/218/290 (55/39/5% wt.)	Rhone Poulenc ISCEON69L	HCFC	Mineral Alkylbenzene Polyol Ester	Low Temperature R-13 & R-503
R-404A 125/143a/134a (44/52/4% wt.)	Dupont HP62 ELF Atocem FX70	HFC	Polyol Ester	Low and Medium Temperature RefrigerationR-502
Blend	**Producer**	**Base**	**Lubricant**	**Application**
R-406A	GHG12	HCFC	Mineral	Stationary R12

22/142b/600a (55/41/4%)	National Refrigerants		Alkylbenzene	Refrigeration. R-12
R-407A 32/125/143a	ICI Americas KLEA 60	HFC	Ester	Low and Medium Temperature R-502
R-407C 32/125/134a (30/10/60% wt.)	Dupont Suva 9000 KLEA 66	HFC	Polyol Ester	Air Conditioning R-22
R-408A 22/125/143a (47/7/46% wt.)	FX10 ELF Atocem	HCFC	Mineral Alkylbenzene Polyol Ester	Low and Medium Temperature R-502
R-409A 22/124/142b (60/25/15% wt.)	FX56 ELF Atocem	HCFC	Mineral Alkylbenzene Polyol Ester	Low and Medium Temperature R-12
R-410A 32/125 (60/40% wt.)	Allied Signal AZ-20	HFC	Ester	High & Medium Temp. Refrigeration., Air Conditioning (Azeotrope) R-22
R-507 125/143a (45/55% wt.)	Allied Signal AZ-50	HFC	Ester	Low and Medium Temperature (Azeotrope) R-502 & R-22
R-508a 23/116 (39/61% wt.)	National Refrigerants	HFC	Polyalpha Olefin Alkylbenzene Mineral	Very Low Temperature Refrigeration. R-503
R-508b 23/116 (46/54% wt.)	Dupont Suva95	HFC	Polyolester Manufacturer recommendation	Very Low Temperature Refrigeration. Cascade R-503, R-13
Note: Constituent percentages and lubricant applications may change or vary as research continues.				

Lubricants

E-60.1 Objective

To provide general information on the use of lubricants in systems containing refrigerants and define the EPA maximum pressure for changing oil.

E-60.2 EPA Pressure Limit for Removing Refrigerant Oil

When changing oil, five (5) psig is the maximum EPA legal pressure a system may be subjected to [40 CFR Part 82 Subpart F §82.156 (a)(2) C].

E-60.3 Lubricants

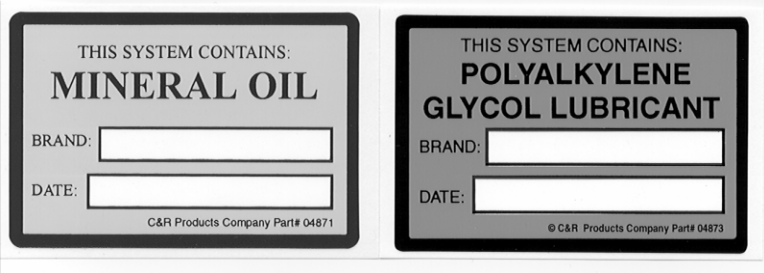
CFC and HCFC systems have traditionally used mineral oil lubricants. HFC-134a and the other alternative refrigerants use several types of synthetic lubricants. (Polyalkylene Glycol, Polyol Ester, Alkylbenzene) The manufacturer's label should identify the correct type of lubricant required. Mixing of synthetic lubricants may also cause system problems. Use only the lubricant specified by the AC/R system manufacturer. RCM *Equipment input form* has a data field to enter lubricant type.

If HFC-134a systems have an overcharge of lubricant, the lubricant may collect in the evaporator and result in warmer evaporator outlet temperatures. Proper system lubricant charge is important.

Refer to Disposal of Refrigerant, Lubricants and Equipment section for proper disposal guidelines.

Labeling units is a best practice to prevent mixing or filling units with the wrong lubricant.

Sample lubricant labels



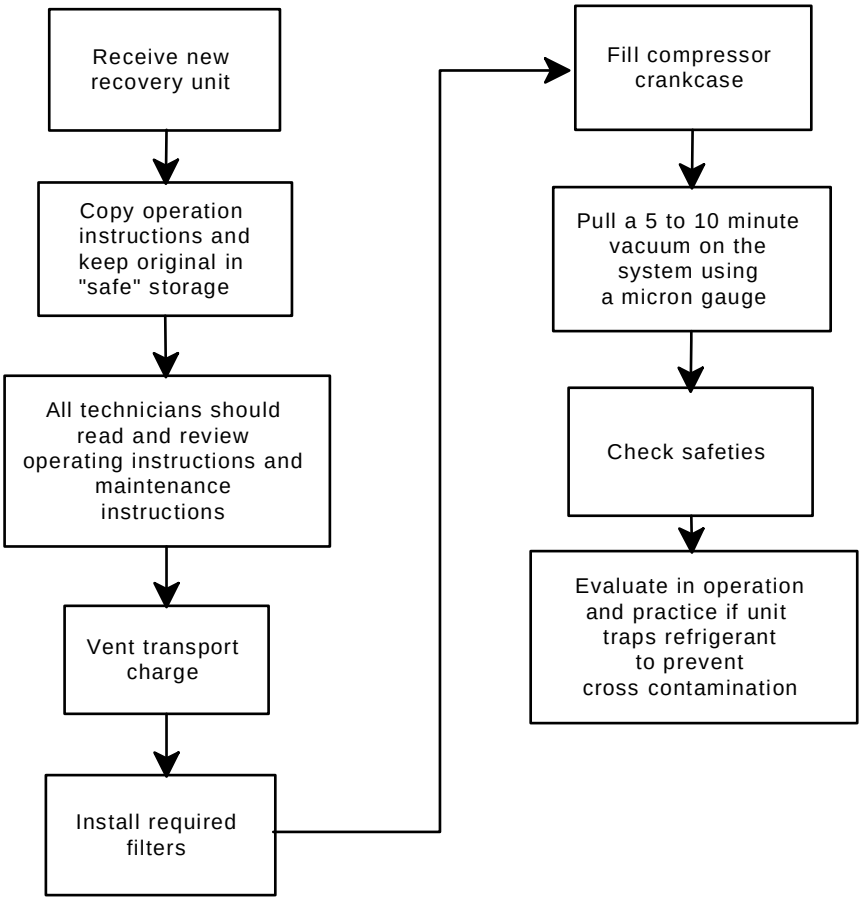
Local AC/R wholesaler

General Processes

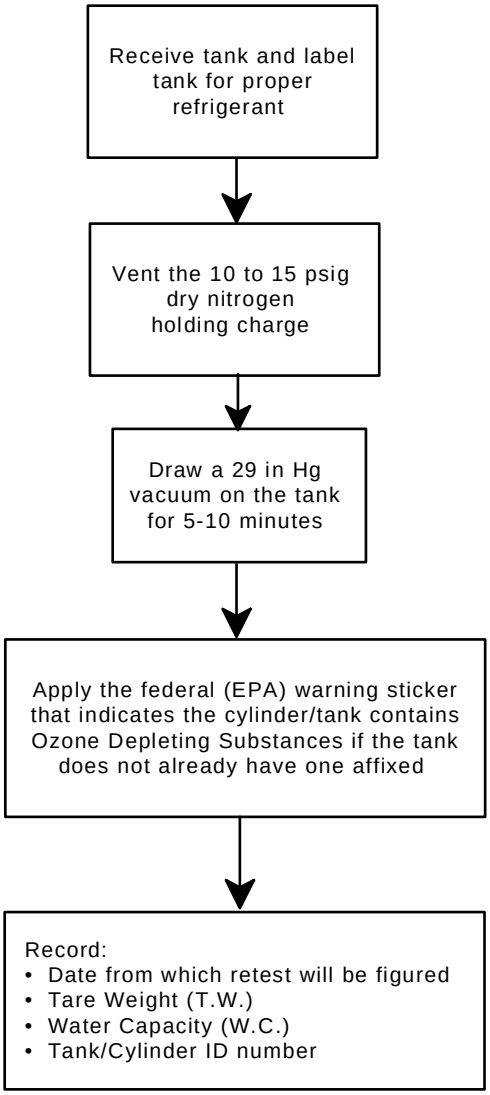
E-70.1 Objective

The following general processes have been developed to provide guidance to the technician. The actual process the technician uses will be dependent on their equipment and circumstances. These diagrams are intended to provide general information only.

E-70.2 Preparation of a New Recovery Unit

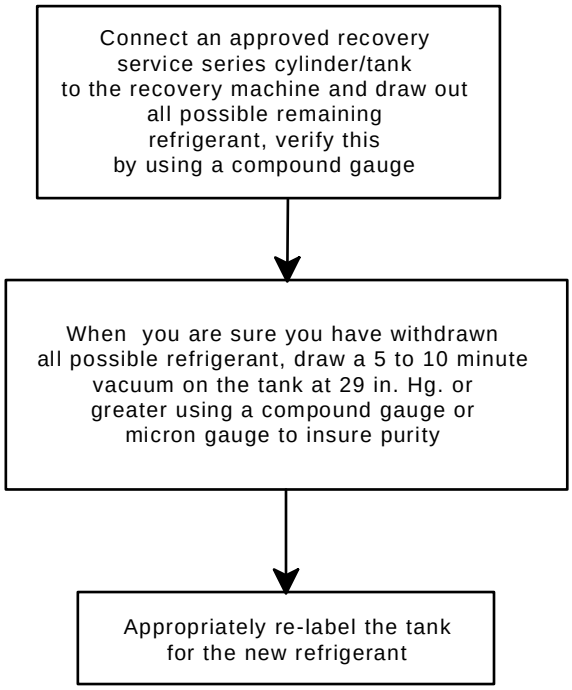


E-70.3 General Procedure for Preparing a New Recovery Cylinder



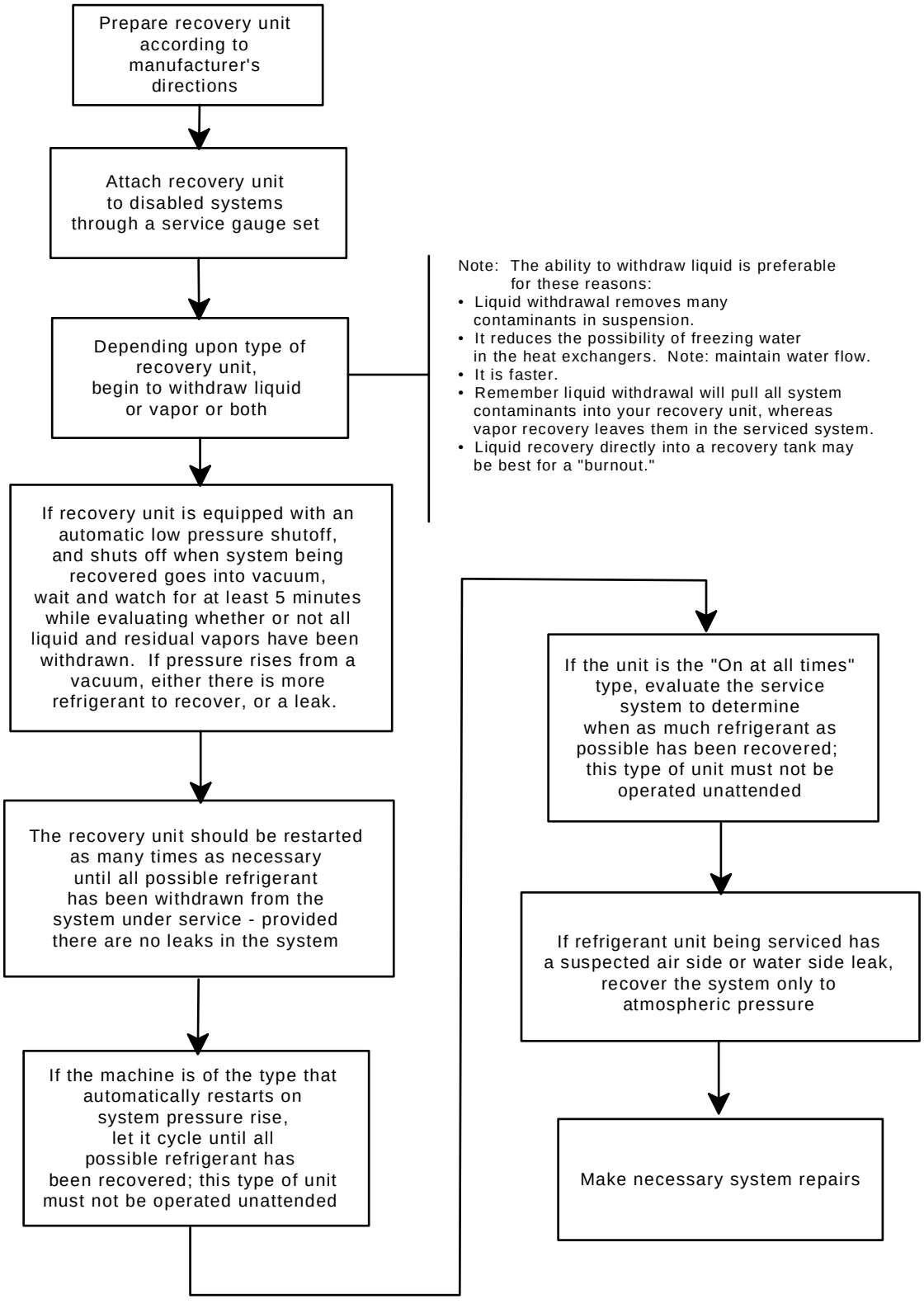
E-70.4 Sample Refrigerant Identification Labels

E-70.5 General Procedure for Switching Refrigerants in a Recovery Cylinder/Tank

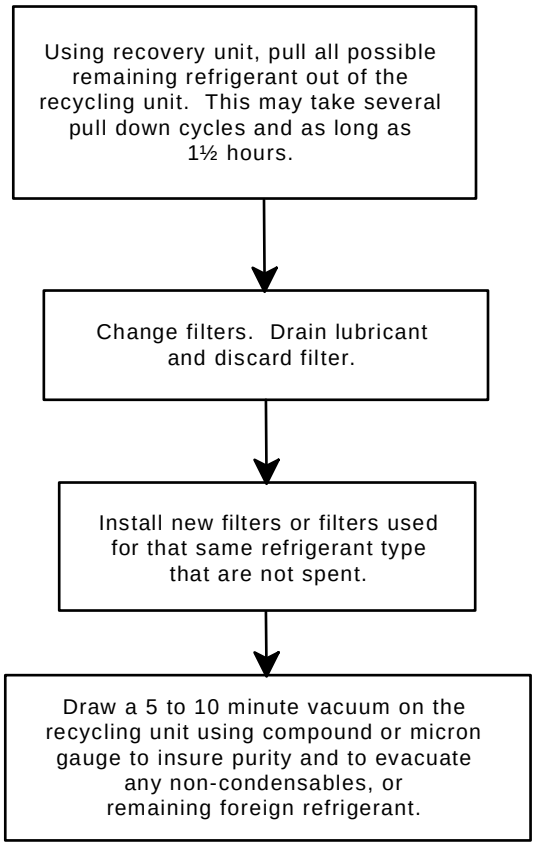


Note: It is recommended that a separate recovery cylinder/tank for each refrigerant be used to minimize cross contamination

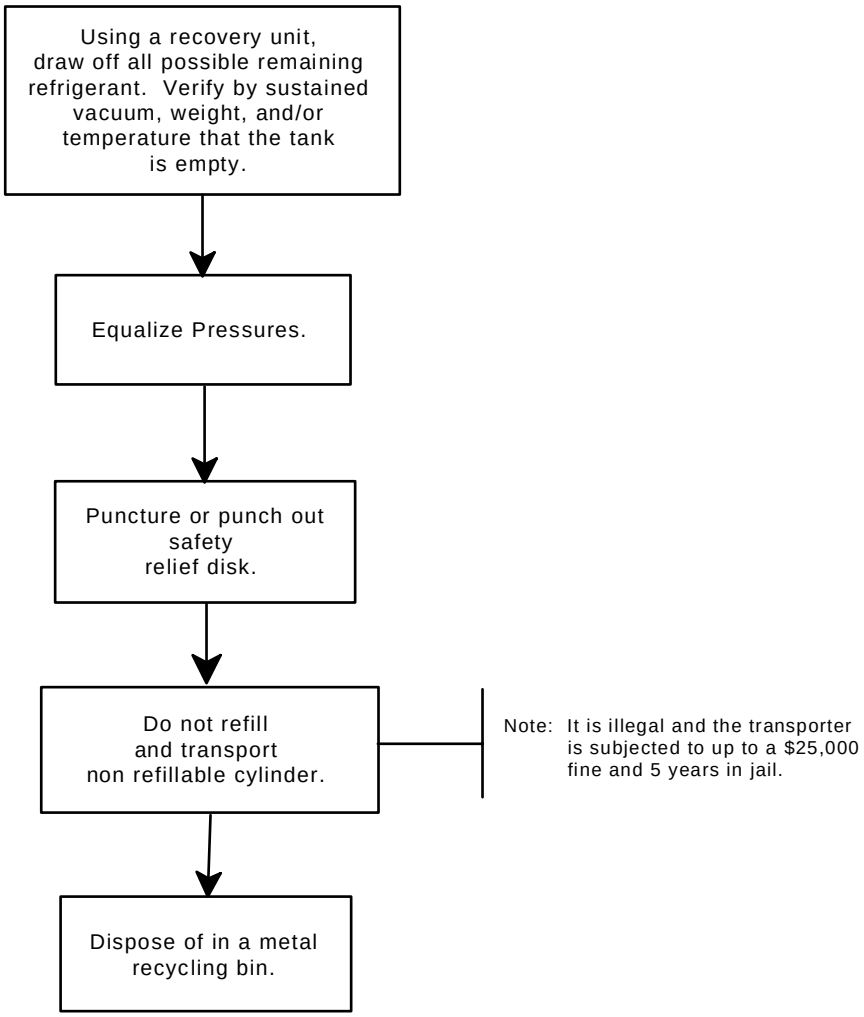
E-70.6 General Procedure for Recovering Refrigerant from a Unit Prior to Servicing



E-70.7 General Procedure for Switching Refrigerants in a Recovery Unit



E-70.8 Procedure for Disposal of Non Refillable Refrigerant Cylinders



Accidental Refrigerant Release

E-80.1 Objective

To define the federal regulations 40 CFR Part 82 requirements on refrigerant venting and accidental refrigerant releases.

E-80.2 Venting Prohibitions

Since July 1, 1992 it has been against the law to intentionally vent refrigerants to the atmosphere while maintaining, servicing, repairing, or disposing of air conditioning or refrigeration equipment. Acceptable releases are:

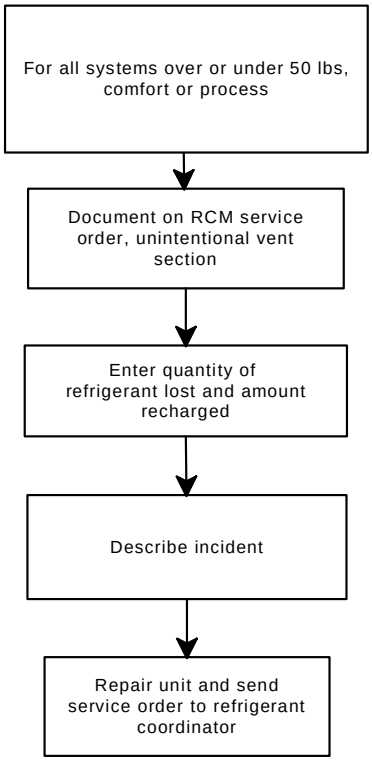
- ☑ A "de minimus" quantity released in the course of making a good faith attempt to recapture, and recycle or safely dispose of refrigerant. An example of a de minimus leak would be the quantity of refrigerant released while disconnecting a manifold gauge set.
- ☑ Refrigerants emitted during the normal course of operation of air conditioning and refrigeration equipment such as purge unit operation.
- ☑ Mixtures of nitrogen and trace quantities of R-22 that are used as a holding charge or as a leak test gas, because in these cases they are not used as refrigerant.

E-80.3 Accidental Refrigerant Release Report

If an accidental refrigerant release occurs such as human caused accidental damage to a refrigerant line, service valve or cylinder the incident shall be documented on the RCM Service Order form. Check the accidental release box on the Service order input form and describe the details of the incident and the repair details in the notes section.

NOTE: Do not record mechanical failures of a unit as an accidental release because the quantity of refrigerants entered is not used in leak rate calculations.

E-80.5 Accidental Refrigerant Release Flow Chart



If venting exceeds 10,000 lbs of a CFC or HCFC refrigerant, notify environmental department. (EPCRA Section 313)

Note: the key point to remember is to document refrigerant usage.

Refrigerant Cylinder Safety

E-90.1 Background

Safety shall be the first priority. The following guidelines provide information on cylinder safety.

E-90.2 Refrigerant Cylinder Safety

Never use a standard disposable 30 lb. cylinder (the type of container in which virgin refrigerant is sold) to recover refrigerant. Use only DOT CFR Title 49 or UL-approved storage containers for recovered refrigerant (containers marked DOT 4BW or DOT 4BA).

E-90.3 Thermal Expansion

- ☑ Safety codes recommend that closed cylinders not be filled over 80% of the volume with liquid. The remaining 20% is called head pressure room.
- ☑ Refrigerant expands when it gets warm.
- ☑ When refrigerant expands some of it boils, thus increasing the pressure.
- ☑ Remaining liquid expands rapidly and may fill the container 100% full with liquid.
- ☑ Pressure within the cylinder increases at a slower rate if there is room for the gases. The pressure increases to the liquid saturation.
- ☑ A cylinder filled with 80% liquid is relatively safe. Do not fill cylinders over 80%.

Cylinder Temp.	**60º F**	**70º F**	**100º F**	**130º F**	**150º F**
	Space Occupied with Liquid				
Starting with Cylinder 80% Full	80%	81%	83%	90%	94%
Starting with Cylinder 90% Full	91%	92%	96%	Cylinder is 100% full Liquid @113º Pressurizes Very Rapidly	**Explosion** 
DO NOT OVERFILL REFRIGERANT CYLINDERS					

E-90.4 Guidelines for Proper Filling of Recovery Cylinders

Cylinder integrity

Prior to filling a cylinder, inspect for signs of damage such as dents or corrosion. Do not fill a damaged or out of date cylinder. Use only recovery cylinders identified for used refrigerant. Do not use cylinders designed for virgin refrigerant. Recovery cylinders should comply with Department of Transportation (DOT) specification 4BA300 and 4BW.

If a cylinder does not hold a vacuum, (29 in hg for 20 minutes) the cylinder should not be used.

Cylinder test date

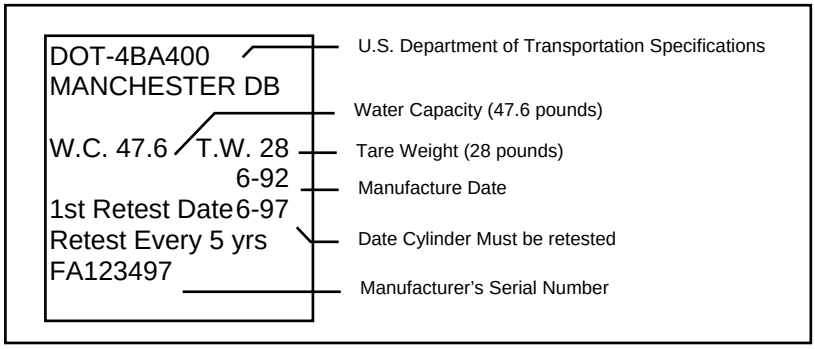
A recovery cylinder should not be filled if today's date is more than five years after the date of manufacture or after the retest date stamped on the shoulder. If the cylinder has been tested the test date will look similar to the following example:

B2

12 93

22

The designation in the above example indicates the cylinder was re-tested in December 1993 by re-tester number B222. **Enter the date the cylinder is to be retested in the RCM Cylinder input form or screen.**



Cylinder Collar, Stamped with Information

Legal fill

Liquid used refrigerant will expand when exposed to high temperatures. Thermal expansion of the liquid in an overfilled cylinder could rupture it. When filling recovery cylinders, carefully monitor the gross weight to ensure this maximum is never exceeded.

Gross Legal Fill Weight (GLFW) for every cylinder, container, cylinder, or other vessel is always 80 percent of capacity. The responsibility rests with the technician to shut off the transfer machine at 80 percent cylinder fill for cylinders that don't do so automatically. By weight, the formula is as follows:

$$GLFW = (0.8 \times WC) + TW$$

WC = Water Capacity: the weight of the fluid that would fill the cylinder 100 percent.
TW = Tare Weight: the weight of the empty cylinder.

Both these weights plus the test date will be stamped on the collar or chine of the cylinder.

For HCFC-22 and/or refrigerants in cylinders, which will encounter large temperature fluctuations, the automotive sector's formula is recommended to allow more head/expansion space in the cylinder:

$$GLFW = (0.6 \times WC) + TW$$

Look at regularly, but do not trust exclusively, a percent-fill gauge or an automatic shut-off device.

Vapor pressure

When a compressor is used to recover used refrigerant vapors from a refrigeration unit, monitor cylinder pressure to avoid exceeding the relief valve set pressure (450 psig). To ensure optimum safety, a maximum cylinder pressure of 300 psig during the filling operation is recommended.

Sealing

After filling, verify that all cylinder valves are closed properly to prevent leaks during subsequent handling and shipping. If necessary, leak test the valve with soapy water.

E-90.5 Guidelines for Filling of Recovery Drums

Recovery drum

The recovery drum must be a tight-head drum, 55-, 20-, or 10-gallon capacity, of 16-gauge steel made to DOT 17E specifications. If a drum is reused, thoroughly inspect it for damage and identify it as a recovery drum by wrapping a strip of yellow tape around the upper one-third of the drum and re-labeling it. Never store used refrigerant drums in open sunlight or in hot areas with poor ventilation. Adequate ventilation is mandatory for technician safety.

Liquid overfilling

Liquid used refrigerant will expand when exposed to high temperatures. Thermal expansion of the liquid in an overfilled drum could cause it to bulge or rupture. To prevent this, fill drums of used refrigerant so that the liquid level is below the top of the drum. The recommended distance between the liquid level and the top of the drum depends on the drum size, as indicated below:

Drum size, gallons	Recommended distance, in. (cm)
55	6 (15)
20	3 (7.6)
10	2 (5.0)

Filling temperature

When hot used refrigerant is loaded into a drum and the drum is properly sealed, a vacuum will form above the liquid as it cools. In extreme cases, the drum may collapse. To avoid this, observe a maximum filling temperature of 13°C (55°F).

Sealing

After filling the drum, verify that the bung is properly installed and tightened to prevent leaks during subsequent shipping and handling. Weigh filled recovery drums prior to shipping.

E-90.6 Precautions for Recovery Drums

Use personal protective equipment such as side shield glasses, gloves, safety shoes, and hardhat when filling and handling containers.

Be aware that inhalation of high concentrations of used refrigerant vapor or mist can be harmful and may cause heart irregularities, unconsciousness, or death. Since vapor is heavier than air, avoid low areas without suitable ventilation or refrigerant-specific monitors.

Glossary

Acute effects	Detrimental health effects resulting from a single, short-term exposure to a toxic substance, as might occur during an accidental release of refrigerants.
Alkylbenzene	A lubricant synthesized from the raw materials propylene and benzene. Used often when incorporating HCFC-based refrigerant blends. Some HCFC-based blends are soluble in a mixture of mineral oil and alkylbenzene up to a 20 percent concentration of mineral oil.
Allowable exposure limit (AEL)	Acceptable concentration levels in air, which are deemed safe for repeated occupational exposure without chronic effects. The chemical producer normally recommends this level.
Appliance	Any device which contains and uses a class I or class II substance as a refrigerant and which is used for household or commercial purposes, including any air conditioner, refrigerator, chiller, or freezer.
Approved equipment testing organization	Any organization which has applied for and received EPA approval
Azeotrope	A mixture of two or more liquids which, when mixed in precise proportions, behave like a compound when phase changing from liquid to gas (evaporating) and gas to liquid (condensing). These blends do not change volumetric composition or saturation temperature as they evaporate or condense at constant pressures. The boiling point of the mixture will be either above or below the boiling point of the individual liquids.
Certified refrigerant recycling or recovery equipment	Equipment certified by an approved equipment-testing organization to meet EPA standards. Currently ARI for stationary equipment and UL for automotive equipment
Chlorofluorocarbon (CFC)	A chemical compound consisting of one or more carbon atoms surrounded by chlorine and fluorine atoms. CFCs are used as refrigerants, foam-blowing agents, aerosol propellants, cleaning agents, and in other applications.

Comfort cooling	Cooling equipment with 50 or more pounds of refrigerant used for comfort or space cooling, usually through an air handler.
Commercial refrigeration	Refrigeration equipment with 50 or more pounds of refrigerant utilized in the retail food and cold storage warehouse sectors.
Containment	The application of service techniques or special equipment designed to preclude or reduce loss of refrigerant from equipment during installation, operation, service and/or disposal of refrigeration and air conditioning equipment.
Containment equipment	Equipment specifically designed to assist in precluding or reducing refrigerant losses during installation, operation, servicing or disposal of refrigerant equipment. Recovery/recycling equipment, low loss fittings, PRVS, refrigerant leak alarms and ultra-high efficiency purge units are all examples of containment equipment.
Disposable container	A container (cylinder or drum) used to ship new refrigerant, which is not approved by the DOT for reuse after its initial contents are used.
Disposal	Any process leading to and including the discharge, deposit, dumping, or placing of any discarded appliance or component parts into or on any land or water.
Ester oil	Any of a class of organic compounds corresponding to the inorganic salts formed from an acid by the replacement of hydrogen by an alkyl radical.
Fluorescent dyes	These are dyes, which can be put into the lubricant. When there are leaks present, these dyes stain the outside of the chiller showing the location of high rate leaks.
Fractionation	The condition when one or more refrigerants of a blend leak at a faster rate than other refrigerants in the blend.
Global warming	Tropospheric pollutants, like CFCs, HCFCs, HFCs, carbon dioxide, and carbon monoxide, absorb and reflect the earth's infrared radiation, causing re-radiation back to the earth which results in a gradual increase in the earth's average temperature.
Halide torch	A propane powered torch whose flame changes color when small amounts of refrigerant passes through it. It can be used to detect leaks of chlorine containing refrigerant.

Halocarbons	Stable chemical compounds consisting of one or more carbon atoms surrounded by halogen atoms or a combination of hydrogen and halogen atoms. CFCs, HCFCs, HFCs are all halocarbons.
Halogens	Reactive chemical elements with the ability to form one chemical bond in a molecule. Common halogens are fluorine (F), Chlorine (Cl), Bromine (Br), and Iodine (I).
Halon	A bromochlorofluorocarbon (BCFC), a chemical consisting of one or more carbon atoms surrounded by fluorine, chlorine and bromine. Halons are commonly used as flame suppression.
High-pressure appliance	An appliance, which uses a refrigerant with a boiling point between -50 C and 10 C at atmospheric pressure.
Hydrocarbon	A chemical compound consisting of one or more carbon atoms surrounded only by hydrogen atoms. Methane, ethane, butane and propane are all examples of hydrocarbon. Many hydrocarbons have excellent thermodynamic properties. Although they may be used as refrigerants, their highly flammable properties normally restrict their use as low concentration components in refrigerant blends.
Hydrochlorofluorocarbon (HCFC)	A chemical consisting of usually one or more carbon atoms surrounded by chlorine, fluorine, and at least one hydrogen atom. HCFCs are used as refrigerants, foam-blowing agents, and in other applications.
Hydrofluoro-carbon (HFC)	A chemical consisting of usually one or more carbon atoms surrounded by fluorine and hydrogen atoms. Since no chlorine or bromine is present, HFCs do not deplete the ozone layer.
Industrial process refrigeration	Complex, customized appliances directly linked to production of a product or part of the process involved in making the product. Commonly found in the in the chemical, pharmaceutical, petrochemical, and manufacturing industries. (Computer rooms are not considered industrial process refrigeration
Long-term chronic effects	Detrimental health effects from long term repeated exposures to low level toxic materials, generally assessed over the lifetime of test animals to gauge the late-in-life signs of toxicity.
Low-pressure appliance	An appliance that uses a refrigerant with a boiling point above 10 C at atmospheric pressure. (CFC-11. HCFC-123, CFC-113)

Lubricant compatibility	For CFCs and HCFCs: mineral oils For HFC-134a: polyolesters For HCFC ternary blends: alkylbenzenes
Major Service	Service, which requires refrigerant recovery to EPA standards of entire unit or an isolated section of the unit prior to repairing or replacing a component. Note: Check box on RCM Service Order form.
Materials Safety Data Sheet (MSDS)	A safety advisory bulletin prepared by chemical producers for a specific refrigerant or compound.
Minor Service	Service or repair of refrigerant system that does not require recovery. (Tighten valve packing or flare nut). Note: Check box on RCM Service Order form.
Montreal Protocol	An international agreement limiting the production and consumption of chemicals that deplete the ozone layer, including CFCs, HCFCs, BCFCs, HBFCs and others.
Near-azeotropic	A blend, which acts very similarly to an azeotrope, yet has a small volumetric composition change and temperature glide as it evaporates and condenses.
Non-condensable gases	Gases with very low temperature boiling points, which are not easily condensed. Nitrogen and oxygen are the most common ones found in chillers.
Oil monitor	This device uses an infrared sensor to determine when the circulating oil needs to be changed. It is not necessary to take an oil sample using this device, which is permanently attached to the chiller.
Ozone depletion	A condition which results when chlorine molecules broken away from CFC and HCFC refrigerants by ultraviolet radiation in the stratosphere react with and destroy stratospheric ozone, a layer in the atmosphere which protects the earth from the sun's harmful ultraviolet radiation.
Ozone depletion potential (ODP)	A measure of a chemical's ability to deplete ozone, measured on a scale relative to a value of 1.0 assigned to CFC-11.
Ozone layer	An area of the atmosphere, approximately 15 to 60 kilometers (9 to 38 miles) above the earth, where ozone is found as a trace gas (at higher concentrations than other parts of the atmosphere).
Ozone (O_3)	A reactive gas consisting of three oxygen atoms, formed naturally

	in the atmosphere by the association of molecular oxygen (O_2) and atomic oxygen (O).
PAFT	Program for Alternative Fluorocarbon Toxicity.
Permissible exposure level (PEL)	A time-weighted concentration level that must not be exceeded during any eight-hour work week. The U.S. Occupational Safety and Health Administration (OSHA) set PEL values.
Polyolesters (POE)	Stable, five-carbon neopentyl alcohols mixed with fatty acids. A popular synthetic lubricant for use with HFC refrigerants. Used as a jet engine lubricant for years.
Purge system	A device used on low-pressure chillers to expel air and other non-condensables from the circulating refrigerant.
Refillable container	A container, used to ship and store refrigerant. Refillable containers are designed to be used over and over again, but should be retested at least every five years.
Refrigerant monitors	Devices, which can detect small amount of refrigerant in the air.
Relief valve	This is a device, which vents refrigerant when the pressure in a chiller becomes dangerously high. Newer relief valves have a resealing mechanism so that when the pressure of the chiller returns to a normal level they reseal and prevent further refrigerant loss.
Replacement	The conversion of an air conditioning or refrigeration system to an alternative refrigerant, which requires the removal of the existing chiller and installation of a completely new chiller.
Retrofit	The conversion of an air conditioning or refrigeration system to an alternative refrigerant. Unlike a replacement; only parts of components of the existing system may need to be replaced.
Simple retrofit	A conversion to an alternative refrigerant, which only requires the change out of a few incompatible parts, typically gaskets. Simple retrofits typically result in some decrease in either efficiency, capacity or both.
System-dependent recovery equipment	Refrigerant recovery equipment that requires the assistance of components contained in an appliance to remove the refrigerant from an appliance.
System optimization or	A conversion to an alternative refrigerant, which includes the replacement of system components with new components that have

engineered retrofit	been redesigned specifically for the alternative refrigerant. System optimized or engineered retrofits typically include redesigned impellers, drive gears or heat exchangers.
Technician	Any person who performs maintenance, service, or repair who could reasonably be expected to release class I or class II substances from appliances into the atmosphere, including but not limited to installers, contractor employees, in-house service personnel, and in some cases owners.
Temperature glide	Range of condensing or evaporating temperatures for one pressure.
Ternary	Having three elements, parts, or divisions.
Threshold limit value (TLV)	An inhalation time weighted average exposure level safety limit normally established by the American Conference of Governmental and Industrial Hygienists (ACGIH).
Venting	A service practice where the refrigerant vapor is allowed to escape into the atmosphere after the refrigerant liquid has been recovered. This practice is no longer acceptable.
Very-high Pressure Appliance	An appliance that uses a refrigerant with a boiling point below -50 C at atmospheric pressure.
Zeotrope	A refrigerant blend that changes volumetric composition and saturation temperatures as it evaporates or condenses at constant pressures. Has a temperature glide as it evaporates and condenses. Zeotrope and non-azeotrope are synonyms.

References

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- Title 42, The Public Health and Welfare
  Chapter 85 - Air Pollution Prevention and Control
  Subchapter VI - Stratospheric Ozone Protection, Para. #7671

- Title 26, Internal Revenue Code
  Chapter 38 - Environmental Taxes
  Subchapter D - Ozone-depleting Chemicals, etc., Para. #4682

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- 49 Code Federal Regulation, Parts 100-177

- Title 29, Labor

  Subtitle B Regulations Relating to Labor
  Chapter XVII - Occupational Safety and Health Administration
  Part 1910/1926 - Occupational Safety and Administration Standards
  Subpart Z - Toxic and Hazardous Substances

- Title 40, Protection of Environment

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  Part 82 - Protection of Stratospheric Ozone

  Subchapter I - Solid Waste
  Part 260 - Hazardous Waste Management System: General
  Part 261 - Identification and Listing of Hazardous Waste
  Part 262 - Standards Applicable to Generators of Hazardous Waste
  Part 266 - Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities

- Title 49, Transportation
  Chapter 1 - Research and Special Program Administration
  Subchapter C - Hazardous Materials Regulations Parts 171-180 (Regulations for Shippers, Carriers, and Packagers)

NATIONAL STANDARDS OR GUIDELINES (Use Current Edition)

- American Society of Heating, Air Conditioning, and Refrigerating Engineers (ASHRAE)

  3-90 Reducing Emissions of Fully Halogenated Chlorofluorocarbon Refrigerants in Refrigeration and Air Conditioning Equipment and Applications

  15 Safety Code for Mechanical Refrigeration

  34 Number Designation and Safety Classification of Refrigerants

- Air Conditioning & Refrigeration Institute (ARI) Standards

  700 Specifications for Fluorocarbon Refrigerants

  740 Performance of Refrigerant Recovery, Recycling and/or Reclaim Equipment

  K Guideline K Containers for Recovered Fluorocarbon Refrigerants

  N Guideline N Assignment of Refrigerant Container Colors

  -- Directory of Certified Refrigerant Recovery/Recycling Equipment

- General Electric (GE)

  -- Proposed Method for Testing Recovery Devices for Use with Small Equipment

WEB SITES

Environmental Protection Agency Title VI (EPA)	www.epa.gov/ozone/title6
Department of Transportation (DOT)	www.dot.gov
American Society of Heating, Air Conditioning, and Refrigerating Engineers (ASHRAE)	www.ashrae.org
Air Conditioning & Refrigeration Institute (ARI)	www.ari.org
National Fire Protection Association (NFPA)	www.nfpa.org
Environmental Support Solutions (ESS)	www.environ.com