EPA 608 Certification

Study Guide

Foreword

All HVACR technicians must become certified for the equipment they work on, under the Environmental Protection Agency's (EPA), refrigerant recovery and recycling program.

In order to become certified you must pass a test or series of tests, consisting of multiple choice questions. The certifications and sections to the test are:

- Core Section. Information that applies to all certification types.
- Certification Class I. Small appliances under 5 pounds of refrigerant.
- Certification Class II. High Pressure. HVACR units over 5 pounds.
- Certification Class III. Low Pressure units including Centrifugal chillers.
- Certification Universal. All three, Type I, Type II, and Type III.

Most residential and small commercial HVACR technicians need to be "Class II Certified" Everyone must pass the core test (25 questions) and one to 3 of the other sections. If you take and pass all four sections you become universal certified.

A 70% passing rate is required.

The test questions are made available to testing organizations from the EPA bank of test questions.

Contents

CORE SECTION, EPA Section 608 Refrigerant Recovery

This study guide follows the outline from the EPA describing the subject material to be used for certification exam questions. The titles displayed as *…. Descriptions displayed in italics are from the EPA that outlines subjects to be covered …* are from the EPA.

The other text following the highlighted text provides further explanation.

The CORE section is required for all certifications. This section covers the environmental impact of refrigerants, CFC's and HCFC's, the Clean Air Act and EPA regulations.

... Destruction of ozone by chlorine...

Ozone Depletion

Chlorine reacts with Ozone and creates "Chlorine Monoxide". Chlorine Monoxide doesn't last long and the molecules soon return to the original chlorine state. This reaction continues with one chlorine destroying thousands of Ozone molecules.

The primary objective of EPA Section 608, is to prevent further "Depletion of the Ozone layer" in the earth's stratosphere. Most of the Ozone is in the layer of the atmosphere called the stratosphere. The Troposphere is the first layer extending from the ground to 6-7 miles above the surface. The stratosphere is located from 6-7 miles up, to 30 miles above the earth's surface.

... Presence of chlorine in CFC and HCFC refrigerants...

Refrigerants, CFC and HCFC, containing Chlorine are the source of the Ozone depletion problem. The refrigerants are harmless in the lower layer of the atmosphere, but they eventually drift up into the stratosphere. The increased UV in the stratosphere breaks the CFC and HCFV down releasing the Chlorine contained in the refrigerants.

... Identification of CFC, HCFC, and HFC refrigerants (not chemical formulas, but idea that R-12 is a CFC, R-22 is an HCFC, R-134 is an HFC, etc.)...

REFRIGERANTS

CFC chlorofluorocarbon

C CHLORO (Chlorine)
F FLUORO (Fluorine)
C Carbon

Common CFC refrigerants include R-11, R-12, R-113, R-114, R-115, R-500 and R-502

HCFC hydrochlorofluorocarbon

H Hydro (Hydrogen)
C Chloro (Chlorine)
F Fluoro (Fluorine)
C Carbon

Common HCFC refrigerants include R-22, 123 and 124

HFC hydrofluorocarbon

H Hydro (Hydrogen)
F Fluoro (Fluorine)
C Carbon

Common HFC refrigerants include R-134A

... Idea that CFCs have higher ozone-depletion potential (ODP) than HCFCs, which in turn have higher ODP than HFCs...

Ranking Refrigerants for Potential Damage

Some refrigerants pose a danger to "Ozone depletion". Ozone depletion lets too much UV in. Some refrigerants pose a danger to "Global Warming". Greenhouse gases trap the heat contributing to global warming and climate change.

CFC and HVFC are bad for Ozone depletion and HFC is not.

Ozone can be bad or good depending on where it is located in the atmosphere. Good ozone is in the Stratosphere where it acts as a UV filter. If ozone is in the Troposphere, the air layer closest to the surface, it is considered a pollutant (smog) and is bad.

Ozone is a molecule consisting of 3 oxygen atoms bonded together. Chemicals used as refrigerants in HVACR (heating, ventilation, air conditioning, refrigeration) deplete Ozone, and have created a hole in the ozone layer of the atmosphere. Ozone in the atmospheric layer below the stratosphere, called the troposphere, is a pollutant and causes a greenhouse gas effect contributing to global warming.

... Health and environmental effects of ozone depletion...

Stratospheric **Ozone** creates a protective layer that filters out ultraviolet (UV) sunlight from reaching the earth's surface. Too much UV causes weakening of the immune system, increases skin cancer and eye cataracts.

The **greenhouse gas** effect traps heat close to the earth contributing to global warming.

... Evidence of ozone depletion and role of CFCs and HCFCs...

Since Chlorine Monoxide has a short life, its existence in the stratosphere is the proof that the problem of Ozone Depletion is manmade chlorine. In contrast, naturally occurring chlorine, dissolves in water and is washed away by rain before it can reach the stratosphere. The Chlorine in the CFC molecule does not dissolve in water and the chlorine is not released until it reaches the stratosphere.

Another chemical contained in CFC refrigerants is fluorine. Fluorine does not occur naturally with chlorine. The presence of Fluorine in the Stratosphere is further evidence that the source of the Ozone depletion problems is manmade refrigerants.

... CFC Phase-out Date...

In 1990 the US Congress amended the **"Clean Air Act"** and assigned the **EPA (Environmental Protection Agency)** the responsibility of reducing Ozone depletion by managing air quality and atmospheric protection by giving the EPA regulatory powers.

CFC can no longer be manufactured or imported into the USA effective January 1, 1996. However, refrigerant manufactured before this date or refrigerant recovered and recycled can be used.

... Venting prohibition at servicing...

Knowingly venting regulated refrigerants is prohibited except for the following:

Release of minimal amounts (de minimus, meaning not very much or minimal) of refrigerant while attempting to recapture, recycle or dispose of refrigerant.

Release of refrigerant during normal operation of air conditioning and refrigeration equipment as opposed to release during service, maintenance or repair is allowed. An example is mechanical purging from a purge unit on a low pressure chiller.

Leaks more than specified size must be repaired:

- Commercial refrigeration or industrial process refrigeration. Amount of charge is more than 50 pounds and leaking 35% annually must be repaired.
- All other leaking 15% annually must be repaired.
- Systems containing less than 50 pounds not specified.
- CFC or HCFC not used as refrigerant may be released. An example is R-22 mixed with nitrogen and used as a holding charge. You may not however add nitrogen to refrigerant to use this allowance.
- You may release small amounts of refrigerant to purge hoses used with manifold gauges. Recovery and recycling equipment manufactured after November 15, 1993 must have low-loss fittings.

... Venting prohibition at disposal...

When disposing of appliances and units containing CFC and HCFC refrigerants, the refrigerant must be recovered from all appliances at the same rate used for servicing the units. **Responsibility for disposal falls to the last person involved in the disposal**. This is usually the metal recycler. This person must maintain records including statements that the refrigerant has been removed.

... Venting prohibition on substitute refrigerants in November, 1995...

Venting substitutes for CFC and HCFC became illegal after November 1995. HFC's were included, not because of Ozone depletion, but because of global warming potential.

... Maximum penalty under CAA...

Violating the Clean Air Act (CAA) can result in a fine to the employee and employer of up to $27,500.00 per day per violation. Reporting a violation resulting in a fine can earn a reward of up to $10,000.00.

... Montreal Protocol (international agreement to phase out production of ozone-depleting substances)...

In 1987 an international conference held in Montreal that resulted in a treaty called the **"Montreal Protocol".** The result was a treaty eas to eliminate Ozone depletion chemicals including CFC, HCFC and Halon. Halon is a chemical used in fire extinguishing.

Section 608 Regulations

... Definition/identification of high and low-pressure refrigerants...

High pressure refrigerant has a boiling point between -50C and 10C degrees or -58F and 50F degrees at atmospheric pressure (29.9 inches of mercury). Included refrigerants are 12, 22, 114, 500 and 502

Very high pressure refrigerant has a boiling point below -50C or -58F at atmospheric pressure. Included refrigerants are 13 and 503.

Low pressure refrigerant has a boiling point above 10C or 50F at atmospheric pressure. Refrigerants included are 11, 113, and 123.

... Definition of system-dependent vs. self-contained recovery/recycling equipment...

System dependant recovery (passive recovery) requires the assistance of components (such as the appliance or unit's compressor) contained in the appliance (unit) to remove the refrigerant from the appliance (unit).

Self contained recovery (active recovery) equipment has its own compressor/pump.

... Identification of equipment covered by the rule (all air-conditioning and refrigeration equipment containing CFCs or HCFCs except motor vehicle air conditioners)...

As of July 13, 1993, all systems in general that are to be opened to the atmosphere for any reason, including disposal, must have the refrigerant recovered and must be evacuated to the levels specified.

... Need for third-party certification of recycling and recovery equipment manufactured after November 15, 1993...

Recovery equipment manufactured or imported after November 15, 1993 must be tested and certified by an EPA approved Laboratory or organization.

... Standard for reclaimed refrigerant (ARI 700)...

The purpose of this standard is to establish purity specifications, to verify composition, and to specify the associated methods of testing for acceptability of fluorocarbon refrigerants regardless of source (new, reclaimed and/or repackaged) for use in new and existing refrigeration and air-conditioning products within the scope of ARI.

... Absence of "drop-in" replacements...

Substitute Refrigerants and Oils

Due to incompatibility of substitute refrigerants with many lubricants used with CFC and HCFC refrigerants and incompatibility of CFC and HCFC refrigerants with many new lubricants, drop-in replacements are not available. (includes identification of lubricants for given refrigerants, such as esters with 134; alkylbenzenes for HCFCs) ...

Refrigeration Oils

The purpose of refrigeration oil is to lubricate the compressor. The oil and refrigerant are present in the same sealed system. If the oil does not mix well with the refrigerant (**miscible**), the oil would be carried into the system and become separated and trapped.

Water is the enemy of oil. Pressure, heat and water in oil will produce acids and cause problems with the insulation on motor windings and corrosion of metal parts. Oil that absorbs moisture is called **hygroscopic**. Filter dryers are used to keep the refrigerant and oil dry.

Many compressors are equipped with a crankcase heater to keep the refrigerant from migrating to the compressor. Refrigerant can condense in the oil and boil off when the compressor starts causing compressor damage.

CFC and HCFC use the older mineral oil and alkylbenzenes. New refrigerants have required the development of new refrigerant oils including POE (polyol esters) and PAG (polyalkylene glycol.

... Fractionation problem--tendency of different components of blends to leak at different rates...

Refrigerant Blends

Refrigerants numbered 4xx are **zeotropic** meaning each refrigerant in the blend keeps its own temperature/pressure characteristics. These refrigerants have "**temperature glide",** meaning the higher pressure refrigerant will vaporize first and condense last followed by the lower pressure refrigerant. A blend of three refrigerants is called a ternary blend.

The component refrigerants in zeotropic blends can leak at different rates since they vaporize at different times. This characteristic, called **fractionation** can cause a change in the blend and a change in how the refrigerant performs. These refrigerants should be introduced into the system (charged) as a liquid and not a gas, so they keep their characteristics.

Refrigerants with a 5xx numbering are azeotropic meaning they will act like a single refrigerant in regard to pressure/temperature.

Refrigeration

... Refrigerant states (vapor vs. liquid) and pressures at different points of refrigeration cycle; how/when cooling occurs...

(See reference book on the basics of the refrigeration cycle and become knowledgeable in this process)

... Refrigeration gauges (color codes, ranges of different types, proper use)...

The **gauge manifold** set (also known as a **service manifold**) is an important tool for the Technician that measures pressure readings at different points in the refrigeration system. The **Compound gauge** is usually blue and measures low pressure (psig) and vacuum (inches Hg).

The **High pressure gauge** is usually red and measures the high side (discharge) pressure. The scale on the high pressure side is a continuous scale and is usually calibrated to read from 0 to 500 psi.

The **center port** of the manifold is usually a yellow hose and can be connected to a recovery device, evacuation vacuum pump or charging device.

Leak Detection

Reducing intentional release of CFC and HCFC refrigerants is one of the primary goals of this rule as is preventing and eliminating accidental leaks.

Pressure testing new or repaired systems with nitrogen before charging with refrigerant is a good practice. If the system does not hold pressure a leak must be located and repaired. If the leak cannot be found using an inert gas and pressure test, the EPA allows, as a last resort, using some refrigerant as a trace gas and a refrigerant sensing tool to find the leak.

The system should be evacuated and hold a vacuum prior to charging with refrigerant.

Leaks are indicated by:

- Low refrigerant charge
- High superheat
- Traces of oil on a tube or fitting joint
- Worn tubing due to vibration
- Access points such as Schrader valves and service valves

- Shaft seals on open compressors

Tools used to locate leaks

- Electronic IR leak detectors
- Electronic ultrasound leak detectors
- Brushing bubble producing soap liquid on potential leak areas
- Halide torch flame turns green indicating refrigerant
- Adding dye to the system

Leak Repair Requirements

- It is good practice to find and repair leaks.
- EPA **does not** require repair of leaks holding **less than 50 pounds** of refrigerant
- EPA **does** require repair of leaks in systems containing **50 pounds or more** of refrigerant when:

  Commercial and industrial process refrigeration systems when the leak exceeds 35% of the charge per year.

  Equipment other than commercial and industrial process refrigeration when the leak exceeds 15% of the charge per year.

Leaks requiring repair must be repaired within 30 days of discovery. Exception, when the owner of the equipment develops a plan to retrofit or retire the equipment within one year. Documentation of the plan must be kept on site and work completed within one year.

Three R's

... Definitions... Recover...

To remove refrigerant in any condition from a system in either an active or passive manner, and store it in an external container without testing or processing.

Recovery

Regulated refrigerants, HFC, HCFC, must be recovered prior to opening a system. Non regulated refrigerants do not have to be recovered.

All other non-MVAC (motorized Vehicle AC) Appliances. You must have an active recovery devise available unless you are only working on small appliances. An active recovery device has its own compressor, pump or device to remove refrigerant.

Recovery Evacuation Rules

- Appliance, HCFC 22 w/ **less than** 200 pounds, (0) Inches of Hg Vacuum
- Appliance/Unit, HCFC 22 w/ **more than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance/Unit, CFC 12, 500, 502, 114 **less than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance/Unit, CFC 12, 500, 502, 114 **more than** 200 pounds (4 or 15*)
- Very high-pressure appliance CFC 13, 503 (0) Inches Hg Vacuum
- Low-pressure appliance CFC 11, 123 (25 or 25 mm Hg absolute*)

*On or after November 15, 1993, recovery equipment certified by EPA approved testing organization.

You are not required to recover refrigerant if the leak is too large and will draw air into the system.

... Recycle...

To reduce contaminants in the used refrigerant by:

- Oil separation
- Non-condensable removal
- Single or multiple passes through devices that reduce moisture, acidity, and particulate matter, such as replaceable core filter dryers.

... Reclaim...

To process the used refrigerant to new product specifications by means which may include distillation.

Chemical analysis of the refrigerant is required to assure that appropriate product specifications are met.

...Need to avoid mixing refrigerants...

Never mix refrigerants in recovery containers.

... Factors affecting speed of recovery (ambient temperature, size of recycling or recovery equipment, hose length and diameter, etc.)...

Recovery Techniques

You can speed up recovery using these techniques:

- Keep the system pressure high to move refrigerant to the lower pressure recovery device faster.
- Keep the recovery container pressure as low as possible to draw out the refrigerant.
- High outside ambient temperature will produce a higher system pressure.
- Heating the system components with heaters will increase system pressures.
- Place the recovery container in ice to lower its pressure.
- Use short large diameter hoses to reduce pressure drop.
- Properly maintain your recovery equipment

Dehydration Evacuation

... Need to evacuate system to eliminate air and moisture at the end of service....

Evacuation and Dehydration

Using a vacuum pump and lowering the pressure in the system causes any moisture to vaporize. The pump can then remove the vapor. Air, moisture and non condensable gas are harmful to HVACR systems, their capacity and efficiency. Any system or tubing that has been exposed to the atmosphere should be evacuated before charging with refrigerant.

Lowering the system pressure rapidly can freeze water in the system. Caution should be exercised if there is potential for excessive water. Take longer to pull the vacuum, introduce nitrogen or provide heat.

A micron gage should be used to determine effectiveness of your evacuation. The system should pull down to **500 microns**. After the 500 micron level is obtained the pump should be valved off from the system while you observe if the vacuum holds. The following will result in an observable loss of vacuum.

- The system contains liquid refrigerant that continues to vaporize
- Water in the system continues to vaporize
- There is a leak
- Loose connections

Evacuation Level Requirements for Appliances (effective July 13, 1993)

- Appliance, HCFC 22 w/ **less than** 200 pounds, (0) Inches of Hg Vacuum
- Appliance, HCFC 22 w/ **more than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance, CFC 12, 500, 502, 114 **less than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance, CFC 12, 500, 502, 114 **more than** 200 pounds (4 or 15*)
- Very high-pressure appliance CFC 13, 503 (0) Inches Hg Vacuum
- Low-pressure appliance CFC 11, 123 (25 or 25 mm Hg absolute*)

*On or after November 15, 1993, recovery equipment certified by EPA approved testing organization

Evacuation Level Exceptions

If a system has a leak large enough to prevent evacuation to the prescribed level, the system must be evacuated to atmospheric pressure (0 psig) before being opened.

Safety

... Risks of exposure to refrigerant (e.g., oxygen deprivation, cardiac effects, frost bite, long-term hazards)...

Use good judgment and remember gas under high pressure can be dangerous

- Escaping gas can cause skin and eye damage.
- Escaping gas can stir up dust and debris that can be hazardous.
- Wear goggles when handling pressurized gases.
- All systems should have a high pressure relief valve.
- Nitrogen cylinders are under about 2000 psi. Always use a pressure regulator with nitrogen. System components such as coils can be damaged. Make sure a pressure relief valve is installed in case the pressure regulator fails. Don't install pressure relief valves in series.
- Never use compressed air or oxygen in a system. Air containing compressed oxygen in the presence of oil, is highly explosive.

... Personal protective equipment (gloves, goggles, self-contained breathing apparatus--SCBA--in extreme cases, etc)...

- Refrigerants at atmospheric pressure produce extremely cold temperatures and can cause frostbite. Wear safety glasses, goggles, rubber lined gloves, long sleeve shirts and long pants.

- Refrigerants are heavier than air. If you are in a confined space the refrigerant can displace the oxygen resulting is suffocation. In areas where large amounts of refrigerant exist, safety gear such as self contained breathing apparatus (SCBA) should be available. Evacuate the area until it can be ventilated.
- Some refrigerants are toxic. Others are considered non-toxic but are still dangerous in higher concentrations. Safe limits are measured in parts per million (ppm). Another common measure is the "Threshold Limit Value – Time Weighted Average" (TLV-TWA) Safety standard are developed for protection above these limits.
    - **ASHRAE Standard 34.** This standard classifies refrigerants into groups according to flammability and toxicity. Low toxicity refrigerants are class A, high toxicity are class B. Non-flammability refrigerants are class 1 and higher flammable refrigerants are class 3. (A1, A2, A3, B1, B2, B3)

Chemical changes from heat. Flames or high heat from soldering or welding can produce acids or poisonous gases from refrigerants. Hydrochloric acid, hydrofluoric acid and phosgene gas can be deadly. Remove refrigerant and evacuate any components before soldering or welding.

... Reusable (or "recovery") cylinders vs. disposable cylinders (ensure former DOT approved, know former's yellow and gray color code, never refill latter)...

Refrigerant Cylinders

Refrigerant cylinders are color coded according to the type of refrigerant contained in the cylinder and the use of the cylinder.

- **Storage cylinders.** Larger cylinders used for storing refrigerant to be transferred to smaller refillable cylinders.
- **Reusable cylinders** (refillable) Gray with a yellow top. These cylinders are used for recovery or transporting refrigerant.
- **Disposable cylinders.** Single use cylinders. It is a violation to refill disposable cylinders. These cylinders are designated as DOT Specification 39, non-reusable cylinders. Empty cylinders should have the pressure reduced to zero and the cylinder rendered unusable.

... Risks of filling cylinders more than 80 percent full...

Use good judgment and remember gas under high pressure can be dangerous. Never fill a container more than 80% to allow for expanding gas.

... Use of nitrogen rather than oxygen or compressed air for leak detection...

Never use compressed air or oxygen in a system. Air containing oxygen when compressed is highly explosive.

... Use of pressure regulator and relief valve with nitrogen...

Nitrogen cylinders are under high pressure, about 2000 psi. Always use a pressure regulator with nitrogen. System components such as coils can be damaged. Make sure a pressure relief valve is installed in case the pressure regulator fails. Don't install pressure relief valves in series.

Shipping

... Labels required for refrigerant cylinders (refrigerant identification, DOT classification tag)...

DOT (Department of Transportation) requires proper DOT tags be attached to cylinders including the refrigerant type contained in the cylinder. DOT requires all cylinders be hydrostatically tested and stamped every five years.

Disposable cylinders **are** designated as DOT Specification 39, non-reusable cylinders.

TYPE 1 (Small Appliances)

Recovery Requirements

... Definition of "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.

... Evacuation requirements for small appliances with and without working compressors using recovery equipment manufactured before November 15, 1993...

Evacuation Level Requirements for Small Appliances (effective July 13, 1993)

Appliance with a charge under 5 pounds

Using a recovery device manufactured before November 15, 1993

- Compressor running or not, 80% of charge or 4 Inches Hg vacuum
- Compressor running 90% or 4 Inches Hg vacuum

... Evacuation requirements for small appliances with and without working compressors using recovery equipment manufactured after November 15, 1993...

Using a recovery device manufactured on or after November 15, 1993

Evacuation of Small Appliances. If you only work on small appliances you can use a passive recovery device. A passive recovery device can utilize the compressor or pressure in the appliance you are working on to move the refrigerant to an external container.

Before November 15, 1993

- 80% of the charge must be removed or 4 inches Hg of vacuum.

On or after November 15, 1993

- Remove 80% if the appliance is not running and 90% if running or 4 inches Hg vacuum.

Recovery Techniques

... Use of pressure and temperature to identify refrigerants and detect noncondensables...

Once you have recovered the refrigerant and it is at room temperature, use a pressure/temperature chart to verify that the pressures in the cylinder match the pressures on the chart. Pressures and temperatures that do not match indicate the presence of air or other noncondensables.

... Methods to recover refrigerant from small appliances with inoperative compressors using a system-dependent or "passive") recovery device (e.g., heat and sharply strike the compressor, use a vacuum pump with non-pressurized recovery container)...

You can recover refrigerant on small appliances using a passive recovery device. This can be an evacuated refrigerant cylinder or an atmospheric bag. Any appliance with 15 pounds or less refrigerant can use a passive recovery device.

Methods to assist passive recovery:

- Use the appliance compressor to pump refrigerant.
- Use the pressure of the refrigerant to facilitate transfer.
- Heat the compressor and strike the compressor to cause the oil to give up refrigerant.

... Need to install both high and low side access valves when recovering refrigerant from small appliances with inoperative compressors...

If the compressor on the appliance is not operable you will recover refrigerant from high side and low side access valves in order to recover the required 80% of the refrigerant at 4 inches Hg vacuum.

... Need to operate operative compressors when recovering refrigerant with a system-dependent ("passive") recovery device...

If the compressor is capable of running, you should use it to pump refrigerant into the non pressurized compressor from a single access valve on the high side.

... Should remove solderless access fittings at conclusion of service...?

Solderless fittings can leak over time and should be removed.

... 134a as likely substitute for R-12...

... Decomposition products of refrigerants at high temperatures (HCl, HFl etc) ...

Chemical changes from heat. Flames or high heat from soldering can produce acids or poisonous gases from refrigerants. **Hydrochloric acid, hydrofluoric acid and phosgene gas** can be deadly. Remove refrigerant and evacuate any components before soldering or welding.

This compound can be decomposed by high temperatures (open flames, glowing metal surfaces, etc.) forming hydrochloric and hydrofluoric acids and possible carbonyl halides.

Safety

Refrigerants at atmospheric pressure produce extremely cold temperatures and can cause frostbite. Wear safety glasses, goggles, rubber lined gloves, long sleeve shirts and long pants.

Refrigerants are heavier than air. If you are in a confined space the refrigerant can displace the oxygen resulting is suffocation. In areas where large amounts of refrigerant exist, safety gear such as self contained breathing apparatus (SCBA) should be available. Evacuate the area until it can be ventilated.

Some refrigerants are toxic. Others are considered non-toxic but are still dangerous in higher concentrations. Safe limits are measured in parts per million (ppm). Another common measure is the "Threshold Limit Value – Time Weighted Average" (TLV-TWA) Safety standard are developed for protection above these limits.

- **ASHRAE Standard 15-1994** This standard required that mechanical rooms contain sensors, alarms and ventilation systems to keep the concentration of covered refrigerants below the TLV-TWA.
- **ASHRAE Standard 34.** This standard classifies refrigerants into groups according to flammability and toxicity. Low toxicity refrigerants are class A, high toxicity are class B. Non-flammability refrigerants are class 1 and higher flammable refrigerants are class 3. (A1, A2, A3, B1, B2, B3)

TYPE II (High-Pressure)

... Signs of leakage in high-pressure systems (excessive superheat, traces of oil for hermetic)...

Leak Detection

Diagnosing a system with a low refrigerant charge may indicate the system has a leak. Low superheat is the primary low charge indicator for fixed orifice systems.

The refrigerant and oil are mixed in the system. At the location of a leak there may be a trace of oil. The refrigerant vaporizes, leaving behind the oil.

... Need to leak test before charging or recharging equipment...

Leak checking or testing can be accomplished by:

- Halide torch, flame turns green in the presence of refrigerant.
- Adding dye to refrigerant
- Electronic leak detectors
- Brushing soap to produce bubbles on the suspected area.

... Order of preference for leak test gases (nitrogen alone best, but nitrogen with trace quantity of 22 better than pure refrigerant)...

It is preferred that you use in inert gas such as nitrogen for leak checking. It is acceptable to use R-22 as a trace gas if required to locate the leak.

... Allowable annual leak rate for commercial and industrial process refrigeration...

Leaks in commercial and industrial process refrigeration equipment with more than 50 pounds of refrigerant must be repaired when the leak exceeds more than 35% of the charge per year.

... Allowable annual leak rate for other appliances containing more than 50 lbs of refrigerant...

All other equipment (not commercial and industrial process refrigeration) containing more than 50 pounds of refrigerant must be repaired when the leak rate exceeds 15% of the charge per year.

... Recovering liquid at beginning of recovery process speeds up process...

Recovery Techniques

Recover the liquid refrigerant first to speed up the recovery process.

... Other methods for speeding recovery (chilling recovery vessel, heating appliance or vessel from which refrigerant is being recovered)...

Other methods to speed recovery:

- Keep the system pressure high and the recovery cylinder pressure low. Warm the system to increase pressure and cool the cylinder to reduce pressure and more readily accept the refrigerant.
- Use large diameter and short hoses to reduce the friction pressure loss in recovery hoses.

... Methods for reducing cross-contamination and emissions when recovery or recycling machine is used with a new refrigerant...

Make sure you never mix refrigerants in a cylinder.

Check your recovery equipment often and change the oil and filter on a regular schedule.

... Need to wait a few minutes after reaching required recovery vacuum to see if system pressure rises (indicating that there is still liquid refrigerant in the system or in the oil)...

After you have completed recovery, make sure you wait a sufficient amount of time for any remaining liquid in the system or in the oil to vaporize. The pressure may increase as trapped refrigerant vaporizes. If pressure rises continue the recovery.

Evacuation Requirements

... Evacuation requirements for high-pressure appliances in each of the following situations: ...

... Disposal...

Disposal of Refrigerant Containing Appliances

CFC and HCFC refrigerants must be recovered from appliances prior to disposal. Use the same rate or percentage as would apply when servicing the appliance. The last person in the disposal

chain is responsible for removing the refrigerant. This is normally the metal recycler. This person must maintain records documenting recovery.

... Major vs. non-major repairs...

As of July 13, 1993, all systems in general that are to be opened to the atmosphere for any reason, must have the refrigerant recovered and must be evacuated as follows.

Evacuation Level Requirements for Appliances (effective July 13, 1993)

- Appliance, HCFC 22 w/ **less than** 200 pounds, (0) Inches of Hg Vacuum
- Appliance, HCFC 22 w/ **more than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance, CFC 12, 500, 502, 114 **less than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance, CFC 12, 500, 502, 114 **more than** 200 pounds (4 or 15*)
- Very high-pressure appliance CFC 13, 503 (0) Inches Hg Vacuum
- Low-pressure appliance CFC 11, 123 (25 or 25 mm Hg absolute*)

*On or after November 15, 1993, recovery equipment certified by EPA approved testing organization

Evacuation Level Exceptions

If a system has a leak large enough to prevent evacuation to the prescribed level, the system must be evacuated to atmospheric pressure (0 psig) before being opened.

... Leaky vs. non-leaky appliances...

See above

... Appliance (or component) containing less vs. more than 200 lbs...

See above

... Recovery/recycling equipment built before vs. after November 15, 1993...

Recovery and recycling equipment manufactured or imported on or after November 15, 1993 must be tested and certified by EPA approved libratory or organization and a third party laboratory according to ARI 740.

. ..Definition of "major" repairs...

Any maintenance, service or repair involving the removal of any of the following components:

- Compressor

- Condenser
- Evaporator
- Auxiliary heat exchanger coil

... Prohibition on using system-dependent recovery equipment on systems containing more than 15 pounds of refrigerant...

System dependant equipment (passive method) shall not be used with appliances containing more than 15 pounds of refrigerant.

... How to identify refrigerant in appliances...

Use pressure temperature chart to confirm the refrigerant type..

... Pressure-temperature relationships of common high-pressure refrigerants (may use standard temperature-pressure chart--be aware of need to add 14.7 to translate psig to psia)...

Psig represents the pressure read from a gauge on a closed system

Psia represents the pressure at atmospheric pressure. Atmospheric pressure is 14.7 psi

... Components of high-pressure appliances (receiver, evaporator, accumulator, etc.) and state of refrigerant (vapor vs. liquid) in them...

- Condenser: Condenses high pressure gas from the compressor to high pressure liquid.
- Receiver: Receives high pressure liquid from the condenser
- Expansion device: converts high pressure liquid to low pressure vapor
- Evaporator : Evaporates low pressure vapor from the expansion device
- Accumulator: Accumulates any low pressure liquid from the evaporator so it can vaporize before entering the compressor
- Compressor: Compresses low pressure vapor to high pressure vapor

Safety

... Shouldn't energize hermetic compressors under vacuum...

Starting a compressor under vacuum will damage the compressor.

... Under ASHRAE Standard 15, need to have equipment room refrigerant sensor for 123...

  - **ASHRAE Standard 15-1994** This standard required that mechanical rooms contain sensors, alarms and ventilation systems to keep the concentration of covered refrigerants below the TLV-TWA.

TYPE 3 (Low-pressure)

Leak Detection

... Order of preference of leak test pressurization methods for low-pressure systems (first: hot water method or built-in system heating/pressurization device such Prevac; second: nitrogen)...

Low pressure appliances (usually large chillers) operate at below atmospheric pressure. Preferred leak check methods are:

- Raise the system pressure by running hot water through the system or heating the unit with heat blankets.
- Recover refrigerant and pressurize with nitrogen
- Check the shaft seal on open compressors for leaks
- If water tube leaks are suspected a hydrostatic tube test can be performed.

... Signs of leakage into a low-pressure system (e.g., excessive purging)...

Since low pressure systems operate at below atmospheric pressure, air and moisture will leak into the refrigerant circuit through seals, gaskets or other leaks. A component called a purge unit will remove these noncondensables from the top of the condenser when they are present. Excessive purge unit operation indicates a leak. Some refrigerant is purged in this process.

... Maximum leak test pressure for low-pressure centrifugal chillers...

These systems will have a component called a rupture disk. The rupture disk is a pressure relief device that will release the refrigerant when pressures exceed the disk rating, usually 15 psig.

Maximum test pressure should be 10psig or lower.

... Allowable annual leak rate for commercial and industrial process refrigeration...

Leak repair requirements

EPA **does not** require repair of leaks holding **less than 50 pounds** of refrigerant

It is good practice to find and repair leaks.

EPA **does** require repair of leaks in systems containing **50 pounds or more** of refrigerant when:

Commercial and industrial process refrigeration systems when the leak exceeds 35% of the charge per year.

... Allowable annual leak rate for other appliances containing more than 50 lbs of refrigerant...

Equipment other than commercial and industrial process refrigeration when the leak exceeds 15% of the charge per year.

Leaks requiring repair must be repaired within 30 days of discovery. Exception, when the owner of the equipment develops a plan to retrofit or retire the equipment within one year. Documentation of the plan must be kept on site and work completed within one year.

... Recovering liquid at beginning of recovery process speeds up process...

Recovering liquid refrigerant first before it vaporizes, will speed up the recovery process.

... Need to recover vapor in addition to liquid...

All refrigerant must be removed before nitrogen can be used to pressure test.

... Need to heat oil to 130F before removing it to minimize refrigerant release...

If oil is to be removed heating it to 130F is required to release the refrigerant contained in the oil.

... Need to circulate or remove water from chiller during refrigerant evacuation to prevent freezing...

Lowering the pressure in the refrigerant circuit will cause liquid to vaporize. Refer to a pressure temperature chart for the refrigerant being used during evacuation to insure the temperature remains above freezing. Water in the chiller or condenser could freeze and rupture tubes if allowed to fall below freezing.

... High-pressure cut-out level of recovery devices used with low-pressure appliances...

Recovery machines for low pressure chillers should be equipped with a pressure relief devise to prevent over pressuring the chiller. Rupture disks may release at 15 psig. High pressure relief should be set at 10 psig.

Recharging Techniques

... Need to introduce vapor before liquid to prevent freezing of water in the tubes...

If low pressure liquid is fed into an evacuated refrigerant circuit, the liquid will boil off and could freeze water tubes causing damage. Vapor should be added first until the refrigerant pressure boiling point is above freezing.

... Need to charge centrifugals through evaporator charging valve...

Centrifugal compressors are charged through the lowest access point on the low pressure side at the evaporator charging valve.

Recovery Requirements

... Evacuation requirements for low-pressure appliances in each of the following situations: ...

... Disposal...

Disposal of Refrigerant Containing Appliances

CFC and HCFC refrigerants must be recovered from appliances prior to disposal at the same rate or percentage as would apply when servicing the appliance. The last person in the disposal chain is responsible for removing the refrigerant. This is normally the metal recycler. This person must maintain records documenting recovery.

... Major vs. non-major repairs...

As of July 13, 1993, all systems in general that are to be opened to the atmosphere for any reason, must have the refrigerant recovered and must be evacuated as follows.

Evacuation Level Requirements for Appliances (effective July 13, 1993)

- Appliance, HCFC 22 w/ **less than** 200 pounds, (0) Inches of Hg Vacuum
- Appliance, HCFC 22 w/ **more than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance, CFC 12, 500, 502, 114 **less than** 200 pounds (4 or 10*) Inches Hg vacuum
- Appliance, CFC 12, 500, 502, 114 **more than** 200 pounds (4 or 15*)
- Very high-pressure appliance CFC 13, 503 (0) Inches Hg Vacuum
- Low-pressure appliance CFC 11, 123 (25 or 25 mm Hg absolute*)

*On or after November 15, 1993, recovery equipment certified by EPA approved testing organization

Evacuation Level Exceptions

If a system has a leak large enough to prevent evacuation to the prescribed level, the system must be evacuated to atmospheric pressure (0 psig) before being opened.

... Leaky vs. non-leaky appliances...

See above

... Appliance (or component) containing less vs. more than 200 lbs...

See above

... Recovery/recycling equipment built before vs. after November 15, 1993...

Recovery and recycling equipment manufactured or imported on or after November 15, 1993 must be tested and certified by EPA approved laboratory or organization and a third party laboratory according to ARI 740.

... Definitions of "major" and "non-major" repairs...

Any maintenance, service or repair involving the removal of any of the following components:

- Compressor
- Condenser
- Evaporator
- Auxiliary heat exchanger coil

... Allowable methods for pressurizing a low-pressure system for a non-major repair (controlled hot water and system heating/pressurization device such as Prevac...

Hot water circulated through the system or the use of heating blankets can be used to increase the system pressure for leak checking. Make sure system pressure remains below 10 PSIG to avoid release of refrigerant though the rupture disk, normally set at 15 psig.

... Need to wait a few minutes after reaching required recovery vacuum to see if system pressure rises (indicating that there is still liquid refrigerant in the system or in the oil)...

Refrigerant in the system or oil will continue to boil off in a system under a deep vacuum and the pressure will rise. Waiting until no pressure increase is detected indicates all refrigerant has been removed.

... Purpose of purge unit in low-pressure systems...

Since low pressure systems operate at below atmospheric pressure, air and moisture will leak into the refrigerant circuit through seals, gaskets or other leaks. A component called a purge unit will remove these noncondensables from the top of the condenser when they are present. Excessive purge unit operation indicates a leak. Some refrigerant is purged in this process.

... Pressure-temperature relationships of low-pressure refrigerants...

Become familiar with the use of pressure/temperature charts for different refrigerants. See appendix for charts.

... Equipment room requirements under ASHRAE Standard 15 (oxygen deprivation sensor with all refrigerants)...

Safety

Use good judgment and remember gas under high pressure can be dangerous

Never fill a container more than 80% to allow for expanding gas.
Escaping gas can cause skin and eye damage.
Escaping gas can stir up dust and debris that can be hazardous.
Wear goggles when handling pressurized gases.
All systems should have a high pressure relief valve.
Nitrogen cylinders are under about 2000 psi. Always use a pressure regulator with nitrogen. System components such as coils can be damaged. Make sure a pressure relief valve is installed in case the pressure regulator fails. Don't install pressure relief valves in series.
Never use compressed air or oxygen in a system. Air contains 20% oxygen. Compressed oxygen in the presence of oil is highly explosive.
Refrigerants at atmospheric pressure produce extremely cold temperatures and can cause frostbite. Wear safety glasses, goggles, rubber lined gloves, long sleeve shirts and long pants.
Refrigerants are heavier than air. If you are in a confined space the refrigerant can displace the oxygen resulting is suffocation. In areas where large amounts of refrigerant exist, safety gear such as self contained breathing apparatus (SCBA) should be available. Evacuate the area until it can be ventilated.
Some refrigerants are toxic. Others are considered non-toxic but are still dangerous in higher concentrations. Safe limits are measured in parts per million (ppm). Another common measure is the "Threshold Limit Value – Time Weighted Average" (TLV-TWA) Safety standard are developed for protection above these limits.
- **ASHRAE Standard 34.** This standard classifies refrigerants into groups according to flammability and toxicity. Low toxicity refrigerants are class A, high toxicity are class B. Non-flammability refrigerants are class 1 and higher flammable refrigerants are class 3. (A1, A2, A3, B1, B2, B3)

Chemical changes from heat. Flames or high heat from soldering can produce acids or poisonous gases from refrigerants. Hydrochloric acid, hydrofluoric acid and phosgene gas can be deadly. Remove refrigerant and evacuate any components before soldering or welding.

... Under ASHRAE Standard 15, need to have equipment room refrigerant sensor for 123...

- **ASHRAE Standard 15-1994** This standard required that mechanical rooms contain sensors, alarms and ventilation systems to keep the concentration of covered refrigerants below the TLV-TWA.

From the EPA website.

EPA 608 Definitions

Appliance

Any device which contains and uses a class I (CFC) or class II (HCFC) substance as a refrigerant and which is used for household or commercial purposes, including any air conditioner, refrigerator, chiller, or freezer. EPA interprets this definition to include all air-conditioning and refrigeration equipment except that designed and used exclusively for military purposes.

Apprentice

Any person who is currently registered as an apprentice in service, maintenance, repair, or disposal of appliances with the U.S. Department of Labor's Bureau of Apprenticeship and Training (or a State Apprenticeship Council recognized by the Bureau of Apprenticeship and Training).

High-pressure appliance

Uses a refrigerant with a boiling point between -50 and 10 degrees Centigrade (-58F and 50F) at atmospheric pressure (29.9 inches of mercury). This definition includes but is not limited to appliances using refrigerants 12, 22, 114, 500, or 502.

Low pressure appliance

Uses a refrigerant with a boiling point above 10 degrees Centigrade (50F) at atmospheric pressure (29.9 inches of mercury) This definition includes but is not limited to equipment utilizing refrigerants 11, 113 and 123.

Major maintenance, service, or repair

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

MVAC (motor vehicle air conditioning)-like appliance

Mechanical vapor compression, open-drive compressor appliances used to cool the driver's or passenger's compartment of a non-road vehicle, including agricultural and construction vehicles. This definition excludes appliances using HCFC-22.

Opening

Any service, maintenance, or repair on an appliance that would release class I or class II refrigerant from the appliance to the atmosphere unless the refrigerant were recovered previously from the appliance. Connecting and disconnecting hoses and gauges to and from the appliance to measure pressures within the appliance and to add refrigerant to or recover refrigerant from the appliance shall not be considered "opening."

Reclaim

To reprocess refrigerant to at least the purity specified in the ARI Standard 700-1993, Specifications for Fluorocarbon Refrigerants, and to verify this purity using the analytical methodology prescribed in the Standard. Reclamation requires specialized machinery not available at a particular job site or auto repair shop. The technician will recover the refrigerant and then send it either to a general reclaimer or back to the refrigerant manufacturer.

Recover

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

Recycle

To extract refrigerant from an appliance and 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-driers, which reduce moisture, acidity, and particulate matter. Under section 609, refrigerant can be removed from one car's air conditioner, recycled on site, and then charged into a different car.

Refrigerant circuit

The parts of an appliance that are normally connected to each other (or are separated only by internal valves) and are designed to contain refrigerant.

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.

Technician

Any person who performs maintenance, service, or repair that could reasonably be expected to release class I (CFC) or class II (HCFC) substances from appliances, except for MVACs, into the atmosphere. Technician also means any person performing disposal of appliances, except for small appliances, MVACs, and MVAC-like appliances, that could be reasonably expected to release class I or class II refrigerants from appliances into the atmosphere. (See page 6 for a more detailed discussion)

Very high pressure appliance

Uses a refrigerant with a boiling point below 50 degrees Centigrade (-58F) at atmospheric pressure (29.9 inches of mercury). This definition includes but is not limited to equipment utilizing refrigerants 13 and 503.

Core Test Sample Questions

1. As of what date did it become unlawful to release Class 1 and Class II refrigerants to the atmosphere?
    a. **July 1, 1992**
    b. July 1, 1993
    c. November 14, 1994
    d. January 1, 1996
2. What is the ozone layer and why is it important to us on Earth?
    a. Thin layer of R-22 in the atmosphere that filters UV.
    b. **Protective shield for Earth from the sun's harmful ultraviolent (UV) rays in the stratosphere layer that extends about 6 to 30 miles above earth**
    c. Thin layer of CFC and HCFC in the atmosphere that filters UV.
    d. Protective layer that shields UV in the Troposphere
3. The atom found in CFC and HCFC refrigerants that destroys ozone in the stratosphere is?
    a. Fluorine
    b. Carbon
    c. Hydrogen
    d. **Chlorine**
4. What is an ozone molecule made of?
    a. Refrigerant
    b. Ammonia
    c. **Three oxygen atoms (O3).**
    d. Oxygen and ammonia.
5. Which refrigerant is a CFC?
    a. R-134A
    b. R-123
    c. R-22
    d. **R-12**
6. What is the name of the atom that attacks ozone molecules?
    a. CFC atoms
    b. HCFC atoms
    c. **Chlorine and bromine atoms emitted into the atmosphere**
    d. a and b
7. Which refrigerant is a HFC?
    a. **R-134A**
    b. R-123
    c. R-22
    d. R-12

8. Describe how one Chlorine atom can destroy 100,000 ozone molecules.
    a. **Chlorine releases one of the oxygen atoms and forms two O2 oxygen molecules, leaving the chlorine molecule free to attack another ozone molecule and repeat the process**.
    b. Chlorine locks up the ozone molecule and then and then goes after another.
    c. Chlorine converts the ozone to bromine and then attacks more ozone molecules.
    d. Chlorine can bleach 100,000 ozone molecules before it weakens.
9. Which refrigerant contains no chlorine?
    a. R-134A
    b. R-123
    c. R-22
    d. R-12
10. Name the refrigerant types that belong to CFCs, HCFCs and HFCs
    a. CFC R-11, R-12, R-500
    b. HCFC R-22, R-123
    c. HFC R-134a
    d. All of the above are correct
11. The rule of thumb for refilling approved cylinders is a maximum of ___ percent liquid?
    a. 60%
    b. 79%
    c. 80%
    d. 90%
12. What do the letters in “HCFC” stand for?
    a. High Carbon Fluorine Chlorine
    b. **hydrochlorofluorocarbons**
    c. Harmful Carbon Fluorine Chlorine
    d. highchlorinefluorocarbon
13. To recover refrigerant is to?
    a. Remove a refrigerant in any condition from a system in either an active or passive manner, and store it in an external container without necessarily testing or processing
    b. Reduce contaminants in used refrigerant by oil separation through filter dryers.
    c. Reprocess refrigerant to new product specifications
    d. Remove refrigerant and change ownership.
14. What is ODP?
    a. Oxygen Destruction Properties
    b. **Ozone Depletion Potential**
    c. Ozone Destruction Properties
    d. Oxygen Depletion Potential
15. R-134A is a “drop in” refrigerant for?

a. R-12
b. R-22
c. R-11
d. R-134A is not a drop-in refrigerant

16. Name some of the health and environmental effects of ozone depletion.
    a. Increased Temperature of the Earth
    b. Increased Cases of Skin Cancer
    c. Increased numbers of Cataracts in the eyes
    d. All the above
17. The condition and state of the refrigerant leaving a receiver is?
    a. Subcooled liquid
    b. Subcooled vapor
    c. Superheated vapor
    d. Superheated liquid.
18. What evidence do we have that CFCs and HCFCs are depleting the ozone?
    a. The rise in the amount of chlorine measured in the stratosphere over the past two decades matches the rise in the amount of fluorine.
    b. The rise in the amount of chlorine measured in the stratosphere over the past two decades matches the rise in CFC emissions over the same period.
    c. Samples of air taken from the stratosphere over erupting volcanoes show that volcanoes contribute a small quantity of chlorine to the stratosphere compared to CFCs.
    d. All the above
19. The component of an air conditioning system that changes a low pressure vapor to a high pressure vapor is the?
    a. Condenser
    b. Metering device
    c. Evaporator
    d. Compressor
20. What characteristics make it easy for CFCs to reach the stratosphere and how do they get there?
    a. CFCs are lighter than air atoms and rise into the Stratosphere.
    b. CFCs will not dissolve in water or break down into compounds that dissolve in water. Wind moves them into the Stratosphere
    c. Heating of the CFCs makes them lighter than air.
    d. a and c
21. Why do we now use R-134a refrigerant?
    a. It costs less
    b. HFCs do not contain any chlorine
    c. It is a drop in replacement for R-22
    d. It is a drop in replacement for R-11
22. What is the purpose of the CAA?

a. Regulate California Air quality
b. Clean the air in the US
c. Limit how much of a pollutant can be in the air in the US
d. Regulate Civil Aeronautics

23. What three things is the CAA doing to control chlorofluorocarbon emissions?
a. Set dates to phase out CFC's and HCFC's
b. Prohibit venting of CFC and HCFC
c. Require the EPA to set standards for recovery of refrigerants prior to appliance disposal
d. All the above

24. What can states do in addition to the CAA?
a. Enforce standards more strict than the CAA laws
b. Nothing
c. States can create their own laws.
d. All of the above

25. What three things can happen if you violate the CAA?
a. Fine up to $27,500 per day, per violation
b. May lose your certification to handle refrigerants
c. May need to appear in US Federal Court for the charges
d. All the above

26. What incentive do others have to turn you in for violating the CAA?
a. An award of up to $10,000 is offered by the EPA
b. An award of up to $100,000 is offered by the EPA
c. An award of up to $1,000 is offered by the EPA
d. None of the above

27. Who can purchase refrigerants and what size cylinders can be purchased?
a. Only certified technicians may purchase refrigerants as of November 14, 1994
b. The smallest cylinder a 608 certified technician may purchase is 20 lbs
c. A certified technician can purchase HCFC
d. **All the above**

28. What is the Montreal Protocol?
a. Treaty between Canada and the US to limit use of refrigerants
b. **Treaty among nations designed to protect the stratospheric ozone layer**.
c. Method to clean the air developed in Montreal
d. Carbon regulation

29. What chemicals does the Montreal Protocol control?
a. chlorofluorocarbons (CFCs), halons,
b. carbon tetrachloride
c. methyl chloroform
d. **All the above**

30. When was the CFC phase out date?
a. November 31, 2003
b. **December 31, 1995**
c. November 15, 1990

d. November 15, 1993

31. Where do CFC refrigerants come from for equipment servicing of older systems?
    a. DuPont
    b. Government warehouse
    c. Recovery and recycling
    d. Imported from South America
32. What must be done before scrapping a refrigerant container?
    a. Release the refrigerant
    b. **Recover to (0 psig) or lower and rendered useless**
    c. Punch a hole in the container
    d. Add compressed air.
33. What must be done before disposing of an appliance containing CFCs or HCFCs?
    a. Identify refrigerant by attaching DOE tag.
    b. Identify refrigerant by attaching CAA tag
    c. Identify refrigerant by attaching EPA tag
    d. Refrigerant must be recovered
34. Who is responsible for removing refrigerants from a system that is being disposed of?
    a. HVACR tech
    b. EPA
    c. Original owner
    d. Final person in the disposal chain
35. Are there "drop-in" replacements for R-12 systems and if not, why?
    a. There is no “drop-in” replacement gas for R-12
    b. New refrigerants are incompatible with the oils and lubricants used in R-12
    c. 134A uses a different oil than R-12
    d. All the above
36. What type of oil is used in R-134a and what oils will mix with it?
    a. Ester based oils
    b. Ester based oils do not mix with other oils.
    c. Synthetic alkylbenzene lubricant
    d. a and b
37. Will the gases in a ternary blend leak at the same rate and why or why not?
    a. They leak at different rates because they retain their different vapor pressures.
    b. They leak at the same rate. A leak is a leak.
    c. Ternary blends have the same vapor pressure.
    d. All the above

38. What does a compressor compress?
    a. Liquid refrigerant
    b. Hot vapor
    c. High pressure vapor
    d. Low pressure, low temperature vapor
39. Explain how cooling of a space occurs in a refrigeration cycle
    a. The indoor air is cooled
    b. Heat is removed from inside the building and is deposited outside the building
    c. Liquid refrigerant absorbs the heat and transfers it to the exterior.
    d. Cold liquid refrigerant cools the indoor air.
40. Will refrigerant migrate to the crank case in a compressor?
    a. Refrigerant seeks the lowest point in the system, the compressor crankcase.
    b. Refrigerant vaporizes and does not collect tin the compressor.
    c. Oil migrates to the compressor crankcase.
    d. Refrigerant will migrate towards the compressor crank case while the oil will not
41. What color is the compound gauge and what does the compound gauge measure?
    a. Blue and measures low pressure (psig) and vacuum (inches Hg)
    b. Red and measures head pressure
    c. Yellow and measures vacuum.
        6 Green and measures temperature and pressure.
42. What color is the high pressure gauge?
    a. Blue and measures high pressure
    b. Red and measures the high side (discharge) pressure
    c. Red and measures low side pressure
    d. Yellow and measures high pressure.
43. What are three things the center hose is used for and what color is it usually?
    a. Red, high pressure, low pressure and vacuum
    b. Yellow hose and can be connected to a recovery device, evacuation vacuum pump or charging device
    c. Blue, low pressure, vacuum and recovery
    d. Green, recovery, vacuum, low and high pressure
44. What things should you look for in equipment and systems to help limit refrigerant emissions?
    a. Equipment used is approved by the EPA
    b. Leak check, repairing leaks
    c. Making sure that all fittings are tight during service and recovery
    d. All the above
45. What is the most effective method for checking for small leaks?
    a. Leak noise
    b. Refrigerant dye
    c. Pressurize with nitrogen
    d. **Halide torch**

46. How can you test a system for leaks?
    - **a. Evacuate the system and pull a vacuum on it**
    - b. Use a hydrostatic test
    - c. Pressurize with oxygen
    - d. Use water pressure
47. What should you look for if a compressor burns out?
    - a. Frayed wires
    - b. Check paint on compressor body
    - **c. Strong smell in refrigerant**
    - d. Melted tubing
48. What will need to happen if the oil has been contaminated by a burnout?
    - a. Triple evacuate the system
    - b. Install a permanent filter-drier
    - c. Conduct a deep vacuum before recharging
    - **d. All the above**
49. How is recovery different from recycling?
    - a. Recycle is to clean refrigerant for immediate reuse
    - b. Recover is to remove refrigerant in any condition from a system and store it in an external container
    - c. There is no difference
    - **d. a and b**
50. How is recycling different from reclaiming?
    - a. Recycling must be performed by a recycling plant
    - b. Recycle is to clean
    - c. Reclaim is to process refrigerant to the level of new product specifications
    - d. **b and c**
51. Name reasons recovery is important?
    - a. To have adequate supplies of refrigerant for service after production bans
    - b. Prevent venting to the atmosphere
    - c. Prevent stratospheric ozone depletion
    - **d. All the above**
52. What standards must refrigerant recovery equipment meet?
    - a. **Certified and labeled by an EPA approved equipment manufacturer**
    - b. None
    - c. CAA approval
    - d. DOT standards and labeling
53. What are types of recovery equipment used?
    - a. System dependent
    - b. Self-contained
    - c. Container less
    - **d. a and b**
54. What should you tell a consumer who complains about the added cost and time of recovering refrigerant?
    a. Recovery is the law.
    b. Recovery is necessary to protect human health and the environment.

c. All professional service personnel are duty bound to follow the law and protect the environment.

d**. All of the above**

55. How should you handle recovery of a system that has mixed refrigerants?
    a. **Recover into a separate tank**
    b. Vent the refrigerant
    c. Call the EPA
    d. Call the police
56. After recovery, what are nitrogen and a filter drier used for?
    a. Dry the system.
    b. Filter dryer is used to clean the nitrogen before removal
    c. **Flush debris and trap any debris**
    d. All of the above
57. What are the variables that affect the recovery rate?
    a. Size of refrigeration system and recovery equipment
    b. Size of suction hose,
    c. Temperatures.
    d. **All of the above**
58. Why is it important to have faster recovery?
    a. **Taking longer increases chance of emissions of the refrigerants to the atmosphere**
    b. Faster recovery saves energy
    c. Faster recovery removes oil
    d. All of the above
59. If you smell a strong odor during recovery, what is most likely the problem?
    a. **Compressor has burned out**
    b. Sour gas
    c. Pressure is too high
    d. Recovery machine is overloaded
60. Why is it necessary to dehydrate a refrigeration system?
    a. Remove water from a hydrostatic pressure test
    b. Remove debris from the system
    c. Remove ice contaminates
    d. **Remove water and water vapor contaminating the system**
61. What happens if moisture is left in an operating refrigeration system?
    a. Freezes up
    b. **Create highly corrosive and toxic acids**
    c. Increases head pressure
    d. Reduces head pressure
62. What must be done before starting evacuation?
    a. Install nitrogen
    b. Install dryer
    c. **Recover all refrigerant**
    d. Install site glass
63. What are the four factors that affect the evacuation time?
    a. Size of equipment being evacuated,

b. Ambient temperature, Amount of moisture,
c. Capacity of vacuum pump and suction line
d. All of the above

64. Can you increase the temperature of a refrigeration system for evacuation and if so, what purpose does it have?
    a. Yes. Decrease the evacuation time by increasing pressure
    b. No. It increases time by increasing pressure
    c. No. Creates danger of explosion
    d. None of the above.
65. How long and what diameter should the piping connection to the vacuum pump be?
    a. 3 feet and 3/8”
    b. 2.5 feet and 3/8”
    c. 2 feet and 3/8”
    d. As short in length as possible and as wide in diameter as possible
66. How big should the vacuum hoses be in relation to the pump intake connection?
    a. One size larger than pump intake connection
    b. Equal to or larger than the pump intake connection
    c. One and a half size larger than pump intake connection
    d. None of the above
67. For accurate vacuum readings, where should the vacuum gauge be located?
    a. Close to the vacuum pump
    b. Between the vacuum pump and unit
    c. **As far as possible from the vacuum pump**
    d. On the vacuum pump
68. When should the measurement of vacuum for a system be done and how do we know when dehydration is complete?
    a. With the system isolated and vacuum pump turned on. Dehydration is considered complete when the vacuum gauge shows that have reached and held the required finished vacuum
    b. With the system open and vacuum pump turned off. Dehydration is considered complete when the vacuum gauge shows that have reached and held the required finished vacuum
    c. With the system isolated and vacuum pump turned off. Dehydration is considered complete when the vacuum gauge shows that have reached and held the required finished vacuum for one minute
    d. With the system isolated and vacuum pump turned off. Dehydration is considered complete when the vacuum gauge shows that have reached and held the required finished vacuum
69. What are the risks of inhaling (breathing in) refrigerants?
    a. Refrigerants can be deadly if inhaled or allowed to be heated
    b. Refrigerants inert and harmless if inhaled
    c. Refrigerants are only dangerous if heated
    d. Refrigerants can be safe if heated
70. What is the leading cause of refrigeration accidents leading to death?
    a. Phosgene gas inhalation

b. **Oxygen deprivation**
c. Freezing to death
d. Electrocution

71. What personal protective equipment should you wear when handling refrigerants?
    a. Safety glasses
    b. Butyl-lined protective gloves
    c. Safety shoes\
    d. All the above
72. What are the requirements under ASHRAE standard 15-1994?
    a. Requires a refrigerant sensor that will sound an alarm and automatically start a ventilation system in occupied equipment rooms where refrigerant (regardless of refrigerant type) from a leak will concentrate.
    b. Requires a refrigerant sensor that will sound an alarm and automatically start a ventilation system in occupied equipment rooms where R-123 from a leak will concentrate
    c. Requires a refrigerant sensor that will sound an alarm and automatically start a ventilation system in occupied equipment rooms where R-11 from a leak will concentrate
    d. Requires a refrigerant sensor that will sound an alarm and automatically start a ventilation system in occupied equipment rooms where R-12 from a leak will concentrate
73. Under what conditions will alarm and ventilation sound under ASHRAE standard 15-1994?
    a. The alarm will sound before the TLV-TWA (Threshold Limit Value – Time weighted Average) is exceeded (oxygen deprivation level).
    b. The alarm will sound after the **TLV-TWA** (Threshold Limit Value – Time weighted Average) is exceeded (oxygen deprivation level).
    c. The alarm will sound before when any leak is detected
    d. The alarm will sound before when any leak in excess of 100 PPM is detected
74. What is the safest rating of a refrigerant according to the ASHRAE scale?
    a. **A-1 is considered the safest refrigerant while B-3 is the least safe**
    b. B-1 is considered the safest refrigerant while A-3 is the least safe
    c. B-3 is considered the safest refrigerant while A-1 is the least safe
    d. None of the above.
75. Why should oxygen or compressed air never be used to test leak a system?
    a. Oxygen or compressed air, when mixed with refrigerants, can cause an explosion
    b. Oxygen or compressed air contain moisture and will contaminate the system
    c. Oxygen or compressed air can’t be detected by leak checking tools
    d. None of the above

76. When using nitrogen to charge a system, what piece of equipment should it be charged through and where should a relief valve be located?
    a. Charge through a refrigeration manifold with a relief valve on the nitrogen cylinder
    b. **Charge through a pressure regulator (make sure the nitrogen cylinder has a regulator on it) and insert a relief valve downstream line from the pressure regulator**
    c. Install a relief valve prior to the pressure regulator.
    d. None of the above
77. Where can you find the appropriate test pressures for a system?
    a. ARI directory
    b. **Data plate on the low-side pressure valve**
    c. Manufactures certified test data
    d. None of the above
78. What are the two conditions to be aware of in observing relief valves?
    a. NOT to be installed in series.
    b. Be replaced if corrosion build-up is found within the body of a relief valve.
    c. a and b
    d. None of the above
79. What can happen to refrigerants if they are exposed to direct flame or other excessive heat?
    a. Change into toxic materials like phosgene gas
    b. Explode
    c. a and b
    d. All of the above
80. Before welding, cutting or brazing a refrigerant line, what should be done?
    a. Read MSDS sheet
    b. **Evacuate all refrigerant**
    c. Run a constant flow of refrigerant through it while welding
    d. None of the above
81. In case of a major refrigerant leak, what actions should be taken?
    a. Stop the leak
    b. Close any valves
    c. Turn off any open flames
    d. Immediately vacate and ventilate the area or use Self Contained Breathing Apparatus (SCBA).
82. What types of cylinders can be used for recovery and how can you visually identify them?
    a. Nitrogen marked nitrogen
    b. Cylinders of the appropriate color for the refrigerant being used
    c. Cylinders marked “RECOVERY”
    d. Yellow tops and gray bodies
83. How often should refillable cylinders be hydrostatically tested?
    a. Every 5 years
    b. Every 3 years
    c. Every 2 years

d. Every year

84. What must be done to a cylinder (disposable or refillable) before scrapping it?
    a. Mark the Cylinder “Not For Reuse”
    b. Completely evacuated of all refrigerants and have a pressure of 0 psig or lower
    c. Completely evacuated of all refrigerants and have a pressure of 10 psig or lower
    d. Completely evacuated of all refrigerants and have a pressure of 15 psig or lower
85. Why shouldn’t you fill cylinders above 80% of their capacity by weight?
    a. It takes too much time to top off the tank.
    b. Overfilled cylinders may rise in internal pressure when exposed to heat, resulting in an explosion
    c. a and b
    d. None of the above
86. What can happen if cylinders are exposed to flames or excessive heat?
    a. May cause the cylinder to explode
    b. It may change the state of the refrigerant into a toxic material
    c. The added pressure may cause the cylinder to leak refrigerant.
    d. All the above
87. What are the ways you can control the fill level of a refillable cylinder?
    a. Mechanical float devices
    b. Electronic float devices
    c. Weight
    d. All the above
88. In what position should cylinders be shipped?
    a. Nested in a vertical cradle
    b. Upright position
    c. Stacked in vertical, bundled and strapped on a pallet
    d. All the above
89. What type of DOT tag is required for shipping refrigerant cylinders?
    a. DOT classification tag indicating it is a “2.2 non-flammable gas”
    b. DOT classification tag indicating it is a “high pressure gas”
    c. DOT classification tag indicating it is a “refrigerant gas”
    d. DOT classification tag indicating it is a “liquid refrigerant”
90. A cylinder label must contain what type of information about the refrigerant?
    a. Weight of refrigerant
    b. Type and amount of refrigerant
    c. Pressure of cylinder
    d. None of the above

Type I Sample Test Questions

1. What is the EPA definition of a small appliance?
    a. Manufactured, charged and hermetically sealed in a factory and contains one pound or less of refrigerant
    b. Manufactured, charged and hermetically sealed in a factory and contains two pounds or less of refrigerant
    c. Manufactured, charged and hermetically sealed in a factory and contains five pounds or less of refrigerant
    d. Manufactured, charged and hermetically sealed in a factory and contains fifteen pounds or less of refrigerant
2. Which best describes the definition of Type I “Small Appliance”, as defined by EPA?
    a. Systems manufactured, charged and hermetically sealed with(5) pounds of less of refrigerant
    b. Refrigerators, freezers, room air conditioners, and central air conditioners.
    c. Any appliance charged with more than (5) pounds of refrigerant.
    d. Any appliance charged with less than two (2) pounds of refrigerant
3. Does a PTAC fall under small appliances? What about an MVAC?
    a. PTAC or pressurized terminal air conditioner. Yes
    b. MVAC or motorized vehicle air conditioning systems. No
    c. PTAC and MVAC yes.
    d. a and b
4. For small appliance use, the recovery equipment manufactured after November 15, 1993 must be capable of recovering:
    a. 80% of the refrigerant when the compressor is not running or achieve a 4 inch vacuum under ARI 740-1993.
    b. 90% of refrigerant when the compressor is operating or achieve a 4 inch vacuum under ARI 740-1993.
    c. 99% of the refrigerant reguardless of compressor operation and achieve a 10 inch vacuum under ARI 740-1993
    d. A and b above.
5. What is the maximum amount of refrigerant a small appliance can have by definition?
    a. 1 pound or less
    b. 5 pounds or less
    c. 10 pounds or less
    d. None of the above
6. The sale of Class I and Class II refrigerants will be restricted to technitions certified by an EPA approved program after:
    a. July 1, 1992
    b. November 15, 1993

c. August 12, 1993
d. November 14, 1994

7. Who is responsible for complying with the laws if the EPA changes the laws after technician certification?
    a. It is the responsibility of the company to comply with any future changes in the law
    b. It is the responsibility of the technician to comply with any future changes in the law
    c. It is the responsibility of the equipment owner to comply with any future changes in the law
    d. None of the above
8. The release of vapor from the top of a graduated charging cylinder when filling may:
    a. Be vented to the atmosphere.
    b. Be vented if the quantity does not exceed three (3) pounds.
    c. **Not be vented and must be recovered.**
    d. Be vented, but not inhaled.
9. Should regulations of the clean air act)CCA) change after a technition is certified:
    a. The technician must take a new test to be recertified.
    b. The technician's who previously passed with an 80% will be grandfathered.
    c. It will be the technicians responcibility to learn and comply with future changes in the law.
    d. The technicians must be retested and pass the exam with 84%
10. Recovery equipment manufactured before November 15, 1993 must meet what standards?
    a. Capable of recovering 90% of the refrigerant whether or not the compressor is operating or achieve a 4 inch vacuum under conditions of ARI 740.
    b. 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.
    c. Capable of recovering 80% of the refrigerant whether or not the compressor is operating or achieve a 6 inch vacuum under conditions of ARI 740.
    d. None of the above
11. System dependant (passive) refrigerant recovery of small applianves:
    a. Do not require an operating compressor.
    b. Requires 80% of the refrigerant to be recovered.
    c. Recovers refrigerant in a non pressurized container.
    d. **All of the above**
12. Recovery equipment manufactured after November 15, 1993 must meet what standards if using a *compressor?*

a. Be capable of recovering 90% of the refrigerant with the compressor operating or achieve a 6 inch vacuum under conditions of ARI 740.
b. Be capable of recovering 80% of the refrigerant with the compressor operating or achieve a 6 inch vacuum under conditions of ARI 740.
c. Be capable of recovering 70% of the refrigerant with the compressor operating or achieve a 4 inch vacuum under conditions of ARI 740.
d. **Be capable of recovering 90% of the refrigerant with the compressor operating or achieve a 4 inch vacuum under conditions of ARI 740**.

13. Recovery equipment with no compressor must?

a. Be capable of recovering 70% of the refrigerant without the compressor operating or achieve a 4 inch vacuum under conditions of ARI 740
b. **Be capable of recovering 80% of the refrigerant without the compressor operating or achieve a 4 inch vacuum under conditions of ARI 740**
c. Be capable of recovering 80% of the refrigerant without the compressor operating or achieve a 2 inch vacuum under conditions of ARI 740
d. None of the above

14. Before disposing of a small appliance containing R-12, it is necessary to:
    a. Pressurize with nitrogen
    b. Recover the refrigerant
    c. Turn up side down
    d. Thoroughly leak check
15. What is a low-loss fitting and why is it needed?
    a. Prevents loss when hoses are not in use.
    b. Can be manually or automatically closed when disconnecting hoses in order to prevent refrigerant loss
    c. Quick connect to increase speed
    d. None of the above
16. A system has been operating with a complete restriction at the capillary tube inlet, what access is required for recovery?
    a. One access valve on the low side of the system.
    b. Two access valves high and low side of the system
    c. One access valve on the high side of the system
    d. One access valve on the evaporator, and one on the low side
17. What does the service aperture on a small appliance typically look like?
    a. A hook shape tube to allow a piercing access valve
    b. A straight piece of tubing that is entered with a piercing access valve
    c. A straight piece of tubing that is with a permanent access valve
    d. None of the above
18. CFCs will not be manufactured in the United States after:
    a. 2000
    b. 1995
    c. 2005
    d. 1996

19. What should be done with leaks in small appliances?
    a. **Not mandatory to perform a leak repair; however it should be done whenever possible**
    b. Leaks over 50 pounds must be repaired
    c. Leaks more than one pound and under 5 pounds must be repaired
    d. None of the above
20. To work on small appliances after November 14, 1993, a technician must be certified as:
    a. Type I
    b. Type II
    c. Universal
    d. A or c above
21. How can you tell what type of refrigerant is in a system?
    a. Check the unit label
    b. **Using the temperature / pressure chart**
    c. Manufacturers data sheet
    d. All the above
22. Read a pressure temperature chart. What should the pressure be for:
    a. R-12 refrigerant at 80º F?
    b. R-22 at 70º F?
    c. R-134a at 90º F?
    d. All the above are correct
23. What might happen if a cylinder containing mixed refrigerants is given to a reclamation center?
    a. Refuse to process the refrigerant and return it at the owner's expense
    b. They may destroy the refrigerant, but charge a substantial fee
    c. a and b
    d. None of the above
24. What is the difference between a self-contained recovery tank and a system-dependent recovery tank?
    a. 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
    b. A system dependant (passive) recovery tank does not have its own compressor**.**
    c. a and b
    d. None of the above
25. What are things that can cause high recovery discharge pressures?
    a. Not opening the tank inlet valve
    b. Having excess air will cause higher discharge pressures
    c. a and b
    d. None of the above
26. How can you check if there is excess air / non-condensables in a tank?
    a. Use an excess air gauge
    b. Checking the pressure inside the recovery tank. Reference the pressure / temperature chart

c. Non-condensible test kit
d. None of the above

27. What temperature must a cylinder be at to check for excess air?
    a. Temperature is not relevent
    b. Room temperature before taking a pressure reading
    c. 52F
    d. 55F
28. What type of system can a vacuum pump be used on for recovery?
    a. **System-dependent (passive) recovery**
    b. Active, compressor containing unit.
    c. a and b
    d. None of the above
29. When using a system-dependent recovery system with an operating compressor, where should the refrigerant be recovered from?
    a. **High side of the system**
    b. Low side of the system
    c. Both high and low side
    d. None of the above
30. When using a system-dependent recovery system with an non-operating compressor, where should the refrigerant be recovered from?
    a. High side of the system
    b. Low side of the system
    c. Both high and low side
    d. None of the above
31. How can you release trapped refrigerants in the oil during recovery?
    a. Heat and tap the compressor with a mallet
    b. Activate a defrost heater
    c. a and b
    d. None of the above
32. When should piercing type valves be used and what is a common problem of these valves?
    a. Piercing valves are not allowed.
    b. Fittings tend to leak over time and should not be left on appliances
    c. A and b
    d. None of the above

Type II Sample Test Questions

1. Before charging a new system with refrigerant, what should be done?
    a. Pressurize with compressed air and leak check.
    b. **Pressurize with nitrogen (classified as an inert gas) and leak checked**.
    c. Pressurize with oxygen and leak check
    d. None of the above
2. Which refrigerant can be used for leak detection as a trace gas and pressurized with nitrogen?
    a. R-12
    b. R-11
    c. R-22
    d. R-115
3. What tools can you use to find general area of leaks and pinpoint leaks?
    a. Soap bubbles.
    b. Look for oil residue
    c. Electronic or ultrasonic leak detector will provide the general area of the leak
    d. Refrigerant dye
4. Traces of oil around a sight glass inlet fitting of a refrigeration system might be the indication of:
    a. A leak
    b. Excessive oil in the system
    c. An overcharge
    d. A restriction at the TXV
5. Describe ways you can visually look for leaks.
    a. Using soap bubbles
    b. Looking for traces of oil
    c. Excessive superheat, caused by low refrigerant charge
    d. All the above
6. Type II classification, as identified by EPA, applies to what equipment?
    a. Small appliances with five (5) pounds of refrigerant or less
    b. Refrigerators, freezers, and vending machine appliances
    c. Low pressure appliances
    d. Split air conditioning equipment with five (5) pounds of refrigerant or more
7. What are the leak repair requirements for comfort cooling appliances and commercial Appliances containing 50 lbs. or more of refrigerant?
    a. Must be repaired if leak rate exceeds 15% in comfort cooling appliances.

b. Must be repaired if leak rate exceeds 35% in all commercial and industrial process refrigeration\
c. a and b
d. None of the above

8. What type of refrigerant was the most common before outlawing CFCs and HCFCs?
   a. R-12
   b. R-22
   c. R-500
   d. R-134A
9. The required level of evacuation for recovery equipment manufactured after November 15, 1993, on a system containing less than 200 pounds of R-12 refrigerant is:
   a. 0 inches Hg
   b. 4 inches Hg
   c. 10 inches Hg
   d. 15 inches Hg
10. What is the purpose of the filter drier and when should it be changed?
    a. To filter the oil. Change every year.
    b. To remove moisture from the refrigerant, replace on a routine basis or anytime a system is opened
    c. Cleans the air. Replace monthly
    d. Dryer's air filters. Replace yearly
11. Industrial process and commercial refrigeration equipment with over 50 pounds of refrigerant with an annual leak rate of ___ % requires repair under EPA regulations.
    a. 0
    b. 15
    c. 35
    d. 50
12. How can you tell through a sight glass if there is excess moisture in the system?
    a. You can see moisture bubbles
    b. Look for color changes of the refrigerant
    c. You can see gas bubbles
    d. Site glass is clear
13. Comfort cooling chillers and all other equipment with over 50 pounds of refrigerant with an annual leak rate of ___ % requires repair under EPA regulations:
    a. 0
    b. 15
    c. 35
    d. 50

14. Using large vacuum pumps can lead to freezing of water in the system what are ways the technician can help prevent the freezing?
    a. Increase pressure by introducing nitrogen to counteract freezing
    b. Begin charging with vapor until pressure is above freezing
    c. a and b
    d. None of the above
15. The majority of the liquid to be recovered from a system will be found in the:
    a. Condenser
    b. Receiver (when applied)
    c. Low side of the system
    d. Evaporator
16. Foaming at start-up may be found in what component? What does this mean?
    a. Refrigerant in an accumulator foams on a low pressure.
    b. Refrigerant in the compressor oil will cause oil foaming. Prevent refrigerant migration with a crankcase heater
    c. Refrigerant in the receiver foams with high pressure
    d. Refrigerant in the condenser will foam on hot days
17. What are preferred ways to measure a deep vacuum?
    a. Use an analog vacuum gauge
    b. Measure to 500 Microns is preferred or inches of Mercury (inches Hg).
    c. Use a compound vacuum gauge on your manifold.
    d. Measurement is not necessary
18. If it becomes the owners responsibility to maintain records of all refrigerant added to units that contain more than ___ pounds of refrigerant charge.
    a. 15 pounds
    b. 20 pounds
    c. 35 pounds
    d. 50 pounds
19. What do inches HG stand for?
    a. Inches on high gauge
    b. Inches on hygrometer
    c. Inches of mercury
    d. Inches water
20. Exceptions to the required evacuation levels for recovery equipment that require an appliance be evacuated to only 0 psig apply to appliances that”\:
    a. Are being salvaged
    b. Are filled with water or substances that would damage the recovery equipment
    c. Have defective evaporator fan motors
    d. Have air cooled condensers.
21. When evacuating a vapor compression system how many microns does the vacuum need to achieve?
    a. 50

b. 100
c. 250
d. 500

22. Why should you never start a hermetic compressor when under deep vacuum?
    a. Motor winding could be damaged
    b. Compressor valves could be damaged
    c. Shaft could break
    d. Moisture in refrigerant could freeze
23. The condition and state of refrigerant entering the receiver is:
    a. Superheated high pressure vapor
    b. Superheated low pressure vapor
    c. Subcooled high pressure liquid
    d. Subcooled low pressure liquid
24. What is a receiver, where is it located and what is the state of the refrigerant after leaving the receiver?
    a. After the condenser, high pressure / high temperature liquid
    b. After the compressor, high pressure / high temperature liquid
    c. After the evaporator, high pressure / high temperature liquid
    d. After the TXV, high pressure / high temperature liquid
25. What is the liquid line?
    a. Line between the compressor and the metering device
    b. Line between the evaporator and the metering device
    c. Line between the condenser and the metering device
    d. Line between the accumulator and the metering device
26. What criteria must recovery equipment meet if manufactured after November 15, 1993?
    a. Certified by an EPA laboratory
    b. Equipped with low-loss fittings
    c. Must meet the stringent vacuum standards
    d. All the above
27. How many inches of Mercury vacuum is required for HCFC-22, for appliances containing more than 200lbs refrigerant, using equipment manufactured after 11/15/1993?
    a. 4
    b. 6
    c. 10
    d. None of the above
28. How many inches of Mercury vacuum is required for HCFC-22, for appliances containing more than 200lbs refrigerant, using equipment before 11/15/1993?
    a. 4
    b. 6
    c. 10
    d. None of the above
29. What are considered “major” repairs according to the EPA?

a. Repair requiring removal of refrigerant
b. **Removal of the compressor, condenser, evaporator or an auxiliary heat exchanger coil**.
c. Repair of more than $100.00
d. Repair more than $1000.00

30. What can you do if you can't reach the required evacuation levels on leaky equipment?
    a. Appliances can be evacuated to (4 psig) if leaks make evacuation to the prescribed level unattainable
    b. Appliances can be evacuated to atmospheric pressure (0 psig) if leaks make evacuation to the prescribed level unattainable
    c. Appliances can be evacuated to (10 psig) if leaks make evacuation to the prescribed level unattainable
    d. Appliances can be evacuated to (15 psig) if leaks make evacuation to the prescribed level unattainable
31. What are steps taken before using recovery equipment?
    a. Check the service valve positions.
    b. Check the oil level of the recovery unit.
    c. Evacuate and recover any remaining refrigerant from the unit's receiver.
    d. **All the above**
32. What types of hoses and couplings should be used during the recovery process?
    a. Use quick couplers,
    b. Self-sealing hoses
    c. Hand valves should be used to minimize refrigerant release when hoses are connected and disconnected
    d. All the above
33. What common contaminants can be found in the oils?
    b. acids,
    c. moisture
    d. a and b
    e. None of the above
34. Why might recovery equipment using hermetic compressors overheat?
    a. Cooling air is too hot
    b. **The unit relies on the flow of refrigerant through the compressor for cooling**
    c. Too much oil in the system
    d. Refrigerant overcharge
35. If switching from recovering one refrigerant to another, what steps must be taken before recovering the new refrigerant?
    a. Purge the recover / recycle equipment by recovering as much of the first refrigerant as possible
    b. Change the filter
    c. Evacuate
    d. All the above

36. If switching from recovering one refrigerant to another, what steps must be taken if the refrigerant is 134a?
    a. R-134a must provide a special set of hoses
    b. R-134a must provide special gauges
    c. R-134a must provide special vacuum pump, recovery / recycling machine
    d. All the above
37. Describe ways to speed up the recovery.
    a. Pack the recovery cylinder in ice and / or applying heat to the appliance.
    b. Recover as much as possible in the liquid phase. In order to recover liquid refrigerant, you must connect one hose to the system's liquid line. After recovering liquid refrigerant, any remaining vapor is condensed by the recovery system.
    c. a and b
    d. None of the above
38. Under what circumstances can recovered refrigerant be reused?
    a. Recovered refrigerant cannot be reused
    b. 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
    c. There are no restrictions on the use of recovered refrigerant
    d. None of the above
39. Where should you remove the refrigerant in a system that has a condenser below the receiver?
    a. From the condenser outlet
    b. From the receiver outlet
    c. From the low side service valve
    d. From the evaporator outlet
40. How must you recover refrigerant from a parallel system and why?
    a. **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**.
    b. Do not isolate a parallel compressor system in order to recover refrigerant. Isolation will cause an open equalization connection that will prevent refrigerant recovery
    c. Do not isolate a parallel compressor system unless valves are provided, in order to recover refrigerant. Isolation will cause an open equalization connection that will prevent refrigerant recovery
    d. Do not isolate a parallel compressor system unless access valves are in series. Isolation will cause an open equalization connection that will prevent refrigerant recovery

Type III Sample Test Questions

1. Where do leaks commonly occur in low pressure systems?
    a. Evaporator
    b. Condenser
    c. Purge unit
    d. Gaskets or fittings
2. Where do leaks commonly occur in low pressure systems?
    a. Evaporator
    b. Condenser
    c. Purge unit
    d. Gaskets or fittings
3. Where do leaks commonly occur in open-drive type compressor systems?
    a. Evaporator
    b. Condenser
    c. **Shaft seal**
    d. Cooling tower
4. Where do leaks commonly occur in open-drive type compressor systems?
    a. Evaporator
    b. Condenser
    c. **Shaft seal**
    d. Cooling tower
5. Does refrigerant go out of the system in low pressure systems or does air and moisture go in?
    a. Refrigerant escapes through low pressure leaks.
    b. Air and moisture enter the refrigeration system because it operates in a vacuum
    c. Refrigerant leaks out through shaft seals and gaskets.
    d. Air and moisture enters through the purge unit.
6. Does refrigerant go out of the system in low pressure systems or does air and moisture go in?
    a. Refrigerant escapes through low pressure leaks.
    b. Air and moisture enter the refrigeration system because it operates in a vacuum
    c. Refrigerant leaks out through shaft seals and gaskets.
    d. Air and moisture enters through the purge unit.
7. When should a low pressure system be leak checked according to ASHRAE guideline 3-1996?
    a. There are specific recommendations.
    b. During pressure checks
    c. When the system rises from 1 mm Hg to a level above 2.5 mm Hg during vacuum testing
    d. Leak check every year

8. When should a low pressure system be leak checked according to ASHRAE guideline 3-1996?
    a. There are specific recommendations.
    b. During pressure checks
    c. When the system rises from 1 mm Hg to a level above 2.5 mm Hg during vacuum testing
    d. Leak check every year
9. What does a purge unit do and what is a high efficiency purge unit?
    a. Removes the refrigerant from the system. High efficiency **purge system** will expel large quantities of refrigerant
    b. Removes the refrigerant from the system. High efficiency **purge system** will expel very little refrigerant
    c. Removes the oil from the system. High efficiency **purge system** will expel very little refrigerant
    d. Removes the air from the system. High efficiency purge system will expel very little refrigerant
10. What does a purge unit do and what is a high efficiency purge unit?
    a. Removes the refrigerant from the system. High efficiency **purge system** will expel large quantities of refrigerant
    b. Removes the refrigerant from the system. High efficiency **purge system** will expel very little refrigerant
    c. Removes the oil from the system. High efficiency **purge system** will expel very little refrigerant
    d. Removes the air from the system. High efficiency purge system will expel very little refrigerant
11. How does a centrifugal compressor purge unit work?
    a. Takes its suction from the top of the evaporator, removes the air from the system, and returns the refrigerant to the evaporator
    b. Takes its suction from the top of the chiller barrel, removes the air from the system, and returns the refrigerant to the evaporator
    c. Takes its suction from the top of the compressor suction, removes the air from the system, and returns the refrigerant to the evaporator
    d. Takes its suction from the top of the condenser, removes the air from the system, and returns the refrigerant to the evaporator
12. How does a centrifugal compressor purge unit work?
    a. Takes its suction from the top of the evaporator, removes the air from the system, and returns the refrigerant to the evaporator
    b. Takes its suction from the top of the chiller barrel, removes the air from the system, and returns the refrigerant to the evaporator
    c. Takes its suction from the top of the compressor suction, removes the air from the system, and returns the refrigerant to the evaporator
    d. Takes its suction from the top of the condenser, removes the air from the system, and returns the refrigerant to the evaporator
13. What are visible ways to check for leaks in a low pressure system?
    a. Excessive running of a purge system.

b. Continuous excessive moisture in the purge unit could indicate a leak in the condenser or the chiller barrel.
c. High head pressure
d. All the above

14. What needs to be done to leak check a low pressure system?
    a. Increase the pressure in the system by the use of nitrogen
    b. Increase the pressure in the system by the use of oxygen
    c. Increase the pressure in the system by the use of controlled hot water or heater blankets
    d. Increase the pressure in the system by the use of boiler hot water
15. What are ways you can increase the pressure in the system?
    a. controlled hot water
    b. heater blankets
    c. a and b
    d. None of the above
16. What needs to be done to leak check a low pressure system?
    a. Increase the pressure in the system by the use of nitrogen
    b. Increase the pressure in the system by the use of oxygen
    c. Increase the pressure in the system by the use of controlled hot water or heater blankets
    d. Increase the pressure in the system by the use of boiler hot water
17. What can happen if you exceed 10 psig while pressurizing the system?
    a. Shaft seals will fail
    b. **The rupture disc will fail**
    c. Oxygen combined with oil in the system will explode
    d. None of the above

18. What are ways you can increase the pressure in the system?
    a. controlled hot water
    b. heater blankets
    c. a and b
    d. None of the above
19. How should a water box be leak tested?
    a. Remove water, then place the leak detector probe in through the drain valve
    b. Remove water, pressurize and check with a gas detector
    c. Look for bubble in the water
    d. Test the water for traces of refrigerant
20. What equipment should be used to test a tube?
    a. Remove tubes and place in a tube tester
    b. Inspect with a bore scope
    c. Hydrostatic tube test kit
    d. Use a flashlight to expose pinholes
21. What can happen if you exceed 10 psig while pressurizing the system?
    a. Shaft seals will fail
    b. **The rupture disc will fail**

c. Oxygen combined with oil in the system will explode
d. None of the above

22. What are the leak repair requirements for comfort cooling appliances and commercial appliances containing 50 lbs. or more of refrigerant?
    a. Repair if leak rate exceeds 15% in comfort cooling appliances.
    b. Repair if leak rate exceeds 35% in all commercial and industrial process refrigeration
    c. a and b
    d. None of the above
23. How should a water box be leak tested?
    a. Remove water, then place the leak detector probe in through the drain valve
    b. Remove water, pressurize and check with a gas detector
    c. Look for bubble in the water
    d. Test the water for traces of refrigerant
24. What are the typical pressure settings for rupture discs on low pressure systems and recovery equipment?
    a. 5 psig
    b. 10psia
    c. 15 psig
    d. 15 psia
25. What equipment should be used to test a tube?
    a. Remove tubes and place in a tube tester
    b. Inspect with a bore scope
    c. Hydrostatic tube test kit
    d. Use a flashlight to expose pinholes
26. How should a technician recover refrigerant from a system using R-11 or R-123?
    a. Remove the liquid first.
    b. Recover remaining vapor second.
    c. a and b
    d. None of the above
27. What are the leak repair requirements for comfort cooling appliances and commercial appliances containing 50 lbs. or more of refrigerant?
    a. Repair if leak rate exceeds 15% in comfort cooling appliances.
    b. Repair if leak rate exceeds 35% in all commercial and industrial process refrigeration
    c. a and b
    d. None of the above
28. After removal of liquid, about how much vapor will remain in the system on a 350 ton R-11 chiller?
    a. 10 lbs of vapor after all the liquid has been removed
    b. 20 lbs of vapor after all the liquid has been removed100 lbs of vapor after all the liquid has been removed
    c. 50 lbs of vapor after all the liquid has been removed
    d. 100 lbs of vapor after all the liquid has been removed

29. What are the typical pressure settings for rupture discs on low pressure systems and recovery equipment?
    a. 5 psig
    b. 10psia
    c. 15 psig
    d. 15 psia
30. How can you speed up the vapor recovery process?
    a. Use two recovery machines
    b. **A heater on the recovery vessel side will help to evacuate the vapor faster**.
    c. Heat the recovery tank
    d. Recover on a hot day
31. In a system using a water cooled condenser, what components should be kept on?
    a. The system water pumps
    b. The recovery compressor
    c. The recovery condenser water
    d. All the above
32. How should a technician recover refrigerant from a system using R-11 or R-123?
    a. Remove the liquid first.
    b. Recover remaining vapor second.
    c. a and b
    d. None of the above
33. Where does the water typically come from in a water cooled condensing system?
    a. Evaporator
    b. Chiller
    c. Deep well
    d. Municipal water supply
34. After removal of liquid, about how much vapor will remain in the system on a 350 ton R-11 chiller?
    a. 10 lbs of vapor after all the liquid has been removed
    b. 20 lbs of vapor after all the liquid has been removed100 lbs of vapor after all the liquid has been removed
    c. 50 lbs of vapor after all the liquid has been removed
    d. **100 lbs of vapor after all the liquid has been removed**
35. What parts of the system should be drained of water before recovering refrigerant?
    a. Evaporator
    b. Condenser
    c. Cooling tower
    d. a and b
36. How can you speed up the vapor recovery process?
    a. Use two recovery machines
    b. **A heater on the recovery vessel side will help to evacuate the vapor faster**.

c. Heat the recovery tank
d. Recover on a hot day

37. How should a technician treat the oil before removal and why?
    a. Test the oil with a refrigerant detection kit
    b. **An oil temperature of 130ºF should be attained when removing oil to boil off the refrigerant**.
    c. Remove the oil first
    d. Inject oxygen into the oil to drive out the refrigerant
38. Why should you never charge liquid refrigerant into a deep vacuum?
    a. The refrigerant will flash creating danger of explosion
    b. It's OK to inject liquid refrigerant
    c. Introducing liquid refrigeration into a deep vacuum will cause the refrigerant to boil and may lower the temperature enough to freeze the water in the tubes
    d. The liquid refrigerant will break the vacuum
39. At what point in the system should you charge a low pressure system and what should you start the charge with?
    a. Charge through the evaporator charging valve as this is the lowest point on a low pressure system. First charge the system with vapor
    b. Charge through the evaporator charging valve as this is the lowest point on a low pressure system. First charge the system with liquid
    c. Charge through the condenser charging valve as this is the lowest point on a low pressure system. First charge the system with liquid
    d. Charge through the purge charging valve as this is the lowest point on a low
    e. pressure system. First charge the system with vapor
40. How can a technician determine when it is safe to start charging with liquid refrigerant?
    a. Temperature of the water is 36F
    b. Temperature of the water is above 32F
    c. Temperature of the water is above 40F
    d. Refrigerant saturation temperature reaches 36º F or the vapor pressure reaches 16.9" Hg vacuum.
41. What general standard does recovery / recycling equipment need to meet?
    a. Equipment must be EPA approved third party
    b. Equipment must have low loss fittings
    c. Equipment must meet evacuation levels more stringent that equipment made prior to that date
    d. All the above
42. What are the required levels of evacuation for low pressure systems for equipment manufactured before 11/15/1993 and/or after 11/15/1993?
    a. 25" Hg for equipment manufactured before November 15, 1993.
    b. 25 mm Hg absolute for equipment manufactured after November 15, 1993.
    c. a and b

d. None of the above

43. Why should a technician wait a few minutes after reaching the required vacuum level and what should be done if the pressure begins to rise?
    a. If the pressure drops, this indicates that there is still refrigerant in the system (liquid or trapped in the oil) and the recovery process must be repeated
    b. If the pressure rises, this indicates that there is still refrigerant in the system (liquid or trapped in the oil) and the recovery process must be repeated
    c. If the pressure rises, this indicates that there is still refrigerant in the system (liquid or trapped in the oil) and the recovery process is complete
    d. If the pressure drops, this indicates that there is still refrigerant in the system (liquid or trapped in the oil) and the recovery process is complete
44. What should be done if a leak makes reaching the required vacuum level unattainable?
    a. Contact the EPA for direction
    b. **The system should be evacuated to the lowest attainable level before a major repair**
    c. Install a second recovery unit
    d. Replace the equipment
45. What is considered to be a “major” repair according to the EPA?
    a. Removal of any or all of the following components: the compressor, the condenser, the evaporator or an auxiliary heat exchanger coil.
    b. Removal of all of the following components: the compressor, the condenser, the evaporator or an auxiliary heat exchanger coil.
    c. Removal of any 2 of the following components: the compressor, the condenser, the evaporator or an auxiliary heat exchanger coil.
    d. Removal of any 3 of the following components: the compressor, the condenser, the evaporator or an auxiliary heat exchanger coil.
46. Where is the rupture disc on a low pressure centrifugal system and where should the disc be vented to?
    a. On the evaporator. Discharge from the disc should be vented to recovery tank
    b. On the evaporator. Discharge from the disc should be vented outside
    c. On the condenser. Discharge from the disc should be vented outside
    d. On the condenser. Discharge from the disc should be vented to recovery tank
47. What problem can using large vacuum pumps lead to and how can a technician prevent it?
    a. Power system overload
    b. Can 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
    c. Collapse the tubing
    d. Damage gaskets

48. What step should you take for low pressure systems that will be sitting idle and why?
    a. Remove all refrigerant and place in a holding vacuum
    b. Start monthly and check for leaks
    c. Pressure in the system should be increased to slightly above atmospheric pressure in order to prevent air accumulation in the system.
    d. Pull a vacuum and log the gauge weekly. Repair any leaks
49. Where does the water typically come from in a water cooled condensing system?
    a. Evaporator
    b. Chiller
    c. Deep well
    d. Municipal water supply
50. What parts of the system should be drained of water before recovering refrigerant?
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    c. Charge through the condenser charging valve as this is the lowest point on a low pressure system. First charge the system with liquid
    d. Charge through the purge charging valve as this is the lowest point on a low pressure system. First charge the system with vapor
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c. Removal of any 2 of the following components: the compressor, the condenser, the evaporator or an auxiliary heat exchanger coil.
d. Removal of any 3 of the following components: the compressor, the condenser, the evaporator or an auxiliary heat exchanger coil.

59. Where is the rupture disc on a low pressure centrifugal system and where should the disc be vented to?
a. On the evaporator. Discharge from the disc should be vented to recovery tank
b. On the evaporator. Discharge from the disc should be vented outside
c. On the condenser. Discharge from the disc should be vented outside

d. On the condenser. Discharge from the disc should be vented to recovery tank

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