

Product manual EMB

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1. About the manual

This manual contains valuable information regarding the Energy Machines™ EMB machine. Please read it carefully and keep it in a safe place close to the machine.

1.1. Purpose of the manual

This manual:

- Describes the installation, operation, and maintenance of the machine.
- Provides important information on safe and efficient handling of the machine.
- Presents faultfinding and troubleshooting information.

Follow instructions in the order shown when presented as a numbered list. Items that do not require a specific order are shown as a bulleted list.

1.2. Explanation of symbols and warnings

Safety symbols and warnings are used throughout this manual:



DANGER

Indicates a hazardous situation which, if not avoided, will result in a serious or life-threatening injury.



WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in a serious or life-threatening injury.



CAUTION

Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.



NOTICE

Indicates a possible risk to property, but no risk to people.



INFORMATION

Indicates important information, but no risk to people or property.

2. Safety

This section contains important information on the safe operation of the machine. Read this information before using the machine.

The machine must only be used for its intended purpose. It must not be modified in any way. Energy Machines accepts no liability for damage due to incorrect installation, configuration, repair, service, or use.

In the event of an emergency:

1. Disconnect the power supply to the machine if safe to do so.
2. In case of a fire, use a carbon dioxide fire extinguisher.
3. Raise the alarm and evacuate the building if necessary.



DANGER

Do not use water on machine fires

- Using water on a machine fire can cause electric shock, electrocution, or death.
- ⇒ Only use a carbon dioxide fire extinguisher on machine fires.

2.1. Responsibilities

It is the responsibility of the operator to comply with all instructions in this manual. A thorough knowledge of the safety information and regulations is essential for safe handling and error-free operation of the machine.

2.1.1. Responsibility of the operator

Only authorized and experienced personnel may operate the machine. The maintenance, servicing, and dismantling of the machine are also restricted to authorized personnel.

The machine is not intended for use by people, including children, with reduced physical capabilities or lack of experience and knowledge. Children should be supervised while near the machine to prevent any play or interaction.

The operator has the responsibility to ensure that work on the machine is only performed by individuals who:

- Possess a knowledge of workplace safety information and accident prevention measures.
- Have received training in working with and operating the machine.
- Have read and understood this product manual.
- Possess the competence to install, maintain, and service heat pumps.
- Have expertise in electricity and/or refrigeration.

It is also the operator's responsibility to:

- Ensure that all safety signs on the machine remain legible.
- Replace safety signs that are damaged.

2.1.2. Responsibility of the user

Users working with the machine have the responsibility to:

- Comply with the workplace safety instructions and accident prevention measures.
- Follow all safety information within this manual.
- Read and understand the information regarding safety signs as presented in this manual.
- Follow the guidance displayed on the safety signs while operating the machine.
- Possess a comprehensive knowledge of how the machine functions.
- Read and understand the sections of this product manual related to the tasks being performed.
- Take action to resolve any fault or malfunction immediately.

2.1.3. Risks associated with machine operation

The machine has been constructed in accordance with the latest approved safety regulations.

As with any machine, there are risks associated with its operation. Follow the safety instructions and observe restrictions when operating, maintaining, servicing, and dismantling the machine.

This chapter provides safety instructions and detailed operation risks including:

- Risks to the health and safety of the user and others.
- Risks to the machine itself.
- Risks to property, goods, and equipment.

Only use the machine for its intended purpose and do not make modifications to it. Only use the machine when it is in proper working condition. Address any faults or malfunctions that could compromise safety immediately.

Energy Machines accepts no liability for damage caused by incorrect installation, configuration, repair, service, or use.

2.2. Safety information

It is essential to adhere to the following safety precautions:

- Installation, maintenance, and operation are restricted to authorized personnel only.
- Follow all warnings and instructions.
- Never bypass safety features.
- Only operate the machine when it is in proper working condition.
- Disconnect the power supply before any maintenance work.
- Do not rinse the machine with water.
- Keep all safety panels in place during installation to avoid water exposure to electrical components.

2.3. General safety instructions

Pay careful attention to the following instructions regarding safety, as they concern potential hazards that may arise during use of the machine.

2.3.1. Personal protective equipment

Personal protective equipment (PPE) must be worn while operating, installing, or repairing the machine. PPE should be designed to protect against heat, cold, hazardous chemicals, and electrical shock, as appropriate.

PPE should include:

- Protective clothing
- Protective gloves
- Safety glasses
- Protective shoes
- Hearing protection
- Protective respirator

2.3.2. Sources of ignition

All possible ignition sources, including cigarette smoking, should be kept away from the site of installation, repair, storage, and disposal.

Prior to work taking place, the area around the machine should be surveyed to ensure there are no flammable hazards or sources of ignition.

Display "*No smoking*" signs clearly near the installation site.

2.3.3. Dangers



DANGER

High voltage electricity

The following can cause electric shock, electrocution, or death:

- Touching live electrical parts
 - Direct contact to electrical equipment
 - Disruptive discharge from electrical equipment
 - Electric arcs from electrical equipment
- ⇒ Always disconnect from the power supply before maintenance.



DANGER

Heavy machinery

- Heavy machinery falling can cause injury or death.
- ⇒ Do not go under the machine while it is being lifted.



DANGER

Unstable machinery

- Unstable machinery can cause injury or death.
- ⇒ Keep a safe distance from an unstable machine.



DANGER

Refrigerant leakage

- Significant leakage of refrigerant can cause suffocation or death.
- ⇒ Wear appropriate PPE.
- ⇒ Evacuate others in the case of significant refrigerant leakage.

2.3.4. Warnings



WARNING

High voltage electricity

- Touching live electrical components can cause injury or electric shock.
- ⇒ Wear appropriate PPE.
- ⇒ Always disconnect from the power supply before maintenance.



WARNING

Extreme temperatures

- Release of high-pressure refrigerant, heat transfer fluid, or discharge from safety valves can result in burns, scalds, frostbite, or other injuries.
- ⇒ Wear appropriate PPE.

**WARNING****Fluid leaks and fumes**

The following can cause irritation, respiratory disease, or breathing difficulties:

- Refrigerant leakage
- Inhalation of fumes from refrigerant or heat transfer fluid

- ⇒ Wear appropriate PPE.
- ⇒ Be aware that refrigerants may not contain an odor.
- ⇒ Avoid working in confined spaces.

**WARNING****Entanglement**

- Getting caught or tangled in machine parts can cause physical injury.

- ⇒ Do not operate the machine while wearing loose-fitting clothing.
- ⇒ Prior to operating the machine, remove jewelry and secure long hair.

**WARNING****Risk of personal injury**

- Piercing or burning the machine can lead to hazardous emissions or fire.

- ⇒ Do not pierce or burn the machine, even after use.

2.3.5. Cautions

**CAUTION****Injury from fire**

Fire from the following can cause burns or scalds:

- Electrical equipment faults
- Brazing, welding, grinding, or abrasion work

- ⇒ Wear appropriate PPE.
- ⇒ Follow the evacuation procedure if necessary.

**CAUTION****High voltage electricity**

- Short-circuit in electrical equipment can result in burns or scalds.

- ⇒ Always disconnect from the power supply before maintenance.

**CAUTION****Hot surfaces**

- Touching hot surfaces can cause burns or scalds.

- ⇒ Wear appropriate PPE.

**CAUTION****Cold surfaces**

- Touching cold surfaces can cause frostbite.
- ⇒ Wear appropriate PPE.
-

**CAUTION****Risk of falling**

- Condensation of water on cold surfaces can result in slips or falls.
- ⇒ Wear appropriate PPE.
- ⇒ Be vigilant of water on floors and surfaces.
-

**CAUTION****Sharp edges and hard surfaces**

- Negligent physical contact with the machine can result in bruising, cuts, or lacerations.
- ⇒ Wear appropriate PPE.
- ⇒ Do not strike the machine.
-

**CAUTION****Risk of injury**

- Poor working posture can cause discomfort or pain.
- ⇒ Maintain proper working posture.
-

**CAUTION****Loud noises**

- Loud noises can cause discomfort or hearing damage.
- ⇒ Wear appropriate PPE.
-

**CAUTION****Injury from leaked fluid**

Leaked or spilled fluid can cause injuries, such as:

- Frostbite from refrigerant
 - Injuries from slips or falls
- ⇒ Wear appropriate PPE.
- ⇒ Stay vigilant for leaks or spills on surfaces and floors.
-

2.3.6. Safety signs on the machine

Permanent safety signs are displayed on the machine. The locations of these safety signs are indicated in the *dimensional drawing*.



INFORMATION

Safety signs should not be removed or altered. Damaged or illegible safety signs should be replaced immediately.

The following warning signs are displayed on the machine:

- Machine high voltage warning sign
- Electrical component high voltage warning sign
- Secondary circuit connections warning

Machine high voltage warning sign

A high voltage warning sign, as shown in *Figure 1: Machine high voltage warning sign*, is attached to the control panel door on each cabinet. The warning symbol shows a triangle with a yellow background, black border, and a jagged lightning arrow.

The following text is shown above the warning sign:

“Warning: Risk of electric shock. Can cause injury or death. Disconnect all remote electric power supplies before servicing.”

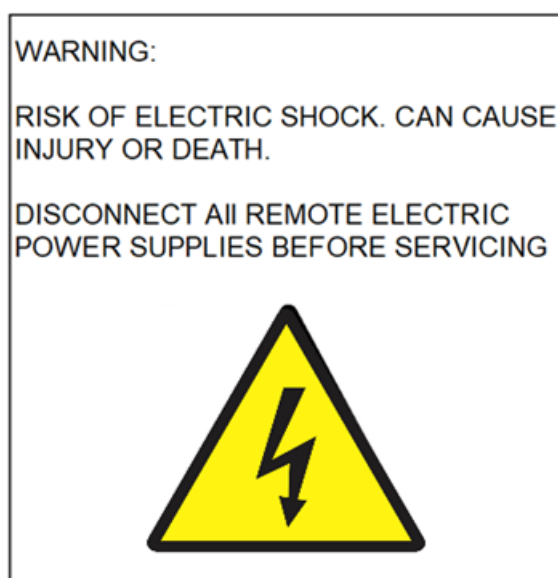


Figure 1: Machine high voltage warning sign

Electrical component high voltage warning sign

The electrical components display a high voltage warning sign as shown Electrical component high voltage warning sign.

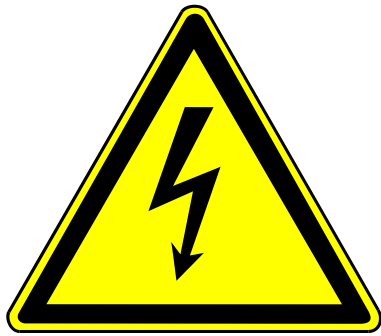


Figure 2: Electrical component high voltage warning sign

Secondary circuit connections warning

The secondary circuit connections display the following warning text:

"Not suitable for potable water connection"

2.3.7. Managing emissions

Exercise caution and follow all local regulations regarding emissions or leakage of hazardous substances.

Implement the appropriate safety measures relevant to the type of fluid emission or leakage.

Refrigerant emission or leakage

- Wear appropriate PPE while handling refrigerant.
- Ventilate the room.
- Control the oxygen level with a level meter.
- Evacuate the area, if necessary.

Heat transfer fluid emission or leakage

- Wear appropriate PPE while handling heat transfer fluid.
- Use an appropriate absorbent, such as a sponge or powder, to collect leaked fluid.
- Clean any surfaces exposed to leaked fluids.
- Follow the instructions on the *material safety datasheet* for the heat transfer fluid.

3. Machine overview

This chapter provides information regarding the machine and its intended operating environment.

3.1. Machine description

Energy Machines units are self-contained, energy-efficient, and reliable machines. These machines are factory-sealed, single-package units. They are made up of refrigerating system components with heating and cooling capabilities. A correctly dimensioned heating system with Energy Machines results in both cost and energy savings.

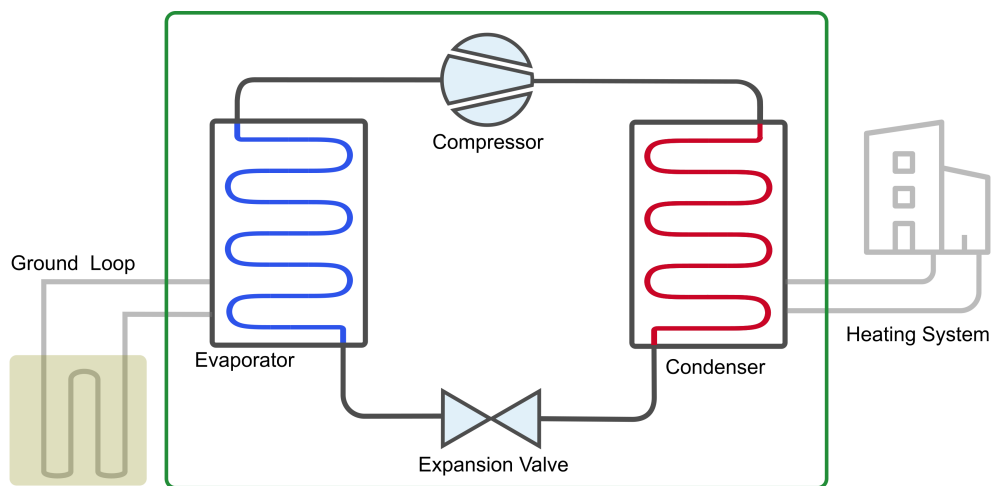


Figure 3: Simple heat pump

The EMB heat pump typically contains two circuits with a twin compressor in each, however smaller models have two circuits with one compressor in each. It offers an optional integrated subcooling system that allows for the recovery of heat energy between the condenser and expansion valve. This results in higher performance due to a greater energy uptake in the machine's evaporator process. It is designed to handle large pressure drops on the chilled water side using the machine's internal chilled water pump. With integrated control valves and circulation pumps, the EMB comes as a completely reversible heat pump in one unit.

The machines are delivered factory-finished, where the only action required on site is connecting the machine to pipework and electricity. With integrated control valves and circulation pumps, the EMB comes as a complete heat pump unit in a single structure, fixed on a common mounting. This creates a discrete unit in which all refrigerating system parts have been sealed tightly by welding, brazing, or a similar permanent connection during the manufacturing process.

3.2. Intended use

Energy Machines units are intended to provide heating for a designated area while in heating mode and cooling while in cooling mode. The machines are designed for heating and cooling spaces, as well as providing hot and cold water to be used on its own or used for other heating and cooling purposes.

3.3. Prohibited use



WARNING

Water not fit for human consumption

- Hot or cold water produced by the machine can cause personal harm if consumed.

⇒ Do not consume water produced by the machine.

The machine must be installed in a location away from flammable materials and potentially explosive gas atmospheres.

Only authorized and experienced personnel may operate this machine. The maintenance, servicing, and dismantling of the machine are also restricted to authorized personnel.

The machine is not intended for use by persons, including children, with reduced physical capabilities or lack of experience and knowledge.

3.4. Key machine specifications



INFORMATION

For specific values, refer to the *project datasheet* and *dimensional drawing*.

Power supply depends on the customer's specification. Usually, it is a 3-phase system with either 400 V at 50 Hz or 480 V at 60 Hz.

3.5. Controls and displays

Use the machine's control panel to start the machine and acknowledge any alarms. Default parameters are set during factory testing. Project-specific parameters need to be set during commissioning. Modifying parameters is possible via the Energy Machines Cloud.

3.6. Operating environment

Energy Machines units must be operated in the following conditions:

- Operated indoors only, where the temperature is 16°C–30°C (60°F–86°F) and at no more than 60% relative humidity.
- Protected from wind, rain, and snow.
- Located in an area that is not accessible to the public, preferably in a separate machinery room, with adequate ventilation.
- Operated on flat ground with a maximum inclination of less than 3 millimeters per floor meter (or less than 0.11 inch per yard).
- Secured at its installation place according to the installation and commissioning instructions included in this manual.
- Kept away from flammable materials or potentially explosive gas atmospheres.

4. Transportation, handling, and storage

This chapter provides information about transporting, handling, and storing the machine.

4.1. Transportation

The machine is stored on a pallet for transportation and relocation. The pallet protects against damage to the machine.

Delivery inspection

- Review the packing slip to ensure the correct machine and accessories have been delivered. For more details, see the list of components provided along with the machine.
- The machine is delivered wrapped in plastic and bolted to a pallet.
- Inspect the machine for transport damage and report any damage to the delivery service immediately.

Unpacking

- Leave the protective plastic wrapping in place as long as possible to protect the machine.
- Only cut the plastic loose around the pallet and make holes in the plastic to access connection points for piping and electricity connections.

Location of accessories during transport

- Vibration dampers are bolted to the pallet on the same end as the control cabinet.
- Cable grommets can be found in the control cabinet.
- Pipe connections are either mounted on the machine or supplied in a separate box.
- External temperature sensors are supplied in a separate box if requested.

4.2. Handling the machine



DANGER

Heavy machinery

- There is a risk of serious personal injury or death if the machine falls or tips over during transportation.
- ⇒ Only use appropriate lifting equipment that has been approved for the weight and dimensions of the machine.
- ⇒ Do not go under the machine while it is being lifted.

Lifting from above

The machine can be lifted from above using a crane approved for the intended size and weight specifications. The angle β should not exceed 45° when lifting.

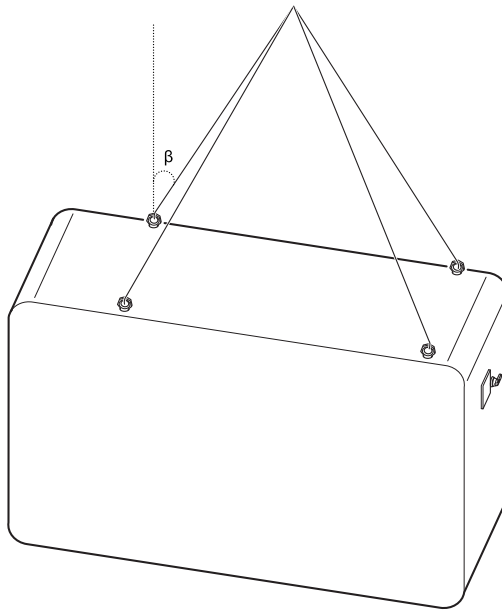


Figure 4: Lifting from above

4.3. Storing the machine

Follow these guidelines to prevent machine damage during storage:

- Store the machine in its protective plastic wrapping prior to installation.
- Maintain a storage temperature of over 5°C (41°F) and at no more than 60% relative humidity.
- Keep storage space adequately ventilated.
- Do not stack or store any objects on top of the machine.
- Do not climb, walk, or work on top of the machine.

5. Installation and commissioning

This chapter provides instructions for installing and setting up the machine.



INFORMATION

Only authorized personnel are permitted to carry out installation and commissioning of the machine.



INFORMATION

Do not install the machine at altitudes of 2000 meters (6562 feet) or above.



NOTICE

Risk of machine damage

- Exposure to water can damage the machine.
- ⇒ Fit side panels onto the machine during installation to protect against water exposure.



NOTICE

Risk of machine damage

- Hydraulic shock can damage the machine.
- ⇒ Design and install piping to minimize risk of hydraulic shock.

5.1. Installing the machine

Energy Machines units must be installed in accordance with the following indoor conditions:

- Kept where the temperature is 16°C–30°C (60°F–86°F) and the relative humidity does not exceed 60%.
- Protected from wind, rain, and snow.
- Located in an area with adequate ventilation.
- Located in an area that is not accessible to the public, preferably in a separate machinery room.



CAUTION

Slippery surfaces

- Higher relative humidity can cause condensation on cold surfaces of the cooling system, which can lead to slippery surfaces.
- ⇒ Keep machine in conditions with no more than 60% relative humidity.

The installation of the machine must meet the following conditions:

- Installed, serviced, and maintained by authorized personnel only.
- Installed on flat ground with a maximum inclination of less than 3 millimeters per floor meter (or less than 0.11 inch per yard).
- Bolted permanently to the floor through vibration dampers.
- Connected permanently to electricity with fixed wiring.
- Secured in a specific location as instructed in the *dimensional drawing*.
- Installed away from flammable objects or potentially explosive gas atmospheres.

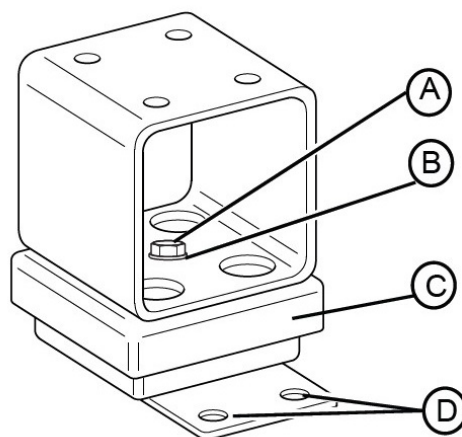
**INFORMATION**

The accessibility requirement for maintenance and servicing is presented in the *dimensional drawing*.

5.1.1. Setting up the machine

See the following instructions for setting up the machine:

1. Remove the bolts holding the machine onto the pallet.
2. Ensure lifting equipment is approved for the size and weight specifications of the machine.
3. Once it has been lifted off the pallet, attach the vibration dampers to the machine (See *Figure 5: Vibration dampers*).
4. Position the machine in the installation location.
5. Ensure that all vibration dampers are evenly in contact with the floor.
6. Permanently secure the machine in place with securing bolts through the attachment holes of the vibration dampers. (See *Figure 5: Vibration dampers*, item D)



A: Securing bolt M12x20

B: Washer M12

C: Vibration dampers

D: Attachment holes

Figure 5: Vibration dampers

5.2. Ventilation

Machines must be installed in a space with adequate ventilation, preferably in a separate machinery room. Air from this space must be vented outdoors using mechanical ventilation in the event of refrigerant leaks or ruptured components.

Follow all national and local regulations regarding ventilation of the installation space.



WARNING

Risk of personal injury

- Leaked refrigerants can pose risks, such as oxygen deprivation or risk of fire.
- ⇒ Ensure adequate ventilation.

Ventilation system

The ventilation system must exhaust leaked refrigerant to the outside of the building where there is no potential ignition source, and the gas can be readily dispersed. This ventilation system must be independent of any other ventilation system on the installation site.

Ensure the machinery room has a sufficient supply of air adequately distributed throughout the room, avoiding dead zones of trapped air.

Refer to the *product datasheet* for the minimum ventilation airflow volume.

Prior to starting the machine, confirm:

- The leak detection system activates the ventilation fans to deliver the required airflow.
- The ventilation fans remain running for at least 5 minutes after the leak detection system has reset.
- The exhaust ventilation fan is appropriately rated for the hazardous area or otherwise positioned with the motor located outside of the airflow.
- The fans are positioned in the machinery room in a way that prevents pressurization of the exhaust ductwork.
- The fans are not in contact with the duct material.

Openings

The space where the machine is installed must not have any openings except a service door. Air ducts should not lead to other rooms with potential ignition sources or occupied spaces.

Position the exhaust openings in such a way to avoid gas recirculation into the room. The outlet from the exhaust ventilation should not be blocked, however having means to keep debris or wildlife from entering is allowed. Rising ductwork that is open to the outside should have access for inspection and a drain with a trap for rainwater collection.

Position and dimension mechanical ventilation openings to ensure adequate airflow with consideration for the type of refrigerant, the choice of intake or exhaust, and the performance of the ventilator.

Arrange the intake and exhaust openings to evacuate fluid in the event of leaking refrigerant. Keep all required ventilation openings clear of obstructions.

Leak detection system

The installation space must be equipped with a leak detection system and sensors suitable for detecting the type of refrigerant used.

Refrigerant sensors should be periodically serviced and maintained as specified in the sensor manufacturer's instructions. Only replace refrigerant sensors with those specified by the detection system manufacturer.

If an internal refrigerant sensor is used, refer to the *electrical wiring and circuit diagram* for further information regarding sensor wiring and mechanical ventilation.

5.3. Commissioning

Energy Machines units should be connected to appropriate heating, cooling, or heat transfer circuits.

5.3.1. Piping connections

Only qualified personnel should perform pipe installation work. Follow all local regulations. For more information, see the *piping instrument diagram*.



INFORMATION

Pipe couplings and compensators that are needed for installation are not included with delivery.



INFORMATION

Safety valves on the secondary circuits are not included with delivery.



INFORMATION

The machine's heating and cooling systems are empty upon delivery. Install each system in accordance with the *pipng instrument diagram*.

Observe the following while performing pipe installation work:

Heating and cooling systems

- Only use connection parts that are designed for use in the heating system.
- Only use connection parts that are designed for use in the cooling system.
- Avoid putting any strain on the machine when attaching the piping.
- Test the pressure of the heating and cooling systems in accordance with the applicable standard.
 - The test pressure should be at least 1.1 times the maximum operating pressure of the heating and cooling systems. For example, if the maximum operating pressure is 10 bar, then the test pressure should be 11 bar.
- Ensure the machine and electrical parts are not exposed to water during operation.
- Prior to filling the system with fluid, flush any impurities from the pipe system that may have accumulated during installation.
- Fill the system with fluid as stated in the project specifications.
- Install a strainer in the heating and cooling systems.
- Avoid excessive vibration or pulsation to the piping of the heating and cooling systems.

Insulation of the heating and cooling systems

- Steel pipes and components must be protected with rustproof coating prior to applying insulation.
- Insulate the heating and cooling systems entirely to prevent condensation, energy loss, and accumulation of debris.
- Be aware that long runs of piping may expand and contract during operation.

Shut-off valves

- Fit the shut-off valves as close to the machine as possible for ease of maintenance.
- Fit the shut-off valves on both sides of the filter for ease of cleaning.

Safety valve discharge pipe

- Pipe the safety valve discharge to an outdoor area according to local safety regulations.

5.3.2. Electrical installation

Only a qualified electrician should carry out electrical installation tasks. Follow local regulations during installation.

**WARNING****Risk of electric shock**

- Electric shock can cause serious personal injury or death.
- ⇒ Wear appropriate PPE.

Energy Machines units should be connected to electricity with fixed wiring.

Observe the following during installation of the electrical system:

- All circuit breakers in the machine are in the 0 position upon delivery.
- Check that the power supply to the machine matches the *electrical wiring and circuit diagram*.
 - The voltage level tolerance is $\pm 10\%$ and the phase-to-phase voltage unbalance tolerance is $\pm 3\%$.
- Dimension main fuses and switches in accordance with the machine's specifications.
- The main power supply must be 5-pole (Al or Cu) and connected to the machine's control cabinet. See further instructions in the *electrical wiring and circuit diagram*.
- Fill the circuits before turning on the machine's power supply to avoid dry running the pumps.
- Ensure the main power switch is turned off before measuring the insulation resistance in the electrical property.
- Run the external sensors cable via the top of the machine.
- Use automatic fuses and overload protectors to safeguard the internal circulation pumps, automation systems, and their cables.
- Refer to the component manufacturers' specifications for the required tightening torque values.
- Install refrigerating components where they are unlikely to be exposed to any corrosive substances unless they are adequately protected.
- If an indirect refrigerating circuit is being used, the secondary circuit must be checked for the presence of refrigerant.
- Ensure all cabling is protected from adverse environmental conditions such as wear, corrosion, excessive pressure, vibration, and sharp edges.

5.3.3. Electrical wiring and circuits

The *electrical wiring and circuit diagram* includes detailed information of the unit's electrical system.



NOTICE

Risk of machine damage

- An incorrectly connected phase sequence can cause motor failure.
- ⇒ Ensure the phase sequence is connected correctly.

Observe the following during connection of the electrical system:

- The compressors and pumps have a 3-phase motor. Ensure that the unit's supply cable phase sequence is correct.
- Review the nameplate on the front of the machine for information on maximum power consumption.
- Use the cable type and area dimensioned for the relevant fuse.
- The machine power cable should always be 5-pole.
- Thread the cable through the pre-drilled holes in the machine by adapting the rubber grommets to the size of the cable.
- Ensure that the cable has sufficient extra length inside the machine's control cabinet before connecting to the connection blocks or clips. Avoid making the cable too short when replacing overload protectors.
- Use a torque wrench to ensure correct tightening torque when connecting cables in connection blocks or clips.
- Ensure the safety shield is correctly fitted to minimize the risk of short circuits or shocks.

5.3.4. External temperature sensors and connectors

The machine is equipped with external temperature sensors and connectors.

Temperature sensors

External sensors are required for certain machines. If external sensors are included with delivery, they must be installed on site by a qualified electrician in accordance with the *electrical wiring and circuit diagram*.

During commissioning, ensure that the measured values are within the requirements for the machine.

External connectors

Network (LAN) and low voltage cables for the building management system (BMS) can be connected to the unit. These cables pass through the same coupling as the external sensors.

All units require connection to the internet.

5.3.5. Inspection points during commissioning

Ensure that all the following inspection points have been performed prior to starting the machine for the first time.

Electricity inspection

- Ensure that all electrical connections have been installed correctly before turning the power on.
- Ensure that external connections and sensors are connected to the machine's control cabinet in accordance with the *electrical wiring and circuit diagram*.
- Ensure the phase sequence is correct.

Heating and cooling system inspection

- Check that the external components (pumps, valves, etc.) are correctly installed in accordance with the project specifications.
- Check that the heating and cooling systems are filled with fluid.
- Check that the cooling system filter has been cleaned after de-aeration.
- Ensure there is pressure in the heating and cooling systems and that they have been vented.
- Check that there is a free flow through the condenser in the heating system.
- Check that there is a free flow through the evaporator in the cooling system.
- Check that the temperature of the heating system water is above 15°C (59°F).
- Check that the safety valves are installed in the heating and cooling systems.

Prior to starting the machine

1. Check that the refrigerating system safety valves have discharge piped to an outdoor area.
 2. Check that the circulation pumps and compressor overload protectors are in the OFF position.
 3. Turn the machine main switch to the ON position.
 4. Check the correct phase sequence with an electricity meter.
 5. Check that all temperature sensors and pressure transmitters show the correct values.
 6. Check the measured values on the external sensors.
 7. Check and set the machine-specific settings.
 8. Check safety settings for the gas detector alarm system in the Energy Machines Cloud (Note: this applies to machines that use refrigerants in the A2L safety classification.)
 9. Check the value setting of the low-pressure alarm system in the Energy Machines Cloud.
 10. Check the value setting of the high-pressure alarm in the high-pressure switch and in the Energy Machines Cloud.
 11. Turn the pump switches to the ON position.
 12. Check that there is a flow in the heating and cooling systems.
 13. Turn the compressor overload protectors to the ON position.
-

Starting the machine

1. Start the machine by pressing the ON button on the control panel.
 2. Confirm the operation of the compressor by checking that the high pressure rises and the low pressure falls within 10 seconds of the machine starting.
 3. Listen for any abnormally loud noises and vibrations coming from the compressors.
 4. Check that superheating is stable in normal operation.
 5. Check that no alarms have been activated.
 6. Monitor the temperature in the heating and cooling systems via the machine's display.
-

After starting the machine

1. Check that all safety features are working (pressure switches, flow switch, freeze switch).
 2. Ensure that there are no leaks in the refrigerant circuit.
 3. Check that all temperature sensors and pressure transmitters show the correct values.
 4. Establish a commissioning protocol and installation checks in accordance with local regulations.
-

6. Handling fluids

This chapter provides instructions regarding the handling of fluids required for machine operation.



WARNING

Risk of personal injury

- Negligence to obey safety instructions can cause serious personal injury.
- ⇒ Obey all safety instructions.



WARNING

Risk of fire

- Machine fluids can be flammable.
- ⇒ Ensure proper earthing and bonding while emptying and filling fluids to reduce the risk of fire.



NOTICE

Risk of machine damage

- Using incorrect fluids can cause system inefficiency or machine failure.
- ⇒ Only use fluids recommended by the manufacturer.



NOTICE

Risk of machine damage

- Fluids and systems are sensitive to contamination.
- ⇒ Ensure the surrounding area and tools are clean while performing maintenance work.

6.1. Refrigerant

The machine's refrigerant circuits are filled with refrigerant upon delivery.



WARNING

Risk of frostbite

- Exposure to refrigerant can cause frostbite.
- ⇒ Use personal protective equipment (PPE) while working with refrigerant.

**NOTICE****Risk of machine damage**

Correct refrigerant charge ensures that equipment works properly.

- Too much refrigerant can lead to excessive subcooling.
- Too little refrigerant can lead to excessive superheating.

⇒ In case recharge is necessary, refer to the machine's nameplate to find the type and charge of refrigerant required.

**INFORMATION**

This manual makes multiple references to refrigerant containers, which are cylinders or vessels used to hold refrigerant. Ensure the containers used are approved for the refrigerant being handled.

6.1.1. Flammable refrigerant

**WARNING****Risk of fire**

- The presence of sources of ignition near the machine can cause the ignition of flammable refrigerants.
- ⇒ Avoid using sources of ignition near flammable refrigerants.

**WARNING****Risk of fire**

- Using methods to accelerate the defrosting or cleaning process can lead to fire.
- ⇒ Follow manufacturer recommendations regarding the defrosting and cleaning process.

While working with flammable refrigerants, ensure:

- Work is completed in a controlled procedure to minimize the risk of flammable gas or vapor being present while work is being carried out.
- Safety checks are completed prior to working on machines with flammable refrigerants to minimize the risk of ignition.
- The area is checked with an appropriate refrigerant detector prior to and during work.

Please refer to the *product datasheet* for the minimum ventilation airflow volume for machines with flammable refrigerants.

6.1.2. Storing and handling refrigerant

Follow all local regulations when storing and handling refrigerant.

When storing and handling the refrigerant, always:

- Wear appropriate PPE.
- Handle the refrigerant in accordance with local regulations.
- Ensure that there are no leaks in the system before use.
- Leave supplier labels intact to identify the refrigerant in the container.
- Use appropriate equipment to transfer containers, such as trolleys, handcarts, or forklifts.
- Keep the container in an upright position.
- Do not allow the container to slide, roll, or tip.
- Protect the container against physical damage.
- Close all valves when they are not in use.
- Store containers in a well-ventilated area.
- Store containers in accordance with local regulations.

6.1.3. Transporting refrigerant

Follow all local regulations when transporting the refrigerant.

When transporting the refrigerant, always:

- Secure containers in place before transporting.
- Close the container valve and ensure it does not leak.
- Fit a control valve or protector cap on top of the container.
- Ensure adequate ventilation.

6.1.4. Checking the refrigerant level

The refrigerant level of the machine should be checked regularly via the sight glass.

When to check the refrigerant levels

- Check the refrigerant levels at least every 12 months.
- Levels should also be checked if low refrigerant or a leak is suspected.

Checking conditions

Operate the compressor for at least 1 hour prior to checking the refrigerant level and continue operation during the check.

Measure the refrigerant charge while the unit is running under the following conditions:

- Part load in high condensation and low evaporation.
- Full load in low condensation and high evaporation.

Using the sight glass

Check the refrigerant level using the sight glasses on the evaporator.

- Wait at least 30 minutes after filling the refrigerant to perform a refrigerant level check.
- The sight glasses should show clear fluid without any bubbles or foam.
 - Clear fluid indicates flow and an adequate amount of refrigerant in the system.
 - If bubbles or foam are present, add refrigerant.
 - If the sight glass has a color indicator, it will show the presence of moisture in the system.

6.1.5. Refrigerant leak detection

This section discusses methods of detecting refrigerant leaks and important information to consider while performing refrigerant leak detection.



WARNING

Risk of personal injury

- Using sources of ignition near flammable refrigerant can cause fire or personal injury.
- ⇒ Never use potential sources of ignition, including halide torches or other naked flames, for refrigerant leak detection.

Methods of detecting refrigerant leaks:

- Electronic leak detectors may be used to detect refrigerant leaks. Ensure the electronic leak detector has the correct sensitivity for the refrigerant used.
- Leak detection fluid methods are suitable for use with most refrigerants.
 - Examples of leak detection fluid methods include the bubble method and fluorescent agent method.
 - Avoid using chlorine-containing detergents, as they can react with the refrigerant and corrode the copper pipework.

Ensure the following during detection of refrigerants:

- Confirm that the detector is suitable for the refrigerant used.
- Calibrate the detection equipment in a refrigerant-free area.
- Set the leak detection equipment at a concentration of less than 25% of the lower flammability limit (LFL) of the refrigerant.
- If a leak is suspected, all naked flames must be removed or extinguished.
- If a refrigerant leak is found which requires brazing, recover or isolate the refrigerant in a part of the system away from the leak.

- Refer to the chapter of this manual discussing refrigerant recovery for detailed instructions on removing refrigerant.

6.1.6. Recovering the refrigerant

When recovering refrigerant from a system, either for repair, servicing, or decommissioning, it is required to follow good practice so that all refrigerants are removed safely. However, for flammable refrigerants it is especially important that best practice is followed to minimize the risk of fire.

Equipment

The following items are required when recovering the refrigerant (See *Figure 6: Equipment used when recovering refrigerant.*)

- Manometer manifold
- Blue hose (A)
- Yellow hose (B)
- Red hose (C)
- Empty refrigerant containers
- Refrigerant scale
- Refrigerant recovery machine



WARNING

Risk of fire

- Incorrect refrigerant recovery machines can lead to self-ignition, fire, or personal injury.
- ⇒ Always use refrigerant recovery machines approved for handling flammable refrigerants.



INFORMATION

Containers must be approved to store the specific refrigerant type and have sufficient capacity needed to hold the quantity of refrigerant.

Observe the following while recovering the refrigerant:

- Do not overfill containers (fill to no more than 80% volume liquid charge).
- Do not exceed the maximum working pressure of the container, even temporarily.
- Do not mix refrigerants in recovery units and especially not in containers.

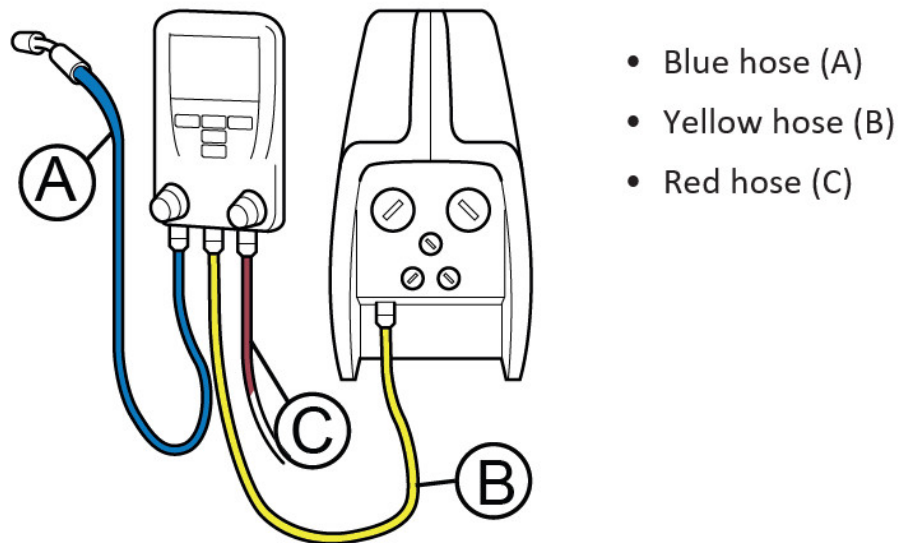


Figure 6: Equipment used when recovering refrigerant.

Instructions

A recovery device is used to drain refrigerant from the circuit.

1. Connect the manifold gauge to the pressure side of the compressor using the red hose (C).
2. Connect the yellow hose (B) to an empty, upside-down refrigerant container.
3. Open the container to drain the refrigerant.
4. Start the recovery machine and operate it in accordance with its instructions.
5. Use a scale to control the amount of refrigerant recovered and avoid overfilling the container.
6. The recovery device closes automatically when the circuit is empty.
7. Once the process is completed, ensure the containers and the equipment are removed from the site promptly and all isolation valves are closed off.
8. Record all recovered refrigerants in a machine logbook kept with the machine.
9. Do not charge recovered refrigerant into another refrigerating system unless it has been cleaned and checked.

6.1.7. Evacuating the refrigerant circuit

Evacuating eliminates moisture and air from the refrigerant circuits. The refrigerant circuits must be evacuated before filling with refrigerant, for example, after a leak has been repaired.

Evacuation should be done at a temperature above 15°C (59°F). The machine's internal compressors must not be used to evacuate the unit under any circumstances.

Evacuating is performed on both the high-pressure and low-pressure sides, so that all parts of the pipe network are cleared. A vacuum gauge should be connected to both the high-pressure and low-pressure sides while the circuit is being evacuated.

Use a vacuum pump to evacuate the refrigerant circuit. Ensure that the outlet of the vacuum pump is not close to any potential ignition sources and that proper ventilation is available.

Refrigerant circuit evacuation procedure:

1. Evacuate the circuit to a pressure of 650 Pa (5 mm Hg), and then close the valve between the refrigerant circuit and vacuum pump.
2. Fill the circuit with inert gas to atmospheric pressure.
3. Evacuate the circuit to a maximum pressure of 150 Pa (1.15 mm Hg).
4. Close the valve between the refrigerant circuit and vacuum pump.
5. The circuit pressure should stabilize and not increase over the next 5-minute period.
 - If the pressure rises, the circuit should be filled with inert gas to atmospheric pressure. Evacuation should be repeated as above until there is no longer any rise in pressure.
6. Fill the circuit to atmospheric pressure immediately after the final evacuation with refrigerant.
7. Leak-test the machine with a gas detector.

6.1.8. Filling the refrigerant



NOTICE

Risk of machine damage

Correct refrigerant charge ensures that equipment works properly.

- Too much refrigerant can lead to excessive subcooling.
 - Too little refrigerant can lead to excessive superheating.
- ⇒ Refer to the machine's nameplate for the type and charge of refrigerant required.

Equipment

The following items are required when filling the refrigerant (See *Figure 7: Equipment used when filling the refrigerant*):

- Refrigerant scale
 - Use a scale to control the refrigerant charge when filling the machine with refrigerant
- Refrigerant container
 - Ensure it contains the same refrigerant as stated on the machine's nameplate.

- Manometer manifold
- Blue hose (A)
- Yellow hose (B)

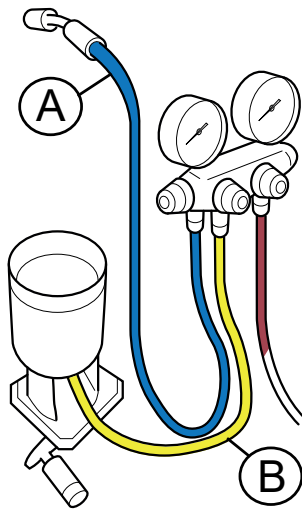


Figure 7: Equipment used when filling the refrigerant

Filling instructions

Refrigerant is filled via the service valve.

1. Connect the blue hose (A) from the manometer manifold to the service valve on the suction side of the compressor.
2. Connect the yellow hose (B) to the refrigerant container. The refrigerant must be filled in liquid form.
3. Open the refrigerant container and purge the blue and yellow hoses.
4. To fill the system, open the blue hose valve in the manometer manifold while the compressor is switched on.
5. Use scales to check the amount of refrigerant being added as the system is being filled.
6. When the correct amount of refrigerant has been added, close all valves, and disconnect the hoses.

Post-refrigerant filling inspection

1. Wait at least 30 minutes after the refrigerant has been filled before starting the inspection.
2. Start the unit and let it run for at least 5 minutes at full capacity.
3. Look in the sight glass to ensure the fluid after the condenser is clear and without any bubbles.
4. Check the temperature difference for superheating.
 - When the machine is working correctly, the superheating is 6–12 K.
 - Lack of refrigerant may cause excessive superheating.

5. Check the temperature difference for subcooling.
 - When the machine is working correctly, the subcooling in the condenser is 1–3 K.
 - Overfilling the refrigerant may cause excessive subcooling.
6. If superheating or subcooling is outside the reference values, recheck the refrigerant charge.
7. Record all changes to the refrigerant charge in a machine logbook kept with the machine.
8. Leak-test the machine with gas detector before leaving the site.

6.2. Heat transfer fluid

Follow all safety instructions included on the heat transfer fluid label.



INFORMATION

Verify the heat transfer fluid details within the project documentation.



NOTICE

Risk of machine damage

- Using incorrect fluids can damage the machine.
- ⇒ Refer to the *material safety datasheet* for comprehensive information on the heat transfer fluid.

6.2.1. Storing and handling heat transfer fluid

Follow all local regulations when storing and handling heat transfer fluid.

When storing or handling heat transfer fluid, always:

- Wear appropriate PPE.
- Store in original packaging in a dry location, away from direct sunlight, at a temperature below 40°C (104°F).
- Handle and store fluid separate from hot or flammable conditions.
- Ensure adequate ventilation.
- Wash hands after handling heat transfer fluid.
- Eliminate and prevent static electricity.
- Ensure proper earthing and bonding while emptying and filling.

6.2.2. Transporting heat transfer fluid

Follow all local regulations when transporting heat transfer fluid. Refer to the heat transfer fluid *material safety datasheet* for more information.

6.2.3. Filling the heat transfer fluid

Equipment

- Refractometer
- Heat transfer fluid

Instructions

1. Use the project specifications to determine the correct concentration of heat transfer fluid.
2. Fill the fluid until the required amount can be observed in the expansion tank.
3. Check the freezing point of the heat transfer fluid with the refractometer.

6.2.4. Draining the heat transfer fluid

Equipment

- Container (50–200 liters)

Instructions

1. Connect the container to the system.
2. Ensure the cover of the container is open to allow air to come in.
3. Drain the system.

6.2.5. Checking the freezing point (cold side only)

Monitor the heat transfer fluid's freezing point at least once a year as part of regular maintenance.

Equipment

- Refractometer

Instructions

1. Take a sample of the fluid from the cooling circuit.
2. Test the freezing point of the fluid using a refractometer.
3. Confirm the desired freezing point value within the project specifications.
4. If the freezing point does not meet the desired value, adjust the freezing point:
 - If the freezing point is too high, add concentrated heat transfer fluid to the cooling system.
 - If the freezing point is too low, add water to the cooling system.
5. Test the freezing point again.
6. Continue adjusting until desired freezing point is achieved.

6.3. Compressor oil

Follow all safety instructions included on the compressor oil label.



INFORMATION

Follow all local regulations when handling, storing, and transporting compressor oil. Refer to the compressor oil manufacturer's material safety datasheet for more information regarding precautionary measures.

6.3.1. Storing and handling compressor oil

Follow all local regulations when storing and handling compressor oil.

Compressor oil is delivered in a metal container and must be labeled in accordance with local regulations.

When storing or handling compressor oil, always:

- Wear appropriate PPE.
- Store in original packaging in a dry location, away from direct sunlight, at a temperature below 40°C (104°F).
- Handle and store oil separate from incompatible materials.
- Ensure adequate ventilation.

6.3.2. Transporting compressor oil

Follow all local regulations when transporting compressor oil. Refer to the *material safety datasheet* for more information.

6.3.3. Checking the compressor oil level

The compressor oil level of the machine should be checked regularly via the sight glass.

When to check the compressor oil levels

- Check the oil levels at least once every 6 months, in accordance with leak detection testing.

Checking conditions

Operate the compressor for at least 3 hours prior to checking the compressor oil level.

Measure the compressor oil level while the unit is running under the following conditions:

- Part load in high condensation and low evaporation.

- In part load conditions, the oil level should be seen at the lower edge of the sight glass.
- Full load in low condensation and high evaporation.
 - In full load conditions, the oil level should be seen at the upper edge of the sight glass.

6.3.4. Filling the compressor oil



NOTICE

Risk of machine damage

- Using incorrect fluids can damage the machine.
- ⇒ Refer to the compressor manufacturer's instructions for the correct oil type.

Equipment

- Container of compressor oil
- Hand pump
- Filling hose

Instructions

1. Pump the oil out of the container using a hand pump to force air out of the hose and container.
2. Connect the container with oil to a nipple for oil filling.
3. Pump the oil into the system using the pump.

6.3.5. Draining the compressor oil

Draining of the compressor oil is rarely needed. It is only necessary in the event of suspecting moisture in the system or if a compressor failure occurs.

Preconditions

- Ensure the system is not in operation.

Instructions

1. Connect an oil container to an oil drain nipple with a filling hose.
 - Use the nipple that is most accessible.
2. Drain the oil.
3. Check the oil level via the sight glass.

6.4. Recycling and disposing of fluids

Collect used fluids in tightly sealed containers for disposal at a local hazardous waste recycling station.

Do not mix refrigerants or heat transfer fluids.

The containers with used fluids should be delivered to a certified recycling center in accordance with local regulations.

7. Original machine manufacturer settings

The settings for the specific unit delivered are programmed at the factory during the unit functionality assurance test. It is only possible to make changes to the manufacturer settings via the Energy Machines Cloud.

7.1. Safety features of the machine

The machine is equipped with safety features. All safety features are set at the factory during the unit functionality assurance test. Safety features can be adjusted via the Energy Machines Cloud.

Safety feature	Description
Flow switch	The flow switch monitors and controls the flow rate if there is a lack of flow detected in the evaporator.
High pressure switch	Each refrigerant circuit has a switch to protect the machine against damage caused by increased pressure in the refrigerant circuit. The high-pressure switch must be reset manually.
Safety valve	Each refrigerant circuit has safety valve(s) on the high-pressure side. The safety valve(s) protect the circuit against overpressure, which could damage the machine.
Compressor motor protection	Compressor motor protection monitors the functions of the compressor motor while in operation. It provides protection against motor overheating and overloading. If the motor is found to operate outside its normal parameters, the system will shut down.
Pump motor protection	Pump motor protection monitors the functions of the pump motor while in operation. It provides protection against motor overheating and overloading. If the motor is found to operate outside its normal parameters, the system will shut down.

8. Operation

Energy Machines units are self-contained, independently operating machines. These units do not require the continuous presence of an operator.



DANGER

Risk of personal safety

- Failure to follow instructions can lead to serious personal injury or damage to property and materials.
- ⇒ Follow all instructions regarding machine operation.



INFORMATION

The side panels around the machine act as a safety feature and help to reduce noise emitted from the machine. Keep side panels in place during use.

8.1. Starting the machine

Before starting the machine, ensure the machine is in good working condition by checking the following points.

Category	Ensure the following:
Correct installation	<ul style="list-style-type: none"> • All external components (pumps, valves, etc.) are correctly installed. • All safety valves have discharge pipes installed. • All safety features are working correctly (pressure switches, flow switch, and freeze protection switch). • The heating and cooling systems have safety valves installed. • The heating and cooling systems have been vented.

Category	Ensure the following:
Flow and pressure	<ul style="list-style-type: none"> • The heat transfer fluid flows freely through the condenser. • The heat transfer fluid flows freely through the evaporator. • There are no leaks in the refrigerant circuit. • There are no leaks in the heating and cooling systems. • There is pressure in the heating and cooling systems. • There is pressure in the refrigerant circuit.
Electrical connection	<ul style="list-style-type: none"> • All electrical connections have been installed correctly. • External connections are connected to the machine control cabinet in accordance with the <i>electrical wiring and circuit diagram</i>. • The electrical wiring has the correct phase sequence.

When each of the points above is acknowledged, press the ON button on the machine's display.

8.2. Switching off the machine

To switch off the machine, press the OFF button on the machine's display or via the Energy Machines Cloud. After shutting off the machine, the pumps and compressors will run for a short period of time before stopping.

8.3. Standby

Check the following when the machine is on standby:

- Set the motor protection breaker to the OFF position to ensure the machine does not start while on standby.
- In the case of extended standby, the power supply should be switched off via the machine's main switch.
- Store the machine at a temperature of at least 5°C (41°F).

9. Maintenance

This chapter provides information regarding maintenance of the machine.



DANGER

Risk of personal safety

- Failure to follow instructions can lead to serious personal injury or damage to property and materials.
- ⇒ Always read the safety information before use, maintenance, or repair of the machine.



WARNING

Sparkling and arcing parts

- Replacing parts with those not recommended by the appliance manufacturer can result in the ignition of refrigerant in the event of a leak.
- ⇒ Only replace electrical components with parts specified by the appliance manufacturer.

9.1. General maintenance instructions

The machine should be serviced at least once every 6 months.

Maintenance should only be carried out by authorized personnel.

The following inspections should be performed regularly:

- Ensure the unit is working correctly and there are no visible signs of damage.
- Ensure that the machine does not make any abnormal noises during operation.
- Check for any leaks.
- Ensure there is no smoke, fire, or burning smell.
- Check for ice, corrosion, or fouling on visible pipework.
- Address any fault codes presented on the machine's control panel. See the chapter regarding troubleshooting for details on the fault codes.



WARNING

Risk of personal injury

- Repairing or changing electrical components incorrectly can lead to personal injury.
- ⇒ Do not repair sealed electrical components.
- ⇒ Always follow the manufacturer's maintenance and service guidelines when changing electrical components.

**NOTICE****Risk of machine damage**

- Removing ice mechanically can cause damage to the machine.
- ⇒ Do not remove ice using machinery or mechanical devices.
-

**INFORMATION**

For detailed information on individual components, refer to the manufacturer's documentation for that specific component.

9.2. Service interval

Perform preventive maintenance on the machine at least once every 6 months.

Perform a leak detection test on the refrigerant circuit at least once every 6 months, unless otherwise specified for the type of refrigerant used.

9.3. Avoiding overpressure

A smooth flow through both the condenser and the evaporator must be ensured to prevent overpressure.

Flow occurs when:

- All valves in the heating and cooling systems are open.
- All valves in the refrigerant system are open.
- The external strainers are clean.

To protect the circuit against overpressure, the refrigerant circuit in the machine has factory-fitted safety valves. Safety valves should also be fitted in the heating and cooling systems.

Perform the following during regular maintenance:

- Visually inspect the safety valves.
- Check that the external strainers are clean.
- Ensure that all valves are open and in the ON position after a service.
- Record the date of the refrigerant circuit safety valve inspection in the machine's logbook.

9.4. Cleaning and sanitizing

Energy Machines units do not require regular cleaning or sanitizing. There is no obligation to clean the machine during normal use.

If cleaning is necessary, the machine must first be disconnected from the power supply. The machine may be wiped with a soft, dry cloth. Do not splash the machine with water. Do not use detergent or solvents.



DANGER

Risk of electrocution

- Splashing or washing the machine with water can cause electric shock.
- ⇒ Do not splash or rinse the machine with water.



NOTICE

Risk of machine damage

- Washing the machine with corrosive detergent or solvent can damage the machine.
- ⇒ Do not use corrosive detergent or solvent on the machine.

10. Troubleshooting and repair

When troubleshooting, check the alarm codes presented on the machine's control panel.



NOTICE

Risk of machine damage

- Addressing alarm codes incorrectly can result in potential damage to the machine.
- ⇒ Unless stated otherwise, only authorized technicians should handle alarm codes.
-

11. Dismantling and decommissioning

Only authorized personnel should handle the dismantling and decommissioning of the system and its components. Prior to dismantling, an oil and refrigerant sample should be taken if recovered refrigerant is intended for reuse.

Ensure the following during dismantling and decommissioning:

- Appropriate personal protective equipment (PPE) is worn.
- Electrical power is available while recovering the refrigerant.
- Appropriate handling equipment is available to handle the refrigerant containers.
- All equipment and containers meet local and national regulations.

The machine should be dismantled in the following order:

1. Remove the refrigerant from the system.
2. Drain the fluid from the heating and cooling circuits.
3. Disconnect the unit from the power supply.
4. Dispose of fluids and components according to local regulations.
5. If decommissioning, label the machine stating that it has been decommissioned and emptied of refrigerant. Sign and date the label.
 - Label any containers with the refrigerant type being stored. Clearly indicate on the label if the refrigerant type is flammable.

For more information on these points, see the chapter concerning the handling of fluids.

12. Additional documents

The following documents are provided with the machine:

- Product datasheet
- Product manual
- Component list
- Material safety datasheets (MSDS)
- Dimensional drawing
- Piping instrument diagram
- Electrical wiring and circuit diagram
- Declaration of conformity

13. Glossary

Term	Definition
Compressor	The component of the heat pump that increases the pressure and temperature of the refrigerant, enabling it to transfer heat efficiently.
Condenser	The component of the heat pump where the refrigerant releases heat to the heat sink and changes from a gas to a liquid (condenses).
De-aerate	The removal of air from the heating or cooling systems.
Evaporator	The component of the heat pump where the refrigerant absorbs heat from the heat source and changes from a liquid to a gas (evaporates).
Expansion valve	A device that regulates the flow of the refrigerant, reducing its pressure and temperature as it enters the evaporator.
Heat exchanger	A device that facilitates the transfer of heat between two mediums, such as the refrigerant and the heat source.
Heat pump	A machine that transfers heat from a lower-temperature heat source to a higher-temperature heat sink, using a compressor and refrigerant to facilitate the heat transfer.
Manifold	A piece of equipment that is used to either split or combine mediums such as liquids or gases.
Manometer	A device used to measure the pressure of mediums such as liquids or gases.
Refractometer	A device used to measure the concentration of a particular substance in fluids.
Refrigerant	A substance that absorbs and releases heat during the process of phase changes in the heat pump cycle.

Term	Definition
Shell-and-tube heat exchanger	A type of heat exchanger that uses tubes within a cylindrical shell to facilitate heat transfer between two fluids.
Subcooling	A measurement of the heat removed when vapor is cooled below its condensing point. Subcooling is calculated by finding the difference between the temperature in the liquid pipe after the condenser and the temperature before the condenser.
Superheating	A measurement of the heat added when vapor is heated above its boiling point. Superheat is calculated by finding the difference between the suction temperature before the compressor and the evaporation temperature.

13.1. Abbreviations

Abbreviation	Definition
Al	Aluminum
BMS	Building management system
°C	Celsius Denotes temperature in the Celsius scale
Cu	Copper
°F	Fahrenheit Denotes temperature in the Fahrenheit scale
Hz	Hertz
In Hg	Inch mercury Denotes pressure in the Imperial system
K	Kelvin Denotes temperature difference in the Kelvin scale
LAN	Local area network
Pa	Pascal Denotes pressure in the SI system
PPE	Personal protective equipment
V	Volt Denotes voltage of the electrical system



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