SECTION 1. HCR188C Safe Handling Procedures

The following procedures apply to all users of HCR188C. Specific precautions and safe practices for automotive, light refrigeration, and air conditioning service are summarized in sections following these general precautions:

Personal Protective Equipment – PPE is always used for extra protection, just in case something goes wrong and energy is unexpectedly released. Anyone handling this refrigerant must use the following personal protective equipment (PPE):

Eye Protection - Refrigeration technicians and observers must wear Z87.1 approved mechanical safety glasses when

- moving, connecting, and installing HCR188C gas cylinders
- working on equipment, piping, and fittings containing HCR188C
- charging or recovering HCR188C from a refrigeration system

Hand Protection - Wear gloves for thermal protection since

- operating compressors may exceed 120 °F causing skin burns
- keep a first aid kit where you can reach it
- expanding HCR188C reaches subzero temperatures instantly causing frostbite on contact

Frostbite First Aid

- Immerse with water at 100 – 110°F to warm rapidly. Use body heat or warm air if a water bath or shower are unavailable.
- Do not expose the wound to an open fire or flame.
- Do not rub or massage the affected parts of the body.
- Patients should not walk on frostbitten feet.
- Do not use medications. Do not apply dressings on intact skin.
- Keep the patient calm and at normal body temperature until medical help arrives.

Source: Jefferson Lab EH&S Manual-6500 Cryogenic and ODH Safety

Controlling Energy – Search for these hazards and eliminate them from the work area before working with HCR188C :

Ignition Sources - Eliminate open flames or other ignition sources like operating thermostats, relays, & open frame motors.

Do not light a halogen flame leak detector, candle, or strike a match. Remove or eliminate hot surfaces from the work area including bare light bulbs, hot plates, and other hot surfaces near the refrigerant or working area, for example, use a shielded fluorescent work light

Table A-1. Description of Ignition Sources*

Arc welding, plasma arc cutting	Open flame, burning candle, lantern
Cigarette or other burning material	Open frame motors
Condensate pump switch	On/off manual switches
Contactors	Oil differential switches
Defrost timers/switches	Pressure switches
Fan delay switches	Propane or MAPP gas soldering torch
Fan speed controllers	Potential relays
Flow switches	Start relays
Gas welding or cutting torch	Static electricity
Halogen flame leak detector	Striking a match
Hot automotive exhaust system	Thermostats
Hot plate or oven	Thermal overload relays
Humidity controllers	Time switches/relays
Incandescent light bulb	Universal relays
Isolator switches	Programmable controllers
Liquid level switch	* List is not exhaustive

Prevent live sparking of components and electrocution

- replace or install line shields over electrical contacts
- use solid state relays and controllers in equipment
- fix loose capacitors and other electrical ignition sources

Warning Labels - Replace any missing ignition source warnings on HCR188C equipment and gas lines.

No Open Flames

No Smoking

Lockout Tagout (LOTO) - Lockout and tag electrical disconnect switches to protect the worker from energized electrical controls and unexpected motor starts. The tag lists the name and tag out date.

- pull fuses or trip circuit breaker before working
- disconnect battery in automotive work
- test after deengergizing electrical lines

Energy Stored as Compressed Gas - Relieve system gas pressure before installing safety retrofit kit

- pump out and recover refrigerant
- pump out before breaking fittings

Job Hazard Review – It is the refrigeration technician's first duty to size up the work area and equipment to identify and mitigate hazards before starting work. A Hazard Review will assure that energy is controlled and adequate PPE is used.

First, list the sequence of steps or tasks for the job at hand. Then list what can go wrong at each step. Finally list the safety factors and PPE necessary to prevent accident or injury. This is a good opportunity for HVAC technicians and their supervisor to work the JHR together, developing safe work practices for routine jobs.

Table A-2. Job Hazard Review: Cutting the Refrigeration Line to Install a Retrofit Safety Valve

Task	Problem	Accident Prevention	PPE Required
1. pump out old refrigerant	Vacuum pump fittings leak Hose separates from quick connect	Inspect/Replace O-rings Push collar until fitting locks	Gloves, Safety Glasses Gloves, Safety Glasses
2. cut refrigeration tubing	Sharp edges on cut tubing	Use deburring tool	Gloves, Safety Glasses
3. install retrofit valve	Tight tubing fit, may leak	Sand off paint layer first	Safety Glasses

Checks for Electrical Hazards

- verify that electrical ignition sources are eliminated
- check that electrical equipment and lines are in good condition
- complete an electrical ground continuity check
- isolate electrical line voltages from the work area
- verify that lock out tag out is complete

Checks for Mechanical Hazards

- check that guards and shields are installed and in good condition
- inspect entrapment and pinch points around rotating equipment
- remove gloves before working around rotating equipment
- secure loose clothing, long hair, and jewelry
- do not work around rotating shafts, pulleys, and belts unless guards are complete and in place

Ask "what can go wrong" and what if...?

- Answer all questions raised before starting work
- Is eye protection and other PPE adequate if something goes wrong?
- If there is a fire, where is the fire extinguisher?
- Is there a clear exit route from the work area for evacuation?

Storing and Transporting HCR188C - We are all required to follow Federal, State and Local safety laws, and the consensus Standards; for example from the American National Standards Institute (ANSI). The National Fire Protection Association (NFPA), and the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). Some of these standards and safety codes are summarized:

- Close the cylinder (canister) valve after each use and when in storage
  - Screw the shipping plug into the cylinder valve before shipping
- Strap or chain cylinders to secure in storage
  - Store the cylinder upright
  - Lock the cylinder to prevent tampering
  - 3-point contact with other cylinders in storage is permitted
- Keep oxygen cylinders away from cylinders of HCR188C or equipment containing HCR188C
  - Comply with local codes on flammable gases
  - Store with a 20 ft minimum separation or use a rated ½ hour fire wall between oxygen and HCR188C cylinders
- Take precautions against overfilling
  - The cylinder must have a working overpressure relief device
  - Never invert the HCR188C cylinder. The pressure relief device must relieve from the vapor phase, not the liquid phase
  - Fill recovery cylinders only to 80% capacity
  - The cylinder must have an overfill protection device
- Store HCR188C at an ambient air temperature less than 120 °F
  - Do not expose the cylinder to fire or strike an electric welding arc on the cylinder
  - Immediately return a cylinder to the vendor if damaged

Confined Space Warnings – You can die by asphyxiation if you store or use HCR188C in a confined space. HCR188C like other combustible and inert gases is an asphyxiant. These gases displace breathing air when released.

- Do not use HCR188C in an unventilated room or space
  - Especially do not use it below grade or ground level.
  - Do not enter any confined space together with a gas cylinder188C
  - For Example, do not ride in an elevator with any gas cylinder

Do Not Ride Elevator with
A Compressed Gas Cylinder

- If someone is unconscious in a confined space, do not enter to attempt a rescue. You will become a second victim. Immediately call 911 for help.

SECTION 4. Window Air Conditioner, Refrigerator, Freezer

This section describes how to recover HCR188C from appliances at the end-of-appliance life. Applicable precautionary measures from Section 1 are required when recovering HCR188C. The refrigerant recharging process for light refrigeration is also reviewed.

- The HVAC Technician recovers the refrigerant using either a recovery machine or following the recovery process described above in Section 3. In both processes an oil separator is required to isolate clean HCR into the recovery canister.

- A vampire connection is used to recover all HCR188C from the system under repair, e.g.: removing the compressor or removing evaporator. Old refrigerant is recycled as described in Section 3.

- Following the HCR188C recovery, a hand tubing cutter can part the tubing, then compressed air or flushing fluid is used to clear the system of any remaining oil/refrigerant mixture. Clean and degrease all tubing surfaces to prepare for joining the new component.

- The system is evacuated and recharged * through the vampire fitting. The Certified Refrigeration Mechanic completes the required information details on the preprinted pink sticker shown in Section 1:

    - The installer's name
    - The service company's address
    - Date of retrofit
    - HCR188C charge rate for the system, grams

- Legacy appliances may also require updating to sparkless electrical wiring and solid state or potted components to prevent ignition.

    * The EU and British standards for hydrocarbon refrigerants permit a maximum1.5 Kg. (3.3. lb) charge for sealed domestic appliances.

SECTION 5. Commercial Refrigeration Compressor Room Precautions

- **Room Design** - Ensure that non-combustible materials are used for room construction
  - Design the room with pressure-relief blowout panels if a release of refrigerant will exceed the Lower Explosive Level (LEL)
  - Provide ventilation for the compressor room
    - Vent room to outside air
    - place the air inlet at floor level sized match the air discharge fan
    - Maintain a negative air pressure balance
      - this prevents entrainment into occupied building areas
      - else, natural ventilation is acceptable if six to ten air exchanges per hour are maintained
      - avoid stratification that could occur in dead air areas, pits, confined spaces; install local ventilation to evacuate these spaces
    - Ensure free air movement around all components containing HCR188C
    - Run forced ventilation continuously, or
      - instead use an exhaust fan activated by fixed combustible gas sensor
      - instead use a fan relay set to ensure concentrations no more than 0.5%, which is 25% of the lower explosive level (LEL)
    - Use the following type of fan system
      - maintains a negative air balance
        - prevents leak flowing to other areas
      - has non-sparking fan system components
      - has an emergency fan control outside equipment room

- **Use HCR188C fixed leak detection in compressor rooms**
  - Install permanent combustibles sensor if a release can reach the LEL
  - The combustibles detector activates exhaust fan system and alarm
    - A/V in mechanical room and at facilities trouble desk
    - mount heavier-than-air combustibles detector at floor level
    - the manufacturer must calibrate the detector for HCR188C, set below one-fourth of LEL=0.5% (as stated in OSHA 29 CFR 1910.94)
    - service sensors at manufacturer's recommended intervals

- **Administrative Controls**
  - Have a response plan if the detector signals a trouble alarm and practice the response action
  - Provide for compressor room security
    - The facility owner must provide access key access only to HCR188C-certified technicians
  - Post flammable gas warning signs at all entrances
    - The signs must warn <<No Open Flames, No Smoking>>
  - Eliminate Ignition Sources
    - No bare light bulbs, hot plates, other hot surfaces

        - use a shielded fluorescent work light
    - No open flames or other ignition sources
        - use only brushless motors
        - Boilers, welding torches, and other open-flame devices must not share this space
    - Insulate electrical contacts
        - use solid state relays and controllers in equipment
    - Enclose the ignition source and use an inert gas purge
        - if ignition sources cannot be removed
- Provide fire extinguishers to meet local code requirements

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