Technician Certification Exam Guide

Proper Use and Handling of Refrigerant Grade Hydrocarbons
R-290 (Propane) R-600a (Isobutane)

NOTE: Under current EPA regulations, there are no special requirements to purchase or use flammable hydrocarbons (HCs). Certification training is voluntary. However, for safety and liability reasons, any technician installing or servicing systems that contain a flammable HC should receive proper training, and maintain a record of that training. Individuals that successfully complete the ICOR HC certification exam will receive a certificate of completion.

For certification exam go to, www.icorinternational.com



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Hydrocarbon Refrigerants

The following presentation will assist the refrigeration technician in understanding the requirements of safely maintaining and servicing systems that use flammable refrigerants.

As stated in the EPA's SNAP list (Significant New Alternative Policy), flammable refrigerants, like R-290, and R-600a, can only be used in applications that are designed for use with flammable refrigerants. R-290 and R-600a are NOT legal for use for use in retrofit applications.



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Liability Concerns

Check with your company's insurance provider to determine what liability exposure, if any, you may have before servicing systems with flammable refrigerants.

That's the guy that put flammable propane in the AC unit





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Introduction to Refrigerant Grade Hydrocarbons

- ✓ Hydrocarbons provide good heat transfer capacity, and efficiency.
- ✓ They can be used in a wide range of EPA SNAP approved ACR applications.
- ✓ The two hydrocarbons most commonly used by equipment manufactures are R-290 (Propane), and R-600a (Isobutane). Go to: https://www.epa.gov/snap/refrigeration-and-air-conditioning
- ✓ Hydrocarbons have a very low environmental impact (low GWP and Zero ODP) compared to CFCs, HCFCs, and HFCs
- ✓ Hydrocarbons are highly flammable. R-290 and R-600a are ASHRAE safety classified A3.
- ✓ Hydrocarbons are compatible with copper components, mineral oils, and other common system components
- ✓ Service procedures for hydrocarbons are similar to CFC, HCFC and HFC systems



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ASHRAE Safety Classifications

High Flammability (3)	**R-290 & 600a A3**	**R-40 B3**
Low Flammability (2)	**R-152a A2**	**R-611 B2**
Lower Flammability (2L)	**R-1234yf A2L**	**R-717 B2L**
No Flame Propagation (1)	**R-22 A1**	**R-123 B1**
*Source: ASHRAE Standard 34	**Lower Toxicity (A)**	**Higher Toxicity (B)**



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EPA/SNAP Approved Hydrocarbons By Application

- ✓ NEW household refrigerators, freezer, and combination refrigerator/freezer units, may use R-290, R-600a, or R-441A with a charge not to exceed 57 grams (2.0 ounces)
- ✓ NEW vending machines may use R-290, R-600a, or R-441A with a charge size not to exceed 150 grams (5.3 ounces)
- ✓ NEW residential and light commercial equipment for self contained room air conditioning, window units, portable air conditioning units may use R-290, R-441A, or R-32 with a charge size based on the Btuh rating of the unit
- ✓ NEW retail food refrigerators and freezers (stand alone units only) may use R-290, R-600a, or R-441A with a charge size not to exceed 150 grams (5.3 ounces)



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Identifying Systems Using Flammable Refrigerants Component Labeling





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Unauthorized Use of Hydrocarbons

If for any reason you suspect that a system has been illegally charged with a flammable HC, you should immediately:

- ✓ Leak test the system using a combustible gas leak detector to insure there are no immediate safety threats.
- ✓ Inform the equipment owner of the situation.
- ✓ The equipment owner should contact the company or technician that initially charged the system and ask them to resolve the issue.
- ✓ If the equipment owners decides he wants, or needs, for you to resolve the issue, follow the procedures laid out in this guide to properly evacuate and recharge the system with an EPA SNAP approved, non-flammable, refrigerant.



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Combustible Gas Leak Detectors

To avoid accidental combustion, make sure your combustible gas monitor is turned on before entering any area with equipment that may contain a flammable refrigerant.

You should always test for system leaks before unplugging, plugging in, or servicing a system that contains a flammable refrigerant.

Your gas monitor needs to meet CSA C22.2 or ANSI/ISA 12.13.01 Standards



Inficon Gas-Mate



JB LDC-4000



Yellow Jacket AccProbe/UV



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Flammability Hazard Ratings

Lower Explosive Limits (LEL)

At a concentration in air below the LEL, there is not enough fuel to ignite. The LEL of R-290 (propane) is 2.1% concentration in air. For R-600a (isobutane), the LEL is 1.8% concentration.

Upper Explosive Limit (UEL)

Concentration higher than the UEL are [too rich] to burn. The UEL of R-290 (propane) is 9.5% concentration in air. For R-600a (isobutane) the concentration is 8.5% concentration in air.

It is very hard to determine the amount of flammable refrigerant that will be concentrated in the air, so it is critical to avoid any ignition sources.

Ignition Temperature or Auto Ignition Temperature

Both R-290 (propane) and R-600a (isobutane) have a ignition temperature >800 ºF

Flash Point

R-290 (propane) flash point is -155 ºF and R-600a (isobutane) flash point is -117 ºF



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Additional Health Hazards

Unprotected contact with refrigerants may cause severe burns.

You will need to wear protective eyewear, gloves, and clothing when servicing any ACR system.

Hydrocarbons like R-290 and 600a are heavier than air, and have NO odor, making them more susceptible to ignition sources.

Working with HC refrigerants in poorly ventilated areas create a greater risk of combustion, or suffocation from the displacement of oxygen.



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Proper Handling and Use Of Hydrocarbons

These safety precautions apply to both flammable and non-flammable refrigerants.

- ✓ Never store or expose cylinders to temperatures above 125 ºF.
- ✓ Never apply an open flame to a cylinder.
- ✓ Never use water or an electric blanket exceeding 104 ºF to heat the cylinder.
- ✓ Open access valve slowly.
- ✓ Always use proper handles, wrenches, and fittings to access the refrigerant.
- ✓ Never refill disposable cylinders.



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Proper Handling and Use Of Hydrocarbons - Continued

These safety precautions apply to both flammable and non-flammable refrigerants.

- ✓ Never fill a recovery cylinder with a non approved refrigerant
- ✓ Never exceed the maximum allowable liquid fill weight (AHRI Guideline K-2009)
- ✓ Store and transport cylinders in the upright position and in a secure manner
- ✓ The relief valve must be in contact with the vapor space at all times for proper operation
- ✓ Never use recovery cylinders that have an expired test date (every 5 years)



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Handling Refrigerant Cylinders

- ✓ Use caution when recovering refrigerants that may have noncondensibles, pressures will be higher than expected.
- ✓ The integrity of the cylinder may be compromised if exposed to a corrosive environment.
- ✓ Prevent cylinder damage, handle and transport in the proper way
- ✓ Recovery cylinders have minimum pressures, R-12 ~260 psi, R-22~350 psi, and 410A~ 400 psi



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Handling Refrigerant Cylinders Cont.

- ✓ Return cylinder to the proper source for reclamation
- ✓ Dispose cylinders in the proper manner, county, city, and or state codes
- ✓ Properly label refrigerant type that is in recovery cylinders
- ✓ Never tamper with relief valves
- ✓ Ensure that scales are accurate. All refrigerants have different liquid density
- ✓ A vacuum on a empty cylinder will keep the refrigerant cleaner



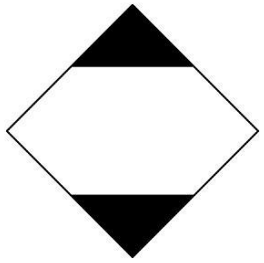
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Shipping Hydrocarbons

DOT Classifies most refrigerants as “Class 2, Compressed Gases”.
Nonflammable and nontoxic refrigerants are classified as Division 2.2 gases.
Flammable refrigerants are classified as Division 2.1 gases.
When transporting flammable refrigerants all appropriate safety consideration must be considered.







Limited Quantity

ICOR’s R-290 and R-600a cans fall below the Limited Quantity regulation for Class 2 Flammable products, they can be shipped in a box with a Limited Quantity Placard, instead of the Class 2 placard.

Required signage and placarding must be used. Some jurisdictions may have more detailed requirements for transporting R-290, 600a, 170, 32, and 441A. Check with your local DOT.





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Warehousing Cylinders

To be in compliance with OSHA's GHS regulation, we still need the Class 2 flammable placard on the can, and we will still have it on the outside of the box. That will keep the distributors that are stocking R-290 and or R-600a in compliance with OSHA

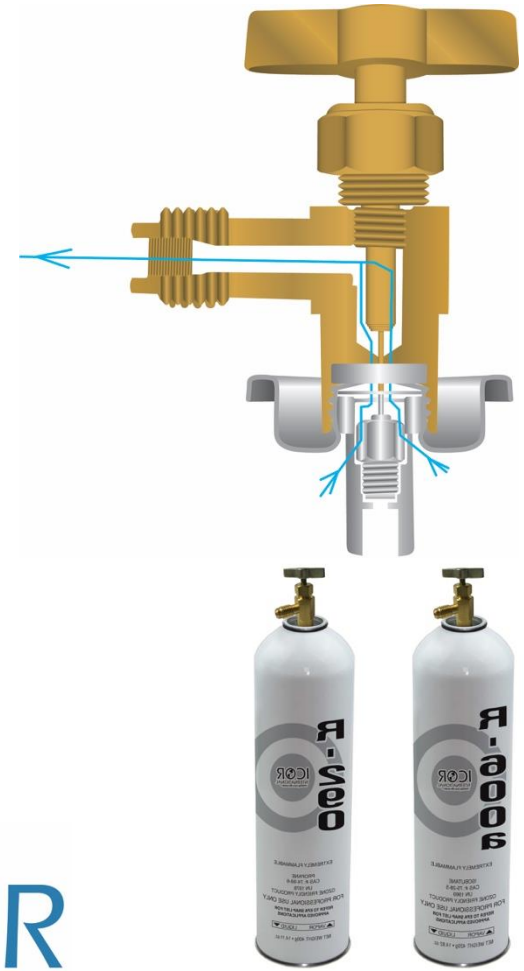
We also recommend that each store review their local and state ordinances for warehousing flammable refrigerants.



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Can Valve Tool

Care must be taken when installing the can valve tool. Make sure the threads on the can and tool are clean. Do not overtighten the tool onto the can. The can is self sealing, so the tool handle needs to be backed out (CCW) before installing. Never leave the valve tool on the can when can is not in use.



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Brazing and Silver Soldering

- ✓ Only qualified personnel should use brazing equipment
- ✓ System refrigerant MUST be recovered before a torch is used
- ✓ The equipment MUST be moved to an unconfined area for service
- ✓ Establish a safe working area while ventilating
- ✓ A minimum of 10 ft of clear area around the equipment is recommended
- ✓ Eye protection, gloves, and safety clothes are necessary for protection
- ✓ Check torch for proper pressure settings and leaks
- ✓ Purge the refrigerant lines and components with an inert gas like nitrogen when brazing



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Equipment Ratings

- ✓ Recovery equipment must be designed for flammable refrigerants.
- ✓ Leak detectors approved for hydrocarbon refrigerants are available at local HVACR distributors.
- ✓ Be cautious when using any tools or instruments that could provide an ignition source.



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Refrigerant Purity

Using refrigerants that do not meet AHRI or ASHRAE standards can cause damage to system components. The use of refrigerants that do not meet the required purity level can cause the following issues:

- ✓ High levels of moisture
- ✓ Moisture saturated filter driers
- ✓ Freezing at the metering device
- ✓ Accelerated acid production
- ✓ Copper plating
- ✓ Lubricant foaming or breakdown
- ✓ Poor heat exchange (reduced system performance)



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Odorless Flammable Refrigerants

Stenching is a method used in fuel-grade propane to identify gas leaks, by adding an additive to the gas that can be detected by smell. Stenching material is not used in refrigerant-grade propane since it is known to cause corrosion and non-condensables in an ACR system.



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Using Hydrocarbons in a Confined Space

- ✓ **Monitor**
  You must turn on a Combustible Gas Monitor before entering the service area.
  Do NOT turn the Combustible Gas Monitor off until you have left the service area

- ✓ **Ventilate**
  Maintain good ventilation in the service area

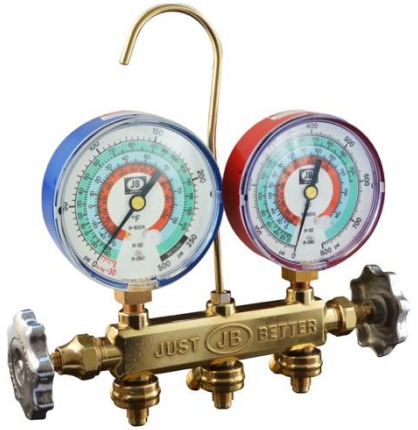
- ✓ **Eliminate**
  Turn off all ignition sources to gas, and or electric power, to all appliances.
  DO NOT use any tools or procedures that could cause a sources of ignition



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Compressor Removal

1. Disconnect all electric power to the system. Some systems may have more than one power supply
2. Attach gauge set hoses to both sides of the system (low & high)
3. Refrigerant MUST be recovered/removed from the system before removing the compressor. Recover from both low and high side. Consult with equipment or compressor manufactures for the approved methods of recovery
4. Use tube cutter NOT a torch to remove tubing from compressor. If you must use a torch do so while purging tubing with nitrogen



JB Patriot Manifold



CPS TRS21 Spark Proof Recovery Unit



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System Flushing, Purging, and Leak Testing

Failure to properly flush, purge, or pressure test a system for leaks, can result in serious injury or death from explosion, fire, or contact with acid saturated refrigerant or lubricant mists.

- ✓ Always use flushing products according to the manufacture's instructions
- ✓ ONLY use dry nitrogen to purge a system
- ✓ ONLY use regulated dry nitrogen when pressure testing a system
- ✓ Use an approved leak detector and or detection method
- ✓ NEVER use oxygen, compressed air, or acetylene to pressure test a ACR system.

Oxygen can explode on contact with oil. Acetylene can decompose and explode when exposed to pressure greater than 15 psig. Combining an oxidizing gas, such as oxygen or air, with a hydrocarbon refrigerant under pressure can result in a fire or explosion.



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System Flushing, Purging, and Leak Testing Cont.

- ✓ A pressure regulator must be used with dry nitrogen along with a manifold gauge set
- ✓ The pressure regulator must be able to reduce the pressure to 1 or 2 psig and maintain this pressure
- ✓ The regulator must be equipped with two gauges, one gauge to measure the cylinder pressure, and one to measure the discharge (system psig)
- ✓ Use a pressure relief down stream from the regulating valve. Relief setting should be 175 psig
- ✓ Dry nitrogen cylinders contain pressures > 2,000 psig at 70ºF



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System Flushing, Purging, and Leak Testing Cont.

- ✓ DO NOT over pressurize a system. Check the name plate test value, if that info is not available check with manufacturer
- ✓ Some manufacturers currently require a system test pressure check of 700 psig
- ✓ Release the dry nitrogen (slowly), and evacuate and hold (15 minutes) to a minimum of 500 microns
- ✓ Check with the manufacturer's requirements some require a 200 micron vacuum (usually for R-290 systems)

Failure to follow the manufacturer's instructions can cause damage to the compressor, this damage can increase the risk of terminal venting.



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System Evacuation

- ✓ Only use a vacuum pump designed to pull a deep vacuum on the system you are servicing.
- ✓ DO NOT start any compressor while it is under a vacuum. Always break a vacuum with refrigerant before energizing (starting) the compressor.
- ✓ Failure to follow these simple instructions can damage the hermetic terminal block (terminal venting). Never energize the compressor with the terminal cover off.
- ✓ Make sure all the refrigerant has been recovered before opening (cutting tubes) to the atmosphere or using a vacuum pump.



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System Evacuation

If the system pressure is showing 0 psig, it does not necessarily mean that all the refrigerant is out of the system.

The best approach is to:

- ✓ Remove the refrigerant
- ✓ Purge the system with dry nitrogen (inert gas)
- ✓ Evacuate the system with a vacuum pump
- ✓ Purge the system again with dry nitrogen
- ✓ Open the system by cutting the tubes with a tube cutter



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Component Compatibility

- ✓ **Compressor**
  Most compressor types are suitable for use with hydrocarbon refrigerants, but compressors that are utilized in hydrocarbon systems must be specifically designed for such use. They must be clearly labeled to indicate hydrocarbon compatibility, and crank case heaters should be considered

- ✓ **Condensers, evaporators, and metering devices**
  As required under SNAP regulations issued by the EPA, these system components are designed to be compatible with the acceptable refrigerants



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Component Compatibility Cont.

- ✓ **Lubricants**

  Check with compressor manufacturer for oil type
- ✓ **Gaskets, seals, O-rings, motor windings**

  Hydrocarbons are compatible with all materials commonly used in ACR systems, including copper and steel
- ✓ **Switches, safeties, relays, contactors, and motors**

  These components should be labeled for hydrocarbon refrigerants and NOT present an ignition source



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Leak Testing

Leaks outside the cabinet have the potential to lead to a mixture of hydrocarbons and air that reaches the flammable level (even if the equipment is outside in the ambient air away from a structure). You must treat a flammable refrigerant system as having the potential to be at the ignition level. Service equipment like drill, pumps, recovery machines, and tools should not produce sparks. Electrical components are also potential ignition sources

Leaks inside a system cabinet will result in a flammable mixture. During manufacturing, potential ignition sources such as door light switches, some fan motors, t-stats, or loose electrical connections are eliminated to prevent possible explosion

Caution must still be taken to ensure that ignition does not occur.

Check for ignition sources!



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System Charging

Proper system charging is a must, if not charged properly serious injury or death from explosion or fire can happen. Always follow these precautions when charging a system:

- ✓ Never operate a compressor without refrigerant in the system. Operating the compressor without the proper refrigerant charge can damage the hermetic terminal block “terminal venting”. Never energize “start” the compressor with the terminal cover off
- ✓ Never use a refrigerant that the system was not designed for. Use only serial label refrigerant. Using a non designed refrigerant will lead to compressor damage, excessive system pressures and can result in an explosion. The use of non designed refrigerant will void the compressor warranty
- ✓ Never overcharge a system. Overcharging a system can result in an explosion.
- ✓ Always use proper charging techniques (Weigh in the charge whenever possible). Serial label or manufacturer’s service information will show the amount of refrigerant the system holds



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System Charging

- ✓ The charging area must be well ventilated
- ✓ The charging equipment must be safe for use with flammable refrigerants
- ✓ As little as possible should be vented “purged” to the air
- ✓ A dry powder-type fire extinguisher must be in the service area
- ✓ Only flammable refrigerant trained personnel should be in the service area

Overcharging the system can result in an immersion (flooding) of the compressor motor, piston, connecting rods, and cylinders in liquid refrigerant. This creates a hydraulic block, preventing the compressor from starting, or “locked Rotor”. Continued supply of electricity to the system causes heat to build in the compressor. Liquid refrigerant will vaporize and rapidly increase system pressure. If the thermal overload fails, (Will Not Open), pressure can rise high enough to explode or rupture the compressor housing.



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For additional information on R-290 and R-600a, go to:

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