INTERNATIONAL TRAINING INSTITUTE

FOR THE

SHEET METAL AND AIR CONDITIONING INDUSTRY

EPA Section 608 Study Guide

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<u>Introduction to the Section 608 Study Guide</u>

This study guide was put together by the International Training Institute to help prepare individuals for the EPA Section 608 certification exam. The information in this study guide is based on the most current information available at the time of publishing.

As a reminder, it is the technician's responsibility to comply with any future changes the EPA may make.

This guide will contain words in **"BOLD"** to help you remember key concepts and words. At the end of each section (Core, Type I, II, & III) there will be a practice quiz. If you can answer the questions on the quiz, then you should be well prepared to take the certification exam.

Certain personal information is required on the exam. Technicians should be prepared to present:

- Picture identification
- Social security number
- Home address

At the beginning of the exam, you will need to fill in your personal information and also create a unique identification number. This number will be in Social Security number format xxx-xx-xxxx and will be visible on the front of your certification card. **DO NOT** use your Social Security number when filling in this part.

During the exam, read each test question thoroughly. Pay special attention to clarifying words like: always, never, not, sometimes, minimum, maximum, least, most, best, worst and similar words.

Read every answer, even if you think the first one is correct. Many questions are missed because not all the answer options are read. And you can always skip a question and come back to it.

About the Section 608 Exam

The test is divided into 4 sections: Core, Type I, Type II, and Type III

Type I: A Type I technician primarily works on small appliances such as domestic refrigerators, window air conditioners, PTACs and vending machines, etc...

Type II: A Type II technician primarily works on equipment using a high pressure refrigerant such as HCFC-22. The equipment includes residential and lt. commercial air conditioners and heat pumps, roof top units, supermarket refrigeration and process refrigeration.

Type III: A Type III technician primarily works on equipment using a low pressure refrigerant such as HCFC-123 or CFC-11. These units are primarily chillers.

Universal: A candidate passing all three types is certified as Universal

Each section has 25 multiple choice questions. A technician must achieve a minimum score of 70% (18 out of 25) to pass that section of the exam. The Core section must be passed to receive any other certification.

For example: A technician could pass Core, Type I and Type III and fail Type II. In this case the technician would be certified as a Type I & Type III technician. Core must be passed to receive any certification. All sections must be passed in order to achieve Universal Technician status.

A technician may choose to take Core plus any combination of Type I, Type II or Type III. It is not required to take all four sections on the exam.

Tests are closed-book tests. The only outside materials allowed are a temperature/pressure chart and a calculator. The temperature/pressure chart and calculator are both available onscreen, on the online version of the exam. Otherwise, you may remove the chart at the end of this study guide for the exam.

CORE

In this section we will cover general knowledge such as:

- Ozone depletion
- Clean Air Act and the Montreal Protocol
- Section 608 regulations
- Substitute refrigerants and oils
- Refrigeration
- Three R's
- Recovery techniques
- Dehydration evacuation
- Safety
- Shipping

Many consider the Core Section to be the most important section as Core is required to achieve any other certification type. And also because the information found in the Core Section, comes up again in other sections.

Ozone Depletion:

Ozone is a naturally occurring gas molecule that is made up of **three oxygen atoms** ($O3$). This gas occurs both in the Earth's upper atmosphere and at ground level. At ground level, ozone is considered "bad" and is a pollutant that causes significant health risks as well as damaging vegetation.

The ozone that occurs in the upper atmosphere or stratosphere is considered "good" ozone. This "good" ozone in the stratosphere is a layer that extends about 6 to 30 miles above earth and creates a protective shield for Earth from the sun's harmful ultraviolet (UV) rays. Depletion of ozone allows more of the sun's harmful UV rays to reach the earth resulting in the following problems:

- Increased temperature of the earth
- Increased cases of skin cancer
- Increased numbers of cataracts in the eyes
- Increased ground level ozone
- Crop and vegetation loss
- Reduced marine life

While the total amount of ozone in the stratosphere varies by location, time and season, the effect of ozone depletion is a global problem.

Destruction Process of Ozone

Ozone can be destroyed by chlorine and bromine atoms emitted into the atmosphere. When a chlorine atom meets with an ozone molecule, it takes an oxygen atom from the ozone molecule. The **ozone molecule ($O3$)** changes to an **oxygen molecule ($O2$),** while the chlorine atom changes to a compound called **chlorine monoxide (ClO).**

When chlorine monoxide meets ozone, it releases its oxygen atom and forms two O2 oxygen molecules, leaving the chlorine molecule free to attack another ozone molecule and repeat the process. It is estimated that a single **chlorine atom can destroy 100,000 ozone molecules**.

There has been a great deal of controversy over the subject of Ozone depletion. Some believe that the Chlorine found in the stratosphere comes from natural sources such as volcanic eruptions. However, air samples taken over erupting volcanoes show that volcanoes contribute only a small quantity of Chlorine as compared to CFC's.

In addition, the rise in the amount of Chlorine measured in the stratosphere over the past two decades matches the rise in the amount of Fluorine, which has different natural sources than Chlorine, over the same period. Also, the rise in the amount of Chlorine measured in the stratosphere over the past twenty years, matches the rise in CFC emissions over the same period.

Unlike other Chlorine compounds and naturally occurring chlorine, the chlorine in CFC's will neither dissolve in water nor break down into compounds that dissolve in water, so they do not rain out of the atmosphere.

Despite being heavier than air, CFCs reach the stratosphere through wind motions that carry them upwards.

Ozone depletion potential (ODP) is the measurement of the ability of CFCs and HCFCs to destroy the ozone. CFCs have the highest ODP, followed by HCFCs. HFCs do not contain any chlorine and therefore do not have an ODP

Gas	Example	Elements	ODP
CFC	R-11, R-12, R-500	Chlorine, Fluorine, Carbon	Higher
HCFC	R-22, R-123	Hydrogen, Chlorine, Fluorine, Carbon	Lower
HFC	R-134a	Hydrogen, Fluorine, Carbon	None

CLEAN AIR ACT:

The United States Environmental Protection Agency (EPA) regulates section 608 of the Federal Clean Air Act.

Failure to comply could cost you and your company as much as $27,500* per day, per violation and there is a bounty of up to $10,000, to lure your competitors, customers and fellow workers to turn you in.

Service technicians who violate Clean Air Act provisions may be fined, lose their certification, and may be required to appear in Federal court.

The EPA may require technicians to demonstrate the ability to properly perform refrigerant recovery/recycling procedures. Failing to demonstrate these skills can result in revocation of certification.

It is a violation of Section 608 to:

- Falsify or fail to keep required records;
- Fail to reach required evacuation rates prior to opening or disposing of appliances;
- Knowingly release (vent) CFC's, HCFC's or HFC’s while repairing appliances, with the exception of de-minimus releases;
- Service, maintain, or dispose of appliances designed to contain refrigerants without being appropriately certified as of November 14, 1994. (It is the responsibility of the final person in the disposal chain to ensure that refrigerant has been removed from appliances before scrapping.)
- Vent CFC's or HCFC's since July 1, 1992;
- Vent HFC's since November 15, 1995;
- Fail to recover CFC's, HCFC's or HFC’s before opening or disposing of an appliance;
- Fail to have an EPA approved recovery device, equipped with low loss fittings, and register the device with the EPA;
- Add nitrogen to a fully charged system, for the purpose of leak detection, and thereby cause a release of the mixture;
- Dispose of a disposable cylinder without first recovering any remaining refrigerant (to 0 psig.) and then rendering the cylinder useless, then recycling the metal;

In addition, some state and local government regulations may contain regulations that are as strict as or stricter than Section 608.

Montreal Protocol:

The Montreal Protocol is an international agreement (Treaty) regulating the production and use of CFCs, HCFC's, halons, methyl chloroform and carbon tetrachloride entered into force in mid 1989.

Known as The Montreal Protocol, this landmark agreement initially required a production and consumption freeze.

The Montreal Protocol called for a stepwise reduction and eventual production phase out of various Ozone Depleting Substances in developed countries. CFC's were phased-out of production on **December 31, 1995**.

HCFC refrigerants are scheduled of phase out in the future. When virgin supplies of CFC's are depleted, future supplies will come from recovered, recycled, or reclaimed refrigerants.

Venting:

Since **November 15, 1995**, knowingly venting any refrigerant is a violation of the CAA. This includes CFC & HCFCs, and/or CFC & HCFCs refrigerant substitutes, such as 134-A or 410-A.

Only the **de minimis** release is allowed during service, routine maintenance or repair, which refers to the small amounts of refrigerants emitted unintentionally during good faith efforts to recover refrigerants, during the normal course of appliance operation or during the connection/disconnection to charge or service an appliance.

Nitrogen that is used for holding charges or as leak test gases may be released; however, nitrogen may not be added to a fully charged system for the purpose for leak detection and then released.

All CFCs and HCFCs must be recovered before opening a system for service or disposing of appliances.

Cylinder & Appliance Disposal:

Before disposing of any appliance containing a CFC or HCFC refrigerant, the refrigerant must be recovered. The person responsible for ensuring that refrigerants have been removed from household refrigerators before they are disposed of is the final person in the disposal chain.

All refrigerants in disposable containers have been recovered (0 psig or lower) and rendered useless before recycling the cylinder.

SALES RESTRICTION:

As of **November 14, 1994**, the sale of CFC and HCFC refrigerants is restricted to certified technicians. Only technicians certified under Clean Air Act Section 609 (Motor Vehicle Air Conditioning) are allowed to purchase refrigerants in containers smaller than 20 lbs.

Refrigerant Oils:

Due to the change in refrigerant use, you may encounter new refrigerants, old refrigerants, and blends of older refrigerants as well as different oils in the field.

Mineral, or petroleum, oils include paraffin-based oils, napthene-based oils, and mixed oils (a combination of napthene-based and paraffin-based oils).

Synthetic oils include silicate ester, silicone, neo-pentyl ester, dibasic acid ester, polyglycols such as polyalkylglycol (PAG), alkyl benzene (AB), and polyolyester (POE). Synthetic oils must be stored in metal containers. The ester oils are generally used with alternative refrigerants and are typically compatible with mineral oils and existing system components.

Refrigerant oil must be miscible (able to be mixed) at low temperatures; it must lubricate even when it is diluted; it must have electrical insulating properties; it must maintain its stability; and it must provide a pressure seal.

Oil Types:

Oil Type	Abbreviation	Use
Mineral Oil	MO	CFC refrigerant systems
Alkylbenzene	AB	R-22 and other refrigerant systems
Polyolester	POE	HFC refrigerant systems
Polyalkylene	PAG	R-134a automotive systems
Polyalphaolefin	PAO	R-717 (ammonia) refrigeration systems

Oil Properties:

All refrigerant oils are **hygroscopic** (meaning they attract moisture). All refrigerant oils have certain properties in common. The **viscosity** of an oil refers to its thickness, while the **density** of the oil refers to the composition of the oil at a given viscosity. An oil's **stability** is its ability to lubricate without chemical breakdown; its **solubility** refers to its miscibility with various refrigerants. (Solubility of air refers to the air and moisture entrainment capacity of an oil.) **Miscibility** refers to the ability of an oil to be mixed; **low temperature miscibility** refers to the oil's ability to remain mixed (in other words, not separate) at a low temperature

Foaming refers to the tendency of the oil to foam when it is subjected to pressure changes. Foaming will reduce the oil's ability to lubricate. The **dielectric strength** of an oil is the threshold at which the oil conducts electricity. An oil's **oxidation value** is its ability to resist sludge accumulation. Its **boundary film-forming ability** is its ability to separate high pressure and low pressure.

Substitute Refrigerants

There is no "drop-in" replacement gas for R-12 systems; all replacement refrigerants require additional retrofit procedures. In particular, the new refrigerants are incompatible with the oils and lubricants used in R-12 systems and therefore, oils must be checked and changed out as part of the retrofit procedure.

R-134A (also called HFC-134a) is the leading replacement option for retrofitting R-12 systems. The oils used in most R-134A systems are **ester based oils** and ester based oils do not mix with other oils. Leak check an R-134A system using **pressurized nitrogen.**

Temperature glide is the difference in temperature that occurs when a refrigerant evaporates or condenses (changing from vapor to liquid or liquid to vapor) under constant pressure. This means the temperature in the evaporator and the condenser is not constant.

Temperature glide can also be understood as the difference between the **dew point** and the **bubble point.** The dew point occurs when the saturation temperature in the evaporator causes the refrigerant to change from a liquid to a vapor. The bubble point occurs when the saturation point in the condenser changes the refrigerant from a vapor to a liquid.

One problem with blended refrigerants is that since the different refrigerants in the blend have different vapor pressures, they leak from systems at uneven rates. Charging a blended refrigerant should be done as a liquid.

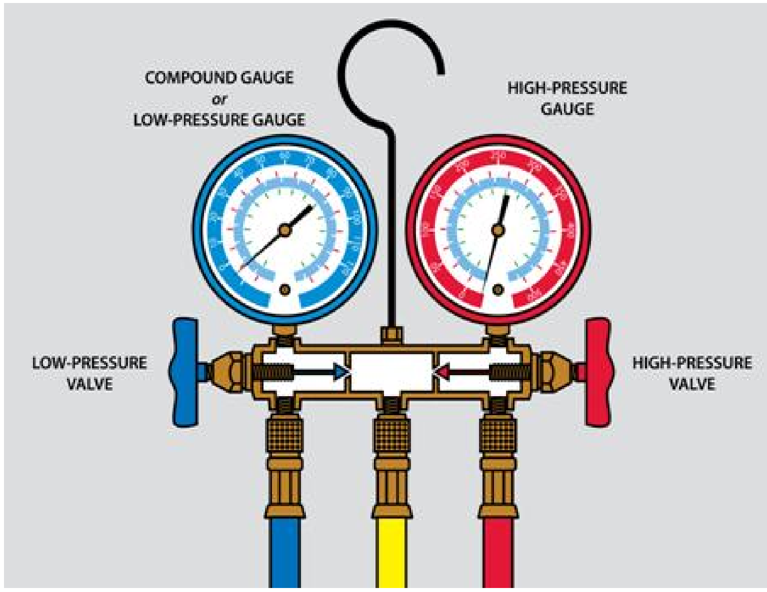
Ternary blends are three-part mixtures. They are common types of refrigerant blends that contain HCFCs. Ternary blends are used with a synthetic **alkylbenzene** lubricant. Alkylbenzene lubricant is **hygroscopic**, meaning that it absorbs (takes on) moisture.

A **zeotropic** (or **non-azeotropic**) refrigerant is a blend of components that change their composition and saturation temperatures as they evaporate or condense at constant pressure. In other words, the blend boils out at different temperatures (exhibits temperature glide) but at the same pressure. Zeotropes are blends of two or more refrigerants that retain the characteristics of each refrigerant. Because the components have different boiling points, they can leak at an uneven rate. Zeotropic mixtures should be charged as a liquid

An **azeotropic** refrigerant contains fluids that boil out at the same temperatures (do not exhibit temperature glide) and act as a single refrigerant. Azeotropes are blends of two or more compounds that act like a single compound. Azeotropic refrigerants can be charged as a vapor or a liquid

A **blended refrigerant,** or **near**-**azeotropic mixture** (sometimes referred to as NARM) contains refrigerants with different boiling points, but that act as one substance when they are in either a liquid or a vapor state. Near-azeotropic mixtures exhibit temperature glide when they change from vapor to liquid, or vice versa. However, the temperature glide is less than 10ºF. Near-azeotropic mixtures can exhibit fractionation (when the mixture’s composition changes as a result of vapor charging) and may affect the leak ratio. Near-azeotropic mixtures should be charged as a liquid.

Gauge Manifold Set



GAUGE MANIFOLD SET:

One of the most important tools to the HVACR technician is the gauge manifold set. The **compound gauge (blue)** and the **high pressure gauge (red)** are connected to the manifold, and the manifold is then connected by hoses to access ports to measure system pressures.

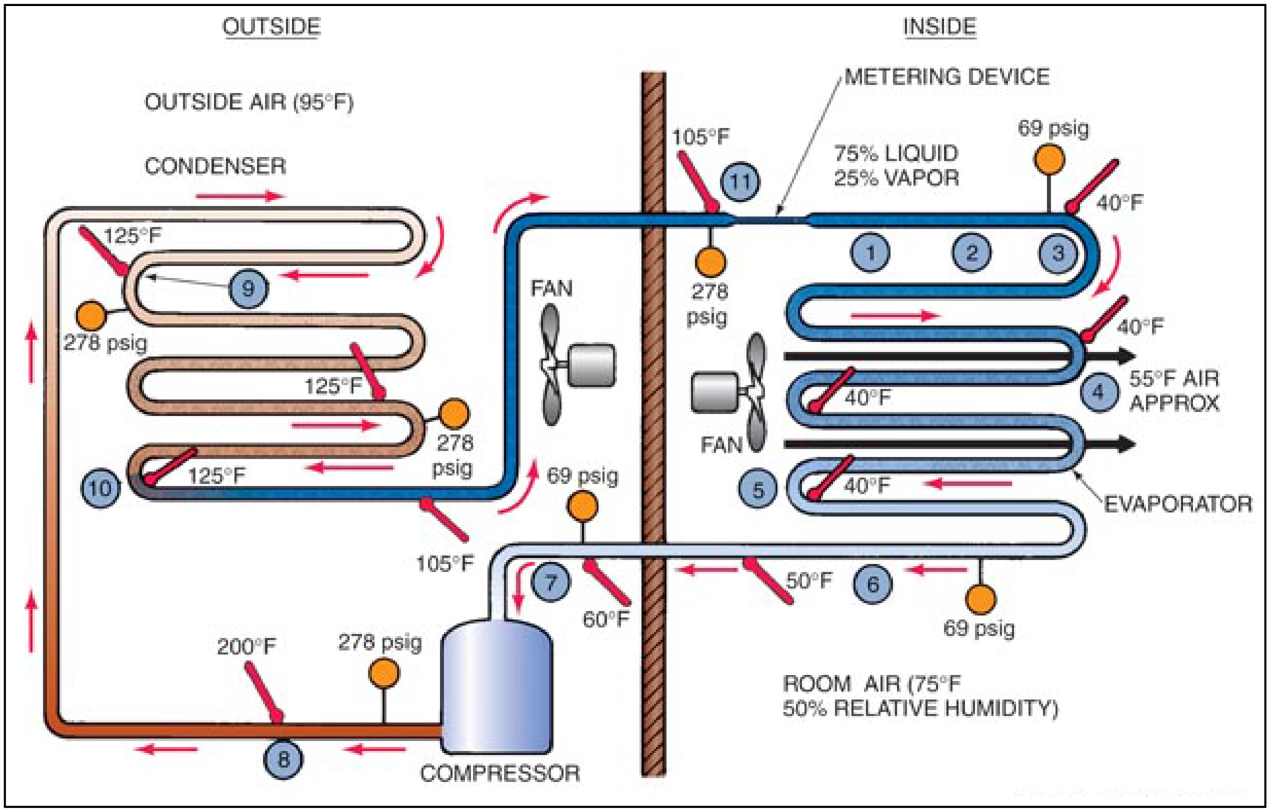
The compound gauge measures low **pressure (psig) and vacuum (inches Hg.)**.

The high pressure gauge measures high side (discharge) pressure.

The manifold is also equipped with a center port, (usually a yellow hose), that can be connected to a recovery device, evacuation vacuum pump, or charging device.

EPA regulations require that hoses be equipped with low loss fittings that will minimize refrigerant loss when hoses are disconnected.

The Refrigeration Cycle:



VAPOR / COMPRESSION REFRIGERATION CYCLE:

In the vapor / compression refrigeration cycle, liquid refrigerant at a high pressure is delivered to a metering device, (**11**). The metering device causes a reduction in pressure, and therefore a reduction in saturation temperature.

The refrigerant then travels to the evaporator, (**1,2,3,4,5**). Heat is absorbed in the evaporator and causes the refrigerant to boil from liquid to vapor.

At the outlet of the evaporator, (**6**), the refrigerant is now a low temperature, low pressure vapor.

The refrigerant vapor then travels to the inlet of the compressor, (**7**). The refrigerant vapor is then compressed and moves to the condenser, (**8,9**). The refrigerant is now a high temperature, high pressure vapor.

As the refrigerant expels heat, the refrigerant condenses to a liquid. At the condenser outlet, (**10**), the refrigerant is a high pressure liquid. The high pressure liquid refrigerant is delivered to the metering device, (**11**), and the sequence begins again.

Some accessories that are not shown in the basic diagram are the receiver and accumulator. Use of these components depends on system design and / or on the type of metering device used. A system that uses a thermostatic expansion valve is usually equipped with a receiver, which would be located in the liquid line directly following the condenser. A system that uses a capillary tube or fixed bore metering device is usually equipped with an accumulator, which would be located in the suction line directly following the evaporator.

Service and Maintenance:

In order to limit the potential of accidental refrigerant emissions, it is important to follow procedures and make sure the refrigeration system is in good operating order. This includes making sure that equipment used is approved by the EPA, checking for leaks, repairing leaks and making sure that all fittings are tight during service and recovery.

Leak detection in a refrigeration system is important to keep the system running well and to prevent refrigerant escaping into the atmosphere. When checking for small leaks, using a **halide torch** is the most effective method. You can also evacuate the system and pull a vacuum on it. If the system will not hold a vacuum, you have a leak. If the system has completely lost its charge and you want to test it for a leak, charge it with dry nitrogen for testing and never use refrigerant gases. Nitrogen is environmentally friendly and is safe to handle.

If you suspect a major leak or major component failure, an oil sample should be taken. If there are contaminants in the oil, the system will need to be flushed.
In the event of a burnout of the compressor:

1. Triple-evacuate the system.
2. Install a permanent filter-drier.
3. Conduct a deep vacuum before recharging

The Three R's:

The three R's of refrigeration are: **recover, recycle**, and **reclaim.**

Recover: is to remove refrigerant in any condition from a system and store it in an external container without necessarily testing or processing it in any way.

Recycle: is to clean refrigerant for immediate reuse by separating the oil from the refrigerant and removing moisture and acidity from the refrigerant by use of products like filter driers.

Reclaim: is to process refrigerant to the level of new product specifications as determined by chemical analysis. Reclaimed refrigerant must meet the standard set forth in **ARI 700** before it can be resold

RECOVERY DEVICES:

Refrigerant Recovery and/or Recycling equipment manufactured after **November 15, 1993**, must be certified and labeled by an EPA approved equipment testing organization to meet EPA standards.

There are two basic types of recovery devices.

1) "**System-dependent**" which captures refrigerant with the assistance of components in the appliance from which refrigerant is being recovered.

2) "**Self-contained**" which has its own means to draw the refrigerant out of the appliance.

Recovery Techniques:

All refrigerant recovery and/or recycling equipment now manufactured must be certified and labeled by an **EPA-approved equipment testing organization** to meet EPA standards. This covers all air conditioning and refrigeration equipment containing CFC and HCFCs.

There are two basic types of recovery devices. **System dependent** devices capture refrigerant with the assistance of the compressor and/or the pressure of the refrigerant in the appliance from which refrigerant is being recovered. **Self-contained devices** have independent means to draw the refrigerant out of the appliance.

The EPA requires a **service aperture** or **process stub** on all appliances that use a Class I or Class II refrigerant in order to make it easier to recover refrigerant. **Schrader valves** (which look like bicycle tire air valves) are common on both refrigerant systems and recovery equipment. When using Schrader valves, it is critical to:

- Check the valve core for bends and cracks
- Replace damaged Schrader cores to prevent leaks
- Cap the Schrader ports when not being used to prevent leaks

Due to the increased charges for recovering refrigerants, consumers have complained about paying for the process. In order to handle these complaints, let the consumer know that:

- Recovery is the law.
- Recovery is necessary to protect human health and the environment.
- All professional service personnel are duty bound to follow the law and protect the environment.

When recovering refrigerants, only put one type of a refrigerant in a tank and do not mix different refrigerant types into one tank. **Mixed refrigerants** in the same tank may be impossible to reclaim. When servicing a system that already has a mix of two or more refrigerants, the mixed refrigerants must be recovered into a separate tank.

The longer it takes to recover the refrigerants, the higher chance of emissions of the refrigerants to the atmosphere. The following factors affect the time it takes to recover refrigerant.

- **Size of refrigeration system and recovery equipment.** The bigger the system, the longer the recovery process. The bigger capacity of the recovery equipment, the faster the recovery.
- **Size of suction hose.** The longer the suction hose and the smaller in diameter it is, the higher the pressure drop in the system and the longer it will take to recover refrigerants.
- **Temperatures.** The colder the ambient temperature, the longer the recovery process. If the refrigerant system is warmer than the recovery cylinder, the recovery process will go faster due to a higher pressure in the refrigerant system and a lower pressure in the recovery cylinder.

Recovery Cylinders:

Recovery cylinders differ in many ways from disposable cylinders. Disposable cylinders are used only with virgin refrigerant and may NEVER be used for recovery.

Recovery cylinders are specifically designed to be refilled. Recovery cylinders have 2 ports, one liquid and one vapor.

Care must be taken not to overfill or heat these cylinders, thereby causing an explosion.

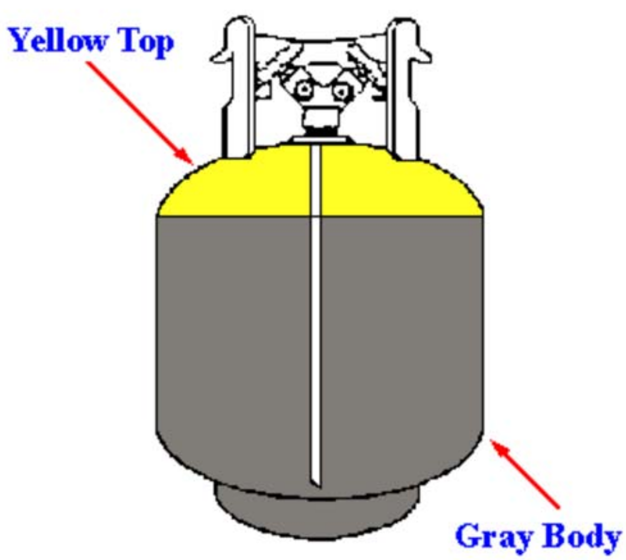
The EPA requires that a refillable refrigerant cylinder MUST NOT BE FILLED ABOVE 80% of its capacity by weight, and that the safe filling level can be controlled by either mechanical float devices, electronic shut off devices (thermistors), or weight.

Refillable cylinders must be hydrostatically tested and date stamped every 5 years.

Refillable cylinders used for transporting recovered pressurized refrigerant must be DOT (Department of Transportation) approved.

Approved refrigerant recovery cylinders can easily be identified by their colors, YELLOW TOPS AND GRAY BODIES.

All refrigerant recovery cylinders should be inspected for RUST. If they show signs of rust or appear to not be secure they should be reduced to 0 psig and discarded.



Dehydration / Evacuation:

The purpose of **dehydrating** a refrigeration system is to remove water and water vapor. The presence of moisture in an operating refrigeration system can create highly corrosive and toxic acids. The recommended method for dehydration is evacuation. Before evacuating a system, it is important to first recover all refrigerant and attain the mandated vacuum level. The factors that affect the speed and efficiency of evacuation are:

- **Size of equipment being evacuated**. The larger the equipment, the longer it will take to evacuate.
- **Ambient temperature**. The warmer the temperature, the faster it will evacuate. You may heat the refrigeration system to decrease the evacuation time.
- **Amount of moisture in the system**. The more moisture in the system, the longer it will take to evacuate.
- **Size (capacity) of vacuum pump and suction line**. The bigger the capacity of the vacuum pump, the shorter the time.

The piping connection to the pump should be as short in length as possible and as wide in diameter as possible. Vacuum lines (hoses) should be equal to or larger than the pump intake connection.

For the most accurate readings during evacuation, the vacuum gauge (Micron Gauge) should be located as far as possible from the **vacuum pump.** Measuring the vacuum of a system should be done with the system isolated and vacuum pump turned off. If the system will not hold a vacuum, then it has a leak. Dehydration is considered complete when the vacuum gauge shows that have reached and held the required finished vacuum. It is not possible to over-evacuate a system.

Safety:

The EPA is not only concerned with the prevention of refrigerant venting, but is also concerned with the technicians overall safety. When handling and filling refrigerant cylinders, or operating recovery or recycling equipment, you should wear safety glasses, protective gloves, and follow all equipment manufacturers safety precautions.

When pressurizing a system with nitrogen, you should always charge through a pressure regulator and insert a relief valve in the downstream line from the pressure regulator. Relief valves MUST NOT be installed in series. If corrosion build-up is found within the body of a relief valve, the valve MUST be replaced.

When leak checking a system, NEVER pressurize the system with oxygen or compressed air. When mixed with refrigerants, oxygen or compressed air can cause an explosion. To determine the safe pressure for leak testing, check the data plate for the low-side test pressure value.

When using recovery cylinders and equipment with Schrader valves, it is critical to inspect the Schrader valve core for leaks, bends and breakage. Replace damaged valve cores to prevent leakage, and always cap Schrader ports to prevent accidental depression of the valve core. NEVER heat a refrigerant cylinder with an open flame. Do not cut or braze refrigerant lines on a charged unit.

In the event of a “large” release of refrigerant in a confined area, Self Contained Breathing Apparatus (SCBA) is required.

If a large leak of refrigerant occurs in an enclosed area, and SCBA is not available, IMMEDIATELY VACATE AND VENTILATE the area. In large quantities, refrigerants can cause suffocation because they are heavier than air and displace oxygen. Inhaling refrigerant vapors or mist may cause heart irregularities, unconsciousness, and oxygen deprivation leading to death (asphyxia).

NEVER expose R-12 or R-22 to open flames or glowing hot metal surfaces. At high temperatures, R-12 and R-22 decompose to form Hydrochloric acid, Hydrofluoric acid, and Phosgene gas.

Always review the material safety data sheets, when working with any solvents, chemicals, or refrigerants.

Refrigerant safety is addressed in **ASHRAE Standard 15-1994,** Safety Code for Mechanical Refrigeration. This standard specifies an oxygen sensor and alarm for A1 refrigerants, and a refrigerant detector for all other refrigerants, as well as specifying ventilation requirements, but may not prevent hazardous accumulations.

Refrigerants are classified by a letter and a number; the letter indicates its toxicity and the number indicates its flammability. Refrigerants in the “A” category have a lower toxicity, while refrigerants in the “B” category have a higher toxicity. Similarly, refrigerants in the “1” category have no flame propagation (minimal flammability), while refrigerants in the “3” category have high flammability.

Refrigerant mixtures are classified based on worst-case fractionation.

ASHRAE Classification	Lower Toxicity	Higher Toxicity
Higher Flammability	A3	B3
Lower Flammability	A2	B2
No Flame Propagation	A1	B1

Shipping:

Before shipping any used refrigerant cylinders, check that the cylinder meets DOT standards, complete the shipping paperwork including the number of cylinders of each refrigerant, and properly label the cylinder with the type and amount of refrigerant.

Cylinders should be transported in an upright position. Each cylinder must be marked with a DOT classification tag indicating it is a “2.2 non-flammable gas”. Some states may require special shipping procedures to be followed based on their classification of used refrigerants. Check with the DOT in your state.

TYPE I

Recovery Requirements:

According to the EPA, a **small appliance** is one that is manufactured, charged, and hermetically sealed in a factory and contains five pounds or less of refrigerant. A **pressurized terminal air conditioner (PTAC)** is a common example of a hermetically sealed air conditioning system. MVAC or motorized vehicle air conditioning systems ***do not*** fall under the small appliance and require q separate certification.

Technicians that handle refrigerant during service, maintenance, or repair of small appliances must have a Type I or Universal certification. The sales of CFCs and HCFCs are restricted to certified technicians. If the EPA changes regulations after the technician is certified, it is the responsibility of the technician to comply with any future changes in the law.

Refrigerant Recovery Requirements for Small Appliances

	Before Nov. 15th 1993	**After Nov. 15th 1993**
Operating Compressor	80% or 4" of Vacuum	90% or 4" of Vacuum
Non-Operating Compressor	80% or 4" of Vacuum	80% or 4" of Vacuum
Fittings	Low-loss Required	Low-loss Required
Approvals	None	EPA Lab Approved

Recovery equipment manufactured ***before*** **November 15, 1993** must be capable of recovering 80% of the refrigerant whether or not the compressor is operating or achieve a 4 inch vacuum under conditions of ARI 740

Recovery equipment manufactured ***after*** **November 15, 1993** must be capable of recovering 80% of the refrigerant without the compressor operating or achieve a 4 inch vacuum under conditions of ARI 740; be capable of recovering 90% of the refrigerant with the compressor operating or achieve a 4 inch vacuum under conditions of ARI 740; and must be approved by an EPA approved third-party laboratory.

Recovery equipment fittings must be equipped with **low-loss fittings** which can be manually or automatically closed when disconnecting hoses in order to prevent refrigerant loss

All appliances must have a **service aperture** valve for recovering and charging refrigerants. For small appliances, the service aperture valve is typically a straight piece of tubing that is entered with a piercing access valve.

When servicing a small appliance, it is **not mandatory** to perform a leak repair; however, it should be done whenever possible.

Recovery Techniques:

Before beginning the refrigerant recovery process, you should always know the type of the refrigerant in the system first. One way to identify the refrigerant is by using the **temperature/pressure chart** (see back page). Never mix refrigerants in a recovery cylinder. If a reclamation facility receives a tank of mixed refrigerants, they may either refuse to process the refrigerant and return it at the owner's expense or they may destroy the refrigerant, but charge a substantial fee.

For small appliances, the technician may use either a self-contained recovery device or use a system dependent recovery system.

Self-contained (active) recovery equipment uses its own power to recover the refrigerant from systems and is capable of reaching the required recovery rates with or without the compressor operating.

The recovered refrigerant in a self-contained system is stored in a pressurized recovery tank

Before operating a self-contained recovery device, make sure the tank inlet valve is open and that the tank does not contain excessive air or non-condensables. Not opening the tank inlet valve or having excess air will cause higher discharge pressures

Checking for air or non-condensables can be done by checking the pressure inside the recovery tank. References to the pressure/temperature chart are only valid if the temperature is known; therefore, when checking for non-condensables inside a recovery cylinder, allow the temperature of the cylinder to stabilize to room temperature before taking a pressure reading.

Refer to the recovery equipment instructions in order to purge air and non-condensables. All refrigerant recovery equipment should be checked for oil level and refrigerant leaks on a daily basis.

A **system-dependent (passive) recovery process** captures refrigerant into a non-pressurized container. The system-dependent equipment uses the system's compressor, an external heat source, or a vacuum pump to recover the refrigerant. A vacuum pump can only be used as a recovery device in combination with a non-pressurized container and can not be used with self-contained recovery equipment (pressurized container).

When using a system-dependent recovery process with an operating compressor, run the compressor and recover from the high side of the system. Normally, one access fitting on the high side will be enough to reach the required recovery rate as the compressor should be able to push the refrigerant to the high side.

When using a system-dependent recovery process with a non-operating compressor, it may be necessary to access both the low and high side of the system to achieve the required recovery level and it will speed the recovery. In order to release the trapped refrigerant from the compressor oil, it will be necessary to heat and tap the compressor with a mallet several times and/or use a vacuum pump.

If the appliance has a **defrost heater** as commonly found in domestic refrigerators, operating the defrost heater will help to vaporize any trapped liquid refrigerant and will speed the recovery process

When filling a **graduated charging cylinder,** refrigerant that is vented off the top of the cylinder must be recovered if it is a regulated refrigerant.

When installing an **access fitting** onto a sealed system, the fitting should be leak tested before proceeding with recovery. It is generally recommended that **solderless piercing type valves** only be used on copper or aluminum tubing. These fittings tend to leak over time and should not be left on appliances as a permanent service fixture. After installing an access fitting, if the system pressure is 0 psig, do not start the recovery process

Small appliances used in campers or other recreational vehicles may use refrigerants not covered in Section 608, such as **ammonia, hydrogen** or **water** and therefore, should not be recovered using current EPA-approved recovery devices. Similarly, systems built before 1950 may have **methyl formate, methyl chloride,** or **sulfur dioxide** as refrigerants and require special recovery equipment and training.

TYPE II

Technicians maintaining, servicing, repairing or disposing of high pressure or very high-pressure appliances such as roof top units, residential split systems, etc…, except small appliances and motor vehicle air conditioning systems (MVAC), must be certified as a Type II Technician or a Universal Technician.

LEAK DETECTION:

After the installation of any type of system, the unit should first be pressurized with nitrogen (an **inert gas**) and leak checked. In order to determine the general area of a leak use an electronic or ultrasonic leak detector. Once the general area of the leak is located the use of soap bubbles will pinpoint the leak.

A refrigeration unit using an open compressor that has not been used in several months is likely to leak from the rotating shaft seal. During a visual inspection of any type of system, traces of oil are an indicator of a refrigerant leak. Excessive superheat, caused by a low refrigerant charge, is also an indication of a leak in a high-pressure system.

LEAK REPAIR REQUIREMENTS:

EPA regulations require that all **comfort cooling appliances containing more than 50 lbs**. of refrigerant MUST be repaired when the annual leak rate exceeds **15%.**
EPA regulations require that **all Commercial and Industrial Process Refrigeration containing more than 50 lbs.** of refrigerant MUST be repaired when the annual leak rate exceeds **35%.**

RECOVERY TECHNIQUES:

Proper recovery techniques begin with the use of appropriate recovery equipment that has been certified by an EPA approved laboratory (UL or ETL) to meet or exceed ARI standards.

Recovered refrigerants may contain acids, moisture, and oil. It is therefore necessary to frequently check and change both the oil and filter on a recycling machine. Both recycling and recovery equipment using hermetic compressors have the potential to overheat when drawing a deep vacuum because the unit relies on the flow of refrigerant through the compressor for cooling. Before using a recovery unit you should always check the service valve positions, the oil level of the recovery unit, and evacuate and recover any remaining refrigerant from the unit's receiver.

Technicians working with multiple refrigerants, before recovering and/or recycling a different refrigerant, must purge the recover/recycle equipment by recovering as much of the first refrigerant as possible, change the filter, and evacuate.

The only exception to this rule is for technicians working with R-134a who must provide a special set of hoses, gauges, vacuum pump, recovery or recovery/recycling machine, and oil containers to be used with R-134a only.

Although recovering refrigerant in the vapor phase will minimize the loss of oil, recovering as much as possible in the liquid phase can reduce recovery time. The technician may choose to speed up the recovery process by packing the recovery cylinder in ice and/or applying heat to the appliance. After recovering liquid refrigerant, any remaining vapor is condensed by the recovery system.

When performing refrigerant system service on a unit that has a receiver/storage tank, refrigerant should be placed in the receiver. Refrigerant should be removed from the condenser outlet if the condenser is below the receiver. In a building that has an air-cooled condenser on the roof and an evaporator on the first floor, recovery should begin from the liquid line entering the evaporator.

After recovery, refrigerant may be returned to the appliance from which it was removed or to another appliance owned by the same person without being recycled or reclaimed, unless the appliance is an MVAC (Motor Vehicle Air Conditioner) like appliance.

The technician should always evacuate an empty recovery cylinder before transferring refrigerant to the cylinder. Quick couplers, self-sealing hoses, or hand valves should be used (as low loss fittings) to minimize refrigerant release when hoses are connected and disconnected.

RECOVERY REQUIREMENTS:

Refrigerant Recovery and/or Recycling equipment manufactured **after November 15, 1993**, must be certified and labeled by an EPA approved testing organization.

The following is a list of the required recovery levels (in inches of mercury) for Type II appliances:

Required Level of Evacuation (Except for Small Appliances & MVAC)		
Type of Appliance	Manufactured before 11/15/93	Manufactured after 11/15/93
	Inches Hg	
HCHF-22 appliance < 200 lbs. refrigerant	0	0
HCFC-22 appliance > 200 lbs. refrigerant	4	10
Other high-pressure appliance* < 200 lbs. refrigerant	4	10
Other high-pressure appliances* >200 lbs. refrigerant	4	15
Very high-pressure appliance	0	0
Low-pressure appliance or isolated component	25	25

Appliances can be evacuated to atmospheric pressure (O psig) if leaks make evacuation to the prescribed level unattainable. The technician must isolate a parallel compressor system in order to recover refrigerant. Failure to isolate a parallel compressor system will cause an open equalization connection that will prevent refrigerant recovery. System-dependent recovery equipment cannot be used on appliances containing more than 15 pounds of refrigerant.

Under EPA regulations, a "**major repair**" means any maintenance, service or repair involving the removal of any or all of the following components: the compressor, the condenser, the evaporator or an auxiliary heat exchanger coil.

REFRIGERATION NOTES*:*

(*Review vapor/compression system in Core Section)*

For many years, the most common refrigerant used in residential split air conditioning systems was R-22, but with the current changes in the industry, read the nameplate to determine the type of refrigerant used.

Filter driers will remove moisture from the refrigerant in a system, but there is a limit to their capacity. Some systems are equipped with a moisture indicating sight glass. When the sight glass changes color, the system contains excessive moisture and will need to be evacuated. The filter-drier should be replaced anytime a system is opened for servicing. If a strong odor is detected during the recovery process, a compressor burn-out may have occurred. When recovering refrigerant from a system that experienced a compressor burn-out, watch for signs of contamination in the oil.

A **crankcase heater** is often used to prevent refrigerant from migrating to the oil during periods of low ambient temperature.

Refrigerant in the oil will cause oil foaming in the compressor at start-up.

When evacuating a vapor compression system, the vacuum pump should be capable of pulling 500 microns (29.90" hg.) of vacuum. The more accurate and preferred method of measuring a deep vacuum is in microns.

Warning: A hermetic compressor's motor winding could be damaged if energized when under a deep vacuum.

The use of a large vacuum pump could cause **trapped water to freeze**. During evacuation of systems with large amounts of water, it may be necessary to increase pressure by introducing nitrogen to counteract freezing.

The source of most non-condensables is **air**. Non-condensables will cause higher discharge pressures.

Where there is a risk of freezing, charging of an R-12 refrigeration system should begin with vapor from a vacuum level to a pressure of approximately 33 psig. followed by a liquid charge through the liquid-line service valve. This is also the proper method to charge a system that contains a large quantity of refrigerant.

SAFETY*: (Additional Safety and shipping information is covered in the core section of this manual.)*

ASHRAE standard 15 requires a refrigerant sensor that will sound an alarm and automatically start a ventilation system in occupied equipment rooms where refrigerant from a leak will concentrate.

Refrigerants CFC-12, CFC-11, and HFC-134a are categorized as A-1.
All refrigeration systems must be protected by a pressure relief valve (s) (must not be installed in series).

NEVER energize a reciprocating compressor if the discharge service valve is closed.

TYPE III

Technicians maintaining, servicing, repairing or disposing of low-pressure appliances must be certified as a Type III Technician or a Universal Technician.

As of November 14, 1994, the sale of CFC and HCFC refrigerants is restricted to certified technicians.

NOTE: If EPA regulations change after the technician is certified, it will be the technician's responsibility to comply with any future changes.

LEAK DETECTION:

Because a low-pressure system operates below atmospheric pressure (in a vacuum), leaks in the gaskets or fittings will cause air and moisture to enter the system.

The most efficient method of leak checking a charged low-pressure refrigeration unit is to **pressurize the system** by the use of controlled hot water or heater blankets. When controlled hot water or heater blankets are not feasible, use nitrogen to increase system pressure.

When pressurizing a system, do **not exceed 10 psig**. Exceeding 10 psig can cause the rupture disc to fail.

When leak testing a water box, be certain the water has been removed before placing the leak detector probe through the drain valve. To leak test a tube, use a hydrostatic tube test kit. Systems with open drive compressors are prone to leaks at the shaft seal.

Controlled hot water can be used to pressurize a system for the purpose of opening the system for a non-major repair.

Under EPA regulations, a “major repair” means any maintenance, service or repair involving the removal of any or all of the following components: the compressor, the condenser, the evaporator or any auxiliary heat exchanger coil.

LEAK REPAIR REQUIREMENTS:

EPA regulations require that all **comfort cooling appliances containing more than 50 lbs**. of refrigerant be repaired when the annual leak rate exceeds **15%.**

EPA regulations require that all **commercial and industrial process refrigeration containing more than 50 lbs**. of refrigerant be repaired when the annual leak rate exceeds **35%.**
(See Type II for definition of commercial and industrial appliances.)

RECOVERY TECHNIQUES:

A recovery unit's high pressure cut-out is set for 10 psig when evacuating the refrigerant from a low-pressure chiller and a rupture disc on a low-pressure recovery vessel relieves at 15 psig.

Refrigerant recovery from a system using R-11 or R-123 starts with liquid removal and is followed by vapor recovery.

A substantial amount of vapor will remain in the appliance after all liquid is removed. For instance, an average 350 ton R-11 chiller at 0 psig still contains 100 lbs. of vapor after all the liquid has been removed.

Water must be circulated through the tubes when evacuating refrigerant in order to prevent freezing the water. Most low-pressure recovery machines utilize a water-cooled condenser that is connected to the municipal water supply.

When recovering refrigerant, the system water pumps, the recovery compressor, and the recovery condenser water should all be on.

If a chiller is suspected of tube leaks, the water sides of the evaporator and condenser should be drained prior to recovering the refrigerant.

The ASHRAE Guideline 3-1996 states that if the pressure in a system rises from 1 mm Hg to a level above 2.5 mm Hg during vacuum testing, the system should be leak checked.

A temperature of 130° F should be attained when removing oil from a low-pressure system. Less refrigerant is contained in the oil at this higher temperature.

RECHARGING TECHNIQUES:

Refrigerant is added through the lowest access point on the system, the evaporator charging valve. However, introducing liquid refrigerant into a deep vacuum will cause the refrigerant to boil and may lower temperatures enough to freeze water in the tubes. Therefore, initial charging is in the vapor phase. Before charging with liquid, an R-11 refrigeration system requires a vapor pressure of 16.9" hg. vacuum, or a saturation temperature of 36° F.

RECOVERY REQUIREMENTS:

Refrigerant Recovery and/or Recycling equipment manufactured after November 15, 1993, must be certified and labeled by an EPA approved equipment testing organization to meet EPA standards. All equipment must have low loss fittings to minimize refrigerant loss when hoses are disconnected.
The following is a list of the required levels of evacuation for Low Pressure appliances:

Using recovery or recycling equipment manufactured or imported before Nov. 15, 1993
25 inches Hg

Using recovery or recycling equipment manufactured or imported on or after Nov. 15, 1993
25 mm Hg absolute

Once the required vacuum has been achieved, the technician should wait for a few minutes and monitor the system pressure.
If the pressure rises, indicating that there is refrigerant remaining in the system, recovery must be repeated. When leaks in an appliance make evacuation to the prescribed level unattainable, the appliance should be evacuated to the lowest attainable level prior to a major repair.

REFRIGERATION NOTES*: (Review vapor / compression system in Core Section)*

The use of a large vacuum pump could cause trapped water to freeze. During evacuation of systems with large amounts of water, it may be necessary to increase pressure by introducing nitrogen to counteract freezing.

If a strong odor is detected during the recovery process, a compressor burn-out may have occurred.
When recovering refrigerant from a system that experienced a compressor burn-out, watch for signs of contamination in the oil.

Because chillers using refrigerants such as CFC-11 and HCFC-123 operate below atmospheric pressure, they require a **purge unit**. The primary purpose of a purge unit is to remove non-condensables from the system.
A centrifugal chiller's purge condensing unit takes its suction from the top of the condenser, removes air and other noncondensables from the system, and returns refrigerant to the evaporator.

Although a high efficiency purge unit discharges a low percentage of refrigerant with the air they remove, frequent purging and subsequent refrigerant loss can indicate that a leak is allowing air into the system. High discharge pressure is also an indication of air in the system.

Excessive moisture collection in the purge unit can indicate tube leakage.
To protect the system from over-pressurization, low-pressure chillers typically use a rupture disc mounted on the evaporator housing. The typical design burst pressure for a rupture disc is 15 psig.

SAFETY*: (Additional Safety and shipping information is covered in the core section of this manual.)*

ASHRAE standard 15 requires a refrigerant monitor that will sound an alarm and automatically start a ventilation system in equipment rooms before the refrigerant concentration reaches the TLV-TWA, (threshold limit value-time weighted average).

A refrigerant monitor is required for all ASHRAE refrigerant safety groups. CFC-12, CFC-11, and HFC-134a are code grouped as A-1. R-123 is code grouped as B-1.

All refrigeration systems must be protected by a pressure relief valve(s) (must not be installed in series).

Additional Safety and shipping information is covered in the core section of this manual.

Glossary

ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers): An international organization that advances heating, ventilation, air conditioning and refrigeration; among other things, they developed a standard for classifying the safety of refrigerants.

Blended refrigerant: Also called a **near-azeotropic mixture** (sometimes referred to as NARM), a blended refrigerant contains refrigerants with different boiling points, but that act as one substance when they are in either a liquid or a vapor state. Near-azeotropic mixtures exhibit temperature glide when they change from vapor to liquid, or vice versa. However, the temperature glide is less than 10ºF. Near-azeotropic mixtures can exhibit fractionation (when the mixture's composition changes as a result of vapor charging) and may affect the leak ratio. Near-azeotropic mixtures should be charged as a liquid.

Azeotrope: A blend of two or more components whose equilibrium vapor phase and liquid phase compositions are the same at a given pressure. These refrigerants are given a 500 series ASHRAE designation and behave like a single refrigerant. They can be charged as a liquid or vapor.

Disposal: The process leading to and including any of the following:

- The discharging, depositing, dumping, or placing of any discarded appliance into or on any land or water.
- The disassembly of any appliance for discharging, depositing, dumping, or placing of its discarded component parts into or on any land or water.
- The disassembly of any appliance for reuse of its component parts.

(Refrigerant added/Total charge) x (365 days/year/D) x 100% where D = the shorter of: # days since refrigerant last added or 365 days

Filter-Drier: An accessory that filters the refrigerant and protects it from dirt and moisture, as well as acids.

Fractionation: The separation of a liquid mixture into separate parts by the preferential evaporation of the more volatile component

Halocarbon: A halogenated hydrocarbon containing one or more of the three halogens: fluorine, chlorine, and bromine. Hydrogen may or may not be present.

High-Pressure Appliance: (prior to March 12, 2004, referred to by the EPA as higher-pressure appliance) An appliance that uses a refrigerant with a liquid phase saturation pressure between 170 psia and 355 psia at 104°F. This definition includes but is not limited to appliances using R-410A, R-22, R-401B, R-402A/B, R-404A, R-407A/B/C, R-408, R-409, R-411A/B, R-502 and R-507A.

Hydrocarbon: A compound containing only the elements hydrogen and carbon.

Leak Rate: The rate at which an appliance is losing refrigerant, measured between refrigerant charges or over 12 months, which ever is shorter. The leak rate is expressed in terms of the percentage of the appliance's full charge that would be lost over a 12-month period if the current rate of loss were to continue. The rate is calculated using the following formula:

Low-Loss Fitting: Any device that is intended to establish a connection between hoses, appliances, or recovery/recycling machines, and that is designed to close automatically or to be closed manually when disconnected to minimize the release of refrigerant from hoses, appliances, and recovery or recycling machines.

Low-Pressure Appliance: (definition unchanged by the EPA's March 12, 2004 rule change): An appliance that uses a refrigerant with a liquid phase saturation pressure below 45 psia at 104°F. Evacuation requirements for the low-pressure category apply to these appliances. This definition includes but is not limited to appliances using R-11, R-113, and R-123.

MSDS (Material Safety Data Sheet): A material safety data sheet (MSDS) is a form with data regarding the properties of a particular substance. An MSDS provides workers with physical data and information about handling that substance in a safe manner.

Major Repair: Maintenance, service, or repair that involves removal of the service or repair appliance compressor, condenser, evaporator, or auxiliary heat exchanger coil.

Medium-Pressure Appliance: (prior to March 12, 2004, referred to by the EPA as high-pressure appliance) An appliance that uses a refrigerant with a liquid phase saturation pressure between 45 psia and 170 psia at 104Â°F. R-114 appliances are at the low-pressure end since the saturation pressure of R-114 at 104°F is slightly above 45 psia. This definition includes but is not limited to appliances using R-12. R-114, R-124, R-134A, R-401C, R-406A and R-500

Mixture: A blend of two or more components that do not have a fixed proportion to one another and that no matter how well blended, still retain a separate existence (oil and water, for example).

Motor Vehicle Air Conditioner (MVAC): Mechanical vapor compression refrigeration equipment used to cool the driver or passenger compartments of any motor vehicle. This definition is NOT intended to encompass the hermetically sealed refrigeration system used on motor vehicles for refrigerated cargo or the air conditioning systems on passenger buses. Section 609 certification is required for working on MVAC systems, while either Section 608 Type II or Section 609 certification is required for MVAC-like A/C systems (e.g. farm equipment and other non-roads vehicles). Section 608 certification is required for working on hermetically sealed refrigeration systems used on motor vehicles for refrigerated cargo or the air conditioning systems on passenger buses.

Non-Azeotropic Refrigerant: A synonym for zeotropic, the latter being the preferred, though less commonly used term. Zeotropic: blend with multiple components of different volatilities that, when used in refrigeration cycles, change volumetric composition and saturation temperatures (exhibit temperature glide) as they evaporate (boil) or condense at constant pressure. These refrigerants are given a 400 series ASHRAE designation.

Normal Charge: The quantity of refrigerant within the appliance or appliance component when the appliance is operating with a full charge of refrigerant.

Person: Any individual or legal entity, including an individual corporation, partnership, association, state, municipality, political subdivision of a state, Indian tribe, and any agency, department, or instrumentality of the United States and any officer, agent, or employee thereof.

Process Stub: A length of tubing that provides access to the refrigerant inside a small appliance or room air conditioner that can be resealed at the conclusion of repair or service.

psia: The absolute pressure in pounds per square inch, where 0 psia corresponds to 29.9 inches of mercury vacuum and 14.7 psia corresponds to 0 psig (pounds per square inch gauge).

psig: The gauge pressure in pounds per square inch, where 0 psig corresponds to atmospheric pressure (14.7 psia). A positive psig value indicates the pressure in pounds per square inch above the ambient pressure.

Reclaim: To reprocess refrigerant to at least the purity specified in the ARI Standard 700, Specifications for Fluorocarbon Refrigerants, and to verify this purity using the analytical test procedures described in the Standard.

Recovery Efficiency: The percentage of refrigerant in an appliance that is recovered by a unit of recycling or recovery equipment.

Recover: To remove refrigerant in any condition from an appliance and to store it in an external container without necessarily testing or processing it in any way.

Recycle: To extract refrigerant from an appliance and to clean refrigerant for reuse without meeting all of the requirements for reclamation. In general, recycled refrigerant is refrigerant that is cleaned using oil separation and single or multiple passes through devices such as replaceable-core filter dryers, which reduce moisture, acidity, and particulate matter.

Refrigerant: The substance used for heat transfer in a refrigeration system. A refrigerant absorbs heat during evaporation at low temperature and pressure, and releases heat during condensation at a higher temperature and pressure.

Refrigerant: Any class I or class II substance used for heat transfer purposes, or any substance used as a substitute for such a class I or class II substance by any user in a given end-use, except for the following substitutes in the following end uses:

- Ammonia in commercial or industrial process refrigeration or in absorption units.
- Hydrocarbons in industrial process refrigeration (processing of hydrocarbons).
- Chlorine in industrial process refrigeration (processing of chlorine and chlorine compounds).
- Carbon dioxide in any application.
- Nitrogen in any application
- Water in any application

Self-Contained Recovery: Recovery or recycling equipment that is capable of removing refrigerant from an appliance without the assistance of components contained in the appliance

Small Appliance: Any of the following products that are fully manufactured, charged, and hermetically sealed in a factory with five pounds or less of refrigerant: refrigerators and freezers designed for home use, room air conditioners (including window air conditioners and packaged terminal air conditioners), packaged terminal heat pumps, dehumidifiers, under-the-counter ice makers, vending machines, and drinking water coolers.

Substitute: Any chemical or product substitute, whether existing or new, that is used by any person as a replacement for a class I or II compound in a given end-use.

System-Dependent Recovery Equipment: Recovery equipment that relies upon the compressor in the appliance and/or the pressure of the refrigerant in the appliance.

System-Dependent: Recovery equipment that requires the assistance of recovery components contained in an appliance to remove the refrigerant from the appliance.

Technician: Any person who performs maintenance, service, or repair that could reasonably be expected to release Class I (CFC) or Class II (HCFC) substances into the atmosphere, including but not limited to installers, contractor employees, in-house service personnel, and in some cases, owners. Technician also means any person disposing of appliances except for small appliances.

Very-High-Pressure Appliance: (definition unchanged by the EPA's March 12, 2004 rule change) An appliance that uses refrigerants with a critical temperature below 104°F or with a liquid phase saturation pressure above 355 psia at 104°F. This category includes but is not limited to appliances using R-13, R-23, R-503.

Refrigerant Temperature / Pressure Chart Bring this chart to the test with you.							
Temperature (°F)	Pressure PSI						
	Red numbers = inches Hg			Black numbers = psig			
	R-11	R-12	R-22	R-123	R-134A	R-500	R-502
-100	29.8	27.0	25.0	29.9	27.8	26.4	25.3
-90	29.7	25.7	23.0	29.8	26.9	24.9	20.6
-80	29.6	24.1	20.2	29.7	25.6	22.9	17.2
-70	29.4	21.8	16.6	29.6	23.8	20.3	12.8
-60	29.2	19.0	12.0	29.5	21.5	17.0	7.2
-50	28.9	15.4	6.2	29.2	18.5	12.8	0.2
-40	28.4	11.0	0.5	28.9	14.7	7.6	4.1
-30	27.8	5.4	4.9	28.5	9.8	1.2	9.2
-20	27.0	0.6	10.2	27.8	3.8	3.2	15.3
-10	26.0	4.4	16.4	27.0	1.8	7.8	22.6
0	24.7	9.2	24.0	26.0	6.3	13.3	31.1
10	23.1	14.6	32.8	24.7	11.6	19.7	41.0
20	21.1	21.0	43.0	23.0	18.0	27.2	52.4
30	18.6	28.4	54.9	20.8	25.6	36.0	65.6
40	15.6	37.0	68.5	18.2	34.5	46.0	80.5
50	12.0	46.7	84.0	15.0	44.9	57.5	97.4
60	7.8	57.7	101.3	11.2	56.9	70.6	116.4
70	2.8	70.2	121.4	6.6	70.7	85.3	137.6
80	1.5	84.2	143.6	1.1	86.4	101.9	161.2
90	4.9	99.8	168.4	2.6	104.2	120.4	187.4
100	8.8	117.2	195.9	6.3	124.3	141.1	216.2
110	13.1	136.4	226.4	10.5	146.3	164.0	247.9
120	18.3	157.7	259.9	15.4	171.9	189.2	282.7
130	24.0	181.0	296.8	21.0	199.4	217.0	320.8
140	30.4	206.6	337.2	27.3	230.5	247.4	362.6
150	37.7	234.4	381.5	34.5	264.4	280.7	408.4

RED indicates a vacuum.