# SECTION 608 CERTIFICATION TEST PREPARATORY MANUAL

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# INTRODUCTION

This booklet is intended to prepare technicians for the certification test, and contains all the information a technician will require to successfully complete the test, except information covering very basic knowledge of refrigeration. This booklet is not intended to be a formal training manual in refrigeration.

Section 608 of the Federal Clean Air Act requires that all persons who maintain, service, repair, or dispose of appliances must be certified by November 14, 1994. Failure to comply can cost you and your company as much as $25,000 per day, per violation; and there is a bounty of up to $10,000 for providing information and/or serviced concerning violations to the EPA.

There are four (4) categories of technician certification:

TYPE I

Persons who maintain, service or repair small appliances must be certified as Type I technicians.

TYPE II

Persons who maintain, service, repair or dispose of high or very high pressure appliances, except small appliances and motor vehicle air conditioning systems, must be certified as Type II technicians.

TYPE III

Persons who maintain, service, repair, or dispose of low-pressure appliances must be certified as Type III technicians.

UNIVERSAL

Persons who maintain, service or repair low and high pressure equipment, including small appliances, must be certified as Universal technicians.

TEST FORMAT

The test contains four (4) sections, Core - I - II - III. Each sections contains twenty five (25) multiple-choice questions.

A technician MUST achieve a minimum passing score of 70 percent in each group in which they are to be certified. For instance a technician seeking Universal certification must achieve a minimum score of 70 percent, or 18 out of 25 correct, on each of the Sections of the test. If a technician fails one or more of the Type on the first try, he may retake the failed Section(s) without retaking the Type on which he earned a passing score. In the meantime the technician

will be certified in the Type in which he received a passing score. There is one exception, a technician MUST achieve a minimum passing score on Core to receive any type of certification.

The Core consists of 25 general knowledge questions concerning stratospheric ozone depletion, rules and regulations of the Clean Air Act, the Montreal Protocol, the Three "R's", recovery devices, substitute refrigerants and oils, recovery techniques, dehydration, recovery cylinders, safety, and shipping.

Type Icontains 25 sector specific questions pertaining to Type I certification.

Type II contains 25 sector specific questions pertaining to TYPE II certification.

Type III contains 25 sector specific questions pertaining to TYPE III certification.

Technicians seeking a Type I certification must complete and achieve a passing score on Core and Type I.

Technicians seeking a Type II certification must complete and achieve a passing score on Core and Type II.

Technicians seeking a Type III certification must complete and achieve a passing score on Core and Type III.

Technicians seeking a Universal certification must complete and achieve a passing score on Core,Type I,Type II and Type III.

The law requires the test to be a closed book exam. The only outside materials allowed are calculators.

Although there is no time limit for completing the test, the average technician completes a Section in 30 to 45 minutes.

Certain personal information is required on the exam.

Technicians should be prepared to present;

PICTURE IDENTIFICATION
SOCIAL SECURITY NUMBER
HOME ADDRESS-INCLUDING ZIP CODE
EMPLOYERS-NAME, ADDRESS, ZIP CODE

All technicians should carefully study Core and the Type(s) related to the Type of certification in which they are seeking to achieve a passing score.

# SECTION A
# GENERAL KNOWLEDGE

## STRATOSPHERIC OZONE DEPLETION

During the last half century, CFC's and HCFC's have dramatically changed our lifestyles. Little did we know that the use and release of these compounds into the atmosphere would have far reaching effects on theEarth's environment. The greatest effect is far removed from the Earth's surface.

The Stratosphere is the Earth's security blanket. It is located between 10 and 30 miles above the Earth's surface and is comprised of, among other things, Ozone. An Ozone molecule consists of three oxygen atoms (O3). The Ozone layer serves two important functions. Ozone protects us from harmful ULTRA VIOLET RADIATION and helps maintain stable Earth temperatures. Stratospheric Ozone Depletion os a Global problem. Depletion of Ozone in the Stratosphere causes;

* CORP LOSS
* INCREASE IN EYE DISEASE,
* SKIN CANCER and other RADIATION related DISEASES,
* REDUCED MARINE LIFE,
* INCREASED GROUND LEVEL OZONE
* DEFORESTATION

CFC's and HCFC's when released into the atmosphere, depleted the Ozone layer. The Chlorine in these compounds is culprit. When the Chlorine is released it takes one oxygen molecule from the Ozone, forming Chlorine Monoxide (CIO) and Oxygen (o2). One Chlorine atom can destroy 100,000 Ozone molecules. Unlike other Chlorine compounds and naturally occurring Chlorine, the Chlorine in CFC's will neither dissolve in water, so they do not rain out of the atmosphere.

There has been a great deal of controversy over the subject of Ozone depletion. Some believe that the Chlorine found in the Stratosphere comes from natural sources such as volcanic eruptions. However, air samples taken over erupting volcanoes show that volcanoes contribute a small quantity of Chlorine compared to the CFC's found in air samples taken from the Stratosphere. In addition, the rise in the amount of Chlorine measured in the stratosphere over the past two decades matched the rise in the amount of Flurorin, which has different natural

sources than Chlorine, over the same period. Also, the rise in the amount of Chlorine measured in the Stratosphere over the past twenty years matches the rise in CFC emissions over the same period.

OZONE DEPLETION POTENTIAL

Ozone depletion potential (ODP) is a measurement of CFC's and HCFC's ability to destroy Ozone. CFC's have the highest ODP. HFC's (R-134A) do not contain Chlorine and have no Ozone Depletion Potential.

The three (3) primary types of refrigerant are;

| | TYPE | ELEMENTS |
|---|---|---|
| * | CFC | Chlorine - Fluorine - Carbon |
| * | HCFC | Hydrogen - Chlorine - Fluorine - Carbon |
| * | HFC | Hydrogen -Fluorine - Carbon |

R-11, R-12 & R-500 are examples of CFC's
R-22 & R-123 are examples of HCFC's.
R-134A is an HFC.

# CEAN AIR ACT AND MONTREAL PROTOCOL

Following several years of negotiations, an international agreement (Treaty) regulating the production and use of CFC's, halons, methyl chloroform and carbon tetrachloride entered into force in mild 1989. Known as the Montreal Protocol, this landmark agreement initially required a production and consumption freeze. It currently calls for a stepwise reduction and eventual production phaseout of various Ozone Depleting Substances in developed countries. CFC's will be phased out of production on December 31, 1995. When virgin supplies of CFC's are depleted, all future supplies of CFC's will come from recovered, recycled, or reclaimed CFC's. Developing countries have been given an additional 10 years to complete transition to new technologies.

Section 608 of the Federal Clean Air Act is regulated by the United States Environmental Protection Agency (EPA). Failure to comply could cost you and your company as much as $25,000. per day, per violation; and there is a bounty of up to $10,000. to lure your competitors, customers and fellow workers to turn you in. Service technicians who violate Clean Air Act provisions may be fined, lose their certification, and may be required to appear in Federal court.

It is a violation of Section 608 to:

* falsify or fail to keep required records;
* fail to reach required evacuation rates prior to opening or disposing of appliances;
* knowingly release (vent) CFC's or HCFC's while repairing appliances;
* service, maintain, or dispose of appliances designed to contain refrigerants without being appropriately certified by Nov. 14, 1994;
* vent CFC's or HCFC's since July 1, 1992;
* vent HFC's on or after Nov. 15, 1995;
* fail to recover CFC's or HCFC's before opening or disposing of an appliance;
* fail to have an EPA approved recovery device;
* add nitrogen to a fully charged system, for the purpose of leak detection, and thereby cause a release of the mixture;
* dispose of a disposable cylinder without first recovering any remaining refrigerant and then rendering the cylinder useless, then recycling the metal;
* fail to possess appropriate and approved equipment with low loss fittings;
* fail to become certified by November 14, 1994.

In addition, some state and local government regulations may contain regulations stricter than Section 608.

## THE THREE "R's"

RECOVER - RECYCLE -RECLAIM

The process of recovery, recycling, and reclaiming sound similar, but they are quite different.

To RECOVER is to remove refrigerant in any condition from a system and store it in an external container.

To RECLAIM is to process refrigerant to a level equal to new (virgin) product specifications determined by chemical analysis. RECLAIMED refrigerant must meet the standard set forth in ARI 700 before it can be resold.

Most contractors have increased their service rates to help offset the cost of recovery equipment an recovery time. Some customers have complained about the increased cost of service. To justify the increase, simply explain that you are duty bound and required by law to recover refrigerants in order to protect the environment and human health.

## RECOVERY DEVICES

Refrigerant Recovery and/or Recycling equipment must be certified by an EPA approved equipment testing organization to meet EPA standards. There are two basic types of recovery devices.

The first type of recovery equipment is referred to as "System-dependent" and captures refrigerant with the assistance of components in the air conditioning and refrigeration equipment. The second type of recovery equipment is refereed to as "Self-contained" and has its own means to draw the refrigerant out of the appliance.

System dependent devices may only be used on appliances containing 15 lbs. of refrigerant or less. In addition, because appliances with non-operating compressors can not achieve desired evacuation rates utilizing System dependent recovery equipment. The EPA is requiring technicians who repair or dispose of appliances other than small appliances to have at least one Self contained recovery device available at the shop to recover refrigerant from systems with non operating compressors.

## SUBSTITUTE REFRIGERANTS AND OILS

Our industry is in a state of change. New refrigerants, blends of older refrigerants, and different oils are beginning to make an appearance in the field. We will have to learn some new terms and service procedures.
R-134A is a HFC and is considered Ozone friendly. R-134A is the leading candidate for CFC retrofit, but it is not a drop-in substitute. Actually, there isn't a drop-in alternative, but R-134 can be used in most R-12 systems by following appropriate retrofit procedures. R-134A will not mix with most refrigerant oils. The oils used in most R-134A refrigeration systems are ESTERS. Esters can not be mixed with other oils. It is also important to remember that when leak testing an R-134A system to the only R-134A or pressurized nitrogen.

There are several refrigerant blends commonly in use. Some of the blends are called Ternary, which means they are a three part blend. Ternary blends are used with a synthetic alkybenzene lubricant. Make certain you are using the correct oil for the refrigerant. Most refrigerant oils are hygroscopic. A hygroscopic oil has a high affinity for water. There is some specific information you will need to know about blends. First, a blended refrigerant will leak from a system in uneven amounts due to different vapor pressures. A term you will need to know is "temperature glide". Temperature glide refers to a refrigerant blend that has a range of boiling points or condensing points throughout the evaporator and condenser respectively. Second, the proper charging method for blended refrigerants is to weigh into the high side of the system as a liquid.

Other blends may be Azeotropic. An azeotropic mixture is one that combines and creates a third, unique refrigerant with its own individual characteristics.

# RECOVERY TECHNIQUES

Now that recovery is the law, you need to know the proper methods of recovery.

When servicing a system, if you discover that two or more refrigerants have been mixed in a system, you must recover the mixture into a separate tank. It is important NOT to mix different refrigerants in the same recovery tank because the mixture may be impossible to reclaim. It is important to recover only one type of refrigerant into a recovery cylinder.

The length of the hose between the unit being recovered from and the recovery machine will greatly effect the efficiency of the recovery process. Long hoses will cause excessive pressure drop, increased recovery time and the potential for increased emissions. Since all refrigerants have a pressure temperature relationship, the lower the ambient temperature, the slower the recovery rate.

After completing the transfer of liquid refrigerant between a recovery unit and a refrigeration system, you should guard against trapping liquid refrigerant between the service valves.

# DEHYDRATION

Proper dehydration procedures through evacuation are important to follow.

As every technician knows, the reason for dehydrating a refrigeration system is to remove water and water vapor. If moisture is allowed to remain in an operating refrigeration system, hydrochloric and hydrofluoric acids may form. Evacuation of a system is the suggested method of dehydration. It is not possible to over evacuate a system.

Never evacuate a system to the ambient air without first following proper recovery procedures and attaining the mandated vacuum level.

The factors affecting the speed and efficiency of evacuation are; size of equipment being evacuated, ambient temperature, amount of moisture in the system, the size of the vacuum pump and suction line. In addition, vacuum lines should be equal to or larger than the pump intake connection. The piping connection to the pump should be as short a length as possible and as large in diameter as possible. The system vacuum gauge should be connected as far as possible from the vacuum pump. Measuring of a systems vacuum should be done with the system isolated. During evacuation you may wish to heat the refrigeration system to decrease dehydration time. The use of a large vacuum pump could cause trapped water to freeze. During evacuation of systems with large amounts of water, it may be necessary to increase pressure by introducing nitrogen to counteract freezing.

Dehydration is complete when the vacuum gauge shows that you have reached and held the required finished vacuum.

## RECOVERY CYLINDERS

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

On the other hand, recovery cylinders are specifically designed to be refilled. Recovery cylinders have at least 2 ports, one liquid and one vapor. The EPA is concerned about over pressurization or heating of these cylinders, thereby causing an explosion. The EPA requires that a refillable refrigerant cylinder MUST NOT BE FILLED ABOVE 80% of its capacity by weight, and that the safe filling level can be controlled by either mechanical float devices, electronic shut off devices (thermistors), or weight. Refillable cylinders must be hydrostatically tested and date stamped every 5 years.

Refillable cylinders used for transporting recovered pressurized refrigerant must be DOT (Department of Transportation) approved. Approved refrigerant recovery cylinders can easily be identified by their colors, YELLOW TOPS AND GRAY BODIES. All refrigerant recovery cylinders should be inspected for RUST. If they show signs of rust or appear to not be secure they should be reduced to o psig and discharged.

## SAFETY

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

Whenever dry nitrogen from a portable cylinder is used in a service procedure, you should always insert a relief valve in the downstream line from the pressure regulator. Relief valves MUST NOT be installed in series, and if corrosion build-up is found within the body of a relief valve, the valve MUST be replaced. When pressurizing a system with nitrogen, you should always charge through a pressure regulator. When leak checking a system, NEVER pressurize the system with oxygen or compressed air. When mixed with refrigerants, oxygen or compressed air can cause an explosion. to determine the safe pressure for leak testing, check the data-plate for the low-side test-pressure valve.

When using recovery cylinders and equipment with schrader valves, it is CRITICAL to inspect the schrader valve core for leaks, blends and breakage, replace damaged valve cores to prevent leakage, and always cap schrader ports to prevent accidental depression of a valve core.

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

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

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

## SHIPPING & TRANSPORTING

When transporting cylinders containing used refrigerant, the Department of Transportation requires that you attach DOT classification tags, and store the cylinders vertically. Also you must place a refrigerant label on a refrigerant cylinder being returned for reclaiming.

Before shipping any used refrigerant in a cylinder, it is necessary to properly label the refrigerant container, properly complete shipping paperwork, and check that the refrigerant container meets DOT standards. DOT Regulation, 49 CFR, requires the number of cylinders of each refrigerant be recorded on the shipping paper for hazard class 2.2. Nonflammable Compressed Gasses.

# TYPE I CERTIFICATION

Technicians servicing small appliances must be certified in refrigerant recovery if they perform sealed system service after November 14, 1994. The EPA definition of a "small appliance" includes products manufactured, charged, and hermetically sealed in a factory with five (5) pounds of refrigerant or less. This includes Packaged Terminal Air Conditioners (PTAC's) with 5 pounds or less of refrigerant. Persons recovering refrigerant during maintenance, service or repair of small appliances must be certified as either a Type I Technician or as a Universal Technician.

Beginning November 14, 1994, the sale of CFC and HCFC refrigerants will be restricted to technicians certified in refrigerant recovery.

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

# EQUIPMENT REQUIREMENTS

Effective August 12, 1993, persons using recovery equipment to recover refrigerant from a small appliance must certify to the EPA that they have equipment capable of removing 80% of the refrigerant or achieving a 4 inch vacuum under conditions or ARI 740-1993. All recovery devices manufactured before November 15, 1993 must meet this same requirement (removing 80% of refrigerant or achieve 4 inch vacuum).

Small appliance recovery equipment (passive or active) manufactured after November 15, 1993, must be capable of recovering 90% of the refrigerant if the compressor is operating, 80% of the refrigerant if the compressor is not operating, or achieving a 4 inch vacuum under the conditions of ARI 740-1993.

Refrigerant recovery devices must be equipped with low loss fittings at the ends of the hoses. Low loss fittings can be manually closed or close automatically when disconnected to prevent refrigerant loss from hoses.

When servicing a small appliance for leak repair, the EPA DOES NOT REQUIRE YOU TO REPAIR THE LEAK, but do so whenever possible.

# RECOVERY TECHNIQUES

Before beginning a refrigerant recovery procedure, it is ALWAYS necessary to know the type of refrigerant that is in the system. If a reclamation facility receives a tank of mixed refrigerant, they may refuse to process the refrigerant and return it at the owner's expense. They may agree to destroy the refrigerant, but typically a substantial fee is charged. DO NOT MIX REFRIGERANTS IN A RECOVERY TANK. Each recovery cylinder should be designated for a specific refrigerant type.

Refrigerators built before 1950 may have used Methyl Formate, Methyl Chloride, or Sulfur Dioxide as refrigerant and should not be recovered with current recovery devices. Small appliances used in campers or other recreational vehicles may have refrigerants containing Ammonia, Hydrogen, or Water, and therefore should not be recovered using current recovery equipment.

R-134A is being considered as a replacement refrigerant for R-12 in household refrigerants, only after proper retrofit procedures have been followed. At present, there are no direct "drop-in" substitutes for R-12.

## SYSTEM DEPENDENT RECOVERY (PASSIVE)

A system dependent recovery process for small appliances captures refrigerant into a non-pressurized container. A standard vacuum pump can only be used as a recovery device in combination with a non-pressurized container. When using a system dependent (passive) recovery process on an appliance with an operating compressor, run the compressor and recover from the high side of the system. On a sealed system with an operating compressor that has a completely restricted capillary tube, only one access valve on the high side of the system is needed to evacuate the refrigerant. On small appliances with non-operating compressors, it is essential to take measures to help release trapped refrigerant from the compressor oil (heat and sharply strike the compressor several times and / or use a vacuum pump). In order to achieve the required recovery efficiency and to enhance the speed of recovery, access to both the low and high side of the system may be necessary. Since small amounts of CFC / HCFC refrigerant have no odor, when a pungent odor is detected during a sealed system recovery and / or repair, a compressor burn-out has likely occurred. When recovering refrigerant from a system that experienced a compressor burn-out, the technician should watch for signs of contamination in the oil because the system will have to be flushed if contaminants are present. After recovering refrigerant, if nitrogen is used to pressurize or blow debris out of the system, the nitrogen may be vented. When installing an access fitting onto a sealed system, the fitting should be leak tested before proceeding with recovery. It is generally recommended that piercing type valves only be used on copper or aluminum tubing material.

When filling a charging cylinder with a regulated refrigerant, the refrigerant that is vented off the top of the cylinder MUST be recovered.

All refrigerant recovery equipment should be checked for oil level and leaks on a daily basis.

## RECOVERY CYLINDERS

The only way to read refrigerant pressure accurately is at a known temperature. Obtaining accurate pressure readings of refrigerant inside a recovery cylinder is necessary to detect the presence of excessive air or other non-condensables.

The proper method for eliminating non-condensables from a recovery cylinder is as follows:

1. Store the cylinder for 12 hours at 65For higher (out of the sunlight)
2. Hold an accurate thermometer within 4" of the cylinder and read the ambient temperature.
3. Use an accurate pressure gauge to determine the internal pressure of the recovery cylinder.
4. Slowly bleed excessive pressure from the vapor port of the recovery cylinder until your pressure reading is at or slightly above the appropriate temperature pressure relationship.

EXAMPLES:

| | | | |
|---|---|---|---|
| R-12 | 70F = 70psig | 75F = 77psig | 80F = 84psig |
| R-22 | 70F = 121psig | 75F = 132psig | 80F =144psig |
| R-500 | 70F = 85psig | 75F = 94psig | 80F = 102 psig |

# TYPE II CERTIFICATION

Technicians maintaining, servicing, repairing or disposing of high pressure or very high pressure appliances, except small appliances and motor vehicle air conditioning systems, must be certified as a Type II Technician or a Universal Technician.

Beginning November 14, 1994, the sale of CFC and HCFC refrigerants will be restricted to technicians certified in refrigerant recovery.

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

## LEAK DETECTION

After the installation of any type of system, the unit should first be pressurized with nitrogen (an inert gas) and leak checked. Testing the system with soap bubbles will pinpoint leaks in the system.

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

## LEAK REPAIR REQUIREMENTS

EPA regulations require that all appliances containing more than 50 lbs. of refrigerant (except commercial and industrial process refrigeration) MUST be repaired when the annual leak rate exceeds 15%, and that commercial and industrial process refrigeration MUST be repaired when the annual leak rate exceeds 35%.

Commercial Refrigeration includes appliances used in the retail food and cold storage warehouse sectors, including equipment found in supermarkets, convenience stores, restaurants and other food establishments, and equipment used to store meat, produce, dairy products and other perishable goods.

Industrial Process Refrigeration means complex customized appliances used in the chemical, pharmaceutical, petrochemical and manufacturing industries, including industrial ice machines and ice rinks.

# RECOVERY TECHNIQUES

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

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

Technicians working with multiple refrigerants, before recovering/recycling a different refrigerant, MUST purge the recover/recycle equipment by recovering as much of the first refrigerant as possible, change the filter, and evacuate. There is one exception to this rule. Technicians working with R-134A MUST provide a special set of hoses, gauges, vacuum ump, recovery or recovery/recycling machine, and oil containers to be used with R-134A only.

Recovery time can be reduced by recovering as much as possible in the liquid phase. The technician may choose to speed up the recovery process by packing the recovery vessel (cylinder)in ice. After recovering liquid refrigerant, any remaining vapor is condensed by the recovery system. Recovery refrigerant in the vapor phase will minimize the loss of oil.

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

After recovery, refrigerant may be returned to the appliance from which is was removed or to another appliance owned by the same person without being recycled or reclaimed, unless the appliance is an MVAC (Motor Vehichle Air Conditioner) like appliance. The technician should ALWAYS reduce an empty recovery cylinder to a negative pressure before transferring refrigerant to the cylinder. Quick cuplers, self sealing hoses, or hand valves should be used (as low loss fittings) to minimize refrigerant release when hoses are connected and disconnected.

# RECOVERY REQUIREMENTS

The following is a list of the REQUIRED LEVELS OF EVACUATION FOR APPLIANCES:

THIS SHOULD BE MEMORIZED

| TYPE OF APPLIANCE | Inches of Hg vacuum<br>Using recovery or recycling equipment manufactured or imported before Nov. 15, 1993 | Using recovery or recycling equipment manufactured or imported on or after Nov. 15, 1993 |
|---|---|---|
| HCFC-22 appliances, or isolated component of such appliance, normally containing less than 200 lbs. of refrigerant. | 0 | 0 |
| HCFC-22 appliances, or isolated component of such appliance, normally containing 200 lbs. or more of refrigerant. | 4 | 10 |
| Other high pressure appliances, or isolated component of such appliance, normally containing less than 200 lbs. of refrigerant. | 4 | 10 |
| Other high pressure appliances, or isolated component of such appliance, normally containing 200 lbs. or more of refrigerant. | 4 | 15 |
| Very high pressure appliance | 0 | 0 |

After reaching the desired vacuum, you should ALWAYS wait a few minutes to see if the system pressure rises indicating that there is still refrigerant in liquid form or in the oil. Appliances containing refrigerants can be evacuated to atmospheric pressure (0 psig) when leaks in the appliance make evacuation to the prescribed level unattainable. The technician MUST isolate a parallel compressor system in order to recover refrigerant. Failure to isolate a parallel compressor system will cause an open equalization connection which will prevent refrigerant recovery.

Under EPA regulations, a "MAJOR REPAIR" means any maintenance, service or repair involving the removal of any or all of the following appliance components: compressor, condenser, evaporator or auxiliary heat exchanger coil. The filter-drier SHOULD be replaced when any system is opened for servicing.

## REFRIGERATION NOTES

A residential split system, providing comfort air conditioning usually contains R-22 but the proper method to determine the type of refrigerant used in a system is to read the name plate.

The state of refrigerant leaving either the receiver or condenser of a refrigeration system is a high pressure liquid.

When evacuation a vapor compression system, the vacuum pump should be capable of pulling 500 microns off vacuum. The more accurate and preferred method of measuring a deep vacuum is in microns. WARNING: A hermetic compressor's motor winding could be damaged if energized when under a deep vacuum.

When a thermal expansion valve (TXV) is used in a refrigeration system, the receiver should ALWAYS be placed directly following the condenser.

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

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

## SAFETY

ASHRAE standard 15 REQUIRES that all equipment rooms containing equipment utilizing an A1 refrigerant (EXAMPLES - r-12, r-11, r-134a ETC.) must be fitted with an oxygen deprivation sensor and alarm.

Refrigeration systems MUST be protected by a pressure relief valve.

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

# TYPE III CERTIFICATION

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

Beginning November 14, 1994, the date of CFC and HCFC refrigerants will be restricted to technicians certified in refrigerant recovery.

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

## LEAK DETECTION

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

The most efficient method of leak checking a charged low-pressure refrigeration unit is to pressurize the system by the use of controlled hot water. When controlled hot water is not feasible, such as leak testing a centrifugal, use nitrogen. DO NOT EXCEED 10 psig. Exceeding 10 psig can cause the rupture disc to fail. When leak testing a water box be certain the water has been removed before placing the leak detector probe through the drain valve.

## LEAK REPAIR REQUIREMENTS

EPA regulations require that all appliances containing more than 50 lbs. of refrigerant (except commercial and industrial process refrigeration) MUST be repaired when the annual leak rate exceeds 15%, and that commercial and industrial process refrigeration MUST be repaired when the annual leak rate exceeds 35%.

Commercial Refrigeration includes appliances used in the retail food and cold storage warehouse sectors, including equipment found in supermarkets, convenience stores, restaurants and other food establishments, and equipment used to store meat, produce, dairy products and other perishable goods.

Industrial Process Refrigeration means complex customized appliances used in the chemical, pharmaceutical, petrochemical and manufacturing industries, including industrial ice machines and ice rinks.

# RECOVERY TECHNIQUES

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

Refrigerant recovery from a system using R-11 or R-123 starts with liquid removal, and as with any low-pressure chiller, you MUST recover the vapor refrigerant after liquid recovery is performed. For instance, in an average 350 ton R-11 chiller at 0 psig pressure, once all the liquid has been removed, still contains 100 lbs. of vapor. Under EPA regulations, controlled hot water can be used to pressurize a system for the purpose of opening the system for a "non-major" repair. In addition water MUST be circulated through a chiller when evacuating refrigerant to prevent freezing of the water. When removing vapor from a refrigeration system, the system water pumps, the recovery compressor, and the recovery condenser water should all be on.

Under EPA regulations, a "MAJOR REPAIR" means any maintenance, service or repair involving the removal of any or all of the following appliance components: compressor, condenser, evaporator or auxiliary heat exchanger coil

The ASHRAE Guideline 3-1990 states that if the pressure in a system rises from 1 mm Hg to a level above 2.5 mm Hg during vacuum testing, the system should be leak checked.

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

# RECHARGING TECHNIQUES

Introducing liquid into a deep vacuum will cause the refrigerant to bill and may lower temperatures enough to freeze water in the tubes. Therefore, after servicing a system, initial charging is in the vapor phase. Before charging with liquid, a refrigeration system with R-11 requires a vapor pressure of 16.9" hg. vacuum in the shells or when the refrigerant saturation temperature increases to 36F, enough vapor has entered the system and you may begin charging liquid refrigerant.

A centrifugal chiller's rupture disk is connected to the evaporator. Refrigerant is added through the evaporator charging valve.

# RECOVERY REQUIREMENTS

The following is a list of the REQUIRED LEVELS OF EVACUATION FOR APPLIANCES:

THIS SHOULD BE MEMORIZED — Inches of Hg vacuum

| TYPE OF APPLIANCE | Using recovery or recycling equipment manufactured or imported before Nov. 15, 1993 | Using recovery or recycling equipment manufactured or imported on or after Nov. 15, 1993 |
|---|---|---|
| Low-pressure appliance | 25"hg vacuum | 25 mm hg absolute |

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

# REFRIGERATION

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

# SAFETY

ASHRAE standard 15 REQUIREMENTS that all equipment rooms containing equipment utilizing an A1 refrigerant (EXAMPLES - R-12, R-11, R-134A etc.) must be fitted with an oxygen deprivation sensor and alarm. R-123, under ASHRAE 34, is code grouped as B1 and requires a refrigerant sensor in the equipment room, under ASHRAE 15.