Guideline on safe handling of self-contained air-to-water residential heat pumps with refrigerants with higher flammability installed outdoors in Europe

SKILLSAFE EU

Grant agreement No: LIFE27 101167753

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DEFINITIONS, ABBREVIATIONS

Operator: The undertaking exercising actual power over the technical functioning of products, equipment or facilities covered by the F-Gas Regulation, or the owner designated by a Member State as being responsible for the operator's obligations in specific cases

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

Self-contained: A complete factory-made system which is in a suitable frame or casing, is fabricated and transported complete or in two or more sections, can contain isolation valves and in which no gas-containing parts are connected on site

Installer: An undertaking which lays the foundation or mounts, places and completes the water and electrical connections of the equipment on-site

Technician: An undertaking which performs any and all activities involving the opening of the refrigerant circuit of the equipment

End-user: The final person/s owning the equipment and using it at their premises

HC: Hydrocarbons

PPE: Personal Protective Equipment

LEL: Lower Explosive Limit

ESD: Electrostatic Discharge

AWHP: Air-to-water heat pump

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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 22712:2023(E): Refrigerating systems and heat pumps — Competence of personnel

ISO 817:2024 : Refrigerants – Designation and safety classification

EN IEC 60335-2-40:2024/A11:2024 : Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

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

- EN 378-1:2016+A1:2020
- EN 378-2:2016
- EN 378-3:2016+A1:2020
- EN 378-4:2016+A1:2019

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

- ISO 5149-1:2014, ISO 5149-1:2014/Amd 1:2015 , ISO 5149-1:2014/Amd 2:2021
- ISO 5149-2:2014, ISO 5149-2:2014/Amd 1:2020
- ISO 5149-3:2014 , ISO 5149-3:2014/Amd 1:2021
- ISO 5149-4:2022

IEC 60079-10-1 : Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres

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

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

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)

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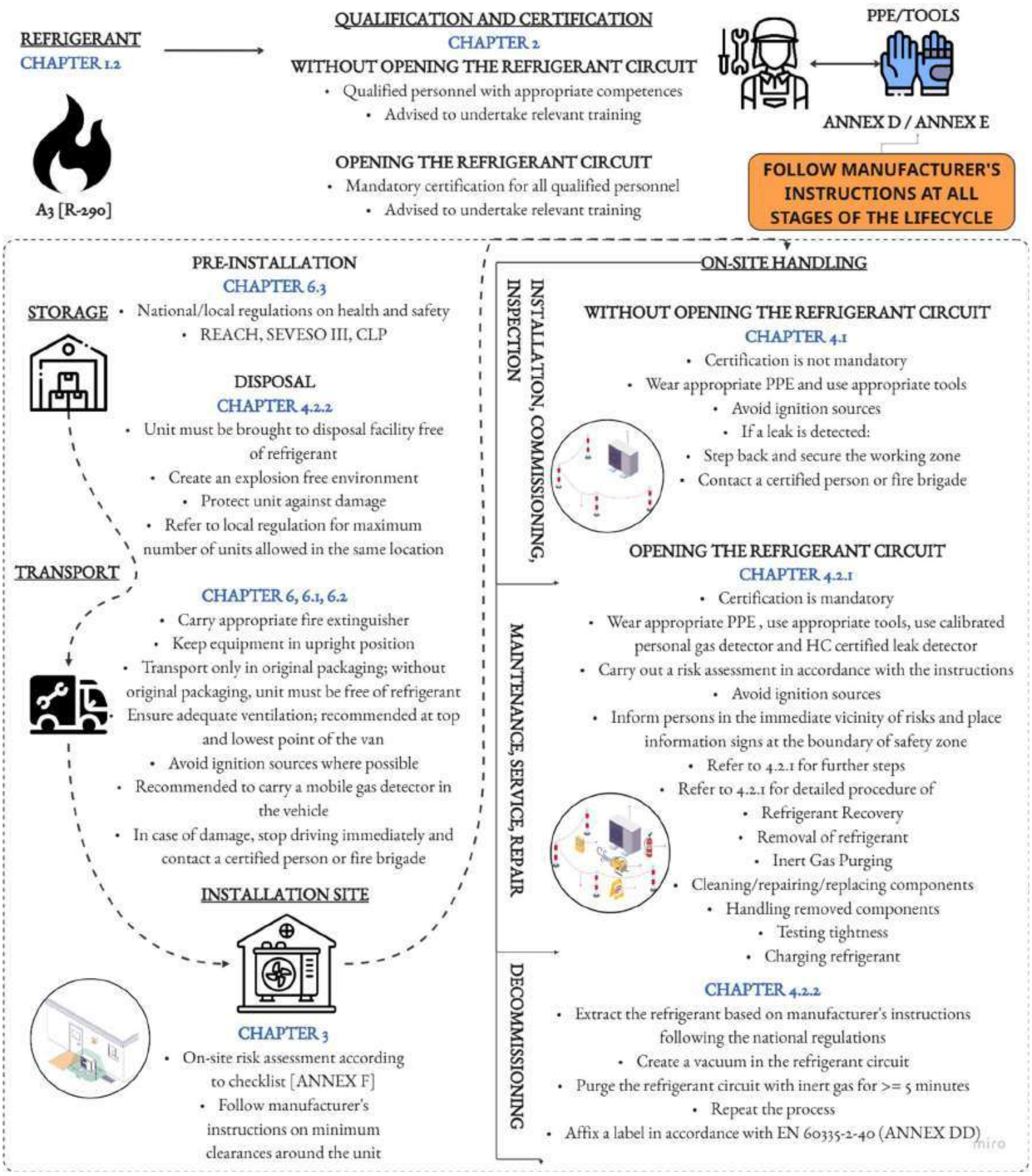
GUIDELINE MAP



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CAUTION:
This document is a guideline and cannot replace the local and/or national health and safety ordinances and the manufacturers' binding instructions which obey the applicable standards and regulations.

1. GENERAL

The revision of the new F-gas Regulation (EU) 2024/573 increased the number of heat pumps using non-fluorinated refrigerants on the market. This can lead to the use of refrigerants with higher flammability. Heat pumps with such refrigerants may require specific recommendations, which are presented in this guide to provide information on relevant legal, normative and technical content. The target audience for this guideline consists of 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 operator for support.

1.1 Scope

This guideline applies to the handling of self-contained air-to-water heat pumps (AWHP) installed outdoors containing refrigerants with a higher flammability such as R-290 for single family households.

Phases of lifecycle covered:

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

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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 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 is 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.

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

Certification in handling refrigerants is not required, nevertheless, expertise is necessary (training, experience, instruction) to perform work outside the refrigerant circuit as it includes activities such as commissioning, transportation, putting into operation, installation, operating, general maintenance and dismantling of the equipment.

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Working outside 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 on transportation, installation and dismantling. Following chapters will advise further on actions to be taken should a leak be detected.

2.2 Work involving the opening of the refrigerant circuit

This work involves activities which require the opening of the refrigerant circuit, such as in-service inspection, leak checking, circuit maintenance, decommissioning, removal of refrigerant, filling with 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 for all types of refrigerants 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:

Laying the foundations / groundworks or mounting, placing / locating, and completing the water and electrical connections of the heat pump equipment

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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

Putting into operation:

Integrity inspection and setting to work of the refrigerating system for the first time or after significant changes

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 heat pump system conforms to predefined requirements (e.g. functionality, correlation of temperature and pressure, capacity checks, quality checks of joints for existence of corrosion)

Maintenance:

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

Removal of refrigerant:

Recovering the refrigerant out of a refrigerating circuit

Dismantling:

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

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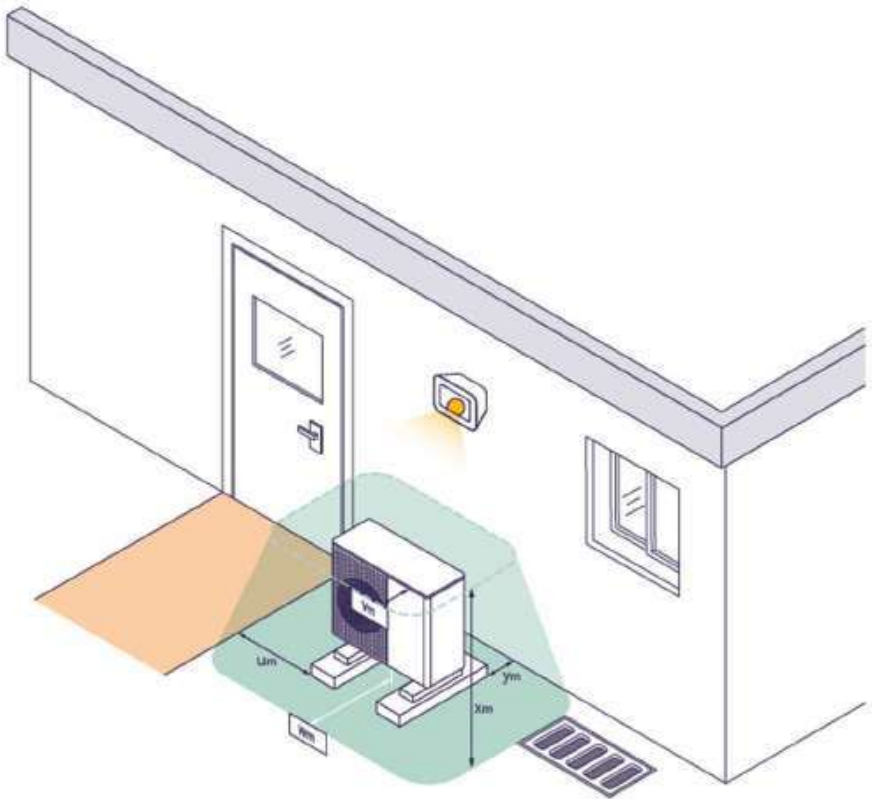
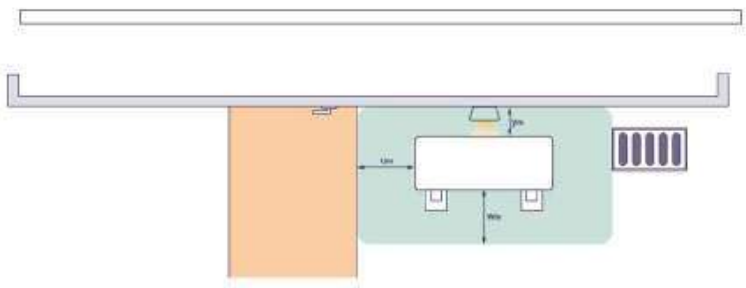
3. Installation site

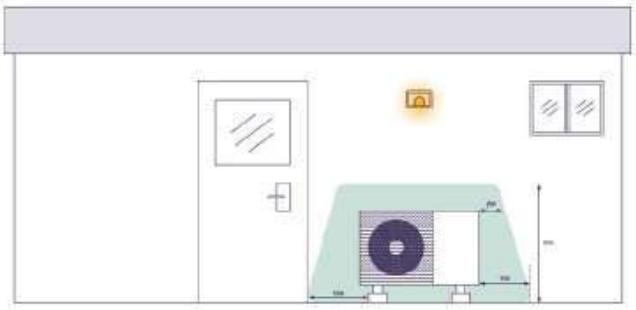
The following recommendations are examples of instructions to be provided by the manufacturer. The manufacturer’s instructions should be followed under all conditions.

3.1 Ground-level outdoor installation

These diagrams are examples and manufacturer instructions for minimum clearances must be followed.







For heat pumps installed outside, it must be ensured that no refrigerant concentrations which could become flammable can enter the building in the event of a leak. In the event of a refrigerant leak, it must be ensured that it does not pose a risk to individuals outdoors or in neighbouring buildings. In all cases, the

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manufacturer instructions must be followed regarding requirements for a 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. Within these minimum clearances, there must be no permanent or short-term sources of ignition during normal operation such as the ones mentioned in table 1 in Annex C.

In addition, within the minimum clearances, there should not be:

- Building inlets such as windows which might be opened, doors, light shafts, flat roof windows, openings of ventilation systems
- Property boundaries or neighbouring properties, walkways and driveways, depressions or ground depressions
- Open inlets in sewers and sewage shafts

The definitions of the minimum clearances can look like those shown above however, they are manufacturer-specific and can vary. During installation, the minimum clearances 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 adhered to at all times.

If the installation location must be chosen in such a way that possible openings (see list above) in the minimum clearances cannot be avoided, it is possible to change the area around the installation location by means of permanent and tight barriers (e.g. walls or partitions). 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 taken into account proportionally. In all cases, it should be ensured that both, the equipment and any obstacles surrounding it, are not potential causes of gas stagnation.

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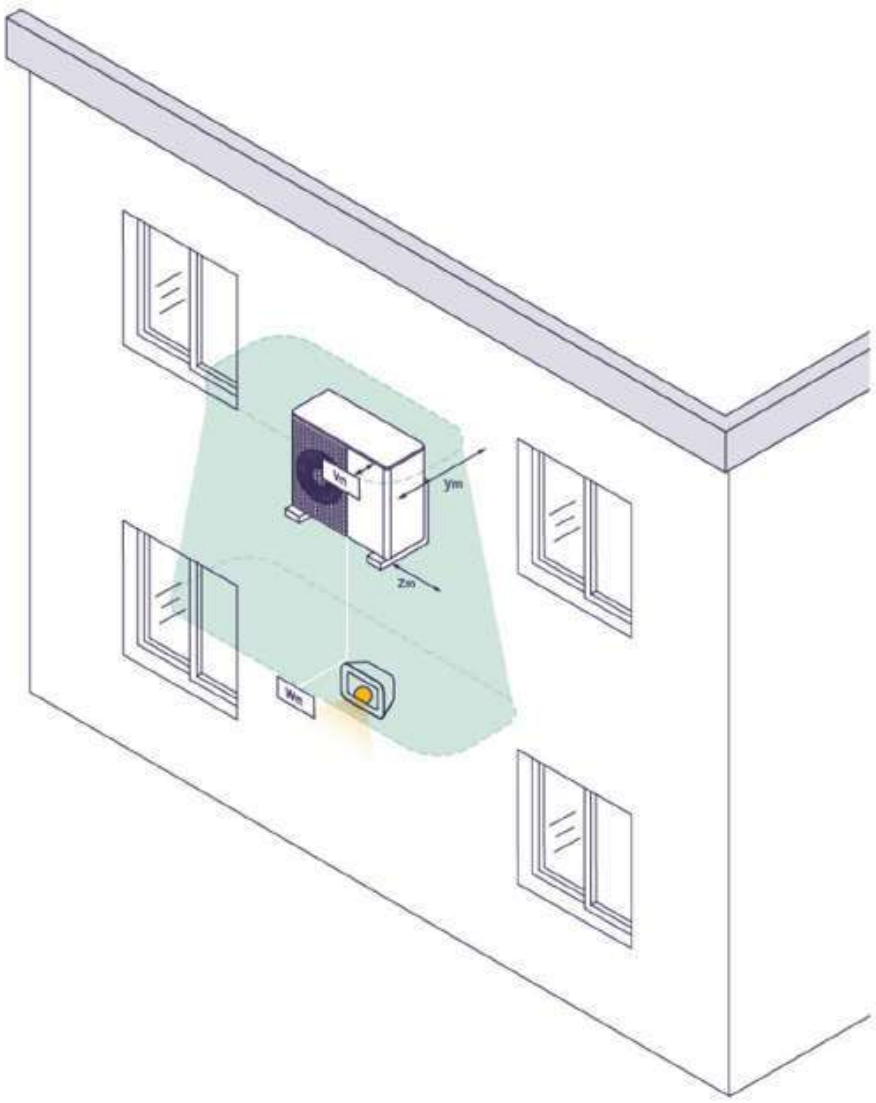
3.2 Wall-mounted installation



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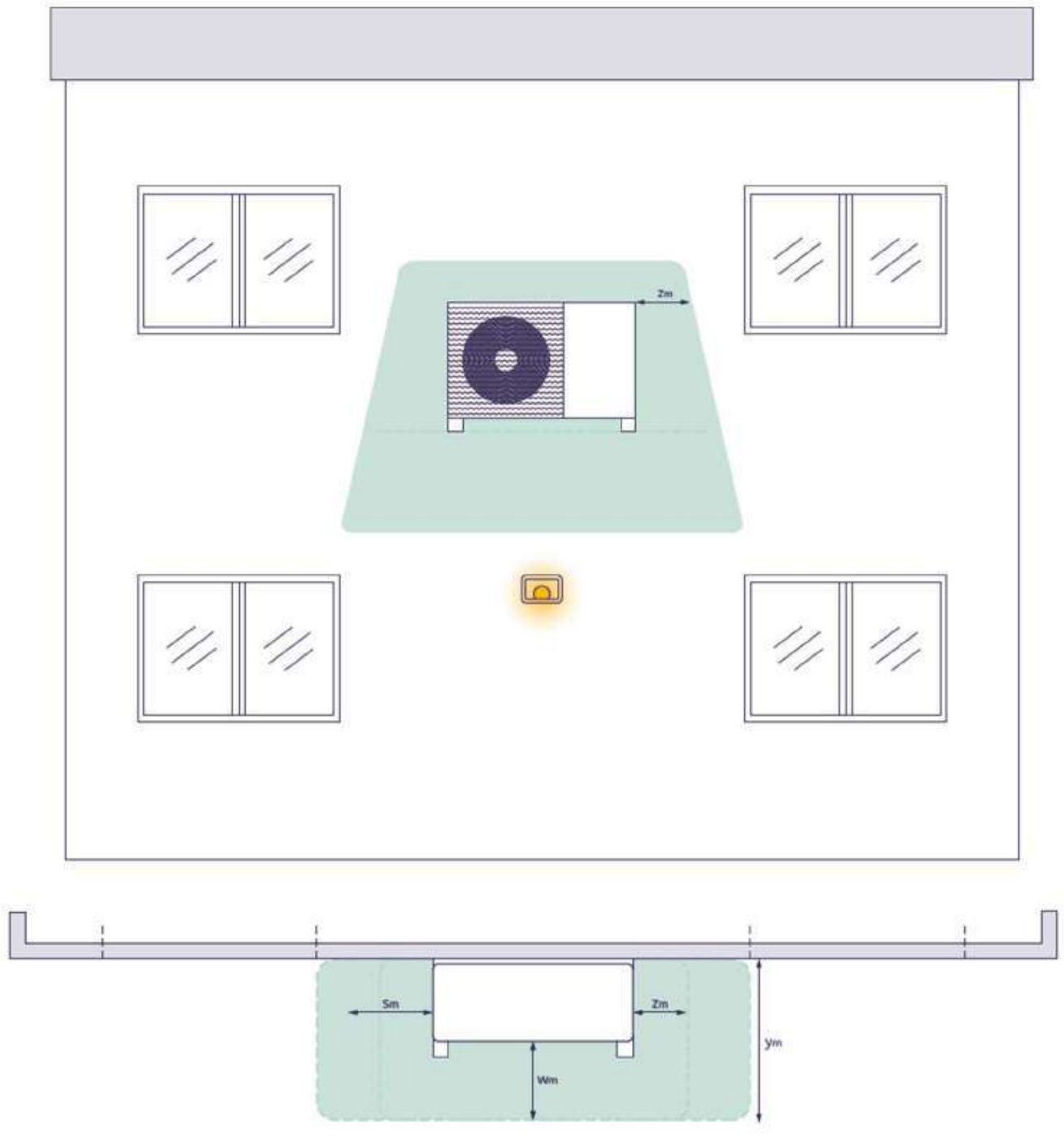

For wall-mounted heat pumps, the minimum clearances are the same as for ground-mounted installations.

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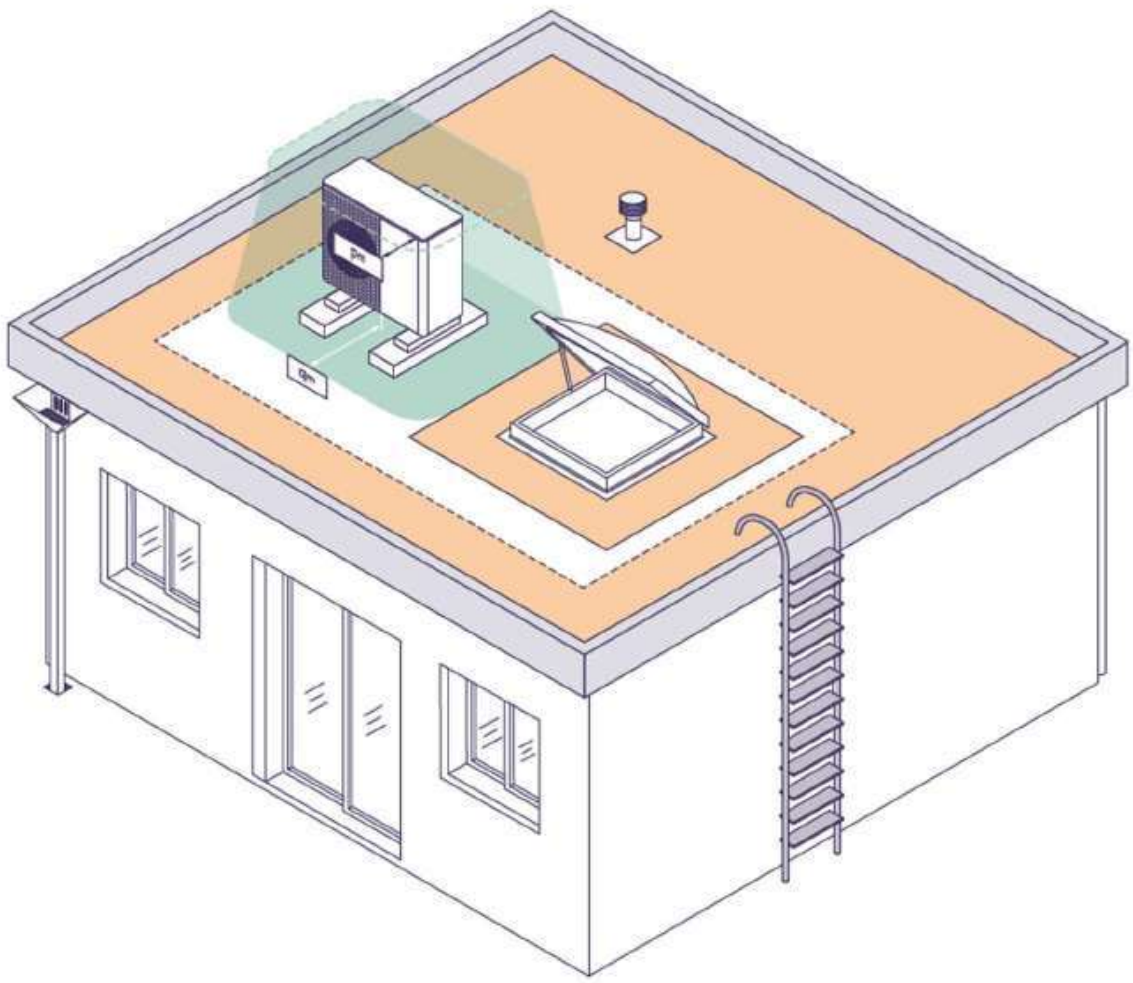
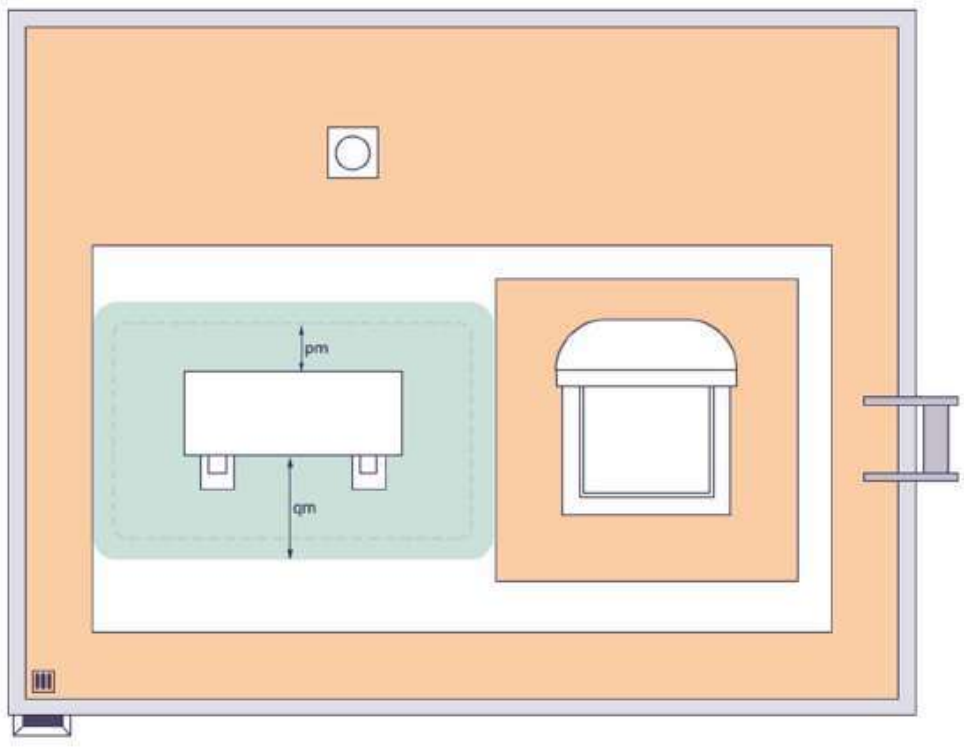
3.3 Roof/Roof terrace installation





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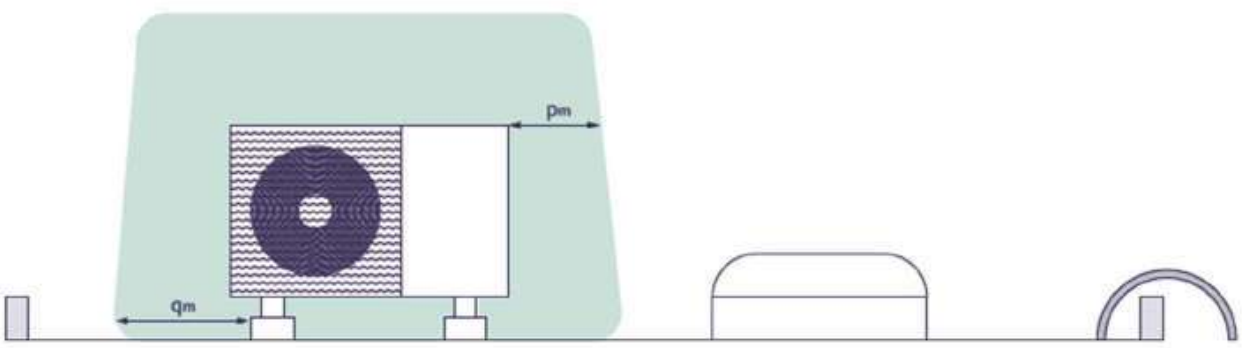
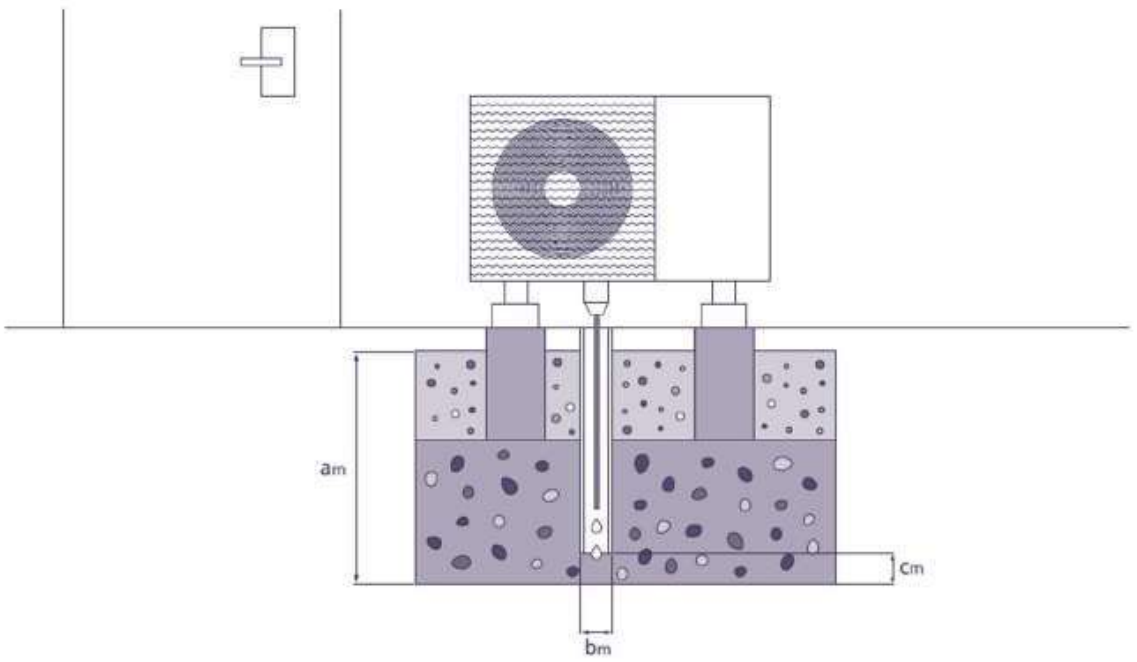


The same requirements apply for outdoors installation close to the ground. In addition, roof ventilators and roof drainage systems must not be located within the protection area. In areas with parapets, accumulation of dense gases should be avoided.

3.4 Condensate drain



It is important to ensure that the condensate drain is frost-free and cannot be blocked by, for example, snow accumulations, in order to avoid ice formation on the evaporator and of damage that can cause a leakage.

Condensate drains should not be connected to any drainage system. During a refrigerant leak, the refrigerant could be dumped into the sewer potentially forming a flammable mixture inside it.

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4. On-site handling of the equipment

4.1 Without opening the refrigerating circuit

Every heat pump manufacturer is required to be compliant with all relevant regulations with the CE declaration of conformity before placing their products on the market. This means that each heat pump is subjected by the manufacturer to a pressure strength test, a leak test and a functional test of the safety switching devices for pressure limitation.

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 of safety precautions to prevent possible hazards.

It is advised to avoid ignition sources when working on the heat pump during assembly, commissioning and general maintenance. This includes activities which can generate sparks and/or high temperatures.

The installation may be carried out by qualified personnel without certification as long as the refrigerant circuit is not opened and the safety measures are in place within the minimum clearances.

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 ATEX approved). Caution: using a dilution fan might make it impossible to detect the refrigerant leakage as the leak will be diluted.

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

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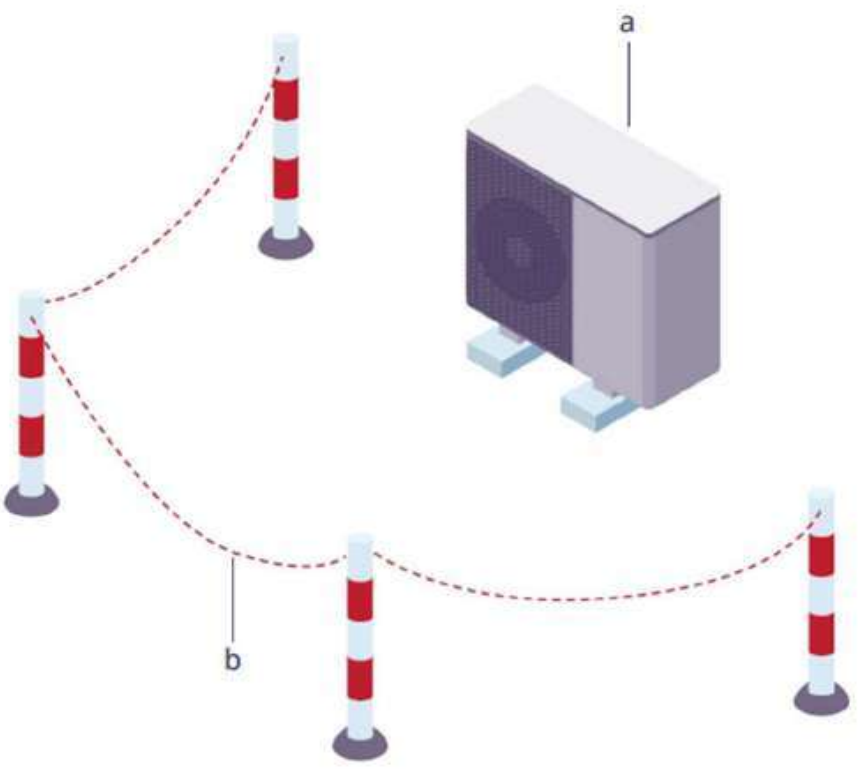
extending the flammable cloud or initiating ignition sources into the flammable zone. They are recommended to step back and secure the working zone as shown below and call a certified person or the fire brigade to ensure a safe handling of the leak.



a. Heat Pump b. Bollards

The recommendations for the manufacturer for safety measures recommended to be taken 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 (e.g. power tools, computers, etc.)
- Use a gas monitoring system, a portable explosion-proof ventilation equipment and a fire extinguisher
- Ensure sufficient ventilation
- Connect earthing according to instructions and type of installation
- The cable and pipe penetrations into the building must be gas-tight
- Power supply is arranged in such a way that during installation the equipment can be de-energized in emergencies and during service work

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For transportation and storage of the equipment for the site operation, see chapter 8.

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 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 spark free screwdriver
6. Search inside the equipment using the HC leak detector
7. 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
8. If at any of the steps there is a measurement of leaking gas. Step away from the equipment and call for help from a certified person or the fire brigade to ensure a safe handling of the leak and secure the working zone.

4.1.1 Installation and commissioning

Heat pumps must be commissioned step by step in accordance with the manufacturer's instructions and shall only be carried out by qualified 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.

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.

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

The manufacturer shall provide information on the risks related to the freezing of the heat transfer fluid in the secondary circuit and might add suggestions and references to the possible measures foreseen by the applicable standard to mitigate similar risks. Manufacturers should specify what types of secondary heat transfer fluids can be used, along with the corresponding setpoint for the frost sensor to protect against freezing in the secondary heat exchanger. Furthermore, they should ensure that mitigation measures like gas separators are functioning properly.

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 venting devices, automatic safety pressure relief valves (minimum opening pressure) or other countermeasures must be observed.

4.1.2 Inspection

According to ISO 5149-4, 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. If leak is detected, step back and secure the working zone and call a certified person or the fire brigade to ensure a safe handling of the leak. 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. If any of the following actions require opening of the refrigerant circuit, it is recommended to follow the procedure in section 4.2.

- Check for damage to the equipment
- Check that all components are as specified by manufacturer

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- Check that safety devices are present
- Check that devices and arrangements for safety protection are present
- Check instructions and directions to prevent deliberate discharge of refrigerant to the environment
- Compare the installation with the system drawings from the operating instructions
- Check vibrations and movements caused by temperature and pressure under operating conditions
- Check installation fittings and valves
- Check supports and fixing
- Check protection against mechanical damage
- Check protection of moving parts

4.2 Opening the refrigerating 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 and any applicable national/local regulations.

4.2.1 Maintenance, Service and Repair

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.

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- 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 taken into account 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.

Once the safety measures have been ensured in accordance with the manufacturer's instructions and as described in the previous chapter, following procedure may be undertaken, as applicable, for the below actions involving the opening of the refrigerant circuit.

Please note that in case of an emergency the refrigerant may leak according to the hat model as shown in Figure A.4a in EN IEC 60079-10-1. This is an example illustration and not exhaustive. 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:

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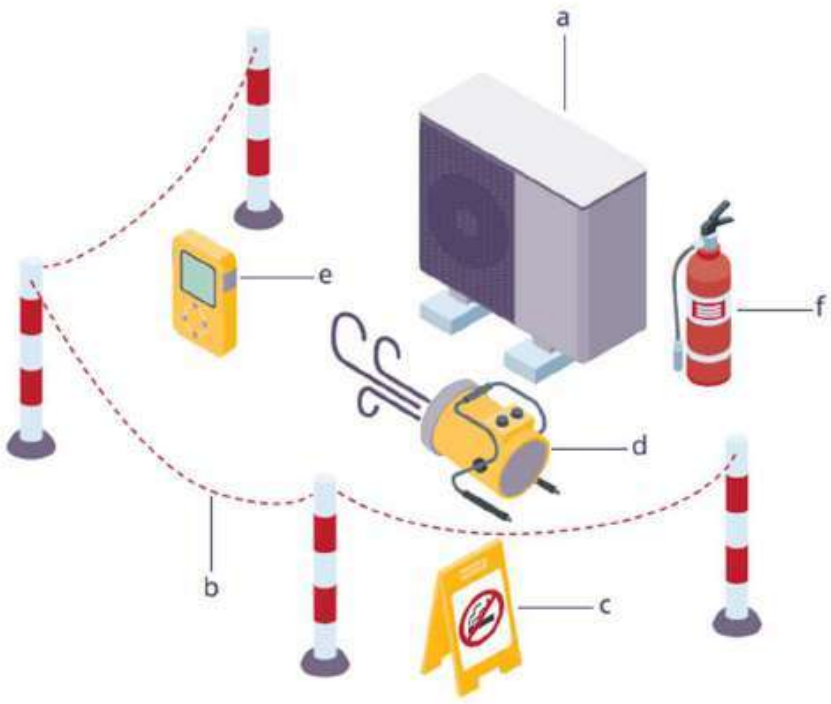

a. Heat Pump b. Bollards c. Safety sign d. ATEX approved fan

e. Gas detector f. Fire Extinguisher

Please note that the safety zone must be evaluated according to the leakage rate and on-site condition and shall be marked according to ISO 7010:2019. Be aware buildings and building openings might be present within the safety zone. Ensure sufficient ventilation at the safety zone to make sure any leaking refrigerant is diluted. If insufficient ventilation is available, an ATEX approved fan should be used. 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 300 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.

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- After the recovery, it is recommended to open the valves on the hoses in a well-ventilated outside area to remove any remaining refrigerant.
- Monitor the recovery operation at all times.

Removal of refrigerant from the oil in the components:

- 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.

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 1.0 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

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- Depending on products, different scenarios are possible, such as possibility and necessity of brazing, and availability of service ports. 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 is able to 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, confirm that the refrigerant type is correct, and amount of refrigerant is sufficient.

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- Avoid 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.

Caution throughout the process:

Do not vent refrigerant inside a building or public area.

4.2.2 Decommissioning and disposal

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

The secondary circuit fluid water must be completely removed from the connecting pipes and the condenser to avoid frost damage.

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.

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- In accordance with EN60335-2-40 (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 qualified disposal companies. Although the equipment must be emptied of refrigerant 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, setup 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.

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:

- Refrigerant number in accordance with ISO 817

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- 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

If a service connection is present and the refrigerant used is not immediately apparent upon access to this service connection, it must be marked to identify the type of refrigerant with a warning of a risk of fire, flammable material. The hazardous substance symbols shall be visible when viewing the appliance after it has been installed. The marking may be behind a detachable part that has to be detached before maintenance or repair work.

5.2 Documentation for the operator

It is the manufacturer's responsibility to provide the operator with, among others, the following documents concerning their product:

- Declaration of conformity
- Physical copy of installation and operation manuals in the respective national language
- The service manual is not required as a physical copy, however, it is up to the manufacturer to choose how it is provided
- 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.

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6. Transport

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 transport of 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 them to and storing them on site:

- It is recommended that the device be transported by a freight forwarder or logistics company (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.
- Transport with refrigerant filling is only permitted in the original packaging. For transport without the original packaging, the refrigerant circuit must be free of refrigerant. This also applies to the return transport to the wholesaler or manufacturer. The terms of return must be clarified before transport. (Reference Chapter 4.2.2 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.

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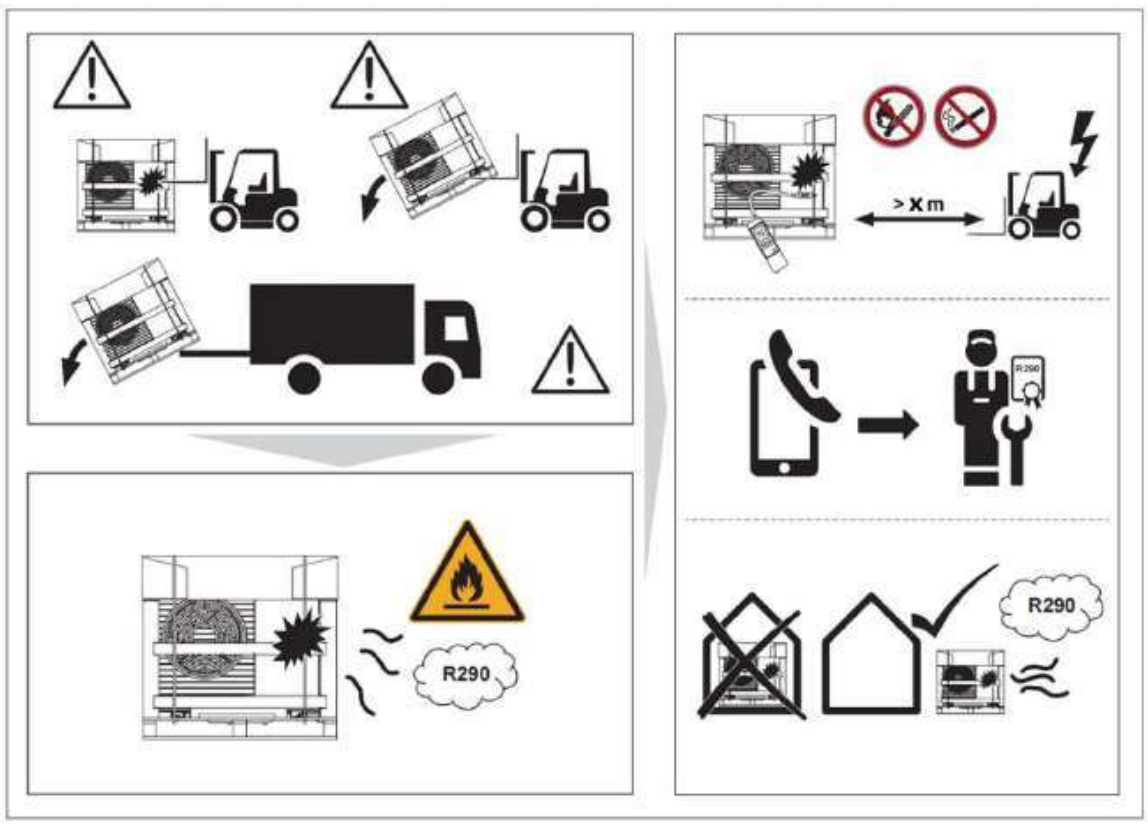
- Ignition sources such as flying sparks, smoking, hot surfaces, etc. must be avoided.
- Intermediate storage at the customer's premises over long periods of time should be avoided; it must always be above ground level with sufficient air exchange. Storage in unventilated containers is prohibited. It is recommended to have stationary detection in a location storing equipment containing flammable HC refrigerants.

Below is an example of a packaging label. Minimum clearances depend on the manufacturer and should be followed accordingly.



Below are examples illustrations of recommended measures during transportation.

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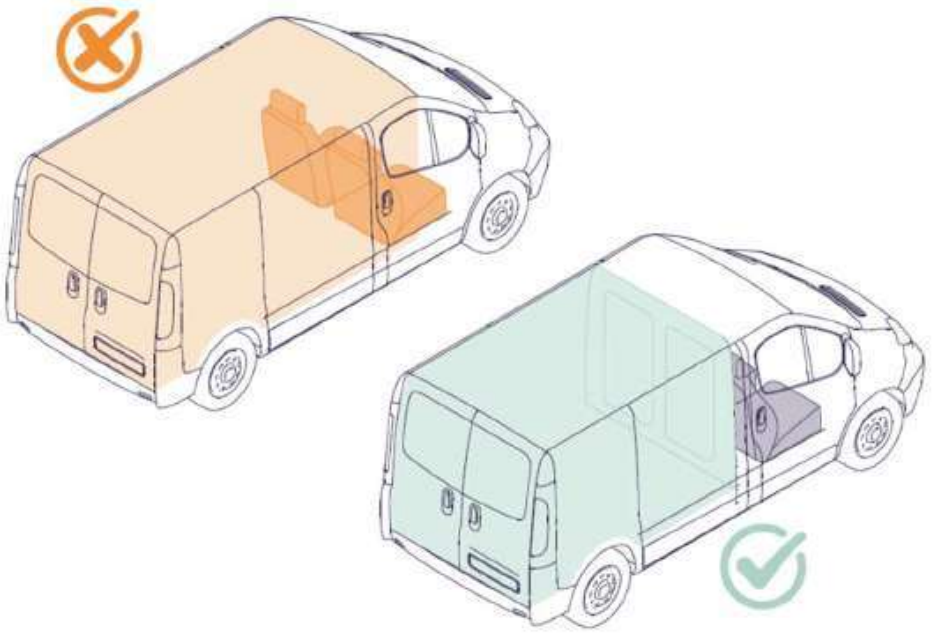

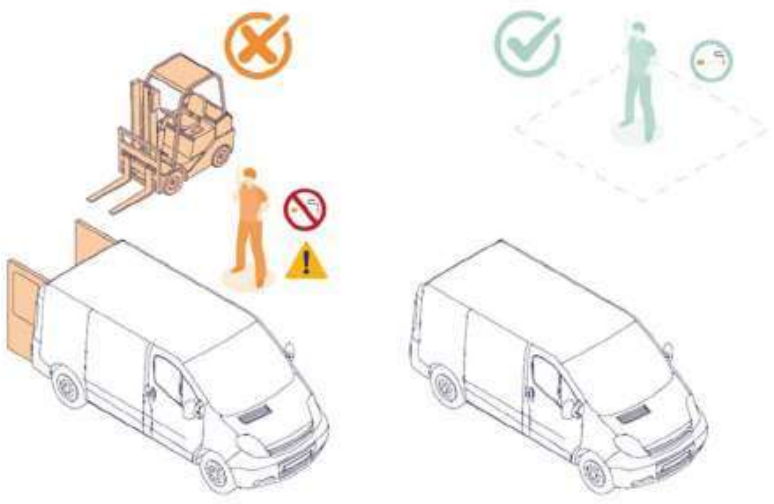

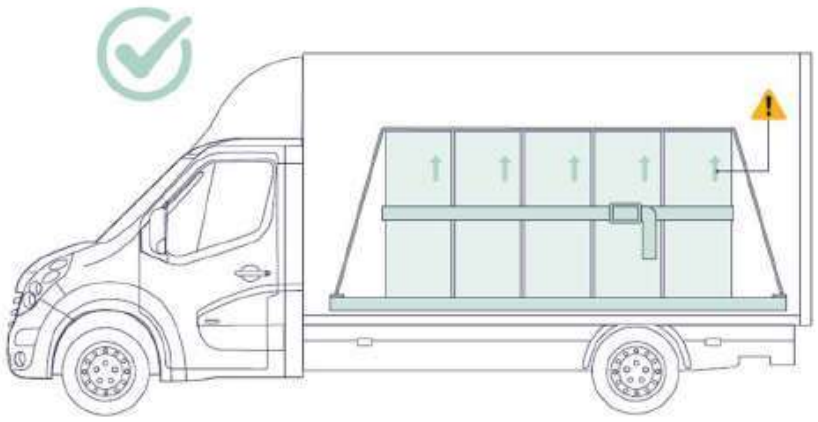

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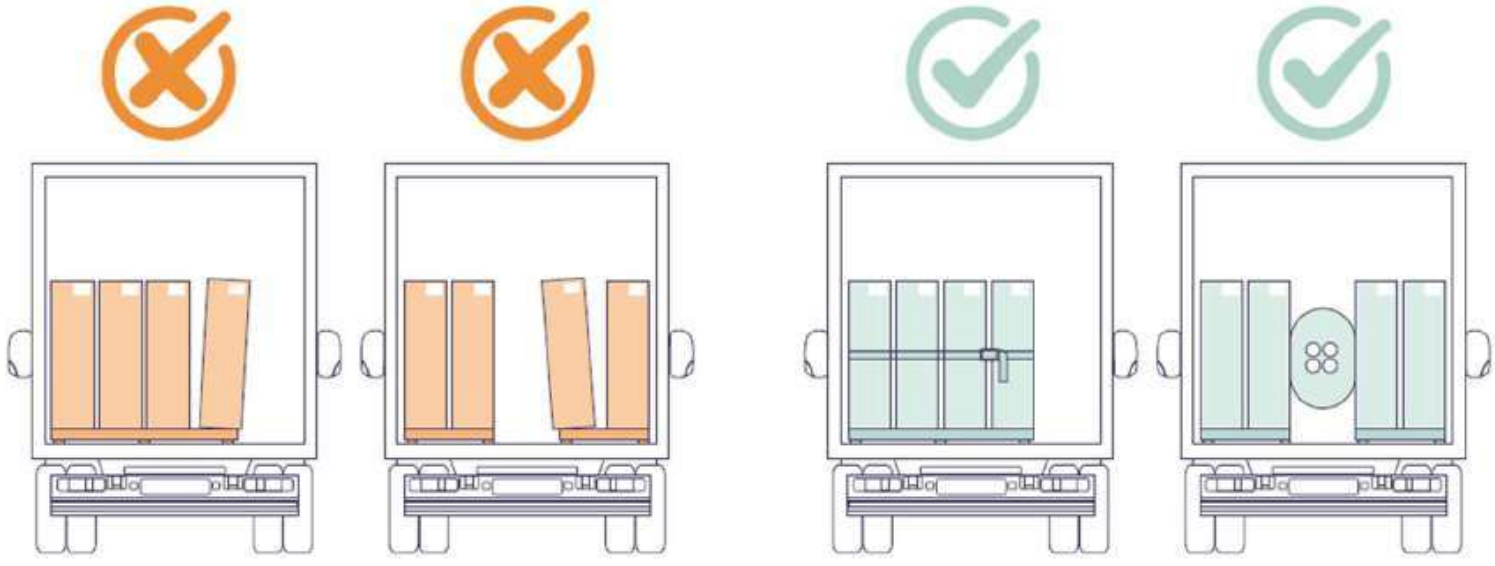

6.2 Transport damage

If the equipment is damaged during transport, it is advised to stop driving immediately. A certified person or a fire brigade 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 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 follow national or local regulations regarding

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labelling or storage of hazardous substances. Instructions provided with the equipment are advised to be read.

6.3.2 Fire protection

When 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. Manufacturers should provide information about training the warehouse operators for storing heat pumps containing refrigerants with higher flammability, dedicated storage spaces, leak sensors, appropriate ventilation systems and eliminating ignition sources. Consider specific measures on a case-by-case basis to ensure adequate protection against the formation of explosive gas mixtures. All risk assessment should be performed by the warehouse management, and action should be taken when and if required.

6.3.3 Explosion protection

Each heat pump is subjected to a leak test by the manufacturer during the manufacturing process. However, any damage during transport 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 large quantities of refrigerants in heat pumps, it is advisable to check the explosion hazard of the storage facility. The basis for this is the number of heat pumps, 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:

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- 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 a stationary gas detection in a location storing equipment containing refrigerants with a higher flammability.

7. 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 F in addition to manufacturers 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.

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ANNEX

A. Classification of refrigerants according to CLP

Classification		Labelling			
Hazard class	Hazard category	Pictogram	Signal word	Code	Hazard statement
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 source
	Electric parts	Appliance (hot surface)
		Parts in equipment (sparks)

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Spark		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.

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Item	Image
Personal Gas detector Minimal detection of LEL + O2	
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.

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Item	Image
EX marked leak detectors	
Spark Free screwdriver to open unit	
Fire extinguisher with an ABC rating Minimal rating 34A 233B C	
R-290 approved vacuum pump	
Measuring scale with 2 decimal digit accuracy for checking reclaimed refrigerant R290 compliant version	
Meterset certified for A3 refrigerants such as R290	
R290 certified 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	

Item	Image
Torchset to repair installation	
ATEX approved fan to be able to dilute the mixture	
Tool to close off pipe in case leaking unit needs to be replaced and transported	
Not possible to transport leaking units according to ADR	
Bollards with 25m of chain	
Safety Sign according to ISO 7010	
Storage	
	

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. Staff may only perform actions in Section 1.4 of the list below if they do not possess the appropriate certification.

	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	

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			☐ 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)** ☐ 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 ☐ The minimum clearances comply with the manufacturer's instructions and don't exceed boundaries with neighbours or public places ☐ Within the minimum clearances, all building openings are sealed	
		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 suitably tested 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	

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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	

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			☐ 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.

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