IMMERGAS

USER'S MANUAL

RAPAX V4

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Safety manual

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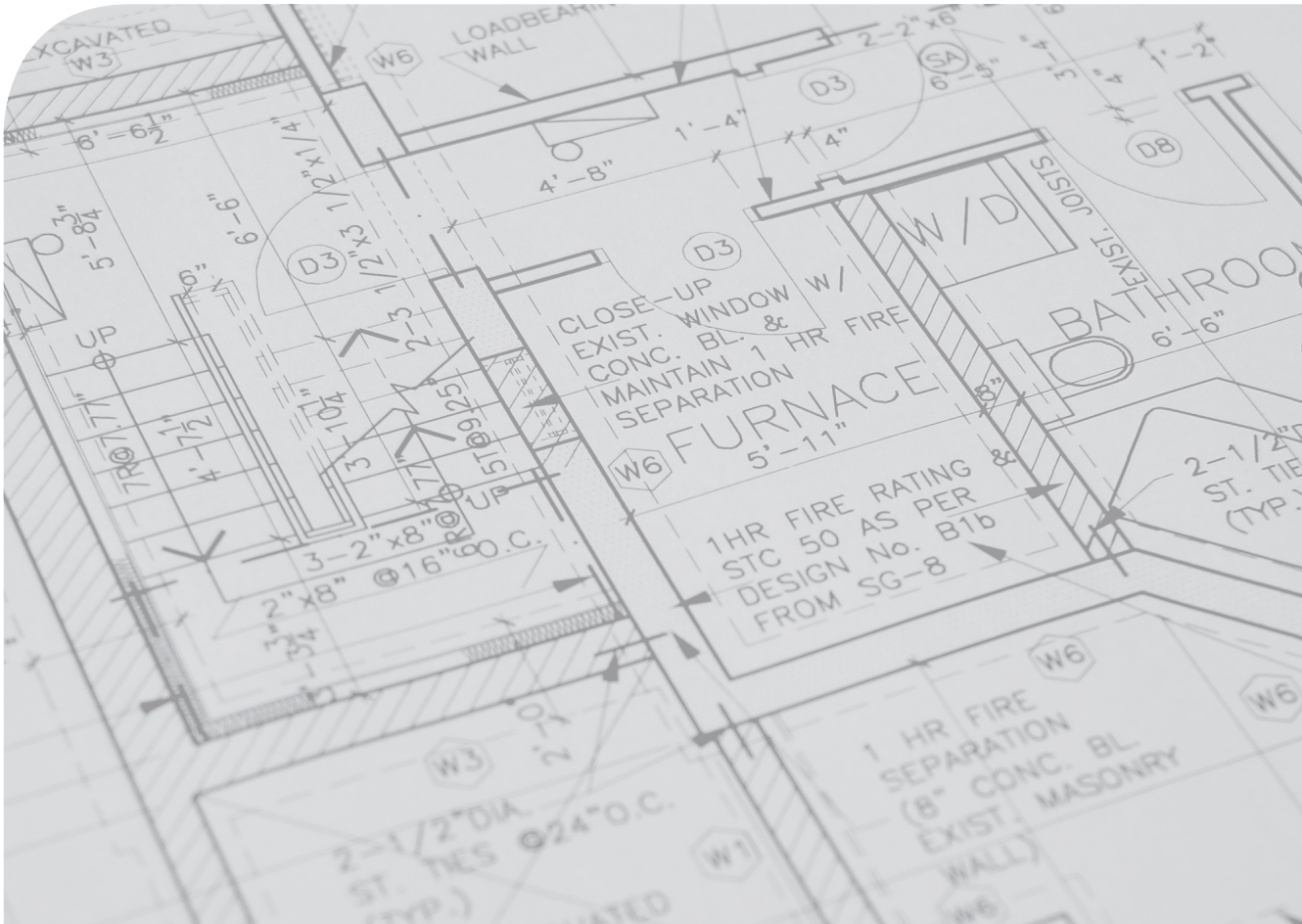

SAFETY SYMBOLS USED

GENERIC HAZARD
Strictly follow all of the indications next to the pictogram. Failure to follow the indications can generate hazard situations resulting in possible harm to the health of the operator and user in general, and/or property damage.

ELECTRICAL HAZARD
Strictly follow all of the indications next to the pictogram. The symbol indicates the appliance's electrical components or, in this manual, identifies actions that can cause an electrical hazard.

WARNING FOR INSTALLER
Read the instruction booklet carefully before installing the product.

WARNINGS
Strictly follow all of the indications next to the pictogram. Failure to follow the indications can generate hazard situations resulting in possible minor injuries to the health of both the operator and the user in general, and/or slight material damage.

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1 SAFETY MEASURES

1.1 GENERAL RECOMMENDATIONS

Read the safety precautions before installation and operation.
Improper installation due to failure to follow the instructions can cause serious damage or injury.

- Pipe installation should be kept to a minimum.
- To prevent any damage, pipes must be installed in such a way that they are physically protected.
- Refrigerant gas pipes must comply with current regulations.
- Mechanical connections of pipes must be accessible for maintenance purposes.
- Where mechanical ventilation is required, the ventilation openings must be kept free from obstructions.
- Follow the current regulations to dispose of the product.
- Anyone working on or opening the refrigerant circuit must have a valid qualification certificate issued by an accredited industry body, certifying their competence to handle refrigerants safely, in accordance with the specifications recognised by the relevant industry.
- Maintenance and repairs that require the assistance of other qualified personnel must be carried out under the supervision of a person authorised to use flammable refrigerants.
- Do not use tools to accelerate the defrosting process or clean other than those recommended by the manufacturer.
- The appliance must be stored in such a way as to avoid mechanical damage, in a well-ventilated environment and without ignition sources in continuous operation (for example: open flames, gas appliance or electric heater in operation).
- Do not puncture or burn.
- Keep in mind that refrigerants can be odourless.
- All operating procedures involving safety measures must be performed exclusively by a professionally licensed company.
- The appliance must be installed in a well-ventilated area, the dimensions of which must correspond to those specified for its correct operation.
- The appliance must be installed in such a way as to avoid mechanical damage.
- Joints shall be tested with measuring devices with a capacity of 5 g/year of refrigerant or better, with the appliance in a stopped and operating condition, or under a pressure at least equivalent to that in the stopped or operating condition after installation. **DO NOT** use removable joints on the inside of the unit (brazed or welded joints may be used).
- When a FLAMMABLE REFRIGERANT is used, the appliance installation space requirements and/or ventilation requirements are determined based on:
  - the amount of mass charge (M) used in the device;
  - the place of installation;
  - the type of ventilation of the place or appliance.

The maximum refrigerant gas charge permitted for installing the product in a room must comply with the following formula:

$$\mathbf{m_{max} = 2{,}5 \times (LFL)^{(5/4)} \times h_0 \times (A)^{1/2}}$$

alternatively the minimum required surface area A_{min} can be verified to install an appliance with a refrigerant charge of M(kg) using the following formula:

$$\mathbf{A_{min} = (M/(2{,}5 \times (LFL)^{(5/4)} \times h_0))^2}$$

Where:
m_{max} = maximum load allowed in a room, in kg;
M = amount of refrigerant charge in the appliance, in kg;
A_{min} = minimum required room surface area, in m^2;
A = room area, in m^2;
LFL = lower flammability limit, in kg/m^3;
h_0 = release height, the vertical distance in meters from the floor to the release point when the appliance is installed;
$h_0 = (h_{inst} h_{rel})$ or 0.6 m, whichever is greater;
h_{rel} = release offset in meters from the bottom of the device to the release point;
h_{inst} = height of the installed unit in meters.

The reference installation heights are shown below:
- 0.0 m = portable and floor-mounted devices;
- 1.0 m = window mounting;
- 1.8 m = wall mounting;
- 2.2 m = ceiling mounting.

If the minimum installation height indicated by the manufacturer is higher than the reference installation height, the manufacturer must also provide A_{min} and m_{max} for the reference installation height. An appliance can have multiple reference installation heights.
In this case, the calculation of A_{min} and m_{max} must be specified for all applicable reference installation heights.
For appliances serving one or more rooms with an air duct system, the lowest opening of the duct connection to each conditioned space or any opening of the indoor unit greater than 5 cm^2 shall be used for h_0, in the lowest position of the space. However, h_0 must not be less than 0.6 m.
A_{min} must be calculated based on the opening heights of the inlet ducts into the spaces and the refrigerant charge for the spaces into which the leaked refrigerant could flow, considering the location of the unit.
All spaces must have a surface area greater than A_{min}.

This formula cannot be used for refrigerants lighter than 42 kg/kmol.
Some examples of the results of the calculations according to the above formula are given in the tables "Maximum refrigerant charge (kg)" and "Minimum room area (m^2)".

For factory sealed units, the nameplate on the unit itself, which shows the refrigerant charge, can be used to calculate A_{min}.

For the maximum load in a room and the minimum surface area required to install an appliance, refer to the unit's "User and installation Manual".
For specific information on the type of gas and quantity, refer to the label on the unit itself.

2 MAINTENANCE INFORMATION

2.1 AREA CHECK

Before starting any work on systems containing flammable refrigerants, safety checks are necessary to ensure that the risk of ignition is minimised. When repairing your refrigeration system, you must follow the precautions listed below before performing any work on the system.

2.2 WORK PROCEDURE

Operations must be performed following a controlled procedure in order to minimise the risk of flammable gases or vapours being present during execution. Technical personnel responsible for the operation, supervision, and maintenance of heat pump water heaters must be adequately trained and competent in their duties.
Operations must be performed only with suitable tools (if in doubt, consult the manufacturer of the tools for use with flammable refrigerants).

2.3 GENERAL WORK AREA

Maintenance personnel and all those working in the local area must be trained in the nature of the work being performed. Operations in confined spaces should be avoided. The area surrounding the work space must be cordoned off. Ensure that conditions within the area have been made safe by controlling flammable material.

2.4 REFRIGERANT PRESENCE CHECK

The area must be checked with a suitable refrigerant detector before and during work to ensure the technician is aware of potentially flammable gases. Ensure that the leak detection equipment used is suitable for use with flammable refrigerants, i.e. non-sparking, adequately sealed or intrinsically safe.

2.5 PRESENCE OF A FIRE EXTINGUISHER

If hot work operations are to be carried out on refrigeration equipment or associated parts, suitable fire extinguishers must be available within easy reach. Have a dry powder or CO_2 fire extinguisher available near the charging area.

2.6 NO SOURCE OF IGNITION

Any work on the refrigeration system involving the exposure of any pipe containing or having contained flammable refrigerant must be carried out avoiding the use of any source of ignition which could pose a risk of fire or explosion.
All possible ignition sources, including cigarette smoke, must be kept sufficiently far away from the place of installation, repair, removal and disposal, as during these operations the flammable refrigerant may be released into the surrounding space.
Before starting the intervention, it is necessary to inspect the surrounding area to ensure that there are no hazards related to flammable materials or risks of ignition.
Post "NO SMOKING" signs.

2.7 VENTILATED AREA

Before opening the system or performing hot work operations, make sure the area is outdoors or adequately ventilated.
Adequate ventilation must be maintained throughout the entire period of execution of the intervention.
Ventilation must safely disperse all of the released refrigerant and preferably expel it into the environment.

2.8 CHECKS ON ELECTRICAL DEVICES

Repair and maintenance operations on electrical components must include initial safety checks and inspection procedures of the components. If a fault occurs that could compromise safety, do not connect any electrical power source to the circuit until the fault is satisfactorily resolved. If the fault cannot be resolved immediately but it is necessary to keep the system in operation, an appropriate temporary solution must be used. Report the situation to the equipment owner so that all parties are informed.
Initial safety checks must include the following:

- Make sure the capacitors are discharged. This check must be performed safely to avoid possible sparks;
- Ensure that there are no live components or cables during charging, recovery or purging of the system;
- Ensure that there is continuity in the earth connection.

2.9 REPAIRS ON SEALED COMPONENTS

a. When carrying out repairs on sealed components, all electrical power connections must be disconnected from the equipment being worked on before removing any seals, etc. If it is absolutely necessary to have the electrical power connected to the equipment during maintenance, a permanently operating leak detection system should be installed at the most critical point to detect any potentially hazardous situation.

b. Pay particular attention to the following to ensure that when working on electrical components, the enclosure is not tampered with in such a way as to compromise the level of protection. This includes damaged cables, excessive connections, terminals not meeting original specifications, damaged seals, incorrectly fitted cable glands, etc.
   - Make sure the device is securely mounted.
   - Ensure that gaskets or sealing materials have not degraded to the point that they no longer prevent the entry of flammable gases. Spare parts must conform to the manufacturer's specifications.

- Make sure the device is securely mounted.

The use of silicone sealants may inhibit the effectiveness of some types of leak detection equipment. Intrinsically safe components do not need to be isolated before use.

2.10 REPAIR OF INHERENTLY SAFE COMPONENTS

Do not apply permanent inductive or capacitive loads to the circuit without ensuring that they do not exceed the voltage and current ratings for the equipment in use. Intrinsically safe components are the only ones that can be worked on when they are energized in the presence of flammable gases. The test device must have the correct rating.
Replace components only with parts specified by the manufacturer. Other components can start a fire due to the presence of refrigerant in the atmosphere due to a leak.

2.11 ELECTRICAL WIRING

Verify that the wiring is not subject to wear, corrosion, excessive pressure, vibration, sharp edges or other adverse environmental effects. The inspection must also take into account the effects of ageing or continuous vibration from sources such as compressors or fans.

2.12 DETECTION OF FLAMMABLE REFRIGERANTS

When searching for or detecting refrigerant leaks, do not under any circumstances use potential ignition sources. Do not use a halide torch (or any other detector that uses an open flame).

2.13 LEAK DETECTION METHODS

The following leak detection methods are considered acceptable for systems containing flammable refrigerants. Electronic leak detectors must be used to detect flammable refrigerants, but their sensitivity might not be adequate or require recalibration (detection equipment must be calibrated in a refrigerant-free area). Make sure that the detector is not a potential source of ignition and that it is suitable for the refrigerant. The leak detection equipment must be set at an LFL (lower flammability limit) percentage of the refrigerant and calibrated for the refrigerant used; the appropriate percentage of gas is confirmed (25% at maximum). Leak detection fluids can be used with the majority of refrigerants, but detergents containing chlorine must not be used as this element can react with the refrigerant and corrode the copper pipes.
If there is a suspected leak, all naked flames must be removed or put out. If a refrigerant leak is found that requires brazing, all refrigerant must be recovered from the system or isolated (using an ATEX gas recovery device in a recovery cylinder specifically for A2L or A3 gas). The system must then be purged with oxygen-free nitrogen (OFN), both before and during the brazing process.

2.14 REMOVAL AND DISCHARGE

When working on the refrigeration circuit for repairs or any other purpose, conventional procedures must be used. However, for flammable refrigerants, it is important to observe best practices as flammability is a factor to consider. The following procedure must be followed:

- Remove the refrigerant;
- Purge the circuit with inert gas;
- Discharge;
- Purge again with inert gas;
- Open the circuit by cutting or brazing.

The refrigerant must be recovered in special recovery cylinders. The appliance must be purged with oxygen-free nitrogen to make the unit safe. You may need to repeat this procedure several times. Compressed air or oxygen must not be used for this operation.
Cleaning is achieved by breaking the vacuum in the system with oxygen-free nitrogen and continuing to fill until operating pressure is reached, then venting to atmosphere and finally recreating the vacuum.
This process must be repeated until there is no more refrigerant left inside the appliance. When using oxygen-free nitrogen, the appliance must be vented to atmospheric pressure to allow operation. This operation is absolutely essential if brazing is required on the pipe.
Make sure that the vacuum pump outlet is not located near any ignition sources and that there is ventilation.

2.15 CHARGING PROCEDURE

In addition to the standard charging procedure, the following requirements must be met:

- Operations must be performed only with appropriate tools. If in doubt, consult the tool manufacturer for use with flammable refrigerants.
- Ensure that cross-contamination between different refrigerants does not occur when using equipment to charge refrigerant. Pipes, both flexible and rigid, must be as short as possible to minimise the amount of refrigerant they contain.
- The cylinders must be kept upright.
- Make sure that the chilling device is earthed before charging the system with refrigerant.
- Label the appliance when charging is complete (if it is not already).
- Extreme care must be taken not to overfill the chilling device.
- Before recharging the appliance, it must undergo a pressure testing with oxygen-free nitrogen. Perform a leak test after charging, before putting the unit into operation. Perform a further check for leaks before completing the job.

2.16 DECOMMISSIONING

Before starting this procedure, it is essential that the technical personnel are fully familiar with the equipment and its characteristics. It is good practice that all refrigerants are recovered safely. Before the operation is performed, an oil and refrigerant sample must be taken in case analysis is required before reusing the recovered refrigerant.
If analysis is required prior to reuse of recovered refrigerant, it is essential that electrical power is available before starting operation.

a. Become acquainted with the equipment and its operation.
b. Electrically isolate the system.
c. Before starting the procedure, make sure that:
   - mechanical handling equipment for refrigerant cylinders is available, if necessary;
   - all personal protective equipment is available and used correctly;
   - the recovery operation is supervised at all times by a skilled person;
   - recovery equipment and cylinders comply with relevant standards.
d. Empty the refrigeration system, if possible.
e. If it is not possible to obtain a vacuum, use a manifold so that the refrigerant can be removed from various parts of the system.
f. Make sure that the cylinder is placed on the scale before proceeding with recovery.
g. Start the recovery machine and operate it according to the manufacturer's instructions.
h. Do not overfill cylinders 42 Kg/L or 42% by volume.
i. Do not exceed the maximum working pressure of the cylinder, not even temporarily.
j. Once the cylinders have been properly filled and the process is complete, ensure that the cylinders and equipment are removed from the site immediately and that all equipment isolation valves are closed.
k. The recovered refrigerant must not be charged into other chilling systems, unless it has been recycled or regenerated.

2.17 LABELLING

The equipment must be labelled to guarantee that it has been decommissioned and emptied from the refrigerant. The label must bear the date and signature. Make sure that the labels are applied on the equipment to indicate that it contains flammable refrigerant.

2.18 RECOVERY

When refrigerant is removed from a system, for maintenance or dismantling operations, it is recommended to remove all refrigerant safety.
When transferring the refrigerant in the cylinders, make sure that only refrigerant recovery cylinders are used. Make sure that the correct number of cylinders are available to hold all the refrigerant charged into the system.
Cylinders designed for the recovered refrigerant and labelled for that refrigerant must be used (e.g., specific cylinders for recovered refrigerant). The cylinders must be equipped with pressure valves and shut-off valves in the good condition.
The recovery cylinders must be emptied and, if possible, cooled before the recovery operation. Recovery equipment must be in good working order with a set of instructions for the equipment readily available and must be suitable for the recovery of flammable refrigerants. Additionally, a set of calibrated scales in good condition must be available.
Flexible hoses must be complete with leak-free disconnect joints and in good condition. Before using the recovery machine, check that it is in good condition, suitable for A3 flammable refrigerants (Atex certification), that it has been correctly maintained and that the associated electrical components are sealed to avoid the risk of ignition in the event of a refrigerant leak. Consult the manufacturer if in doubt.
The recovered refrigerant must be treated according to local legislation in the appropriate recovery cylinder and the relative waste transfer note must be drafted.
Do not mix refrigerants in recovery units and especially not in cylinders.
If compressors or compressor oils must be removed, make sure that they have been emptied to an acceptable level to prevent the presence of residual quantities of flammable refrigerant in the lubricant. To speed up this process, the only way to heat the compressor housing is by using an electric radiator suitable for this type of refrigerant.
Draining oil from a system must be done safely.

2.19 HC REFRIGERANT (R290) BLEEDING

In some cases, refrigerant bleeding can be an alternative to recovery, especially for hydrocarbon (HC) refrigerants which have minimal environmental impact (zero OPD and negligible GWP). However, this practice must comply with any applicable national regulations, if any.

In particular, before bleeding a system, it is necessary to:

- Verify compliance with waste materials and environmental legislation.
- Ensure compliance with legislation on the safety of hazardous substances.
- Bleeding is only performed on systems containing a small amount of refrigerant, typically less than 500g.
- Bleeding inside a building is not permitted under any circumstances.
- Bleeding should not take place in public areas or in places where people are not informed of the procedure being performed.
- The flexible hose used must be long enough and of adequate diameter to extend at least 3 meters outside the building.
- Bleeding should only occur when certain that the refrigerant is not blown back into adjacent buildings or leaked to a point below ground level.
- The flexible hose is made of material compatible with HC refrigerants and oil. A device is used to raise the hose outlet at least 1 m above ground level and so that the outlet faces upwards (to facilitate dilution).
- The end of the hose can now discharge and disperse the flammable fumes into the ambient air.
- There must be no restrictions or sharp bends within the bleeding line that could impede flow.
- There must be no ignition sources near the hose outlet.
- The hose should be checked regularly to ensure that there are no holes or kinks that could cause leaks or block the flow.

When bleeding, the refrigerant flow should be measured using low-flow manifold gauges to ensure the refrigerant is well diluted.

Once the bleeding is complete, if possible, the system should be flushed with OFN. Alternatively, the system should be pressurised with OFN and the bleeding procedure repeated at least twice, to eliminate residual refrigerant.

2.20 TRANSPORT, MARKING AND STORAGE OF UNITS

a. Transport of equipment containing flammable refrigerants.
   - Compliance with transport regulations.

b. Marking of equipment using signs.
   - Compliance with local regulations.

c. Disposal of equipment using flammable refrigerants.
   - Compliance with national regulations.

d. Equipment/appliance storage.
   - The equipment must be stored in compliance with the instructions of the manufacturer.

e. Storage of packaged equipment (unsold)
   - The protection of the storage packaging must be built in such a way that any mechanical damage to the equipment inside the packaging does not cause a leak of the refrigerant charge. The maximum number of pieces of equipment that can be stored together will be determined by local regulations.

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