

Guideline for safe handling of split heat pumps with A3 refrigerants in residential applications in Europe



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DEFINITIONS, ABBREVIATIONS

Undertaking: Any natural or legal person which carries out an activity referred to in the EU F-Gas Regulation

Split system: A refrigeration system consisting of a number of refrigerant piped units that form a separate but interconnected unit, requiring the installation and connection of refrigerant circuit components at the point of use.

Installer: A certified undertaking which performs the assembly of components of a refrigerating system and all the apparatus necessary for its operation and completes the electrical connections of the equipment on-site.

Technician: A certified undertaking which performs activities involving the opening of the refrigerant circuit of the equipment

End-user: The person/s using the equipment at their premises

HC: Hydrocarbons

PPE: Personal Protective Equipment

LEL: Lower Explosive Limit

ESD: Electrostatic Discharge

ATEX: Potentially explosive atmosphere

STANDARDS AND REGULATIONS

F-Gas Regulation 2024/573: Regulation (EU) 2024/573 of the European Parliament and of the Council of 7 February 2024 on fluorinated greenhouse gases

EN ISO 22712: Refrigerating systems and heat pumps — Competence of personnel

ISO 817: Refrigerants – Designation and safety classification

EN IEC 60335-2-40: Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

Note: EN IEC 60335-2-40 as a product specific standard, takes precedence, and therefore the manufacturer information provided with the product shall be followed

EN 378: Refrigerating systems and heat pumps – Safety and environmental requirements

- EN 378-1 Basic requirements, definitions, classification and selection criteria
- EN 378-2 Design, construction, testing, marking and documentation
- EN 378-3 Installation site and personal protection

ISO 5149: Refrigerating systems and heat pumps – Safety and environmental requirements

- ISO 5149-1 Definitions, classification and selection criteria
- ISO 5149-2 Design, construction, testing, marking and documentation



- ISO 5149-3 Installation site
- EN ISO 5149-4 Operation, maintenance, repair and recovery

CLP Regulation: Regulation (EC) No 1272/2008 on the classification, labelling and packaging of substances and mixtures

ADR: Agreement concerning the International Carriage of Dangerous Goods by Road, 2025

SEVESOIII: Directive 2012/18/EU on control of major-accident hazards involving dangerous substances

REACH: Regulation 1907/2006/EC (REACH, Registration, Evaluation, Authorization and Restriction of Chemicals)

PED – Pressure Equipment Directive, Directive 2014/68/EU



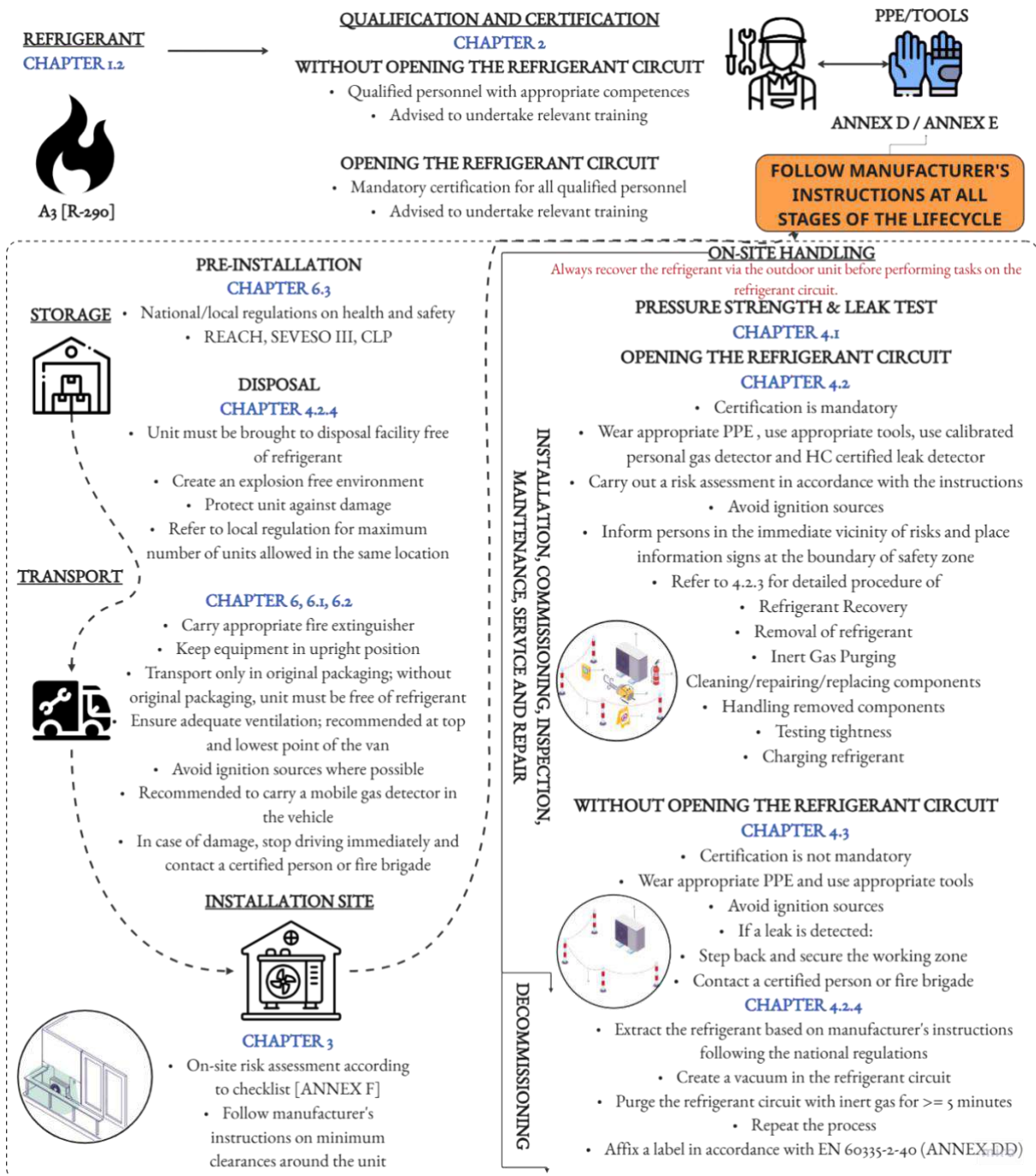
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Guideline Map



1. General

The revision of the new EU F-gas Regulation (EU) 2024/573 increased the number of heat pumps using non-fluorinated refrigerants on the market. This may lead to the increased use of refrigerants with higher flammability, which require specific recommendations. These recommendations have been presented in this guide. It provides information on relevant legal, normative and technical content. The target audience for this guideline are manufacturers, installers, plumbers and relevant professionals handling the product in scope of this guideline throughout its lifecycle, from the factory to its disposal. End-users are always advised to contact their responsible installer or technician for support.

1.1 Scope

This guideline applies to the handling of air-to-air and air-to-water refrigerant split heat pumps containing refrigerants with a higher flammability such as R-290 for single family households. This includes apartments in multi-family buildings.

Phases of lifecycle covered:

- On-site risk assessment
- Installation site
- Storage and transport
- Installation
- Commissioning
- Usage
- Maintenance and repair
- Decommissioning, removal and disposal

1.2 Information on the refrigerant

A common example of the refrigerant used in the products in scope of this guideline is R-290. A refrigerant can be classified according to European

regulations or industry standards. There is a distinction between these two methods of classification. Under EU Regulation, the official safety classification is known as CLP, which stands for Classification, Labelling, and Packaging of substances and mixtures.

ISO 817, however, is the standard widely referred to in the refrigeration industry for the classification of refrigerants.

It is important to note that the EU and local regulations take precedence over the standards, and it is, therefore, essential to use the CLP categories to ensure clear compliance with the responsible legal authorities. Classification of refrigerants according to both methods are described in Annex A.

R-290 is classified as a 1A refrigerant according to CLP classification and A3 according to ISO 817. Both classifications indicate higher flammability and low toxicity.

It is important to note the sources of ignition that could be present in case of a refrigerant leak. These are mentioned in Annex C.

Manufacturers have different means to enhance safety in case of a refrigerant leak. Hence, always refer to the manufacturers instructions to see the specific methods for the unit.



2. Qualification and certification

Working on or around heat pumps requires specific knowledge and is divided into two categories that require different qualifications:

2.1 Working outside the refrigerant circuit / without opening the refrigerant circuit

Working without opening the refrigerant circuit must be carried out by qualified persons having the appropriate competence required for the respective work using suitable tools and PPE, ensuring that there is no leak. The qualified persons are recommended to attend the manufacturer-specific product trainings.

2.2 Work involving the opening of the refrigerant circuit

This work involves activities which require the opening of the refrigerant circuit, such as installation, commissioning, in-service inspection, leak checking, circuit maintenance, decommissioning, removal of refrigerant, charging of refrigerant and replacement of components of the refrigerant circuit.

Expertise in handling refrigerants is acknowledged if the technician can provide evidence of a certification in accordance with the current F-Gas Regulation 2024/573, certification is mandatory.

If brazing or welding is required to replace components, be aware that the insurance provider may require that the technician has completed a course or obtained permission to perform hot work according to a written procedure. Local requirements should be checked in all cases and suitable tools and PPE must be used.

2.3 Definitions of activities

When working with the equipment, a qualified person may perform the following activities [EN ISO 22712:2023(E)]:

Installation:

Assembly of components of a refrigerating system and all the apparatus necessary for its operation

Leak checking:

Identifying if there is a leak of refrigerant from the refrigerating system and if so, identifying the exact location of the leak and reporting the results without opening the refrigerating circuit

Charging with refrigerant:

Introducing refrigerant into the refrigerating system in a controlled manner.

Putting into operation:

Integrity inspection and setting to work of the refrigerating system for the first time or after significant changes. This can potentially include charging with refrigerant.

Commissioning:

Ensuring that the system is performing according to the predefined conditions after putting the system into operation

In-service inspection:

All activities needed to check if the split system conforms to predefined requirements (e.g. functionality, correlation of temperature and pressure, capacity checks, quality checks of joints for existence of corrosion)

General maintenance:



Keeping or restoring a split system to a state from which the desired operation can be provided, without opening the refrigerating circuit

Circuit maintenance:

Keeping or restoring a split system to a state from which the desired operation can be provided, by opening the refrigerating circuit

Removal of refrigerant:

Recovering the refrigerant out of a refrigerating circuit

Decommissioning:

Ensuring that the refrigerating system is in a safe and environmentally proper condition during the period that it is out of operation

Dismantling:

Disconnecting the electrical, water and refrigerant connections, removing the equipment from its location



3. Installation site

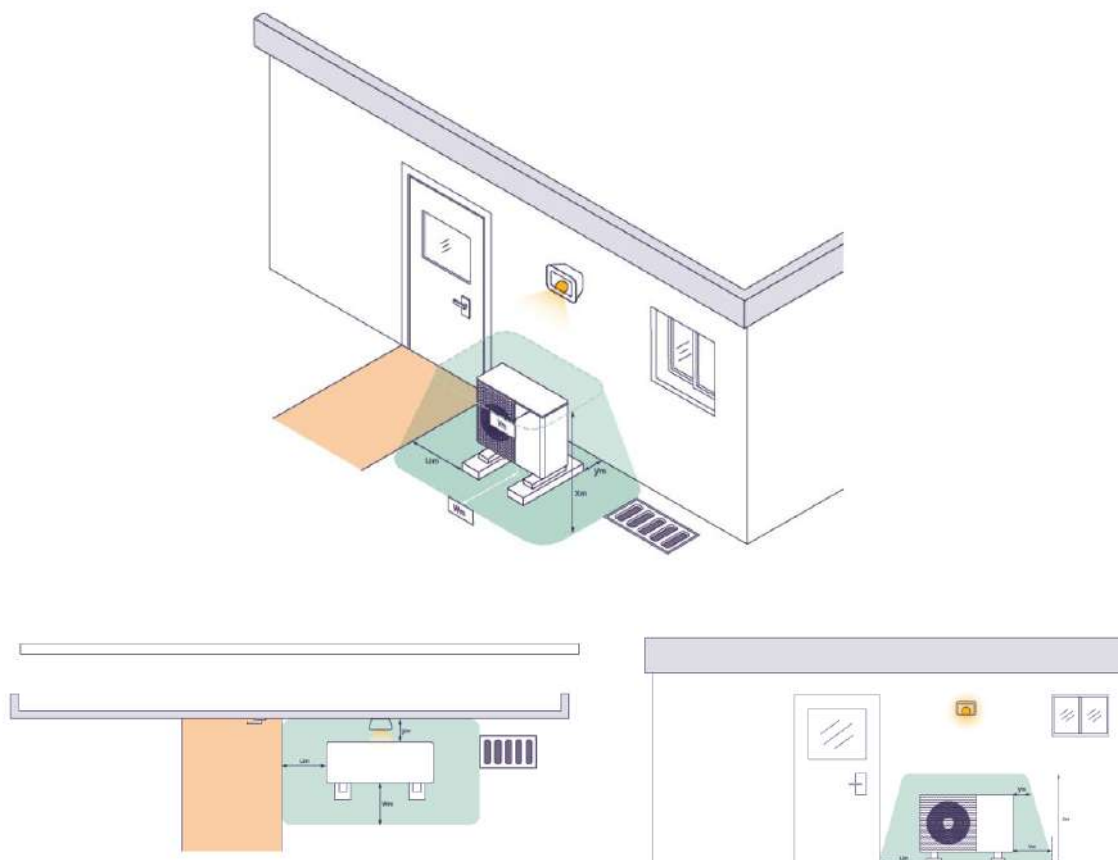
The following examples of instructions may be provided by the manufacturer. Always follow the manufacturer's instructions for device-specific requirements and installation guidelines which shall be in line with Annex DD of EN IEC 60335-2-40.

3.1 Outdoor unit installation

3.1.1 Ground-level outdoor installation

Manufacturers may specify minimum clearances (shown by the green zone) around the outdoor unit. If minimum clearances are required, these diagrams are examples for minimum clearance descriptions stated in manufacturer's instructions.

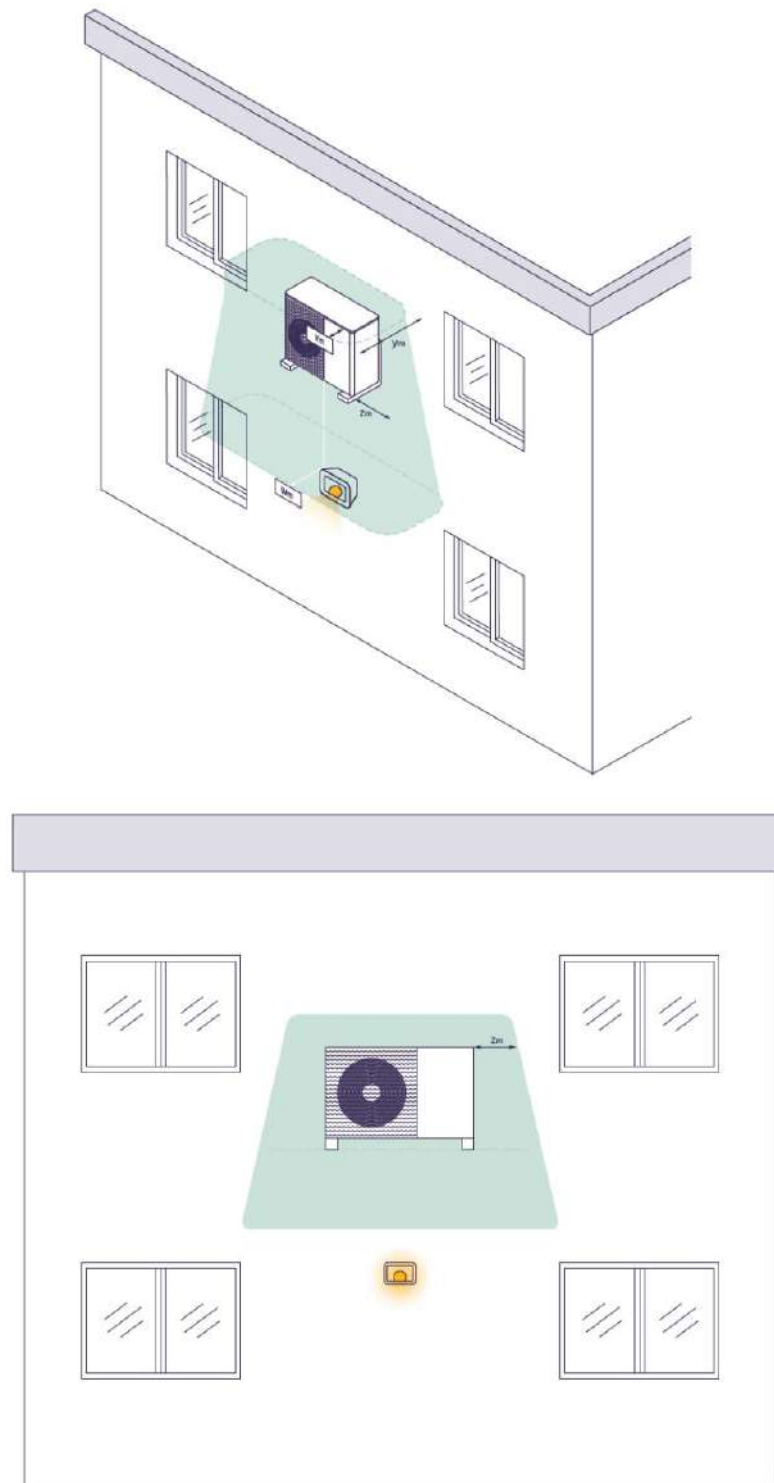
In all cases, the manufacturer instructions must be followed regarding requirements for safety-relevant minimum clearances and/or other mitigation measures which are intended to provide protection in case of refrigerant leakage. In addition to the manufacturer instructions, a thorough on-site risk assessment, such as the one mentioned in Annex F, is recommended. It is also not recommended to make any structural alterations to change the minimum clearances.

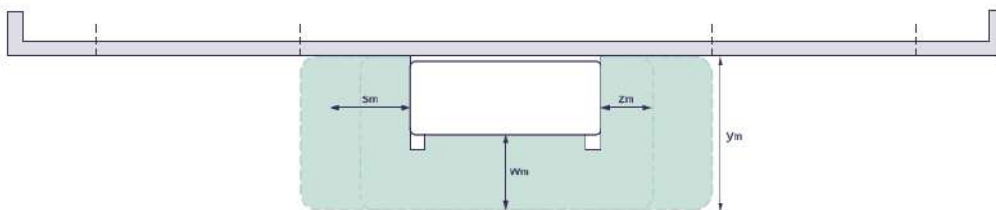


The definitions of the minimum clearances can look like those shown above, however, they are manufacturer-specific and can vary. During installation, if minimum clearances are defined, they must be followed according to the manufacturer's instructions. The installer needs to inform the end-user about their responsibility for ensuring that these are always adhered to.

Manufacturer-specific information such as clearances or instructions on corner or niche installation must be observed. An expansion of the minimum clearances in other directions must be considered proportionally. In all cases, it should be ensured that both the equipment and any obstacles surrounding it, are not potential causes of gas stagnation.

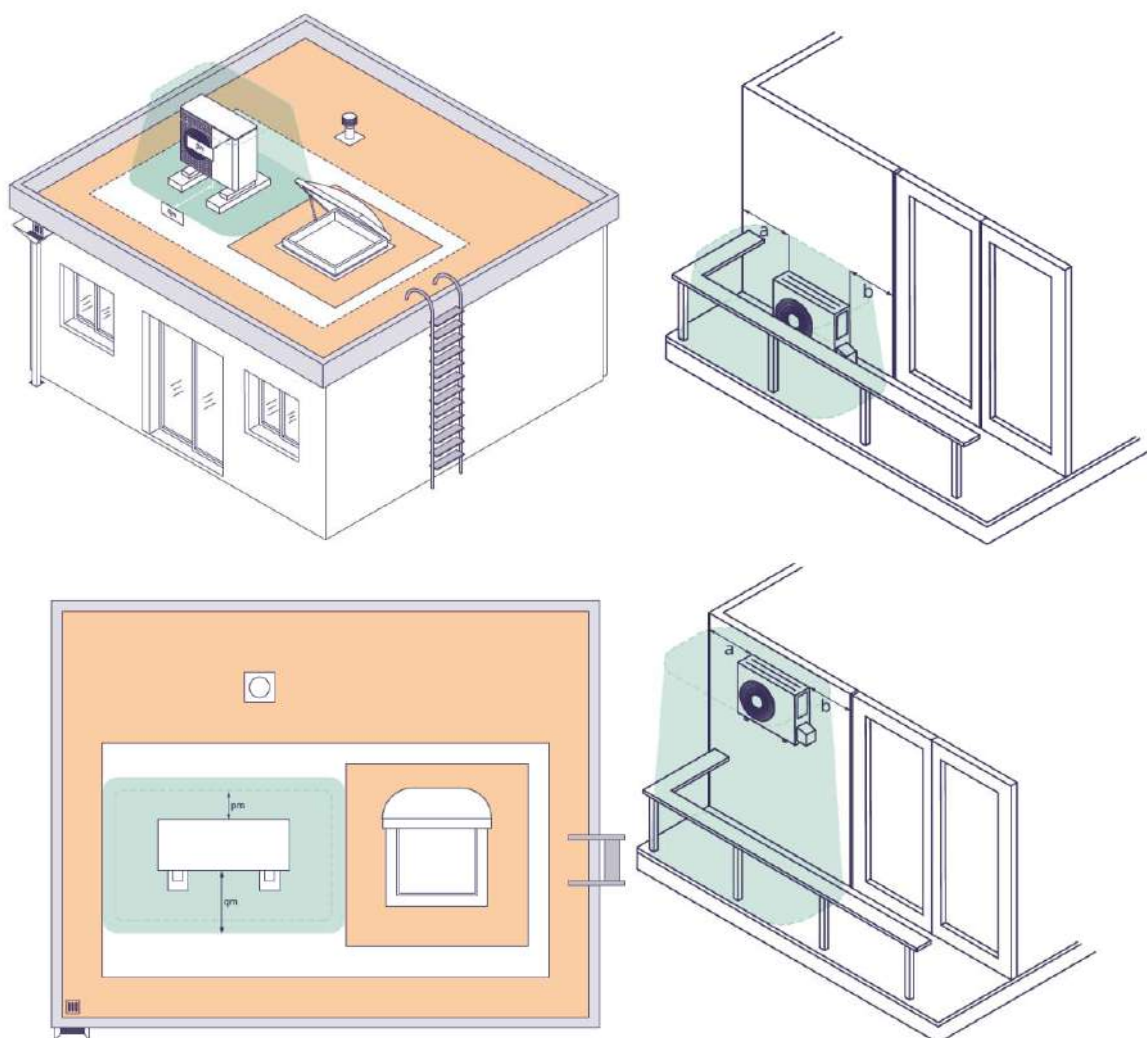
3.1.2 Wall-mounted installation

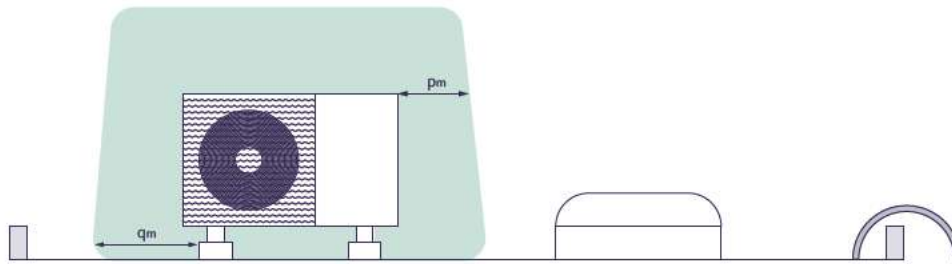




Similarly, for wall-mounted heat pumps, follow the minimum clearances specified by the manufacturer. For heat pumps placed at a height, consider the local safety regulations for working at heights.

3.1.3 Roof/Roof terrace installation





If specified by the manufacturer, the same requirements apply for outdoors installation close to the ground. Openings must not be located within the protection area. In areas with parapets, accumulation of dense gases should be avoided.

3.1.4 Condensate drain

It is important to ensure that the condensate drain is frost-free and cannot be blocked by environmental factors, such as snow accumulation, to prevent ice formation and potential damage leading to leakage.

For residential air conditioning systems, the primary method for condensate disposal shall be a connection to an existing building drainage system, where available and permitted by local building codes. While the possibility of a significant refrigerant release into the drainage system from an outdoor unit through a small diameter condensate line is highly improbable due to the open nature of the outdoor unit and the typical volume and pressure dynamics, the design of the connection should nonetheless minimize any potential for direct refrigerant ingress.

All condensate disposal methods must comply with relevant local and national environmental and plumbing regulations, including those concerning water discharge quality and prevention of property damage.

3.2 Indoor unit installation

General Considerations

Due to different installation locations, requirements for air conditioners (A2A) and split heat pumps (A2W) may differ. Refer to the manufacturer's instructions for guidance and limitations of the installation.

If integrated safety measures require electric power (e.g. to detect leakages or run counter measures), the appliance shall not be turned off and always stay connected to the power supply, except for short periods of repair and maintenance.

Location Selection

The location for the indoor unit installation must be chosen to minimize risks. Manufacturer's instructions regarding mounting height and minimum room size requirements must be followed to enable a safe dispersion of any leakage.

Consider the following points:

- Ignition Sources: Avoid locations near permanent sources of ignition, such as non-safe appliances that could spark. Refer to annex.
- Accessibility: The unit should be easily accessible for maintenance and inspection, ensuring that any refrigerant leaks can be addressed promptly.

Air Circulation Clearances

When air circulation is used as the primary mitigation measure, adhere to manufacturer-specific instructions regarding minimum clearances around the indoor unit. When specified, these clearances are important to ensure proper operation and dispersion in case of leakage:

- Above and Around the Unit: to ensure proper ventilation and to prevent malfunctioning of the unit.
- Adjacent Structures: to ensure that there are no adjacent structures or obstacles that could impede airflow or cause refrigerant stagnation.

Electrical Connections

Electrical connections must be made following the manufacturer's instructions and relevant electrical codes to prevent ignition sources and electrical hazards. Ensure Isolation, grounding and appropriate circuit protection.

Refrigerant Piping

The refrigerant piping must be installed according to the EN IEC 60335-2-40 and local legislation to prevent leaks and ensure safe operation. Tightness tests ensuring the absence of any leak are mandatory prior to charging with refrigerant.

- Material, size and specification: Use piping materials that are compatible with the refrigerant and meet the manufacturer's specifications.
- Routing: Route the piping to minimize the risk of damage and ensure accessibility for inspection and maintenance. It is recommended to use continuous piping to reduce possible leakage locations.
- Connections: Ensure all connections are secure and leak-free, using appropriate fittings (e.g. brazed, welded or mechanical connector compliant to ISO 14903) and techniques.
- Extended piping: Take care of possible limitations of allowed maximum refrigerant charge provided by the manufacturer and national regulations when using longer piping with additional charge needed.

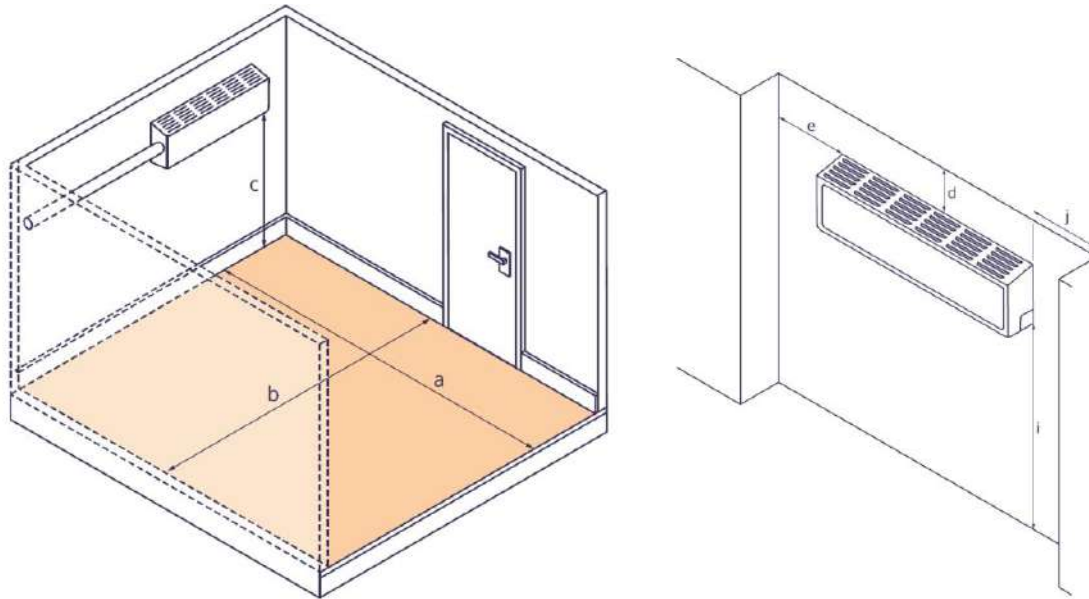
Mechanical connectors used indoors shall comply with ISO 14903. When mechanical connectors are reused indoors, sealing parts shall be renewed. When flared joints are reused indoors, the flare part shall be re-fabricated.



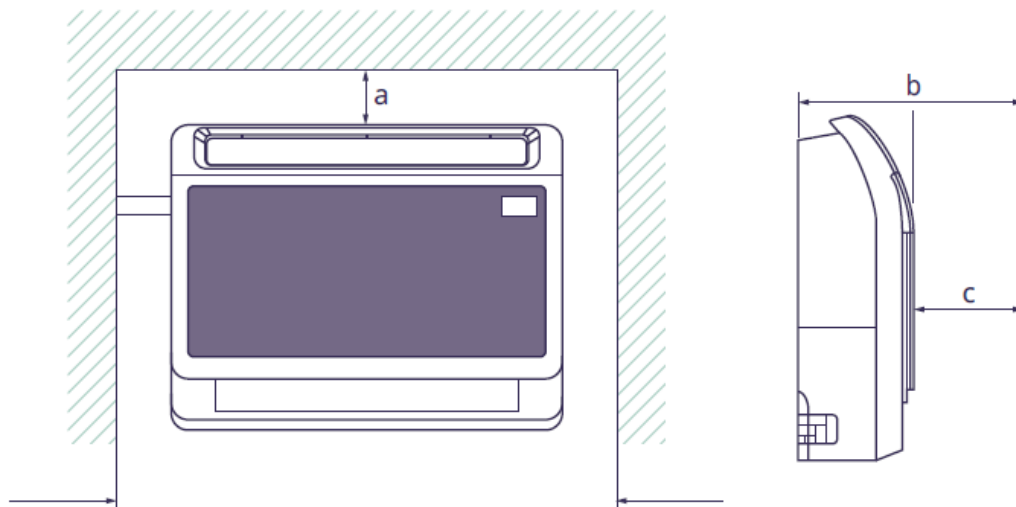
3.2.1 Air-to-air systems

Installation location

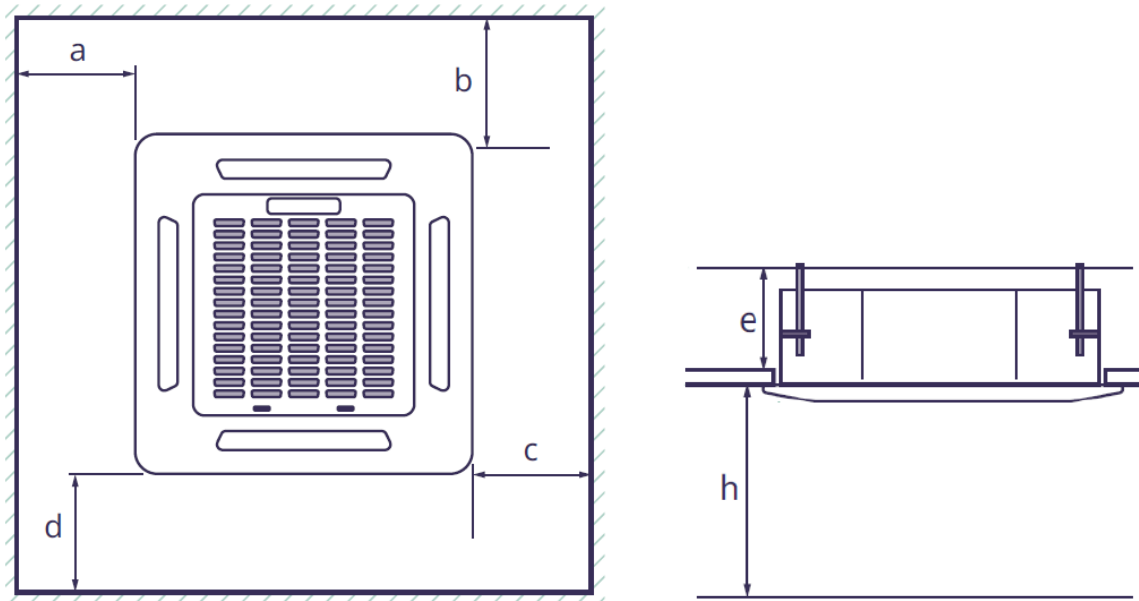
Wall mounted



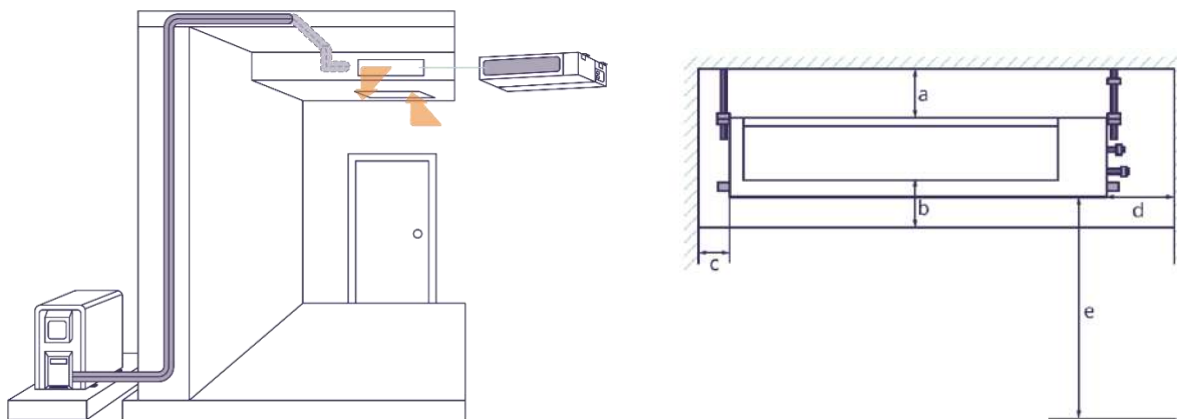
Console



4-way cassette



Ducted



Condensate Drain

Proper installation of the condensate drain is crucial to prevent water damage and ensure safe operation:

- **Drainage Path:** Ensure the condensate drain has a clear and unobstructed path to a suitable drainage location. It is recommended to install a condensate drain trap or a siphon.

3.2.2 Air-to-water split systems

Indoor unit location

Air to water split units, usually do not have an onboard circulation fan to ensure their primary function. Due to the properties of R-290 to be heavier than air, leakages of air to water split units will concentrate on the floor and may lead to an explosive atmosphere in small spaces. Therefore, manufacturers should implement or describe a solution to avoid local higher concentrations and refrigerant pile-up.

Several options can be defined by the manufacturer to resolve this stagnation. Installers must follow these measures defined by the manufacturer.

Protection of the secondary water cycle

If a leak occurs in the indoor heat exchanger (refrigerant to water), the refrigerant on a higher pressure might leak into the water circuit. To prevent the leaked refrigerant from being transported to the radiators or fan coils in the building, adequate precautions need to be taken by the manufacturer. Since the products have been designed to prevent leakage of refrigerants in buildings, manufacturer instructions must be fully applied.

If secondary circuit protection is provided on-site, attention should be given to how the gas can be routed outdoors to a safe location away from public and ignition sources.

4. On-site handling of the equipment

4.1 Pressure strength and leak test

In the case of heat pumps in split construction, the indoor and outdoor unit are pressure strength and tightness tested by the manufacturer. However, joints and pipes are installed on site must be tested according to the manufacturer's specifications prior to charging the system with refrigerant.

The connection between the internal and external unit must be made by certified personnel in accordance with Implementing Regulation EU 2024/2215 in accordance with the F-Gas Regulation. Additional information can be found in EN 378-2. Please refer to the maximum allowed pressure stated on the nameplates. Before opening the valves and releasing the refrigerant, the system must be air evacuated. Any planned painting of the pipes shall be carried out only after the test has been carried out

4.2 Working on the refrigerant circuit

All work described in this section must be performed only by qualified and certified personnel according to the manufacturer's instructions, the F-gas Regulation 2024/573, implementing regulation 2024/2215 and any applicable national/local regulations.

All parts of the refrigeration system are leak and pressure tested, however, if not handled correctly during transport or installation, refrigerant may leak which can lead to an explosive atmosphere. Manufacturers should inform the stakeholders of the need for safety precautions to prevent possible hazards.

It is advised to avoid ignition sources when working on the split system. This includes activities which can generate sparks and/or high temperatures.

In the event of maintenance requiring opening of the refrigerant circuit due to leakage or other issues with the indoor unit, activate the pump down function to transfer refrigerant to the outdoor unit and ensure the indoor unit is empty. Before proceeding, confirm adequate ventilation in the area where the indoor unit is located and eliminate any potential ignition sources. After completing the maintenance, use a gas detector to verify the absence of refrigerant concentration in the area before resuming operations.

The manufacturer recommendations for safety measures may include:

- Wear Personal Protective Equipment (PPE). Refer to the appendix for a list of appropriate PPE.
- Only use tools approved for the safety zone you are working in.
- Secure and mark the working area and remove ignition sources within the work area.
- Use a gas monitoring system, portable explosion-proof ventilation equipment and a fire extinguisher.
- Ensure sufficient ventilation if needed by a suitable fan as mentioned in Annex C.
- Connect earthing according to instructions and type of installation.
- The cable and pipe penetrations into the building must be properly sealed.
- Power supply is arranged in such a way that during installation the equipment can be de-energized in emergencies and during service work.

For transportation and storage of the equipment for the site operation, see chapter 6.

When going near and opening the casing of the equipment it is recommended to always follow the steps below:



1. Wear appropriate PPE: ESD safe Clothing, ESD safety shoes, Personal Gas Detector etc.
2. Use appropriate tools and safety measures: Fire Extinguisher, HC Certified leak detector etc.
3. Turn on and calibrate personal gas detector as instructed during the certification training and HC Leak detector minimal 10m from equipment
4. Inspect under and around the equipment using the HC leak detector.
5. If no gas is present during step 4, open the cabinet with appropriate tools for the zone
6. Search inside the equipment using the HC leak detector
If no gas is present, put HC Leak detector on the inside of the equipment at the bottom to measure any leaking refrigerant during work.

4.2.1 Installation and commissioning

4.2.1.1 Outdoor Unit

Installation must be carried out by certified personnel as the refrigerant circuit still has to be closed and some of the safety measures might not yet be in place.

Before commissioning, check that the installation has been carried out correctly in accordance with the manufacturer's instructions. This includes the installation conditions depending on the refrigerant as well as the electrical and hydronic connections. Installer-added accessories must also be considered potential ignition sources. Verify that any components installed near or within the unit (e.g., a condensate pump) are suitable for use in the presence of R-290.

As a connection is made on site, it needs to be verified that this connection is made correctly and needs to be tested at the appropriate pressure.

Heat pumps must be commissioned step by step in accordance with the manufacturer's instructions and shall only be carried out by certified personnel. The type of qualification depends on the type of system and the work to be carried out (e.g. work on the refrigerant circuit). For more information, see Chapter 2.1 Qualification.

When a qualified person uses tools prescribed by the manufacturer to dilute or detect a possible flammable cloud by ventilation or a gas detection system respectively, one can consider the zone as non-hazardous and use the normal prescribed tools suitable for the work (gas detector and fan need to be suitable and certified for A3). Caution: using a dilution fan might make it impossible to detect the refrigerant leakage as the leak will be diluted.

The unit shall be put in service step by step in accordance with the manufacturer's instructions. Only open the connection valves after the circuit has been confirmed to be leak tight.

If additional charge needs to be added to account for longer pipe lengths, follow the instructions of the manufacturer to perform this action in a safe way:

- to not endanger the refrigeration system and its environment
- to check for any maximum charge limitations
- to check if different room size limitations apply with higher charges

If defects are detected, the unit shall not be put into service until the fault is resolved.

4.2.1.2 Indoor Unit

A2A systems:

When installing and commissioning the system, strength and tightness tests to ensure the absence of leakages are mandatory prior to charging of the system, as well as air evacuation.

During the installation activities, the indoor unit shall stay free of refrigerant. Charging or removing refrigerant shall always be conducted on the outdoor unit. Follow the manufacturer instructions in any case.

A2W systems:

When installing and commissioning the equipment, it is very important to remove all air in the hydronic circuit.

In the event of a refrigerant leak in the heating circuit, it must be ensured that no critical flammable quantity of refrigerant can escape through automatic vents, safety pressure relief valves or radiator vents in the building. The manufacturer's specifications regarding countermeasures to route the refrigerant outdoors must be observed.

4.2.2 Inspection

According to ISO 5149-4, formerly EN378-4 (Annex D), inspection is carried out during the operational life of the system and needs to be carried out in accordance with the instructions of the manufacturer. In the event of a leak, explosive mixtures could be present. Approach the area using a leak detector. When intervening, make sure that there is no source of ignition in the vicinity.

A checklist as mentioned in EN378-2 (Annex G) suggests the following actions. For the full list, refer to the abovementioned annex.

- Check for damage to the equipment such as fitting, valves, supports, covers and other protective elements.
- Check that all components are as specified by the manufacturer
- Check that safety devices are present and are correctly installed and functioning
- Compare the installation with the system drawings from the operating instructions
- Check vibrations and movements caused by temperature and pressure under operating conditions

4.2.3 Maintenance, Service and Repair

4.2.3.1 Outdoor Unit

Besides the procedure mentioned in 4.1, an example of additional safety instructions specific to maintenance, service and repair are recommended below:

- To minimize risk, an on-site risk assessment should be executed in accordance with the installation instructions before carrying routine work on the equipment.
- All persons in the immediate vicinity must be informed of the potential risks and requested to comply with the safety measures. The immediate vicinity must be considered to be at least the safety zone described in the installation instructions from the manufacturer.
- Place information signs at the boundaries of the safety zone.
- (According to local regulations) The personal gas detector and the HC certified leak detector must be set and calibrated in advance in a neutral environment to maximum 20% of the lower explosive limit (LEL) as specified in the operating instructions of the detector.
- Before opening control boxes and control cabinets, the device must be completely de-energized and capacitors must be discharged. It must be considered that there can be capacitors or batteries which might be charged after turning off the power.
- Always carry out work on the open refrigerating system under constant inert gas purge, process explained below. Examples of inert gas are Nitrogen, Argon and Carbon Dioxide.

Please note that in case of an emergency the refrigerant may leak in the vicinity. Refer to the service manual of the manufacturer.

When opening the refrigerant circuit or in the presence of an explosive atmosphere, adequate ventilation must be provided, ignition sources must be avoided and constant monitoring of the presence of the refrigerant is necessary. An illustration of an example of a safety zone is shown below:





a. Heat Pump b. Bollards c. Safety sign d. ATEX approved fan
e. Gas detector f. Fire Extinguisher



Be aware buildings and building openings might be present within the safety zone. If insufficient ventilation is available, an ATEX approved fan should be used.

***Note:** Referenced standards for the following procedures are EN ISO 22712:2023, EN IEC 60335-2-40:2024 (Annex DD), EN IEC 60335-2-40:2024/A11:2024, EN 378-2: 2016, EN 378-3: 2016 and ISO 5149-4:2022.

Refrigerant recovery from the system*

- Ensure suitable recovery cylinders, recovery equipment and vacuum pump are used by checking capacity and type of refrigerant.
- During recovery, check all valves and hoses with an appropriate leak detector to detect any leaking refrigerant. It is recommended to vacuum the refrigerant circuit up to 270 Pa.
- The recovery process might need to be repeated using the inert purging process described below as a small amount of the refrigerant might be present in the compressor oil after recovery.
- After the recovery, it is recommended to open the valves on the hoses in a well-ventilated outside area to remove any remaining refrigerant.
- Always monitor the recovery operation.

Removal of refrigerant from the oil in the components:



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- Even after the refrigerant has been extracted from the system, residual refrigerant may still be dissolved in the compressor oil for a relatively long time and continue to evaporate.
- The recovery process might need to be repeated using the inert purging process described.

Inert gas purging process*:

- Connect the refrigerant circuit and inert gas cylinder using the regulator. Attach an appropriate hose from the circuit's vent to a safe discharge area.
- Open the regulator valve on the inert gas cylinder to 1.5 barG, and flush inert gas through the entire system or the section being repaired until no flammable refrigerant concentration is detected in the discharge area.
- Move the connection point on the refrigerant circuit to a location as far from the original point as possible, and flush again until no flammable refrigerant concentration is detected.
- Repeat this process, as also described in ISO 22712 and ISO 5149-4, of changing connection points and flushing until there is no detectable flammable refrigerant concentration.
- This flushing ensures that no refrigerant remains trapped in the oil. To prevent hazards from evaporating propane bound in the oil, inert gas must continuously flow through the circuit during work on the heat pump system.
- When flushing, use a leak detector and continuously monitor to ensure no flammable cloud concentrates at the outlet. In the area where the gas is vented, residual refrigerant gas with inert gas can be diluted with the ATEX approved fan and must be free from ignition sources or alternatively can be burned off with a mobile gas flare.
- Do not open the system until the refrigerant has been completely removed.

Cleaning, repairing or replacing refrigerant components

- Resolving the problem depends on the component and the type of malfunction. Manufacturers should clarify the process to the professionals.

Handling removed components

- Refrigeration components in which compressor oil residues may be present must be handled with particular care. Place the open container with oil in a safe area and ensure that all refrigerant has evaporated before transferring it into a metal can.
- When the components can be sealed, the affected components must be flushed with nitrogen and sealed under nitrogen at ambient pressure.
- When the components cannot be sealed, take them to a ventilated location and store them. Display caution signs to ensure that no one can approach the components or bring in any ignition sources. For the transport of dismantled components, they must be placed in a manner that prevents leakage and refrigerant accumulation during transport.
- Indicate the risk of refrigerant evaporation. This must be clearly visible until the component or oil is disposed of in accordance with applicable regulations.
- A sticker must be attached to indicate the danger of refrigerant evaporating. This must be clearly visible until the component or oil is disposed of in accordance with regulations.
- EU, national or local regulations must be followed for proper disposal.

Testing tightness

- Before charging refrigerant, carry out the pressure and leak check.
- Manufacturer prescribed safety checks must be carried out (e.g. pressure switch test, potential equalisation, etc.)

Charging refrigerant

- Prior to charging, remove the nitrogen and vacuum the unit.
- Confirm that the refrigerant type is correct, and amount of refrigerant is sufficient.
- Do not let air from entering the refrigerant circuit to reduce fire or explosion risk during operation.
- Do not overfill the refrigerant circuit.

Test run, leak detection and final work

- With the equipment in operation, check the performance of the equipment and final leak check, with special attention to restoring the tightness of sealed housing parts.
- Check warning notices for visibility and legibility.

4.2.3.2 Indoor Unit

Under normal operating conditions, no ATEX zone should be present around the indoor unit due to the integrated safety measure. In case work needs to be performed on the indoor unit, it is always recommended to recover all the refrigerant through the outdoor unit.

4.2.4 Decommissioning and disposal

Before working on the refrigerant circuit or on sealed housings, the points from chapter 4.2.3 must be fulfilled. The installation instructions remain in effect as long as the device is filled with refrigerant or oil.

It is expected that the temporary storage may happen where equipment may be stored in areas that do not comply with the installation restrictions (see chapter 3), such as at public waste collection points and temporary storage of waste treatment facilities, manufacturers should clarify following decommissioning steps:

- Extract the refrigerant following the national regulations
- Create a vacuum in the refrigerant circuit
- Purge the refrigerant circuit with inert gas for at least 5 minutes*.
- Create a vacuum in the refrigerant circuit again.
- Follow the nitrogen purging process.
- In accordance with EN IEC 60335-2-40 (Annex DD), affix a label that states that it has been decommissioned, emptied of refrigerant and that an inert charge is present, along with its pressure. The label shall be dated and signed.

***Note: The 5-minute vacuum period may not be sufficient to completely remove the refrigerant from the oil. Releasing the pressure in the refrigerant circuit can lead to further refrigerant leakage and possibly create an explosive mixture. Therefore, individual components such as compressors must also be sealed during transport.**



In addition, relevant information for technicians must be provided and made available online. Furthermore, marking on equipment is an effective means of raising awareness among end-users, technicians, transporters and waste treatment facility operators. (See also chapter 5 Labelling and documentation) Instructions and markings should include how to bring the equipment and components to authorized waste treatment facilities.

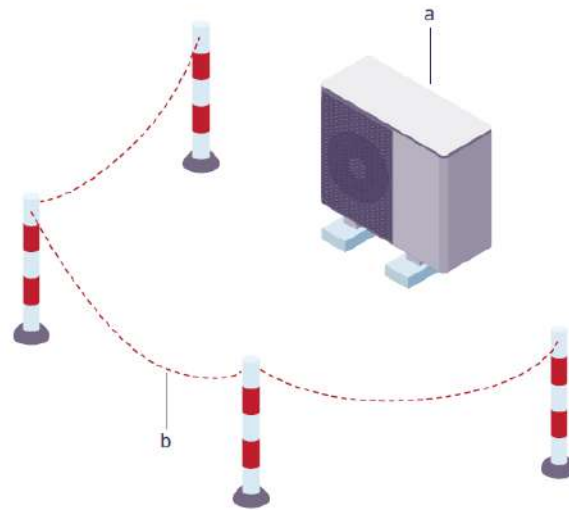
Complete devices may only be disposed of by certified disposal companies. Although refrigerants must be removed from the equipment before transporting to the disposal facility, it is recommended for the waste treatment facilities to consider following:

- Create an explosion free environment: Provide sufficient ventilation, remove ignition sources, set up a concept and policy of explosion protection.
- Protect the equipment against damage
- The maximum number of equipment that may be stored in the same location is determined by local legislation.

4.3 Without opening the refrigerant circuit

When a leak is detected by personnel without certification, it is not allowed to mitigate or solve the issue as they may unintentionally increase the danger by extending the flammable cloud or initiating ignition sources into the flammable zone. They are recommended to step back and secure the working zone as shown below and to call a certified person or the fire brigade to ensure a safe handling of the leak.





a. Heat Pump b. Bollards

As the indoor and outdoor split units need to be connected on site, the installation job cannot be performed by non-certified personnel.

5. Labelling and documentation

5.1 Labelling

Every heat pump must bear a clearly legible nameplate that must not be removed or covered. The nameplate contains among others the following information:

- CE marking
- Refrigerant number in accordance with ISO 817
- Refrigerant charge (kg)
- when necessary, additional marking of the refrigerant refill quantity during commissioning
- maximum allowable pressure(s) (PS)
- Flame symbol according to ISO 7010-W021 (2011-05)
- Name and address of the manufacturer
- Year of manufacturing*

***The year of manufacture may also be part of the serial number, and all information may be part of the identification plate of the equipment and may be coded.**

5.2 Product Documentation

It is the manufacturer's responsibility to make available, among others, the following documents concerning their product:

- Declaration of conformity
- Installation, technical intervention, and operation instructions and safety information
- Technical specifications, e.g. refrigerant used, energy class label, product
- information sheet etc.

Local regulations must be referred to for the provision of a system logbook.



6. Transport and Storage

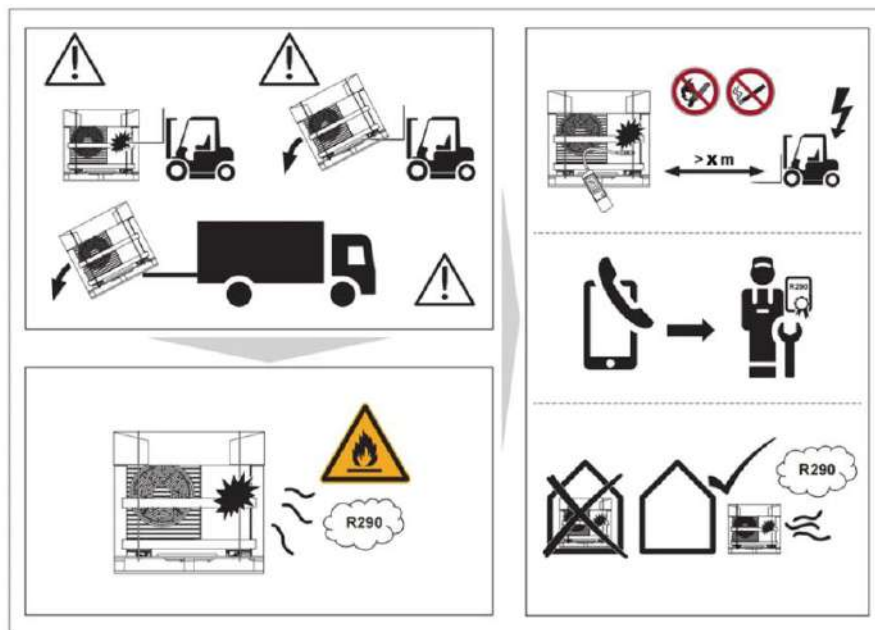
The transport of dangerous goods is regulated throughout Europe by the ADR. Heat pump systems and their components are not subject to these Regulations if they contain less than 12 kg of refrigerant. While the rules for transporting all heat pumps with flammable refrigerants are the same, the recommendations vary based on the risk level concerning flammability. The manufacturer's information and the instructions in the following subsections are recommended for installers, transporters and warehouse operators.

6.1 Information on transport and storage for construction site operations

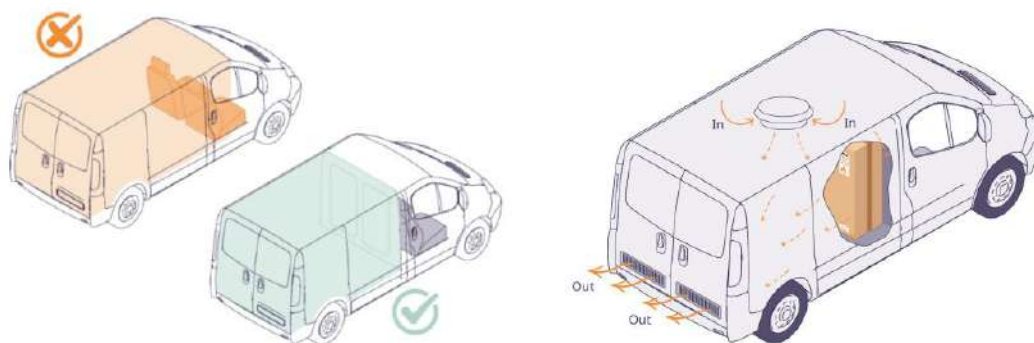
The following general instructions should be observed when transporting components with refrigerant to and storing them on site:

- It is recommended that the components or parts be transported by a freight forwarder or logistics company or approved distributors (e.g. wholesaler)
- An appropriate fire extinguisher shall be carried on board.
- Transport may only be carried out according to manufacturer's requirements or otherwise in an upright position, as transporting the device lying down may cause damage. Packaging labels should carry the necessary information. National or local requirements must also be referred to.
- Transporting new units charged with refrigerant is only permitted in the original packaging. For transport without the original packaging, excluding when intended for storage at warehouses or disposal facilities, it is recommended that the refrigerant circuit is free of refrigerant. The terms of return must be clarified before transport. (Reference Chapter on Decommissioning)
- During transport and storage, ensure adequate ventilation of the environment. It is recommended to have ventilation incorporated both at the top and the lowest point of the van.
- Ignition sources such as flying sparks, smoking, hot surfaces, etc. must be avoided.

- Storage at the end user's premises over long periods of time should be avoided and must always be above ground level with sufficient air exchange. Storage in unventilated containers on the end user's premises is prohibited.
- Below is an example of a packaging label. Minimum clearances depend on the manufacturer and should be followed accordingly.



Below are examples and illustrations of recommended measures during transportation.





6.2 Transport damage

If the part or component containing refrigerant is damaged during transport, it is advised to stop driving immediately. A fire brigade or relevant safety personnel must be contacted without performing any other action. A certified person must ensure that no explosive atmosphere is present. There must be no sources of ignition within a distance specified by the manufacturer or the logistics company in compliance with the local health and safety ordinances. It is recommended to properly extract and dispose of the refrigerant by a service technician. It is recommended that a suitable mobile gas detector be carried in the vehicle. This can be used to check whether refrigerant is escaping in the event of an accident.

6.3 Storage at the specialist tradesman and the wholesaler

6.3.1 Hazardous substances law

The storage of hazardous substances is regulated in the EU by Regulation 1907/2006/EC (REACH, Registration, Evaluation, Authorization and Restriction of Chemicals), Directive 2012/18/EU (SEVESO III), Regulation (EC) No 1272/2008 (CLP). However, it is recommended to also follow national or local regulations regarding labelling or storage of hazardous substances. Instructions provided with the equipment are advised to be read.

6.3.2 Fire protection

When the parts of heat pumps containing flammable refrigerants are stored, the fire load in the storage room increases. In order to alert emergency services to potential dangers at an early stage, the fire brigade plans for the respective storage facilities must be checked and adjusted if necessary. Depending on the volumes stored, the fire protection concepts may also have to be revised and approved separately depending on local requirements. Warehouse operators should take responsibility for appropriate facilities based on local regulations. Manufacturers should provide sufficient information regarding and not limited to dedicated storage spaces, leak sensors, appropriate ventilation systems and eliminating ignition sources to facilitate the same. Consider specific measures on a case-by-case basis to ensure adequate protection against the formation of explosive gas mixtures. All risk assessments should be performed by the warehouse management, and action should be taken when and if required.

6.3.3 Explosion protection

Each part of the heat pump system is subjected to a leak test by the manufacturer during the manufacturing process. However, any damage during transport of the outdoor unit can release the refrigerant. In case damage occurs and a leak is expected, stop operations immediately and provide ventilation. In case a leak is detected, eliminate ignition sources in the vicinity. Let the refrigerant escape safely

and have certified professionals dispose the equipment. Before storing high quantities of heat pump parts filled with refrigerant, it is advisable to check the explosion hazard of the storage facility. The basis for this is the number of outdoor units, the respective amount of refrigerant and the volume of the storage facility. When storing multiple equipment, the volume of the refrigerant increases, and with it, the risk in case of fire. Depending on the volume of the refrigerant in one location, fire safety procedures should be reviewed and modified in line with local requirements.

Examples to be included in the fire safety plans:

- Define measures after an alarm has been triggered, e.g. warn personnel, open doors for cross ventilation.
- Provide fire extinguishers of a type and quantity to be determined as required.
- Train the employees in areas at risk of fire and explosion.
- Appoint and train a fire safety officer or fire safety assistant.
- Install a fire mitigation system.

In individual cases, specific measures should be agreed to ensure adequate protection against the formation of flammable gas mixtures. It is recommended to have stationary gas detection in a location storing equipment containing refrigerants with higher flammability.

7. On-site risk and hazard assessment

All parties involved in the lifecycle of handling the heat pump must participate in their own comprehensive risk assessment. While the manufacturer carries out an initial risk assessment for the heat pump, on the basis of which the installation and planning instructions are drawn up, installers, operators, and end-users also share responsibility for managing risks. An on-site risk assessment checklist is provided in Annex in addition to manufacturer's instructions that may be provided with the heat pump. It is recommended to carry out assessments that include:

- Storage and transport;
- Fire protection concepts for wholesale trade;
- Qualification of employees;
- Tools and PPE;
- Measures in the event of an accident;
- Appointment of a responsible person / acceptance by a specialist as required by the local regulation;
- Entrepreneurial risk;
- Insurance (e.g. business liability insurance)
- Local health and safety ordinances.



ANNEX

A. Classification of refrigerants according to CLP

Classification		Labelling			
<u>Hazard class</u>	<u>Hazard category</u>	<u>Pictogram</u>	<u>Signal word</u>	<u>Code</u>	<u>Hazard statement</u>
Flammable gas	Category 1A (R-290)	 GHS02	Danger	H220	Extremely flammable gas
	Category 1B (R-32)		Danger	H221	Flammable gas
	Category 2	No Pictogram	Warning	H221	Flammable gas

B. Safety groups defined according to ISO 817

	Safety group	
Higher flammability	A3	B3
Flammable	A2	B2
Lower flammability	A2L	B2L
No flame propagation	A1	B1
	Lower toxicity	Higher toxicity

C. Examples of possible ignition sources

Ignition type	Source Category	Ignition source
	Electric parts	Appliance (hot surface)



Spark		Parts in equipment (sparks)
		Power socket
		Isolation switch
		Mobile phone
	Cigarette lighters	Match
		Lighter
	Work tool	Metal spark (forklift)
		Electric tool
		Recovery machine
	Static clothing	Static electricity
Open flame (contact with flammable region)	Cigarette lighters	Match
		Lighter
	Combustion equipment	Heater
		Water heater
		Boiler
		Cooker
		Barbecues
		Motor driven vehicles
		Combustion driven gardening equipment
	Work tool	Brazing torch
		Soldering torch

D. Personal Protective Equipment (PPE)

Examples of PPE below are not exhaustive. National legislation needs to be checked for the necessary PPE.

Item	Image
Personal Gas detector Minimal detection of LEL + O ₂	
ESD Safety wristband for safe earthing (on outside of unit)	 
S3+ ESD working shoes according to EN ISO 20345:2022 and a resistance ranging between 0,1 MOhm and 100 MOhm according to ISO IEC 61340. (yellow ESD logo)	 
Safety clothing in conformity with the provisions of PPE Regulation (EU) 2016/425 (Cat III) and satisfies the essential health and safety requirements set out in Annex II and the relevant harmonised standard(s): EN ISO 11612 A1+A2, B1, C1, E3, F1 EN ISO 11611 Class 1 A1+A2 EN 1149 -5	 
Non-Brazing Safety Glasses DIN 166 minimal 2C – 1,2 for non-brazing	
Working Gloves If only mechanical risk exists use work gloves according to EN388 and EN16530	
Helmet in case of working in locations where debris can fall according to EN 50365	
Hearing Protection conform EN 352:2020	
Fall protection	
Brazing Safety Glasses DIN 166 + DIN 169 1.7 minimal for brazing	
Working Gloves Use when filling or draining refrigerant and during work involving pipes are opened in which refrigerant may be present Viton (viton-butyl) gloves as protection against the risk of frostbite and also against chemical risks, in accordance with EN 374:2016 and if possible EN16530	

E. Tools and safety equipment

Examples of tools below are not exhaustive. National legislation and manufacturers' instructions need to be checked for the necessary tools.

Item	Image	Item	Image
EX marked leak detectors		Torchset to repair installation	
Spark Free screwdriver to open unit		ATEX approved fan to be able to dilute the mixture	
Fire extinguisher with an ABC rating Minimal rating 34A 233B C		R290 approved recovery station	
R-290 approved vacuum pump		Bollards with 25m of chain	
Measuring scale with 2 decimal digit accuracy for checking reclaimed refrigerant R290 compliant version		Safety Sign according to ISO 7010	
Meterset certified for A3 refrigerants such as R290		Storage	
R290 suitable hose with special leak free connectors			
Cylinder 27L suitable for R290			
Inert gas (N2/AR/CO2) bottle for flushing, welding and pressure test			
Mobile Gas Flare			

F. On-site risk assessment checklist

Below is a template of a risk assessment checklist which is recommended to be used on-site. Manufacturer's instructions must always take precedence.

	STAGE		CHECKPOINTS	COMMENTS
1	Working site and preliminary risk assessment	1.1	Competence Verification ☐ Staff have been trained and are qualified in the handling of A3 refrigerants. ☐ The staff has certification as per F-Gas Regulation 2024/573.	
		1.2	Documentation ☐ The manufacturer's installation and maintenance manuals were available and were consulted. ☐ Checked the intervention log if available or prepare a new one. ☐ Check that the declaration of conformity to technical standards exists (e.g. EN IEC 60335-2-40 and local regulations). ☐ Verify that the electrical system serving the equipment and adjacent users is compliant with national regulations.	
		1.3	Permit to work ☐ Hot work permit and certification required (if necessary and provided for by company risk analysis).	
		1.4	Installation location (site) ☐ The minimum clearances comply with the manufacturer's instructions. ☐ If specified, within the minimum clearances, all building openings are sealed. ☐ Check to confirm that the design and structural requirements for the location are according to original manufacturer's instructions. ☐ The heat pump is not located in an area that does not allow free air exchange. ☐ Ensure that no combustible materials or ignition sources are present in the vicinity of the equipment. ☐ Ensure that no obstacles or volumes in which a flammable atmosphere may be created (manholes, shafts, etc.) are present. ☐ The heat pump is not additionally enclosed, except enclosures approved by the manufacturer (eg. Noise isolation). ☐ The heat pump is in the same condition as marketed.	

		1.5	Work area preparation ☐ Remove any flammable materials from the work area. ☐ Use devices (tapes or barriers) to prevent access by non-workers. ☐ Apply signage (based on the company's risk assessment) with flammability warning signs, prohibiting unauthorised entry, ignition sources and unauthorised operation on the systems. ☐ Place a suitable fire extinguisher (based on the company's risk assessment).	
		1.6	Ventilation ☐ If in the presence of obstacles and volumes that can accumulate, ventilate with your own equipment for at least 20 minutes.	
		1.7	Tooling, PPE ☐ The tooling should be appropriate for use with A3 refrigerants. ☐ After ventilation, if required by the company's risk assessment, position one or more detectors adjacent to one or more leak points of the equipment (joints, vibrating parts, etc.). ☐ Equip yourself with a portable detector (if required by the company's risk assessment). ☐ Protective clothing and shoes should be electrostatic dissipative. ☐ A fire extinguisher with an ABC rating is available at the location.	

2	Before the activity	2.1	Self-monitoring of correct behaviors ☐ the PPE required by the company's risk assessment are present and regularly worn.	
		2.2	Refrigerant recovery ☐ Following correct procedures, recovering refrigerant at a manufacturer-specified distance away from potential leak points.	
		2.3	Circuit purging ☐ After recovery, introduce nitrogen into the circuit to allow the removal of the flammable refrigerant dissolved in the oil and inertize.	
		2.4	Cutting, welding and brazing operations ☐ Carry out the operations after the circuit is free from flammable refrigerant gas. Follow the normal safety procedures used for any heat pump system.	
		2.6	Evacuation and system charging ☐ The vacuum pump is controlled by a switch outside the minimum clearance and the pump is in a well-ventilated area. ☐ Once any operations on the circuit have been completed, create a vacuum up to a pressure of 300 Pa and evaluate the seal. ☐ Recharge from the low pressure side, without exceeding the maximum charge, using the scale or volumetric flow meters.	
		2.7	Checking the area at the end of operations ☐ Check the area with a gas detector at all potential leak points.	

3	After the activity	3.1	Leak check ☐ Perform a leak check after each job, using appropriate detection equipment based on the company's risk assessment. Check the tightness of any joints made.	
		3.2	Safety Devices Check ☐ Check that all safety, control and measuring devices, and alarm systems are functioning correctly. ☐ If necessary, deactivate the system and instruct the customer to adapt it according to the technical design standards (EN 378 and local regulations).	
		3.3	Labels and reporting ☐ If necessary, replace warning labels and stickers (e.g. fire hazard).	
		3.4	Final inspection ☐ Perform a visual inspection of the entire system. Verify that the piping is installed according to the drawings. Check the safety devices and confirm all the checks carried out previously.	
		3.5	Minutes of prescriptions ☐ Provide the customer with a report of the positive outcome of the intervention. ☐ Make sure the Operator perform a periodic leak check. ☐ If the system is deactivated for safety reasons, provide the customer with the report with the list of requirements to be complied with. ☐ Refrigerant type and charge are visible. ☐ Replace marking for flammability on equipment if damaged.	

If an item has not been ticked on the checklist, please check with the manufacturer before putting the heat pump into operation.

