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Zhejiang AMA&Hien technology Co,LTD

# SAFETY MANUAL

[File Name] R290 Heat Pump Safety Manual

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# Loading, Unloading, and Transportation Management Requirements

## A. Loading and Unloading Requirements

1、When handling products, unnecessary drops and impacts should be avoided. Handle with care. (Check out Figure①)

2、 Kicking, throwing, dropping, colliding, dragging, and rolling, as well as any other forms of rough or barbaric operations, are strictly prohibited.

(Check out Figure②③)

3、Loading and unloading workers must receive necessary education to understand the dangers associated with barbaric handling.

4、Loading and unloading points must be equipped with dry powder fire extinguishers or other appropriate fire-fighting devices within their validity period.

5、Personnel who have not received training are not allowed to engage in the loading and unloading of air conditioning products containing flammable refrigerants.

Take It Easy

Figure①

Beware Electrostatic

Figure②

6、Before loading and unloading, pay attention to static electricity (Check out Figure ②), take anti-static measures, and do not answer phone calls during the process.

7、Smoking and the use of open flames are prohibited near heat pumps.

## B. Transportation Requirements

1、Finished units may be transported using conventional heavy-duty trucks, but full enclosure during transportation is not permitted.

2、After-sales service vehicles must be used for maintenance and repair services. Refrigerant bottles and products awaiting repair should not be transported in open exposure and must be protected from direct sunlight. (Check out Figure ③)

3、The tarpaulin or similar protective materials on the transport vehicle should have certain fire-retardant properties.

4、Flammable refrigerant leak detection devices must be installed inside non-open cargo compartments.

5、The cargo compartment of the transport vehicle should be equipped with anti-static devices.

6、It is recommended to carry a dry powder fire extinguisher or other appropriate fire-fighting device within its validity period in the vehicle's cab.

Beware of Sun Exposure

Figure③

7、Reflective stripes in orange and white or red and white should be affixed to the sides and rear of the transport vehicle to alert following vehicles to maintain a safe distance.

8、Packages containing R290 heat pumps must be labeled with the new transport category UN3358, hazard labels, and directional arrows, and ensure that all documents are complete and compliant.

9、Carry fire-fighting devices that comply with ATEX standards (explosion-proof) to enhance safety performance.

10、During transportation, maintain a steady speed and avoid sudden acceleration or abrupt braking.

11、Do not transport flammable materials or items that easily generate static electricity in the same vehicle.

12、Avoid high-temperature areas during transportation. If the temperature inside the cargo compartment becomes too high, take necessary cooling measures and pay attention to high temperatures. (Check out Figure ④)

13、Transport heat pumps in an upright position to prevent damage to the equipment during transportation.

14、Ideally, store heat pumps in a location elevated above ground level and ensure that the environment is naturally ventilated. (Check out Figure ⑤)

15、Avoid potential ignition sources, such as sparks and smoking.

16、If damage occurs during transportation, hazardous substances must be moved to a safe outdoor area. Keep ignition sources at least 6 meters away. Ensure the equipment is positioned for safe refrigerant dissipation or professional evacuation by qualified technicians.

17、If product or packaging damage is detected, or if there is suspicion that the product may be damaged, the R290 refrigerant must be removed following the correct procedures before returning the heat pump.

18、It is recommended to equip each transport unit with a portable gas detector, especially when regularly transporting large quantities of heat pumps containing flammable refrigerants.

Caution with High Temperatures
Figure ④

Ensure Proper Ventilation
Figure ⑤

## Warehouse Site Selection and Construction Requirements

### A. Site Selection Standards

Must be located on the ground floor; basements or enclosed spaces are prohibited.

Distance from residential areas and heat sources (boilers, electrical equipment) must be ⩾10 meters (Check out Figure ⑥).

Priority should be given to sites equipped with explosion-proof ventilation systems and concentration detectors.

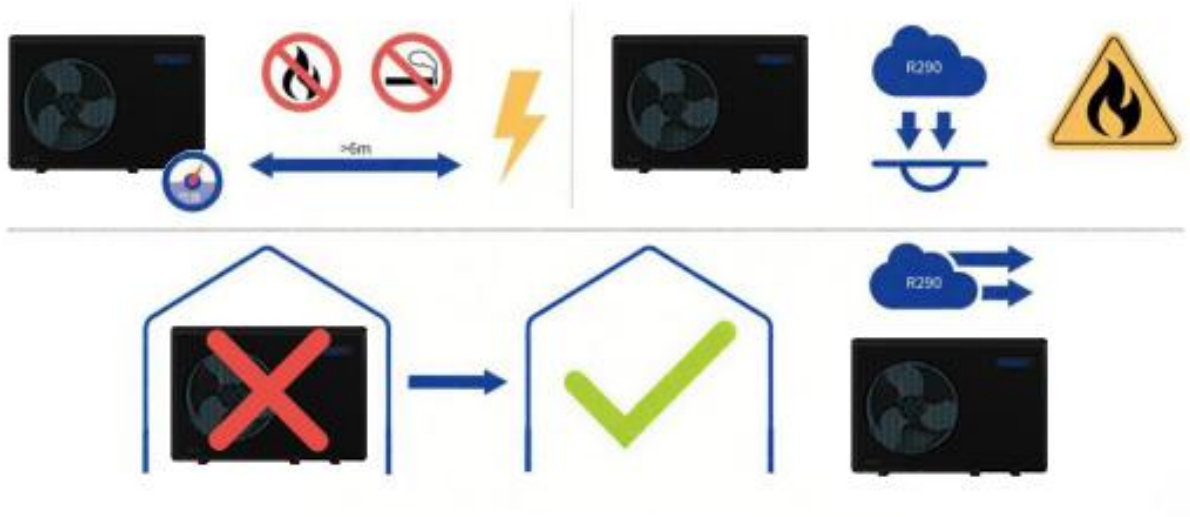



Figure ⑥

### B. Construction Safety

Walls and roofs must be made of fire-resistant materials (fire resistance rating ⩾2 hours); the floor should be coated with anti-static material and marked with static electricity warning signs (Check out Figure ⑦).

The main power switch should be located outside the warehouse and equipped with explosion-proof protection devices; electrical wiring must be run through conduits, with no exposed or aged wires.

Figure ⑦

# Safety Facilities and Operating Standards

## A. Ventilation and Explosion-proof System


Figure ⑧

Explosion-proof exhaust fans (air change rate ⩾12 times per hour) must be installed, with the equipment mounted at a height greater than 1.5 meters (Check out Figure ⑧).
Entry into the warehouse area is only permitted after the ventilation equipment has been activated, and it must remain in operation during the entire period of work.

## B. Leak Detection and Emergency Response


Figure ⑨

290-specific combustible gas detectors should be installed at low levels (⩽0.3 meters above the ground), linked to sound and light alarms as well as automatic ventilation.
An explosion-proof tool kit (leak sealing equipment, anti-static clothing) must be provided. In case of a leak, immediate evacuation and power shutdown are required. Explosion warning signs should be posted regularly (Check out Figure ⑨).

## C. Firefighting Configuration

Figure ⑩

Carbon dioxide or dry powder fire extinguishers (foam extinguishers are prohibited) should be used (Check out Figure ⑩), with their effectiveness checked monthly.
A fire isolation zone (⩾2 meters) should be established outside the warehouse, and the storage of flammable materials is strictly prohibited.

# Special Requirements for the Storage of R290 Finished Units

## A. Stacking Standards

The units must be stored in an upright position.
Safety Spacing: The distance between stacks should be ⩾1 meter, and the distance from walls should be ⩾0.8 meters; the main aisle width should be ⩾3 meters (to accommodate bi-directional forklift traffic and emergency escape).

## B. Anti-static Management

Conductive pallets must be used, and the equipment stacks should be connected to a grounding device with a grounding resistance of ⩽10Ω.
Operators must wear anti-static clothing and are prohibited from carrying non-explosion-proof electronic devices (only fixed-line telephones are allowed).

# Installation Standards

## A. Personnel Qualification Requirements

1. All installation and maintenance personnel must hold a valid certificate issued by an industry-recognized assessment organization, which certifies their competency in handling refrigerants as required by the industry-recognized assessment standards.
   Note: In the absence of relevant certification bodies, the training and certification regulations established by the Hien Training Department shall be followed. The Training Department will be responsible for organizing training and qualification certification for after-sales installation and maintenance personnel.
2. Maintenance and repair work must be carried out strictly in accordance with the methods recommended by the manufacturer. If additional professional assistance is required for the maintenance and repair of R290 heat pumps, it must be conducted under the supervision of personnel who are qualified to handle flammable refrigerants.

## B. Special Tools

1. Miniature Vacuum Pump (Explosion-proof vacuum pump, ensuring a certain level of precision; the vacuum level should be below 10 Pa). (Check out Figure ⑪)
2. Charging Equipment (Special explosion-proof charging equipment, ensuring a certain level of precision; the deviation of the charging amount should be less than 5 g). (Check out Figure ⑫)
3. Leak Detector (Regularly calibrated, with an annual leakage rate not exceeding 10 g). (Check out Figure ⑬)
4. Concentration Detector. (Check out Figure ⑭)
   a) A fixed flammable refrigerant concentration detector should be installed in the maintenance area and connected to the safety protection/alarm system; its error must be guaranteed to be no more than 5%.
   b) A portable flammable refrigerant concentration detector should be equipped at the installation site, capable of providing two-stage audio-visual alarms; its error must be guaranteed to be no more than 10%.
5. Pressure Gauge (The pressure gauge should be regularly calibrated). (Check out Figure ⑮)
6. Fire Extinguisher (A fire extinguisher should be carried during installation and maintenance. The maintenance area must be equipped with more than two types of dry powder, carbon dioxide, and foam fire extinguishers, placed in designated locations with conspicuous labels and easily accessible). (Check out Figure ⑯)

| | | | | | |
|---|---|---|---|---|---|
|  |  |  |  |  |  |
| 1. Vacuum Pump<br>Recommended: "VALUE" V-i180SV<br>Pumping Speed: 14.4 m³/h<br>Ultimate Pressure: 2 Pa | 2. Charging Equipment<br>Recommended: "VALUE" VES-50B<br>Resolution: 2 g<br>Features: Automatic shut-off valve for fixed weight | 3. Leak Detector<br>Recommended: "VALUE" VML-1<br>Response Time: ⩽3 g | 4.Flammable Gas Detector<br>Recommended: "Jin Shengan" JSNAT3000M<br>Features: Audible and visual alarm, automatic ventilation, resolution 0.1% VOL | 5.Pressure Gauge<br>Recommended: "Hongsen" S60-102<br>Features:Read the outermost white circle | 6. Fire Extinguisher<br>1. Dry Chemical Fire Extinguisher<br>2. Carbon Dioxide Fire Extinguisher<br>3. Foam Fire Extinguisher |
| Figure ⑪ | Figure ⑫ | Figure ⑬ | Figure ⑭ | Figure ⑮ | Figure ⑯ |

## C. Installation Safety Principles

1. Maintain good ventilation in the installation area.
2. Prohibit open flames or heat sources with temperatures above 370°C, including welding, smoking, ovens, etc.
3. Take anti-static measures, such as wearing 100% cotton clothing and wearing cotton gloves on both hands.
4. Choose a location that is convenient for installation or maintenance, and avoid areas near heat sources and flammable or explosive environments (Check out Figure ⑰).
5. In the event of refrigerant leakage during the installation process, all personnel should leave the area. Wait for at least 15 minutes after the refrigerant has completely leaked out before handling the situation. If the product is already damaged, it must be transported back to the repair facility for processing. Welding of refrigerant pipes or similar operations is prohibited at the customer's site.

Figure ⑰

## D. Pre-Conditions for Service Inspection

1. Increase Awareness

Familiarize yourself with information provided from other sources, such as system equipment manufacturers, component manufacturers, refrigerant suppliers, and Material Safety Data Sheets (MSDS). Personnel should understand the manufacturer's operating instructions, procedures, guidelines, and safety issues related to the equipment. Be aware of the evacuation of spaces in the event of accidental release of flammable refrigerants.

2. Safe Distances

The safe distance from building openings should take into account the flow of refrigerants. For systems installed outdoors, they should be placed in a location that avoids the ingress of leaked refrigerants into buildings or poses a danger to people and property.

3. No Ignition Sources

Prohibit smoking and open flames, including displaying "No Smoking" (Check out Figure ⑱) and "No Open Flames" (Check out Figure ⑲) signs. Inspect the area around the equipment before maintenance to determine if there are any flammable or ignition risks. Remove all ignition sources. Note that mobile phones or similar electronic devices may be potential ignition sources!


Figure ⑱


Figure ⑲

4. Labels

R290 is classified as a highly flammable A3 class gas and must be labeled accordingly.

5. General Work Area

Inform all personnel in the temporary flammable area about the nature of the work.

6. Personal Protective Equipment

Technicians should wear appropriate protective gear, including chemical goggles, protective gloves, grounding probes, and anti-static straps.

7. Free Airflow

Ensure that all refrigerant-containing components in the system have free airflow around them. Depending on the space size, especially in confined areas, mechanical ventilation may be necessary. Ventilation devices should expel leaked refrigerants and preferably exhaust them to the outside.

8. Basic Purging

R290 is heavier than air. Precautions should be taken to prevent the accumulation of refrigerants in structural recesses and low points.

9. Electrical Equipment

Conduct an initial safety check of components to determine if there are any faults that may endanger safety. Capacitors should be equipped with discharge resistors (at least 2 watts/10000) or a multimeter. Do not use "live" electrical components. Maintain and properly use grounding equipment to prevent accidents and ensure safety.

10. Certified Equipment

Gas leak detectors and monitors, electrical testers, portable lighting equipment, spark-free tools, etc.

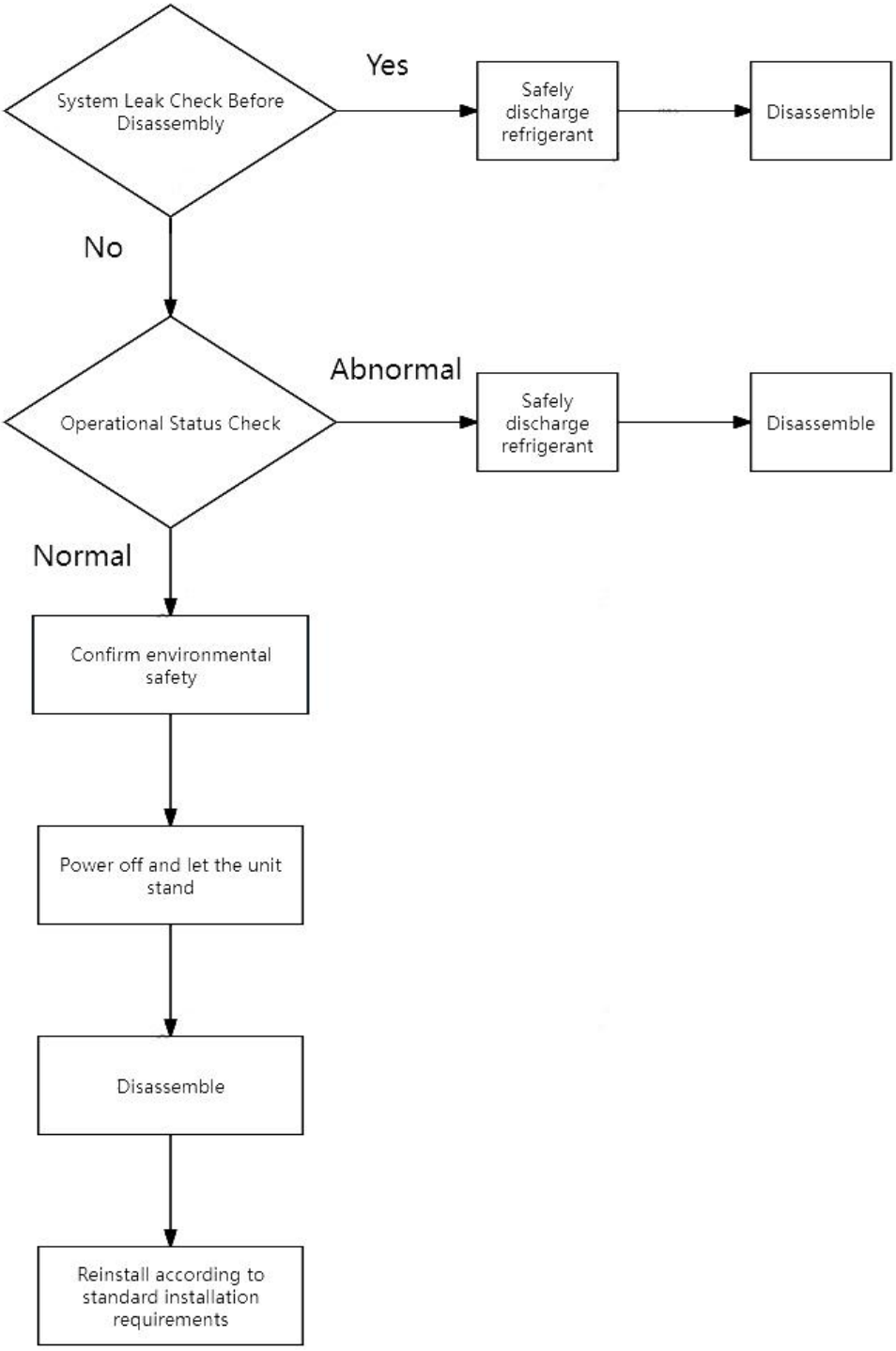
11. Work Space Guidelines

Well-ventilated, with dry powder fire extinguishers available.

Heat pump installation process

| order | content | specific operation |
|---|---|---|
| 1 | Check the Installation Environment | The installation area should meet the requirements specified in the manual: The unit should not be installed in a closed reserved space within the building; there should be no pre-buried water, electricity, or gas pipelines in the wall penetration location. |
| 2 | Unboxing Inspection | The product should be unboxed and inspected in a well-ventilated area; a concentration detector should be prepared before unboxing the outdoor unit; check for any signs of collision and whether the appearance is normal. |
| 3 | Grounding Check | The user's power system should have a grounding wire; the unit's grounding wire must be securely connected to the metal casing; after installation, check with a multimeter or voltage tester to ensure proper grounding. A dedicated power line should be set up and must be firmly connected directly to the unit's power socket. |
| 4 | Installation Foundation | A hardened foundation with vibration isolation pads must be established as the load-bearing end. |
| 5 | Unit Installation | The distance from the wall should not be less than the requirement specified in the manual; there must be no obstructions around. |
| 6 | Pressure Check | Check whether the discharge pressure and suction pressure of the compressor meet the requirements; if they do, there is no problem; if not, a leak check is required. |
| 7 | System Leak Detection | Leak detection should be performed at the unit's interfaces and components, using either the simple soap bubble method or a dedicated leak detector. |
| 8 | Test Run | After installation, a test run must be conducted to observe the overall operation and record the operating data to assess the unit's stability. |

Heat Pump Disassembly Flowchart



# On-Site Maintenance

## A. I. Pre-Maintenance Inspection

1. Worksite Environment Check

a) No refrigerant leakage is permitted in the room prior to servicing.
b) Continuous ventilation must be maintained during the repair process.
c) Open flames or high-temperature heat sources exceeding 370°C (which may ignite flames) are prohibited in the maintenance area.
d) During maintenance:All personnel must power off mobile phones.Radiating electronic devices must be deactivated. Single-person, single-unit, single-zone operation is strongly recommended.
e) A dry powder or CO2 fire extinguisher (in operable condition) must be available in the maintenance area.

2. Maintenance Equipment Inspection

a) Verify that the maintenance equipment is suitable for the heat pump system's refrigerant. Only use professional equipment recommended by the heat pump manufacturer.
b) Check if the refrigerant leak detection equipment has been calibrated. The alarm concentration setting must not exceed 25% of the LFL (Lower Flammability Limit). The equipment must remain operational throughout the entire maintenance process.

3. R290 Heat Pump Inspection

a) Check that the heat pump is properly grounded. Ensure good ground continuity and reliable grounding before servicing.
b) Verify the heat pump's power supply is disconnected. Before maintenance, disconnect the power supply and discharge all electrolytic capacitors inside the unit. If electrical power is absolutely required during maintenance, continuous refrigerant leak monitoring must be implemented at high-risk locations to prevent potential hazards.
c) Inspect the condition of all labels and markings. Replace any damaged, worn, or illegible warning labels.

## B. Leak Detection Before On - site Maintenance

1. While the heat pump is in operation, use the leak detector or concentration detector (pump - suction type) recommended by the heat pump manufacturer (ensure that the sensitivity meets the requirements and has been calibrated, with a leak detector leakage rate of 1 g/year and a concentration detector alarm concentration not exceeding 25% of the LEL) to check the air conditioner for leaks. Warning: Leak detection fluid is suitable for most refrigerants, but do not use solvents containing chlorine to prevent corrosion of copper pipes caused by the reaction between chlorine and refrigerant.
2. If a leak is suspected, remove all visible sources of fire from the site or extinguish the fire. Also, ensure that the area is well - ventilated.

## C. Situations Where Repairs Must Be Conducted at a Service Center

1. Faults that require welding of the internal refrigerant pipes.
2. Faults that necessitate disassembly of the refrigeration system for repair.

## D. Maintenance Steps

1. Prepare the necessary tools.
2. Drain the refrigerant.
3. Check the R290 concentration and evacuate the system.
4. Remove the faulty old parts.
5. Clean the refrigerant circuit system.
6. Check the R290 concentration and replace the new parts.
7. Evacuate and charge with R290 refrigerant.

## E. Safety Principles During On-site Maintenance

1. When maintaining the product, the site should have sufficient ventilation. It is prohibited to close all doors and windows.
2. Open flames are strictly forbidden during maintenance operations, including welding and smoking. The use of mobile phones is also prohibited. Users should be informed not to use open flames for cooking, etc.
3. During maintenance in dry seasons, when the relative humidity is below 40%, anti-static measures must be taken. These include wearing pure cotton clothing, using anti-static devices, and wearing pure cotton gloves on both hands.
4. If a flammable refrigerant leak is detected during maintenance, immediate forced ventilation measures must be taken, and the source of the leak must be sealed.
5. If the damage to the product requires opening the refrigeration system for maintenance, it must be transported back to the repair shop for handling. Welding of refrigerant pipes and similar operations are strictly prohibited at the user's location.
6. If additional parts are needed during maintenance and a second visit is required, the heat pump must be restored to its original state.
7. The entire maintenance process must ensure that the refrigeration system is safely grounded.
8. When providing on-site service with a refrigerant cylinder, the amount of refrigerant filled in the cylinder must not exceed the specified value. When the cylinder is stored in a vehicle or placed at the installation or maintenance site, it should be securely positioned vertically, away from heat sources, fire sources, radiation sources, and electrical equipment.

# Repair Shop Maintenance Category

## A. Requirements for Repair Shop Site

1. The repair site should be well-ventilated and have a flat floor. It must not be located in a basement.
2. The repair site should be divided into welding and non-welding areas, with clear markings. There should be a certain safe distance between the two areas.
3. The repair site should be equipped with ventilation and exhaust devices, which can be composed of exhaust fans, blowers, ceiling fans, pedestal fans, and dedicated exhaust ducts, to ensure that the ventilation and exhaust requirements are met and to prevent the accumulation of refrigerant gases. (Check out Figure ⑳)
4. Instruments such as combustible refrigerant leak detectors should be provided, and a leak detection instrument management system should be in place. Before maintenance, it should be confirmed that the leak detector is functioning properly. (Check out Figure ㉑)

Explosion-proof Ventilation Figure ⑳

Leak Detector Figure ㉑

5. A sufficient number of vacuum pumps and refrigerant charging equipment specifically designed for flammable refrigerants should be provided. A maintenance equipment management system should be in place to ensure that the maintenance equipment is only used for vacuuming and charging a specific type of flammable refrigerant and not mixed for other purposes. (Check out Figure ㉒)
6. The main power switch should be located outside the site and equipped with protective (explosion-proof) devices.

Vacuum Pump Figure ㉒

7. Nitrogen cylinders, acetylene cylinders, and oxygen cylinders should be stored separately. Gases should be kept at least 6 meters away from open flame work areas. Acetylene gas sources should be equipped with flashback arrestors, and acetylene and oxygen hoses must be colored strictly according to national standards.
8. A "No Smoking or Open Flames" warning sign should be displayed in the repair area. (Check out Figure ㉓)
9. Firefighting equipment suitable for extinguishing electrical fires, such as dry chemical fire extinguishers or carbon dioxide fire extinguishers, should be provided and maintained in a usable condition. (Check out Figure ㉔)
10. The exhaust ventilation equipment and other electrical devices at the repair site should be relatively fixed and properly installed with conduit wiring. Temporary wiring and temporary sockets are prohibited on-site.

Figure ㉓

Fire Extinguisher ㉔

## B. Refrigerant Recovery Procedure

The process of refrigerant discharge and recovery involves the careful extraction of refrigerant gas from the system using specialized equipment, ensuring that these gases are safely stored and recovered to prevent environmental harm and comply with regulatory standards. (Check out Figure ㉕)

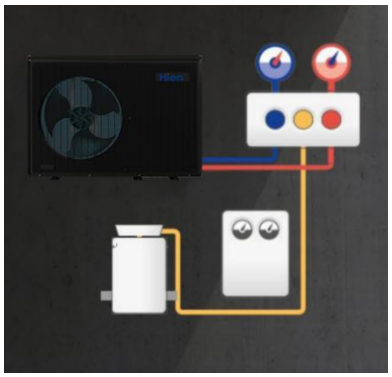


Figure ㉕

1. Always use refrigerant clearly marked as “R290” and avoid using propane alone.
2. Since the R290 charge is minimal, the amount of R290 introduced into the system must be accurately weighed to ensure optimal performance.
3. Before beginning any operations on electrical components, the corresponding power supply must be disconnected first, and then any sealed components can be opened.

These comprehensive procedures ensure the safe and efficient installation, inspection, and maintenance of R290 systems.

# Other Precautions

## A. Safety Zone Requirements

1. The designated safety zone must be located away from any structural openings, such as windows, doors, light wells, skylights, and air intakes or exhausts of ventilation systems. Since R290 refrigerant is denser than air and tends to settle and accumulate on the ground, the safety zone must not have any depressions or excavated areas. Additionally, this area must not encroach upon intact buildings or public spaces. Once established, the safety zone must not be altered in any way to avoid violating established safety regulations.
2. Outdoor refrigeration equipment must be positioned to prevent refrigerant from flowing into building openings or ventilation systems. Equipment that is sheltered should have either natural or forced ventilation to maintain safety.
3. The work area must be well-ventilated before operating the refrigerant circuit, performing brazing, or handling electrical components.

### B. Protective Measures

1. When working with systems using R29 refrigerant, protective equipment and certification (if required) are crucial. Installers should wear appropriate protective gear, including chemical splash goggles, protective gloves, grounding probes, and anti-static straps, to minimize the risks associated with flammable refrigerants.

### C. Precautions for Product Disposal and Recycling

Product disposal and recycling are a critical phase at the end of a system's life cycle, applicable to refrigeration systems regardless of the type of refrigerant used. The standard procedures include:

1. Removal of refrigerant and oil.
2. Dismantling of the refrigeration system and related equipment.
3. Transporting the refrigerant, oil, and rigid materials to designated collection stations.
4. Transporting the system's construction materials (metals, plastics, etc.) to appropriate recycling centers.

These measures ensure the responsible and environmentally friendly disposal of refrigeration systems.

## Emergency Measures

1. For installers of systems using R290 refrigerant, your safety is our top priority, and we will provide you with support. In case of an emergency, please always have the designated contact phone numbers ready.
2. Emergency Contact: Please contact the local customer service team.

## Referenced Standards

1. EN 378 Refrigerating Systems and Heat Pumps - Safety and Environmental Requirements
2. IEC 60335 Safety of Household and Similar Electrical Appliances
3. ISO 5149 Safety and Environmental Requirements for Refrigerating and Heat Pump Systems
4. ISO 22712 Competence of Personnel for Refrigerating Systems and Heat Pumps
5. ISO 817 Designation and Safety Classification of Refrigerants

## Liability Disclaimer

This manual is intended solely for professionally certified installers. The information contained in this manual does not replace the user's own judgment and does not relieve the user of their own risks. Hien and its affiliated companies, partners, suppliers, or licensors assume no responsibility or liability for the accuracy, content, completeness, legality, or reliability of the information provided.