



MasterTherm

Catalog: AM, AQ, EM, LM
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HEAT PUMPS

INSTALLATION AND OPERATING MANUAL

AirMaster, AquaMaster, EasyMaster, LandMaster



MasterTherm

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1 Installation and location of the unit

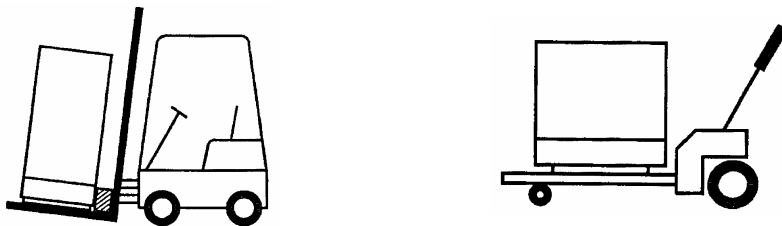
The equipment must be installed and commissioned by an authorized, specialized installation company. The installation must comply with this installation manual and national regulations.

1.1 Unit delivery

Check the unit for possible damage or missing parts. Should you find any damage, or should the delivery not be complete, immediately contact the supplier's forwarder or the manufacturer directly.

1.2 Handling instructions

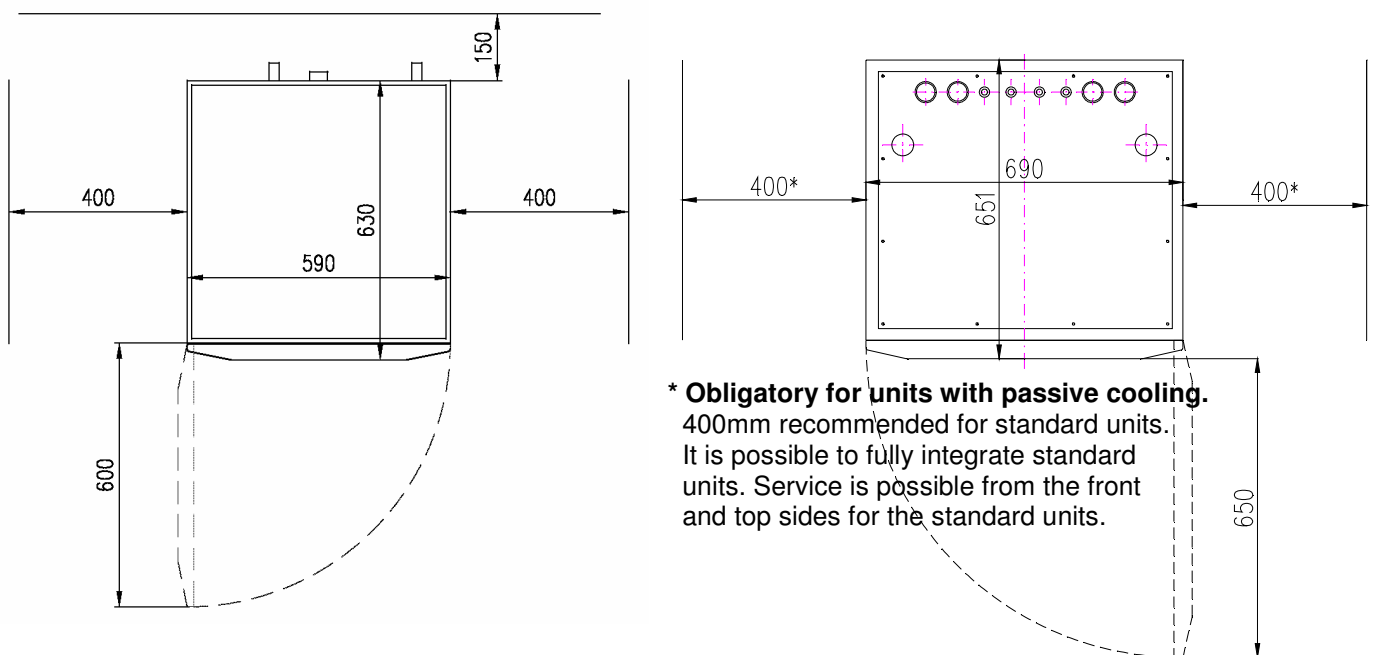
Handle the unit in accordance with the presented drawings. Using other handling methods may damage the unit.



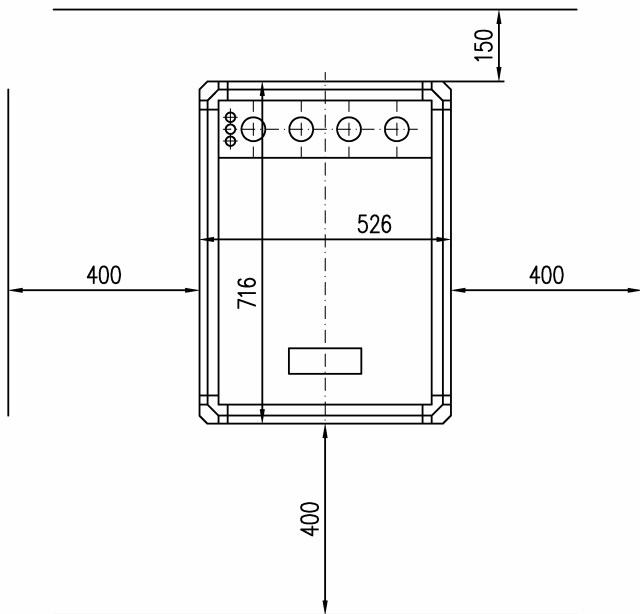
1.3 Location of the indoor unit

1.3.1 Working environment and clearances

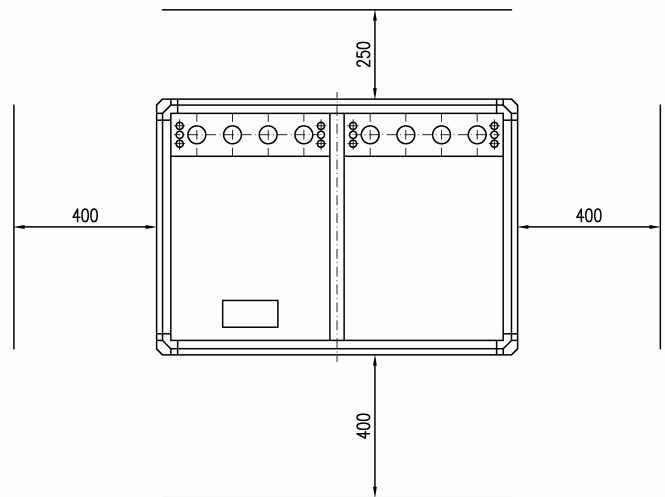
Indoor units are dedicated for indoor installation in dry, non explosive and non corrosive environment at temperatures $+5\div+30^{\circ}\text{C}$ without free public access. There must be a sufficient clearance around the unit for the antifreeze, heating water, refrigerant and electric connections. Minimal clearance for different unit please see on pictures below.



Clearances: AirMaster AKU, AQxxIC



Clearances: AquaMaster, EasyMaster, AirMaster MINI



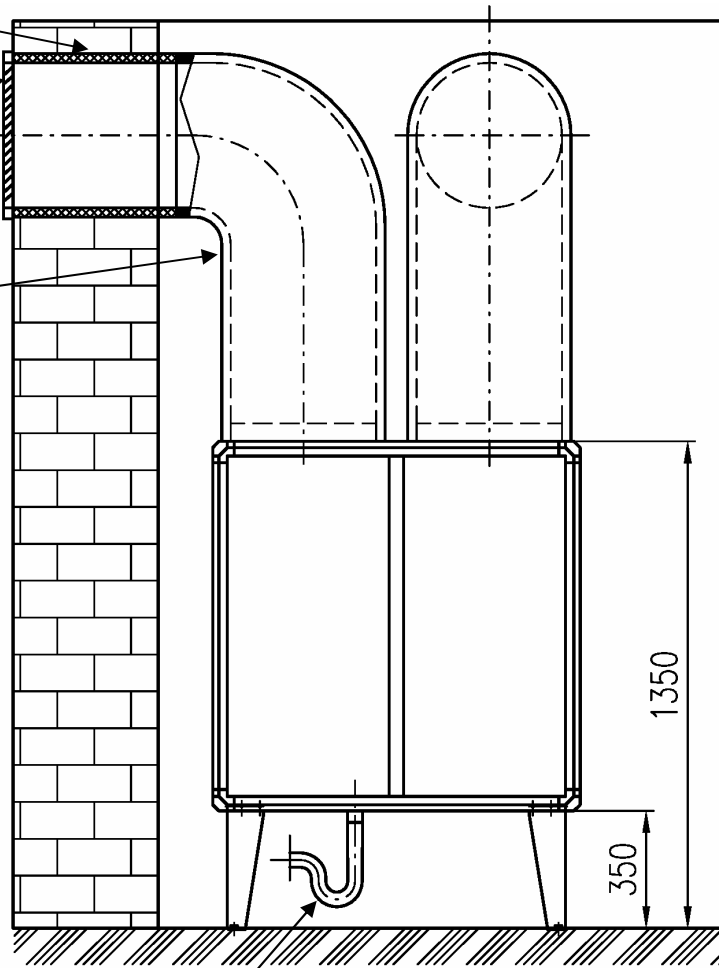
AquaMaster x.2, AirMaster x.2



Spiro tube 400mm
+25mm PUR

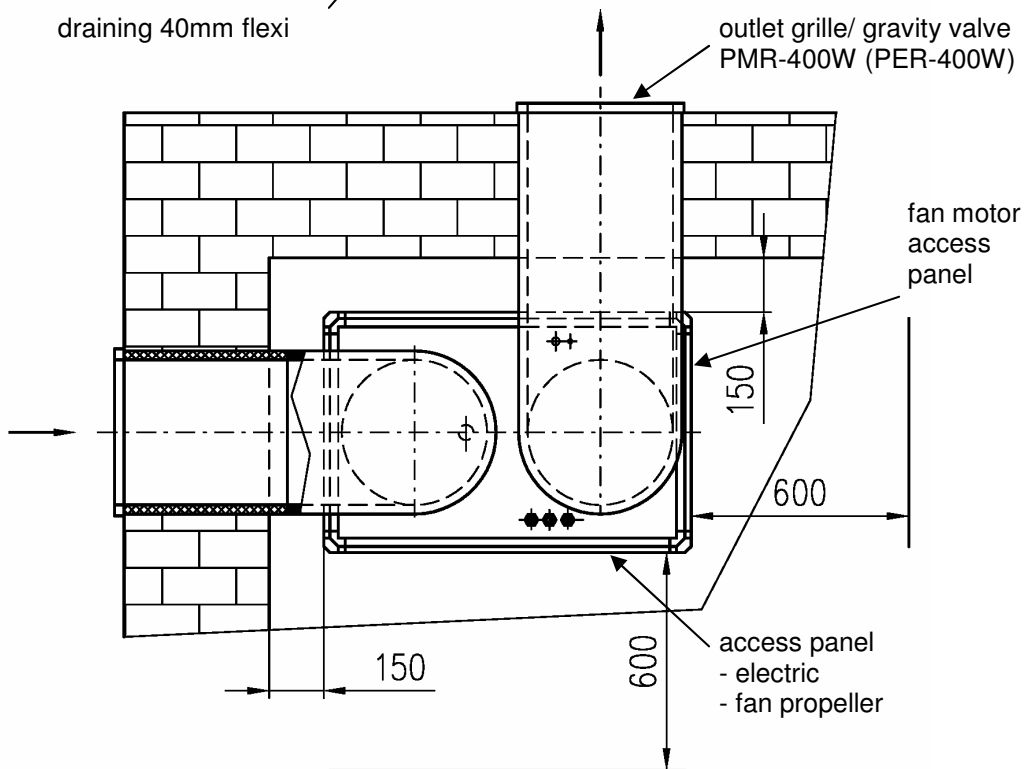
inlet grille
PMR-400W

SONOFLEX 406mm
pipe



draining 40mm flexi

outlet grille/ gravity valve
PMR-400W (PER-400W)



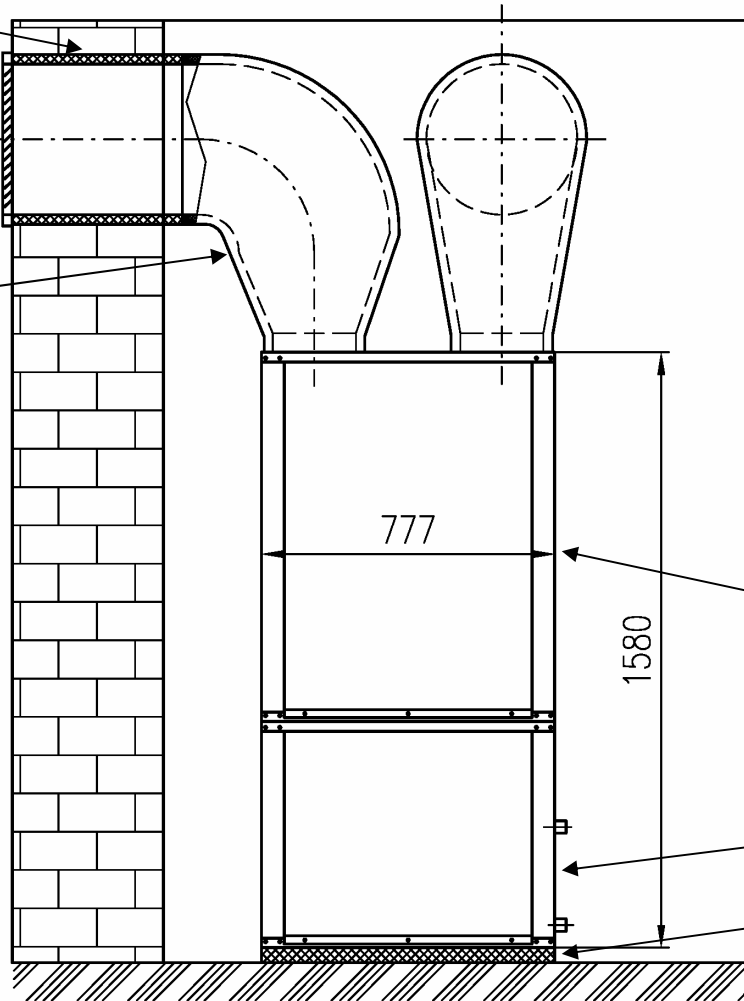
Clearances and installation: 1OEM26-45VK (evaporator - indoor split)



Spiro tube 400mm
+25mm PUR

inlet grille
PMR-400W

SONOFLEX 406mm
tube

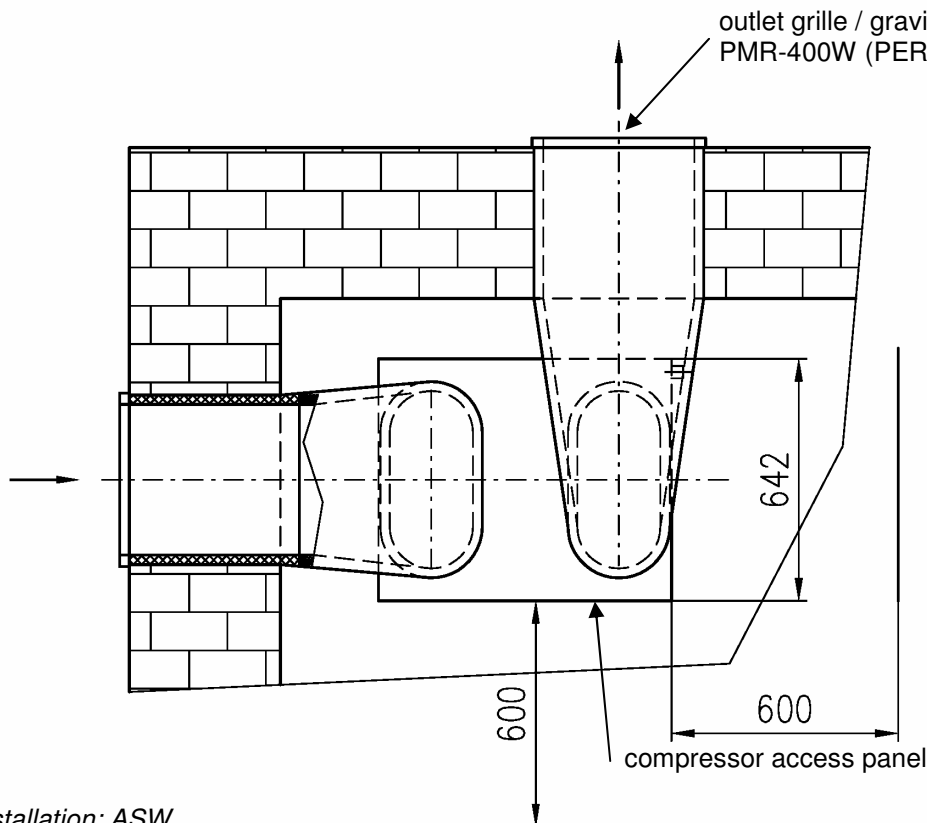


fan
access
panel

electric
access panel

XPS 40mm

outlet grille / gravity valve
PMR-400W (PER-400W)



compressor access panel

Clearances and installation: ASW

1.3.2 Mechanical installation

The inner unit of the Heat Pump should be located in a detached room – a machinery room. In the case the room is next to protected areas (bedroom, children rooms etc.), the wall between must be made as sound-proof, minimum sound reduction of 30dBA. It is also not recommended to install fixtures of piping system or circulating pumps etc. on the dividing wall.

Make sure to always check the noise values of heat pumps in the catalogue sheets and verify the installation area for acoustically protected areas.

Always check the load capacity compared with the unit weight. If necessary, build a concrete base. Do not position the units on light structures as floor heating etc.

Do not position the Heat Pumps in higher floors of the building, we recommend installation in the lowest floor – on solid ground. Installation in higher floors can cause transfer of vibrations to the heated building.

The units have adjustable legs which allow for balancing of minor unevenness and inclination (up to 20 mm) of the floor.

1.3.3 Minimum Inner Volume of the Machinery Room

Each area for installation has to be inspected with regard to the refrigerant charge of the Heat Pump. Permitted limit is 0,3kg refrigerant/m³ of the room volume. This is important due to safety in the case of refrigerant leakage. For approximate minimum room volumes for MasterTherm heat pumps see table below:

Heat Pump	-	AQ17-30	AQ37-45	AQ60-90	AM, EM	LM	AQxxD
Refrigerant Charge	kg	1.8	2.2	3.0	5.7	4.5	12
Min. Room Volume	m ³	6.0	7.3	10.0	19.0	15.0	40.0

In the case the room volume does not reach the values from the table, please see EN378. In most cases the room must be ventilated and a special equipment operating guideline established. Problems usually occur with DirectMaster units which have big volume of refrigerant.

Warning:

Please keep in mind that not respecting the minimum room volume can in the case of coolant leakage result in injury or even death. Always respect actual national directives regarding installation of cooling equipment (for EU EN378).

Underground unventilated rooms are extra hazardous because the coolant always stays near the ground. Try to avoid such applications and use only as the last solution, which requires special operating mode and forced ventilation of the space. In such cases we recommend installing a remote terminal (PGD display) in a safe place.

1.4 Positioning of the Outdoor Unit

The air/water heat pumps are equipped also with an outer unit. These are the AirMaster and EasyMaster types. The units are designed for outside installation. They must be equipped with additional electric protection, more info in the “Electric installation” chapter.

1.4.1 Positioning, with Regard to Air Flow and the Condensate Drain

The units must be installed in an environment with free air flow, with the suctioning parts at least 300 mm from a building wall. Do not install the outer unit underground or in partly or completely enclosed spaces, except in the case of the targeted use of waste heat. Under the unit must be installed a condensate and melted water drain, with a sufficient height reserve for frosty periods, when percolation is problematic.

1.4.2 Positioning, with regard to noise

When selecting the place of installation, you must observe the applicable limits for protected rooms inside buildings and with regard to the environment. The usual acoustic pressure level limit at the boundary of the property (land, building) is 50 dBA during the day (6:00 a.m. to 10:00 p.m.) and 40 dBA at night (10:00 p.m. to 6:00 a.m.). The noise levels of outdoor units are specified in the catalogue sheets as the levels of Sound Power in dBA. There are various methods of estimating the acoustic pressure level in a particular position, with regard to the source of noise. In practice, the use of the ARI275-97 standard has proven to be suitable. It is a practical evaluation that allows you to estimate the resulting noise level quite quickly. In making the estimate, it is advisable to draw the situation on a plan. You can estimate the noise level as follows:

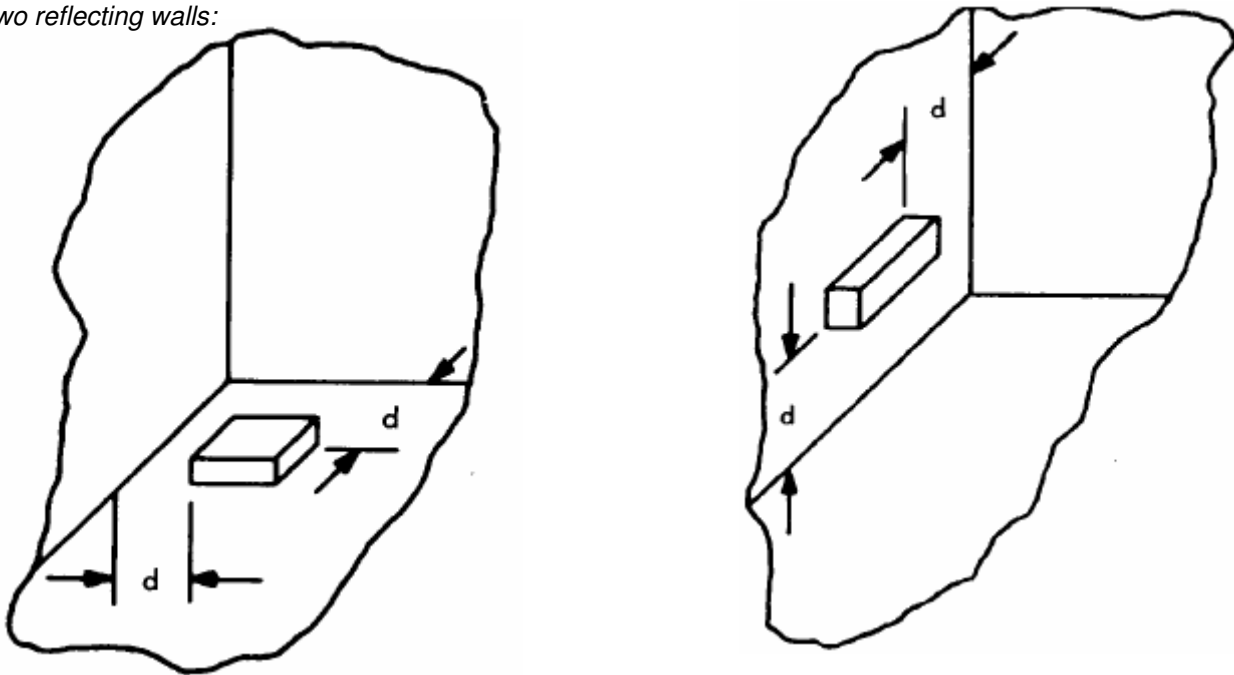
Noise source position factor:

Free space without reflecting walls $U=0$

One reflecting wall:

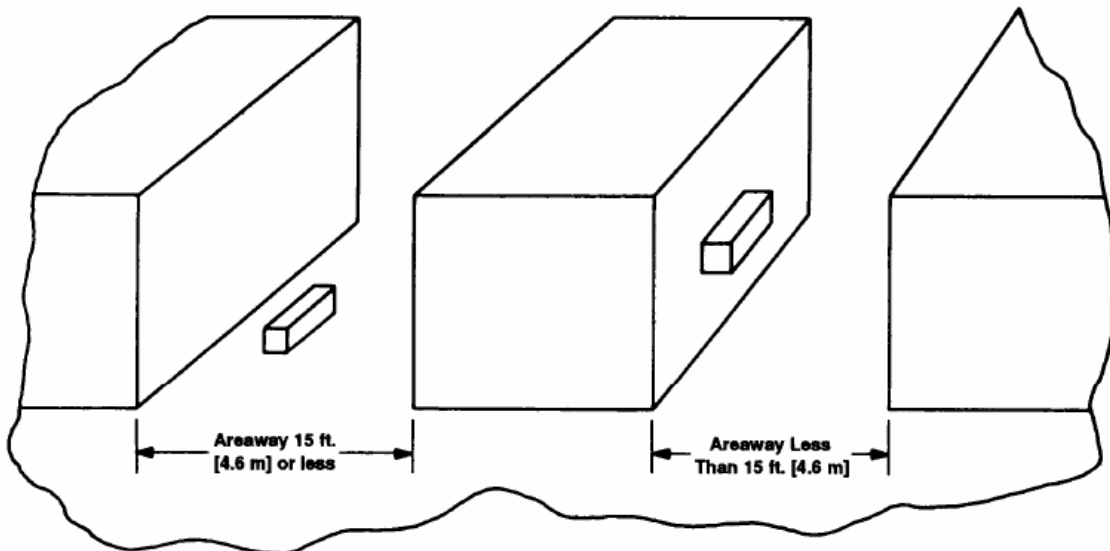


Two reflecting walls:



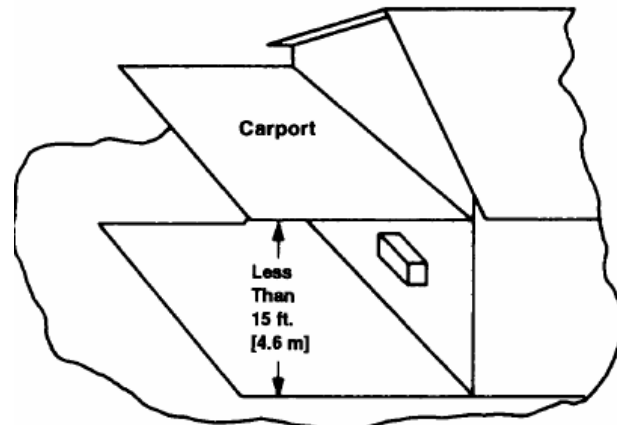
$d < 3\text{m}$, $FU = +6\text{dBA}$

Between reflecting walls:



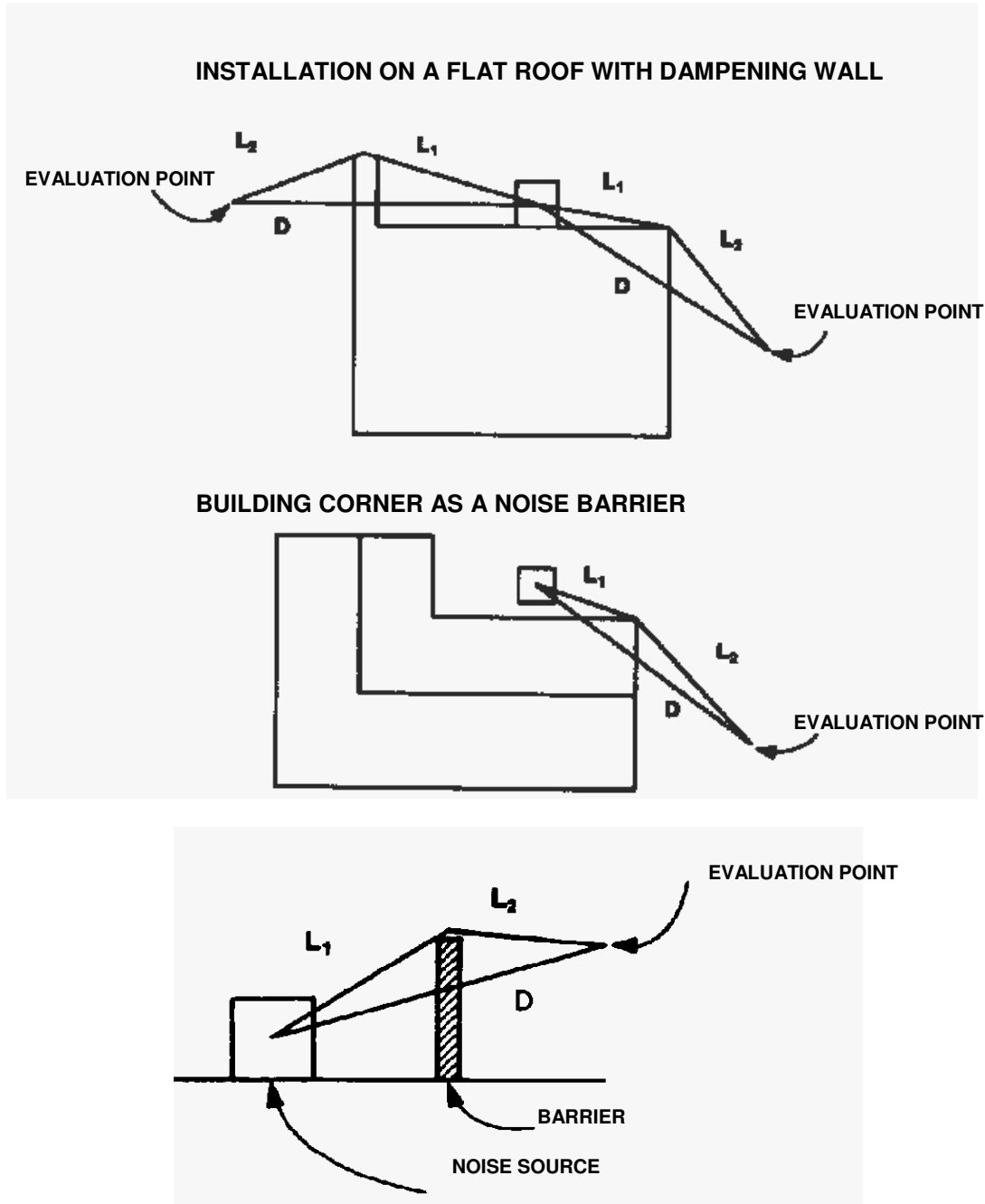
Areaway 15 ft.
[4.6 m] or less

Areaway Less
Than 15 ft. [4.6 m]



$FU = +6\text{dBA}$

Barrier attenuation factor:



$L=L_1+L_2-D$

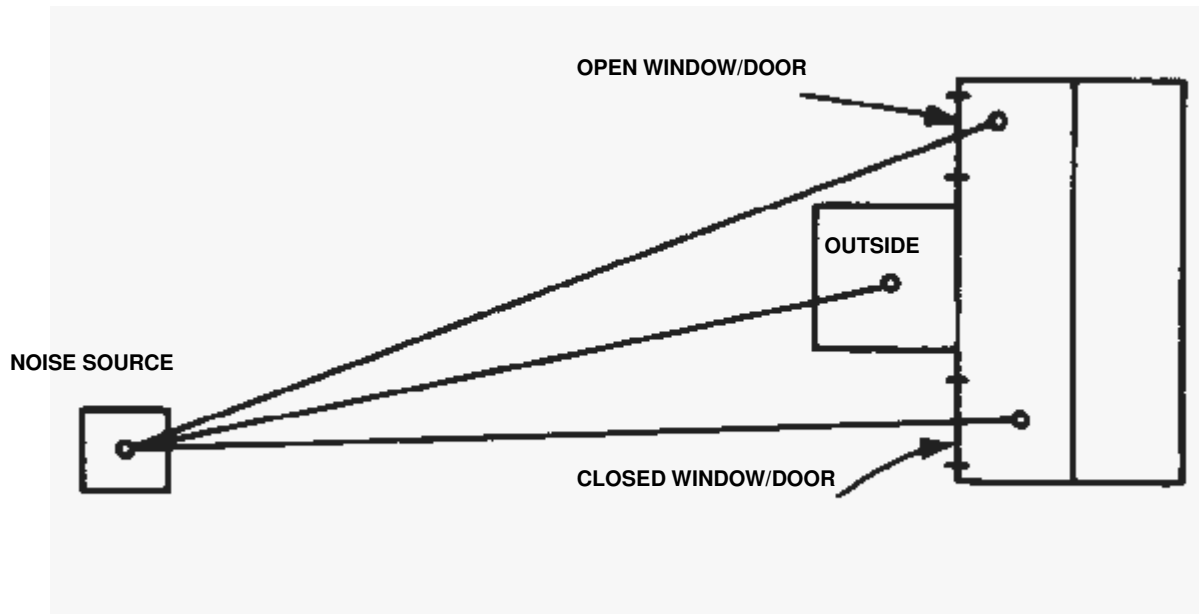
L_1+L_2 – Distance between the noise source and evaluation point around a barrier

D – Direct distance between the noise source and evaluation point

FB – Attenuation factor

L	m	0.15	0.3	0.6	0.9	1.8	3.7
FB	dBA	-4	-7	-10	-12	-15	-17

Evaluation point factor:



Outside, $FB = 0\text{dBA}$
 Open window/door, $FB = -10\text{dBA}$
 Closed single window/door, $FB = -17\text{dBA}$
 Closed double window/door, wall, $FB = -23\text{dBA}$

Distance factor:

Distance	m	1.2	1.5	1.8	2.1	2.4	2.7	3	4.6	6.1	7.6	9.1
FL	dBA	-9.5	-11.5	-13	-14.5	-15.5	-16.5	-17.5	-21	-23.5	-25.5	-27

Distance	m	12.2	15.2	18.3	21.3	24.4	27.4	30.5	38.1	45.7	53.3	61
FL	dBA	-29.5	-31	-33	-34.5	-35.5	-36.5	-37.5	-39.5	-41	-42.5	-43.5

Determining the acoustic noise level at the evaluation point:

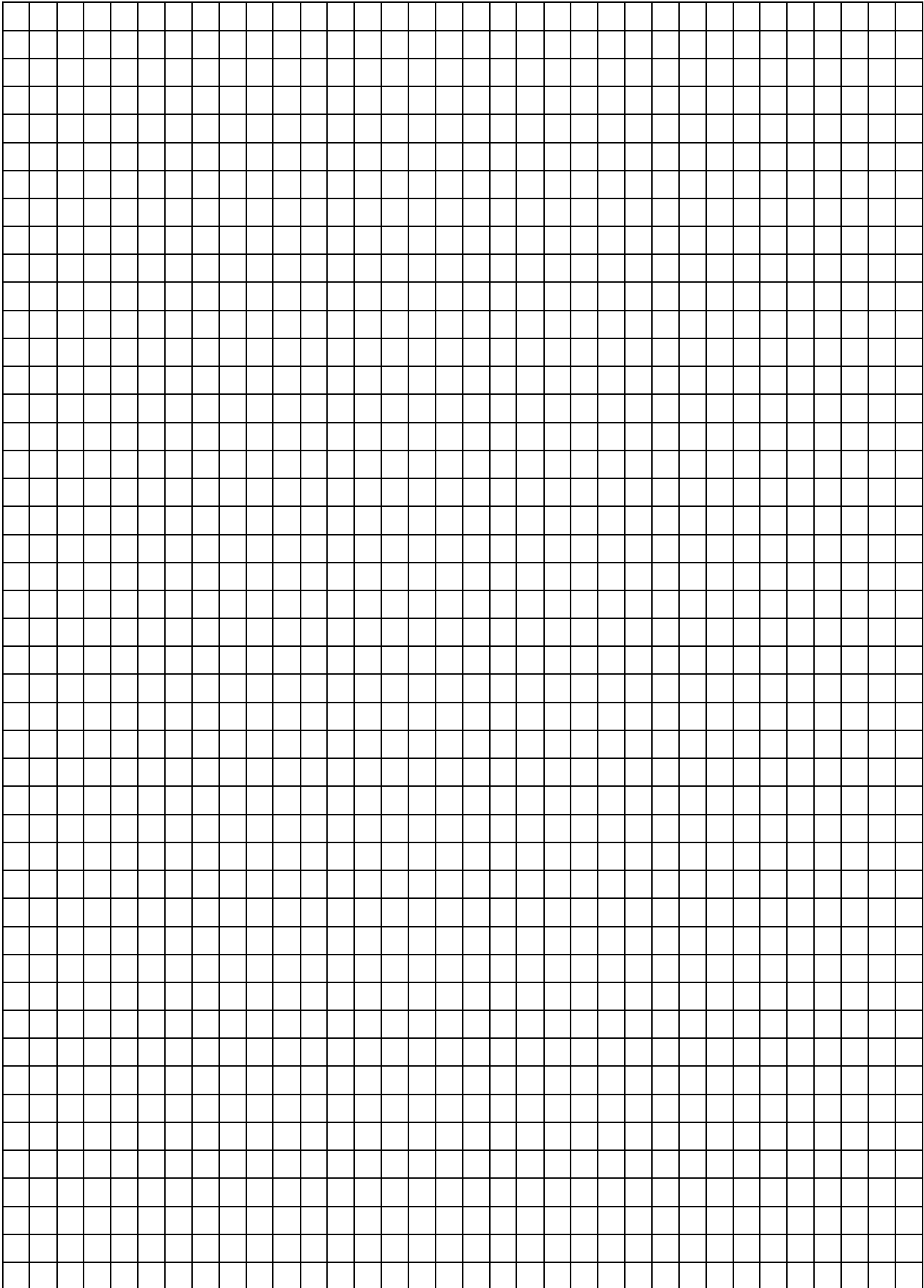
The resulting noise level represents the plain sum of the acoustic output level and all the factors.

Sound Power Level	dBA	
Noise source position factor dBA	dBA	
Barrier attenuation factor dBA	dBA	
Evaluation point factor dBA	dBA	
Distance factor dBA	dBA	
Sound Pressure Level at evaluation point	dBA	

This approach leads to an “ESTIMATE” of the resulting noise level. This estimate assumes the usual installation conditions. The actual noise level can only be established with a measurement after the installation, in every particular case. If this estimate approximates the noise level limit, you should consider the necessity of additional measures.

MASTER THERM CZ IS NOT LIABLE FOR ANY DIFFERENCES BETWEEN THE RESULTS OBTAINED WITH THE USE OF THIS METHOD AND THE INSTALLED REALITY

Layout drawing for the noise evaluation:



1.4.3 Mechanical installation

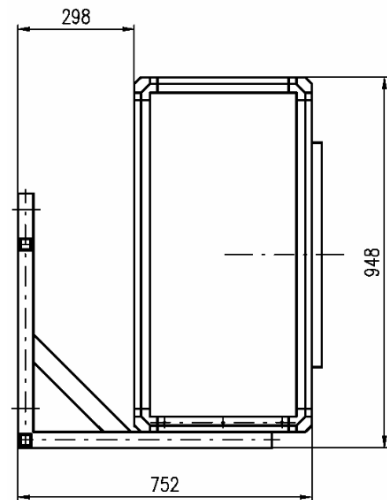
There are 3 different variants of the outer units. A vertical one with a bracket on the wall, a vertical one on legs, and a horizontal one on legs. For types with legs a special base must be built.

Vertical with a bracket:

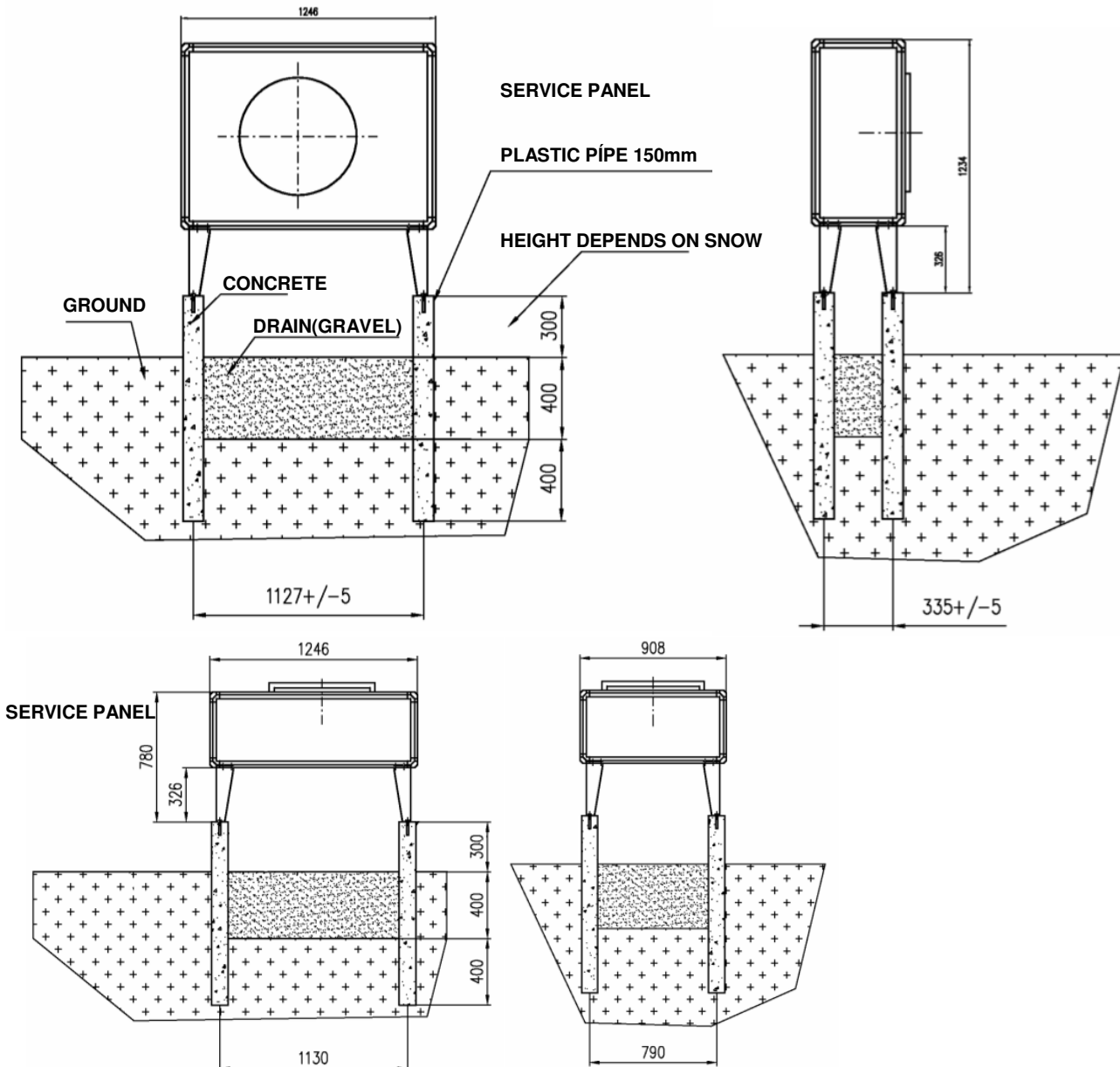
This variant is supplied directly with the bracket. The bracket is placed on the wall. For attaching use chemical anchors and stainless screw rod only, or use stainless screw rod and screw it through the wall. The bracket has 4 holes of 10mm DIA for attachment to the wall. The chemical anchors and stainless screw rods are not a part of the supply.

Vertical and horizontal on legs:

The outer unit is supplied with 4 pcs of stands for positioning on a suitable base. Recommended base is on following drawing.

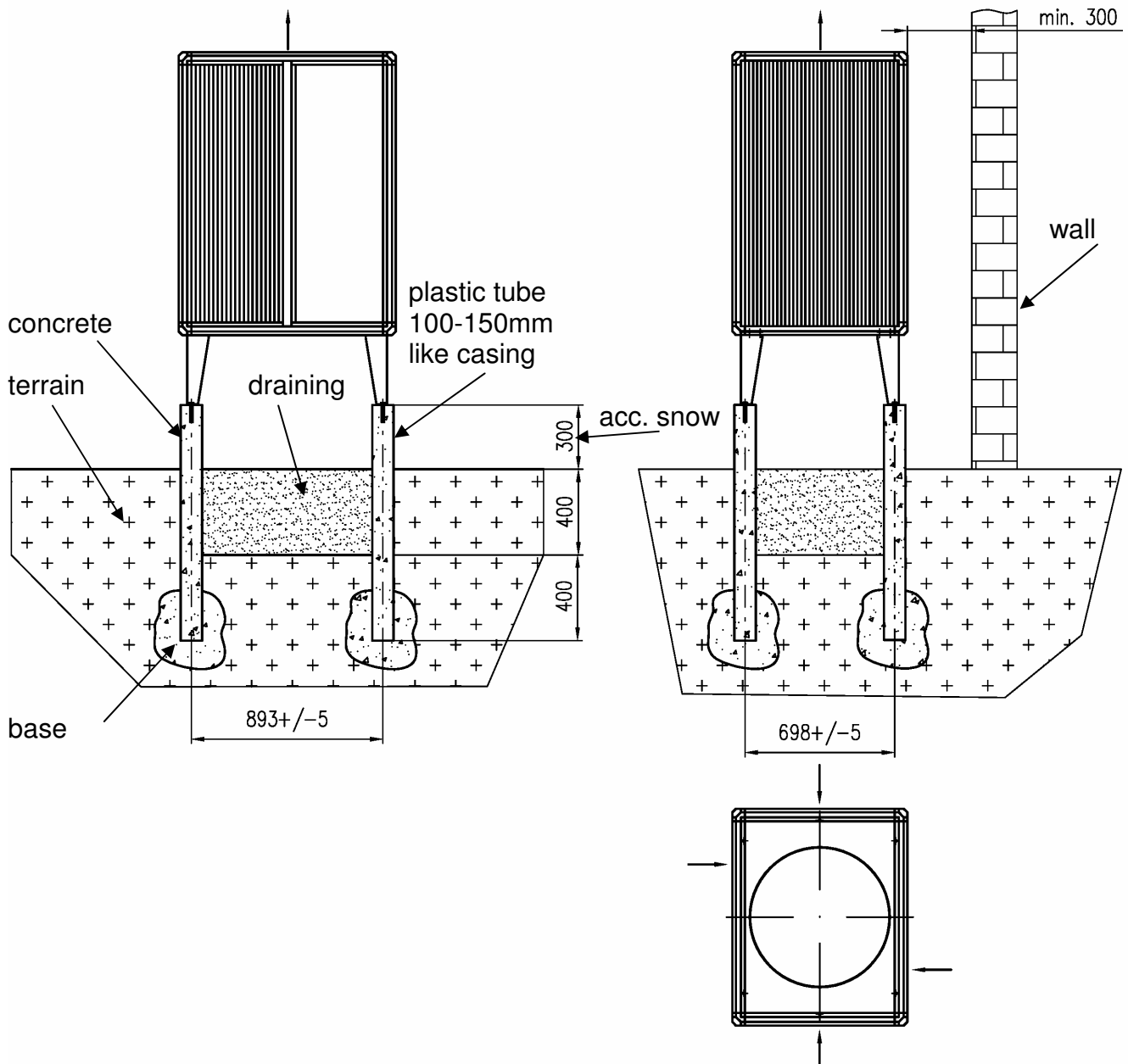


the



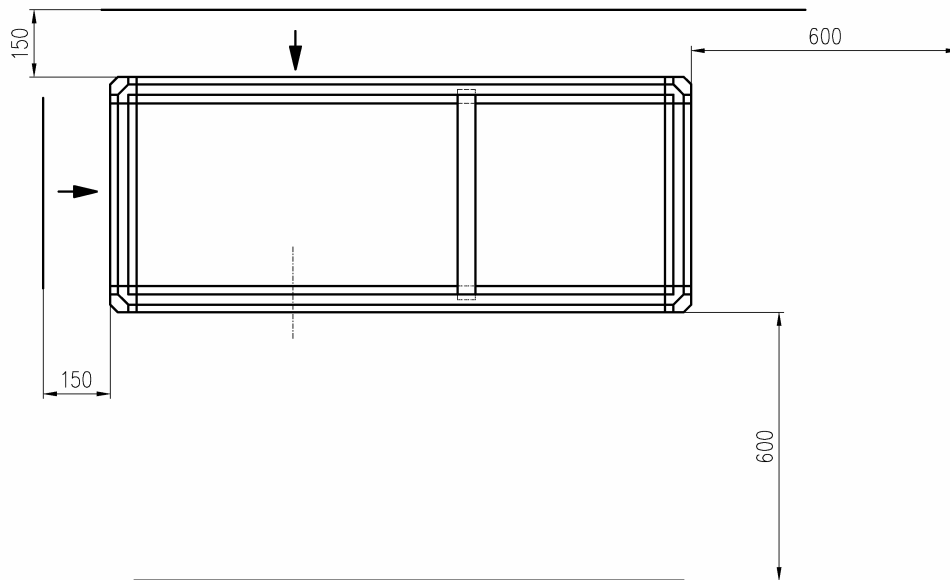
EM60Z / EM75Z outdoor unit:

4 legs are delivered with the outdoor unit for location on a suitable basement. Recommended basement is on picture below.



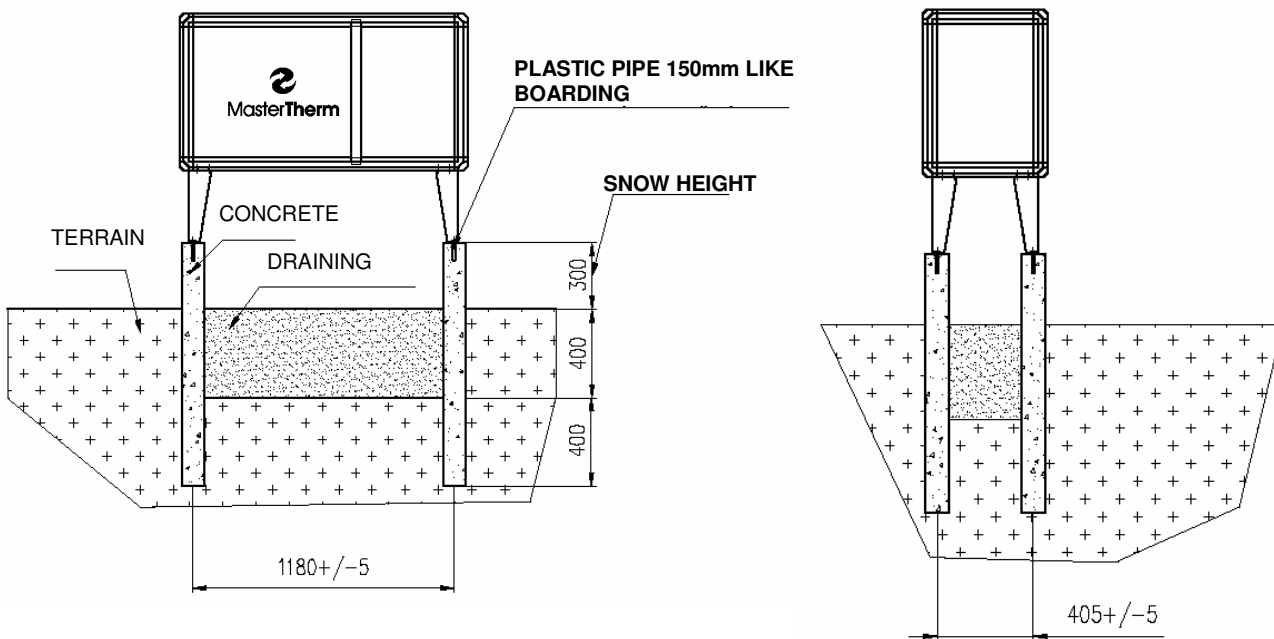
1.4.4 Mechanical installation, BoxAir units

BoxAir packaged air source heat pumps are dedicated for outdoor installation. Operating range is $-20\div+30^{\circ}\text{C}$. Because of outdoor installation, power supply requires additional protection, like RCD circuit breaker or additional earth wiring. Minimum free area around unit is necessary for sufficient air flow, heating water piping and electrical connection. Minimum clearances are shown on the picture below.



Clearances: BoxAir

We recommend preparing of following basement, before unit installation. Height of the basement should be corresponding to the usual snow height during winter.



2 Piping Connection of Indoor and Outdoor Units – AM, EM

After mechanical installation of split heat pumps AM and EM, installation of piping connection between the indoor and outdoor unit must be performed..

2.1 Danger

The inner units of heat pumps are filled with coolant r407c or r410a by the manufacturer. The outer units are pressured by nitrogen to 1,0MPa. Please follow the following safety guidelines:

- Always use safety goggles and protection gloves during manipulation
- In the case of servicing and repairs make sure the equipment has been disconnected from the power source
- Pay attention to the working areas of fans when the equipment is connected to the power source
- Refrigerant causes frostbites
- The coolant becomes toxic after burning, be careful during manipulation with the flame of the welding unit

2.2 Piping

For installation deoxidized, plugged Cu piping with certification for cooling equipment must be used. The piping must be certified in accordance with EN12735-1. We recommend using pre-insulated piping. The connection comprises always of the steam piping and liquid piping.

Never use piping dedicated for water.

Piping dimensions of different types of heat pumps see table below:

typ TČ	D vapour line [mm]	d liquid line [mm]	max. length [m]	max. height [m]
AM3015	18x1 (3/4")	12x1 (1/2")	15	10
AM3021	18x1 (3/4")	12x1 (1/2")	15	10
AM3030	22x1(7/8")	12x1 (1/2")	15	10
AM3038	22x1(7/8")	12x1 (1/2")	15	10
AM3045	22x1(7/8")	12x1 (1/2")	15	10
AM3060.2	2x 22x1(7/8")	2x 12x1 (1/2")	15	10
AM3076.2	2x 22x1(7/8")	2x 12x1 (1/2")	15	10
AM3090.2	2x 22x1(7/8")	2x 12x1 (1/2")	15	10
EM26Z	22x1(7/8")	12x1 (1/2")	15	10
EM30Z	22x1(7/8")	12x1 (1/2")	15	10
EM37Z	22x1(7/8")	12x1 (1/2")	15	10
EM45Z	22x1(7/8")	12x1 (1/2")	15	10
EM60Z	28x1	15x1 (16x1)	20	10
EM75Z	28x1	15x1(16x1)	15	15

Also follow the following instructions:

- Always use only the Cu roller-type pipe cutter for cutting the piping, never use a saw
- Cut the piping immediately prior to connecting operation
- Remove the plugs no sooner than immediately prior to connecting operation
- Never leave the piping and components open to the atmosphere, not even for a short time
- During bending pay attention that the piping is not deformed (narrowed), always use special equipment and tools
- Never bend the piping by hand, over the knee etc.

2.2.1 Mounting the Piping

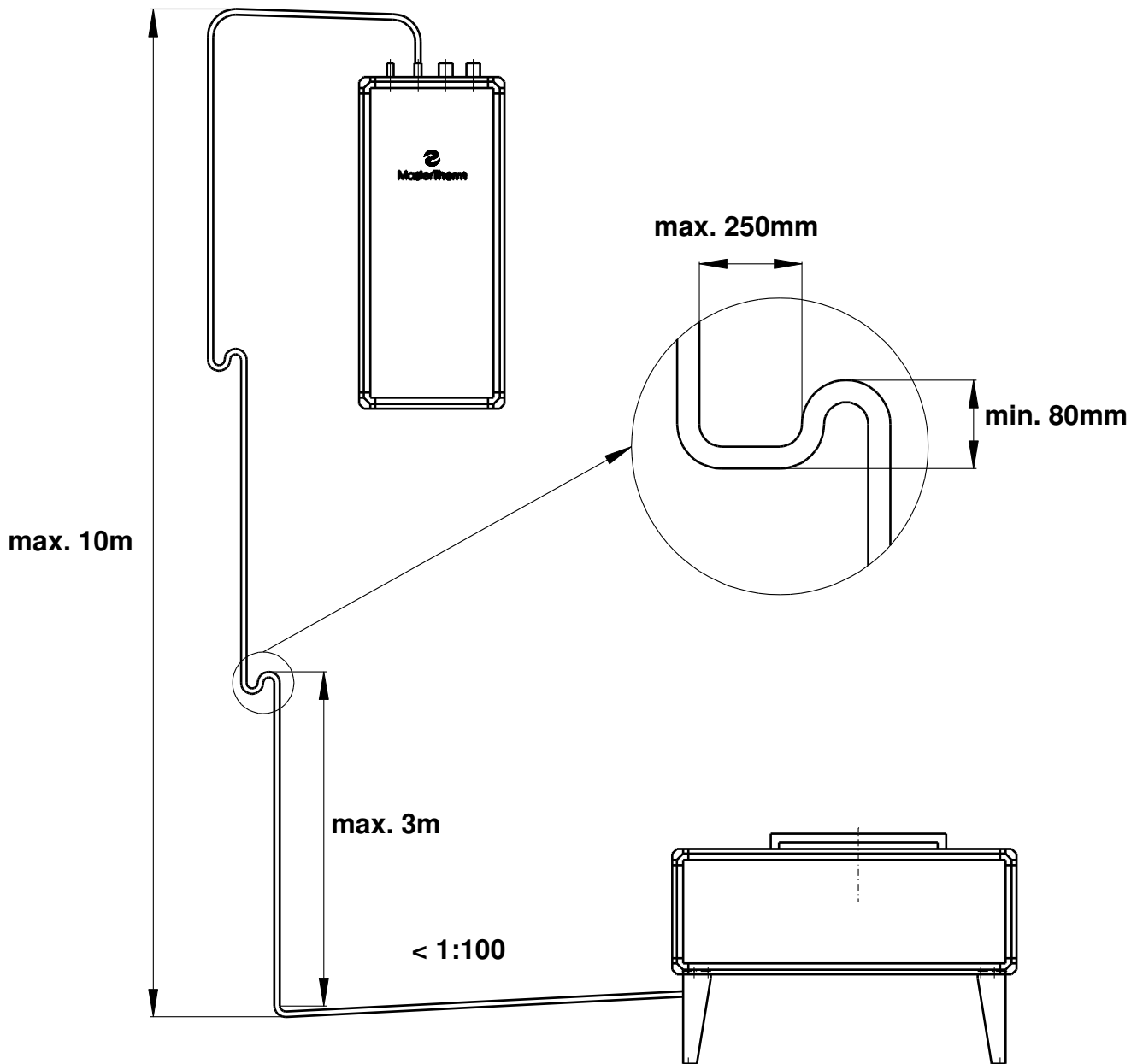
The piping must be mounted to a firm base (wall etc.) using special brackets. Recommended pitch between brackets is 1 to 2m to prevent vibrations of the piping during operation. The piping must not be in contact with the base. The holes through walls and bases must be insulated and filled with PU foam so that the piping is not in contact with the wall, concrete etc. Holes under the ground must be waterproofed to prevent the humidity and water from penetrating the building.

2.2.2 Horizontal Parts of the Vapour line

The horizontal parts of the **vapour piping** must be descended by 1:100 toward the coolant flow in the heating mode (always in direction from the outer toward the inner unit).

2.2.3 Vertical Parts of the Vapour line

In the case the piping is vertical and the coolant ascends (typical for cases where the outer unit is lower than the inner one), the piping must be equipped with oil traps. For typical installation see picture below.

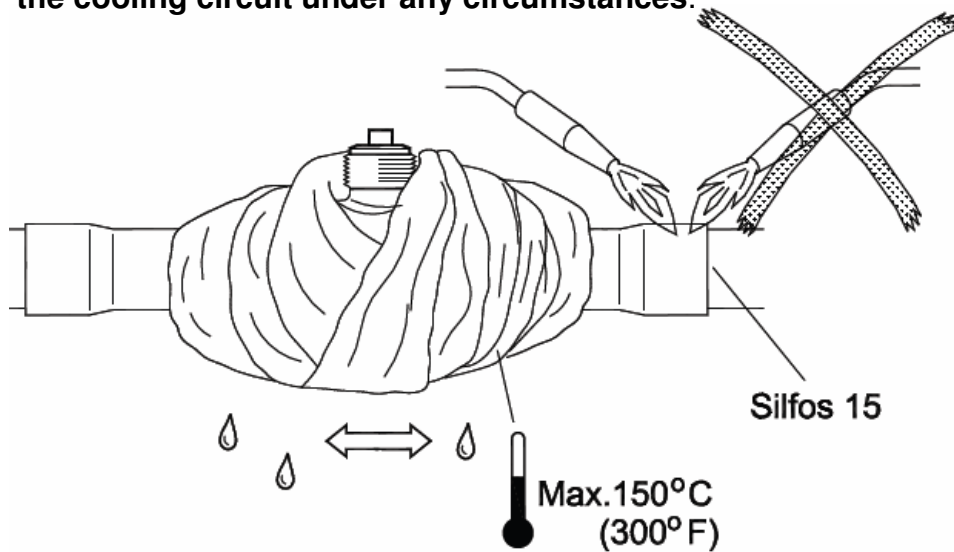


2.2.4 Liquid line

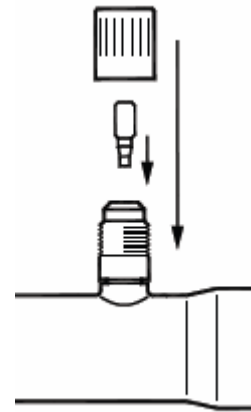
There are no special requirements for liquid piping.

2.3 Welding

Only hard oxygen-propane or oxygen-acetylene flame welding can be employed. Welding material to be used is solder with minimum content of silver 5% (L-Ag5P). The welding is performed with inner protection atmosphere of nitrogen (N₂). **No chemicals are allowed to be used for welding.** After connecting the piping and prior to the welding, the piping is filled with nitrogen using pressureless method. The service valve of the outer unit must remain open to the atmosphere during welding to prevent pressurization due to its warming. Sensitive elements of the cooling circuit, especially the ball valves of the inner unit, must be cooled during welding using a wet cloth covering the body of the valve. Proceed with care, **no moisture must get into the cooling circuit under any circumstances.**



Instructions for ball valve welding



Removing the core of the service valve of the outer unit

Inspect visually after welding and cooling of joints.

2.4 Leak Test

After welding put the core back to the service valve of the outer unit and pressurize it using nitrogen to 10 bars (1,0MPa). Inspect tightness of joints using detection liquid. We recommend attaching the air-pressure gauge to the service valve and after 24 hours check the pressure which must be the same as after the pressurizing. In the case there is a pressure loss the tightness of joints must be rechecked.

2.5 Vacuuming

After successful leak test the nitrogen must be emptied from the circuit and the system must be vacuumed. We recommend using the 2-level vacuum pump. After the pressure is stabilized, close the service valves. After 15 minutes check if the pressure did not increase again and vacuum again for 30 minutes.

2.5.1 Units MINI with In-built Liquid Receiver

Units equipped with the liquid receiver have installed the “ROTALOCK” valve. This valve is located on the upper part of the liquid receiver and it is closed as default. Check that it is closed prior to the vacuuming and then open the ball valve of the liquid line (small valve).

2.6 Circuit Connection

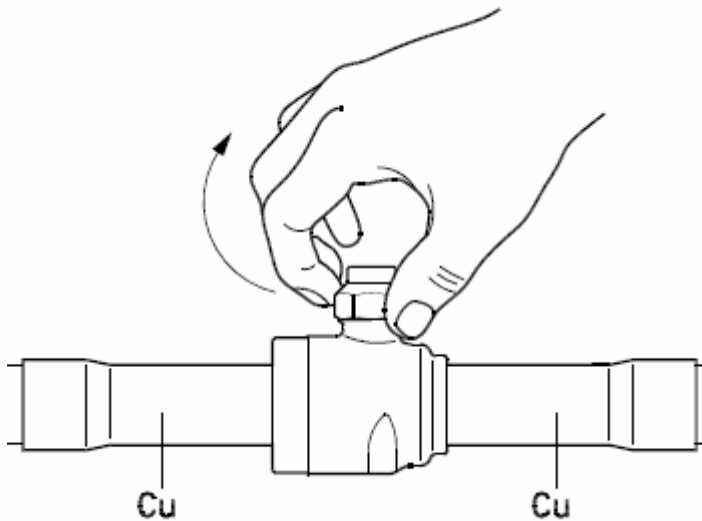
After the vacuuming, connect the outer and inner units by opening the ball valves located in the inner unit.

2.6.1 Opening the ROTALOCK valve

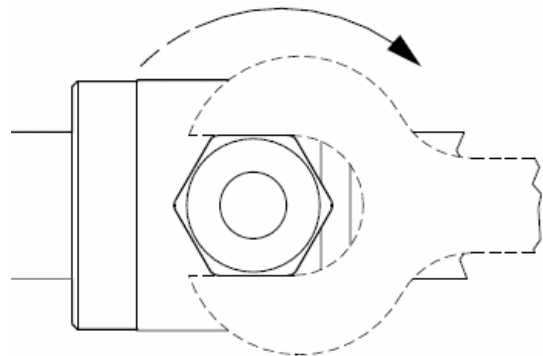
The ROTALOCK valve must be fully open at units equipped with the liquid receiver. The valve is open by turning it counter clockwise. When the valve is opening, the stem is being drawn out the valve body.

2.6.2 Covers and Caps of the Ball Valves and the ROTALOCK Valve

After performing all operations, the caps of ball valves and the ROTALOCK valve must be screwed back on. When manipulating with the ball valve caps special attention must be paid to the Teflon sealing so it is not lost. The plastic cap of the ROTALOCK valve is sealed by the coned surfaces and no sealing is used.



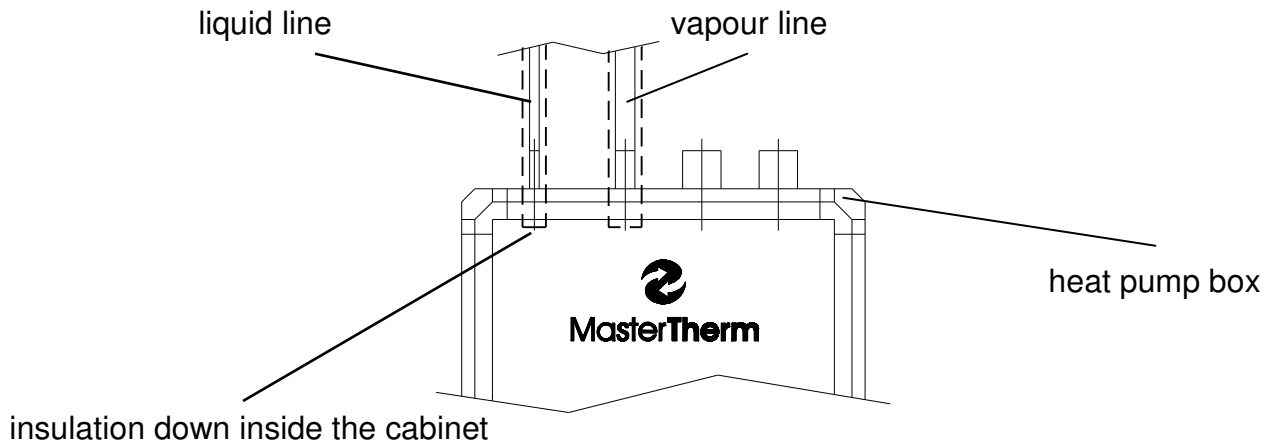
Tighten the valve cap manually



Then tighten by wrench

2.7 Thermal Insulation

Both the liquid and steam piping must be insulated to prevent condensation and frosting on the piping surface. We recommend using pre-insulated piping designed for heat pumps with UV protection. If you are using “naked” piping, it must be insulated by insulation based on the PUR base, e.g. **Armafex**, **Kaiflex** etc. Recommended insulation wall thickness is 9mm., the insulation must be “hermetical”. All joints of the insulation must thus be bonded by special glue or taped over by adhesive insulation tape. The piping must be insulated down inside the heat pump cabinet. In the case the insulation is not performed properly, the condensate leaks inside the heat pump cabinet and corrosion consequently occurs inside the cabinet.



Performance and completion of heat insulation

3 Earth Exchanger for Direct Evaporating– AQxxD

The same instructions as in the previous chapter apply for completion of the earth exchanger and piping positioning.

3.1 Principle of Operation

The heat is drawn from the earth through the Cu piping with plastic coating. The coolant (r407c) circulates directly in the earth exchanger. For this reason it is necessary to adhere to the number of circles of the earth exchanger and the length of piping to make sure the oil returns to the compressor. These heat pumps have relatively high amount of coolant and thus it is necessary to make sure the room is of sufficient volume.

3.2 Collector Piping

Deoxidized, plugged Cu piping with PE or PVC coating and certification for cooling equipment must be used for installation. The piping must be certified per EN12735-1.

Usually piping of 12mm DIA, 65m long, or 14mm DIA, 75m long are available. **Never use piping designed for water.**

The following table lists numbers of earth collector loops.

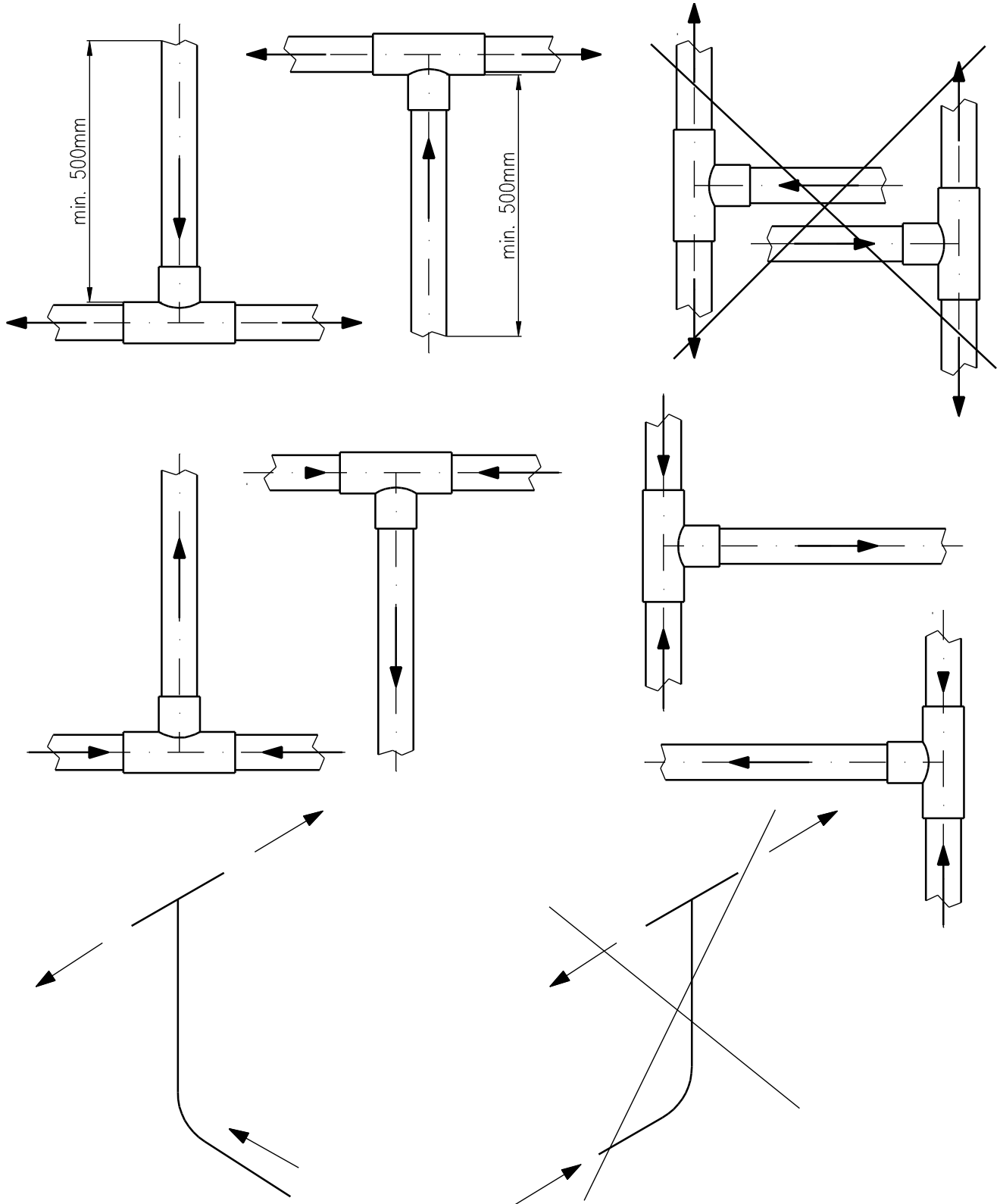
Typ TC	heat.capacity [kW] E0W35	land area [m ²]	piping Cu12x65m		piping Cu14x75m	
			loops	length[m]	loops	length[m]
AQ9Z1D	3,2	130	2	130	-	-
AQ26ZD	10,1	350	8	520	6	450
AQ30ZD	11,4	400	8	520	6	450
AQ37ZD	14,1	500	10	650	8	600
AQ45ZD	17,2	600	12	780	10	750
AQ50ZD	18,5	600	12	780	10	750
AQ60ZD	22,8	800	-	-	12	900

3.2.1 Distributor and Collector

Depending on the type of the heat pump and piping used, a proper distributor and coolant collector must be ordered as equipment. It is not allowed to use components of other suppliers. The distributor is specially designed for correct operation. Sets for 4, 6, 8, 10, and 12 circuits are available. The distributor must be installed vertically with straight liquid pipe at least 50cm long.

3.2.2 Distributor and Collector for AQ9Z1D

2 pieces of standard T fitting are used for distribution and collection of 2 refrigerant lines. Vertical inlet orientation is required for refrigerant distribution (vapor and liquid mixture). If elbow is used in front of the distributor, it must be oriented perpendicularly to the loop lines. There is no direction limitation for collector fitting, cause vapour inside only.



3.2.3 Liquid and Vapor Lines

After connecting the circuits using the distributor and collector, the Heat Pump is connected using the liquid and vapour piping. Diameter and maximum length is in the following table.

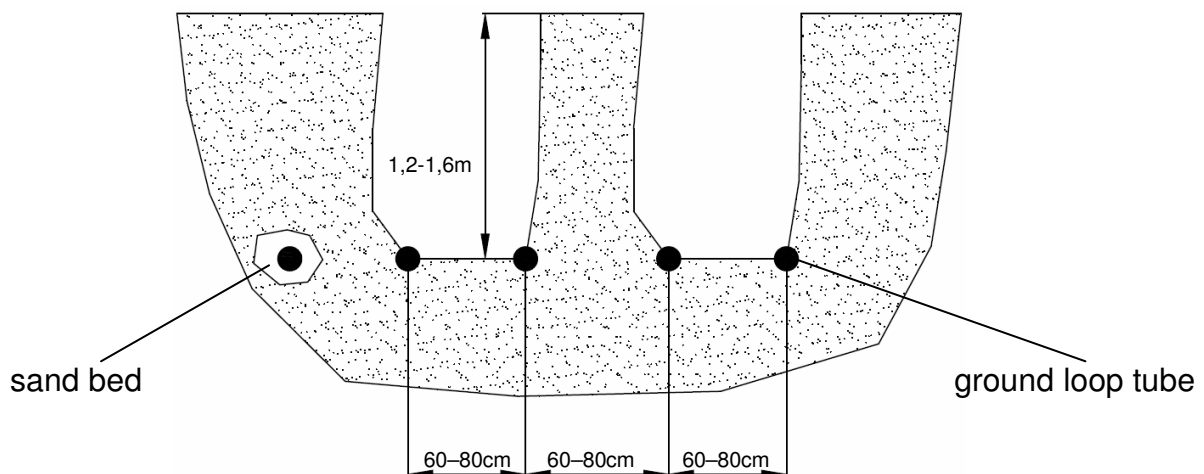
HP type	D Vapour [mm]	d Liquid [mm]	max. length [m]
AQ26ZD	22x1(7/8")	12x1 (1/2")	15
AQ30ZD	22x1(7/8")	12x1 (1/2")	15
AQ37ZD	22x1(7/8")	12x1 (1/2")	15
AQ45ZD	22x1(7/8")	12x1 (1/2")	15
AQ50ZD	22x1(7/8")	12x1 (1/2")	15
AQ60ZD	28x1	15x1	25

3.2.4 Ground Loop Installation

The piping is installed app. 40cm under the frost depth, that is 1,2 to 1,6m deep, depending on the location. The spacing of the piping is to be 60 to 80cm.

Instructions to be followed:

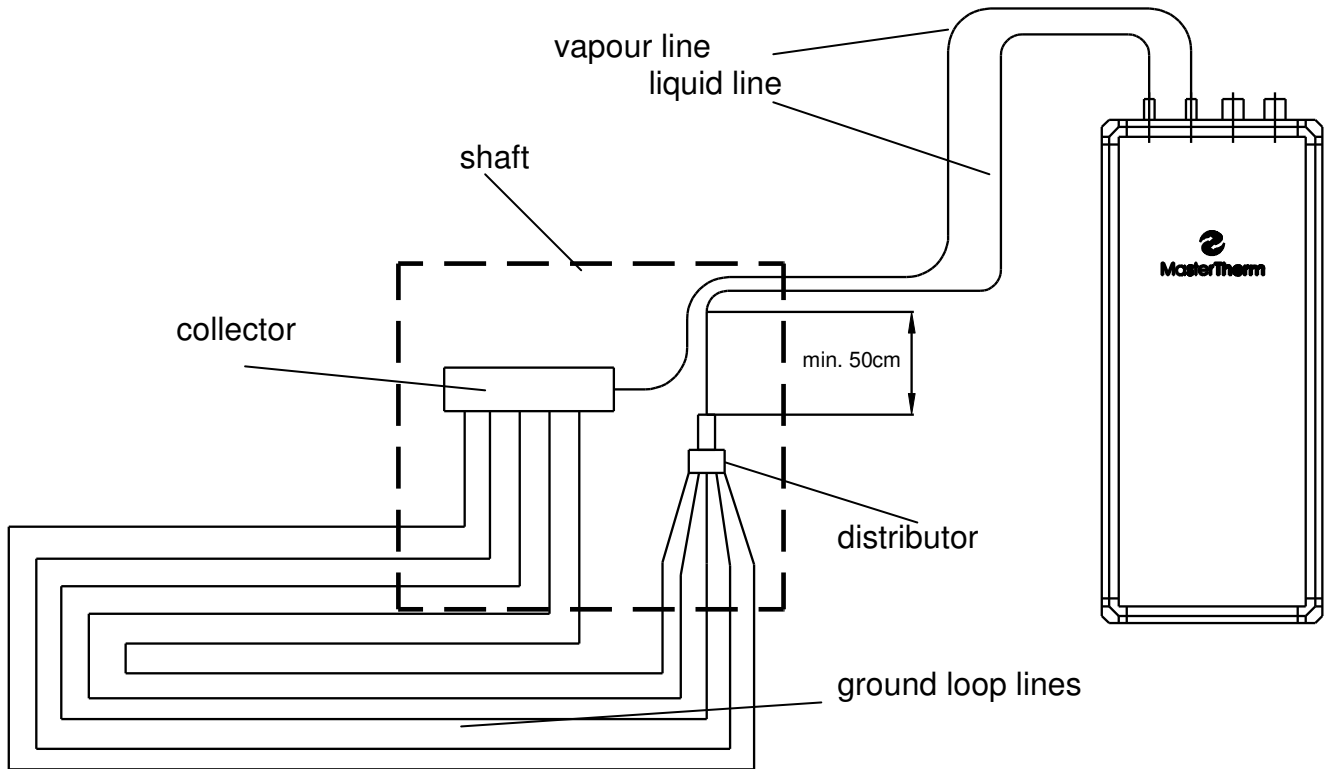
- In the case the land is slope, the piping must be installed in such direction that from a half of its length it is descending in the direction from the distributor toward the collector to make sure the oil returns to the compressor
- Always use only the Cu roller-type pipe cutter for cutting the piping, never use a saw
- Cut the piping immediately prior to connecting operation
- Remove the plugs no sooner than immediately prior to connecting/welding operation
- Never leave the piping and components open to the atmosphere, not even for a short time
- During bending pay attention that the piping is not deformed (narrowed), always use special equipment and tools
- In the case the collector is to be connected later, remove the plastic plugs, flatten the piping ends and weld them carefully to prevent water from entering the piping in the case the underground water rises



Ground loop for direct evaporating heat pump.

3.2.5 Ground Loop and Heat Pump Interconnection

The distributor and collector are usually installed in the collecting shaft which is made of shaft rings of appropriate diameter, usually 80cm. It is also recommended to use plastic prefabricated shafts.



Ground loop and heat pump piping.

3.3 Brazing

Please see chapter 2.3

3.4 Leak Test

Please see chapter 2.4

3.5 Vacuuming

Please see chapter 2.5

3.6 Circuit Connection

Please see chapter 2.6

3.7 Thermal Insulation

Both liquid and vapour lines must be insulated inside the building. Insulation between the building and the collecting shaft is not necessary in the case the piping is put in non-frost depth. Further, Chapter 2.7 applies.

4 Ground Loop for AQ units

4.1 System Description

This natural resource exploits accumulated solar energy. During the summer the earth surface is warmed by solar energy. In winter we withdraw this energy and using the heat pump we use it for heating.

For this, a system of exchangers must be built. Anti-freeze mixture circulates inside the exchangers. It is thus a so-called closed system and the circulatory pump ensures circulation of the anti-freeze mixture. The earth exchangers are made from polyethylene pipes PE32, or PE40. There are several types of earth exchangers.

4.2 Horizontal Ground Loop

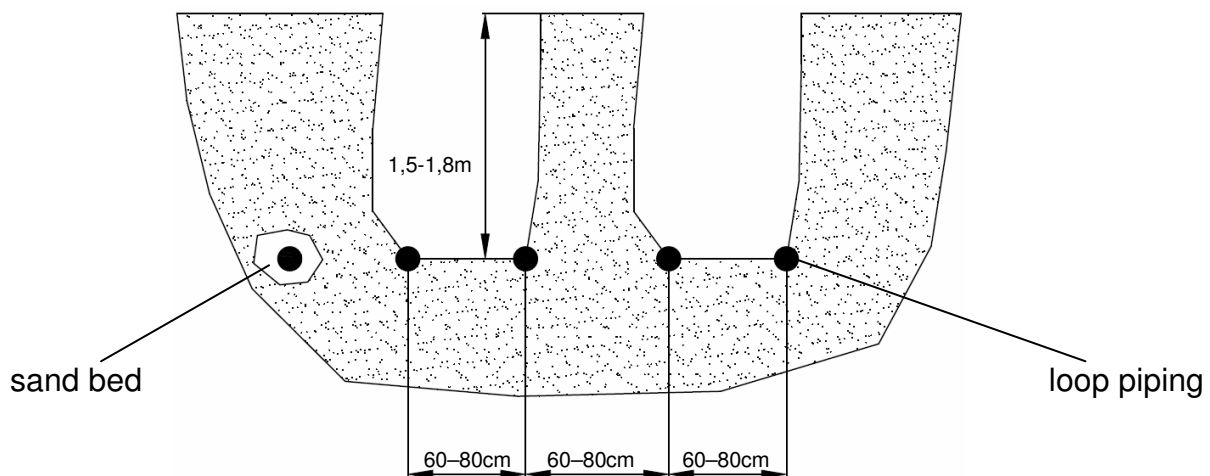
This is a planar collector with piping evenly distributed over the required area of land. The size of the collector system and thus the needed area of land depend on the heat loss of the building – power of the heat pump and the heating capacity of the soil. Following table lists approximate values of various types of soil.

Type of soil	Yield on m ² of land	Area needed for 1kW of building peak heat demand
dry, non-cohesive	10W/m ²	70m ²
moist, cohesive	20÷30W/m ²	40÷26m ²
wet loose	35W/m ²	20m ²

The main requirement of the collector systems is the same length and diameter of all loops to ensure the same flow through all loops. **Building permit is required for building the earth exchanger.**

4.2.1 Standard Horizontal Loop

This type is based on even distribution over the entire area of land. It is suitable for any shape of land. The piping is placed 60cm under the frost depth, that is 1,5 to 1,8m depending on the location. The spacing of the piping is to be 60 to 80cm, maximum 100cm.



Standard horizontal ground loop configuration.

The following table lists recommended configurations of standard horizontal collectors:

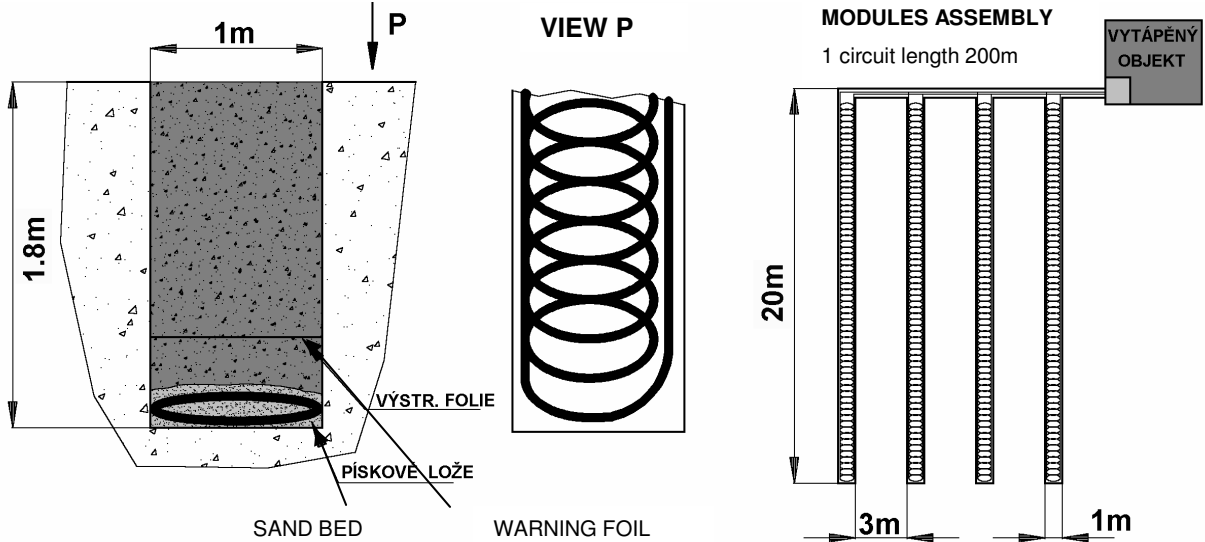
dry soil 70m²/kW								
HP Type	H.Cap. B0W35 [kW]	Soil Area [m ²]	Pipe Dimension	200m Loops	300m Loops	Spacing [m]	Pipe Length [m]	Circuit Volume [l]
AQ17	6,6	500	PE25	6	-	0,4	1200	377
AQ22(AQ22l)	7,8	550	PE25	7	-	0,4	1400	440
AQ26	10,1	750	PE25	9	-	0,4	1800	565
AQ30(AQ30l)	11,4	800	PE25	10	-	0,4	2000	628
AQ37	14,1	1000	PE32	-	6	0,6	1800	955
AQ45	17,2	1250	PE32	-	7	0,6	2100	1114
AQ50	18,5	1300	PE32	-	8	0,6	2400	1274
AQ60(AQ45l)	22,8	1600	PE32	-	9	0,6	2700	1433
AQ75	27,8	1950	PE32	-	11	0,6	3300	1751
AQ90(AQ60l)	33,2	2350	PE32	-	13	0,6	3900	2070

wet soil 40m²/kW								
HP Type	H.Cap. B0W35 [kW]	Soil Area [m ²]	Pipe Dimension	200m Loops	300m Loops	Spacing [m]	Pipe Length [m]	Circuit Volume [l]
AQ17	6,6	300	PE32	3	-	0,6	600	318
AQ22(AQ22l)	7,8	350	PE32	3	-	0,6	600	318
AQ26	10,1	450	PE32	4	-	0,6	800	425
AQ30(AQ30l)	11,4	500	PE32	5	-	0,6	1000	531
AQ37	14,1	600	PE32	5	-	0,6	1000	531
AQ45	17,2	700	PE32	6	-	0,6	1200	637
AQ50	18,5	750	PE32	7	-	0,6	1400	743
AQ60(AQ45l)	22,8	950	PE32	8	-	0,6	1600	849
AQ75	27,8	1150	PE32	10	-	0,6	2000	1061
AQ90(AQ60l)	33,2	1350	PE32	12	-	0,6	2400	1274

sandrock below ground water level 20m²/kW								
HP Type	H.Cap. B0W35 [kW]	Soil Area [m ²]	Pipe Dimension	200m Loops	300m Loops	Spacing [m]	Pipe Length [m]	Circuit Volume [l]
AQ17	6,6	150	PE32	2	-	0,7	200	106
AQ22(AQ22l)	7,8	200	PE32	3	-	0,7	300	159
AQ26	10,1	250	PE32	4	-	0,7	400	212
AQ30(AQ30l)	11,4	250	PE33	4	-	0,7	400	212
AQ37	14,1	300	PE32	5	-	0,7	500	265
AQ45	17,2	350	PE32	5	-	0,7	500	265
AQ50	18,5	400	PE32	6	-	0,7	600	318
AQ60(AQ45l)	22,8	500	PE32	7	-	0,7	700	371
AQ75	27,8	600	PE32	9	-	0,7	900	478
AQ90(AQ60l)	33,2	700	PE32	10	-	0,7	1000	531

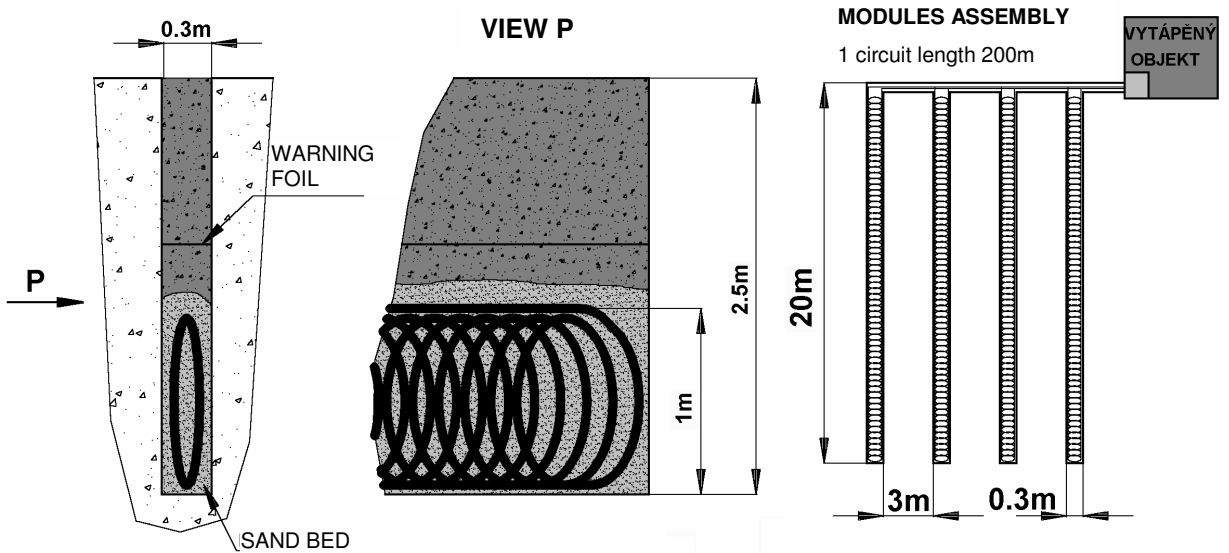
4.2.2 SLINKY H Horizontal Loop

This collector is based on a principle of building a large heat transfer area, which allows for absorbing heat to a distance of up to 2,5m from the center of the piping system. This system has lower costs for excavation works, but it is necessary to use more piping and thus the total volume of anti-freeze mixture is increased.



4.2.3 SLINKY V Horizontal Loop

The principle is the same as the previous type, with the difference that it allows for high savings on excavation works in the case suitable mechanization and suitable subsoil are available.



The following table lists recommended configurations of SLINKY collectors:

dry soil 70m²/kW – use is not recommended

SLINKY - wet soil 40m²/kW

HP Type	H.Cap. B0W35 [kW]	Soil Area [m ²]	Pipe Dimension	200m Loops	Pipe Length [m]	Circuit Volume [l]
AQ17	6,6	300	PE32	4	800	425
AQ22(AQ22I)	7,8	350	PE32	5	1000	531
AQ26	10,1	450	PE32	6	1200	637
AQ30(AQ30I)	11,4	500	PE32	6	1200	637
AQ37	14,1	600	PE32	8	1600	849
AQ45	17,2	700	PE32	9	1800	955
AQ50	18,5	750	PE32	9	1800	955
AQ60(AQ45I)	22,8	950	PE32	12	2400	1274
AQ75	27,8	1150	PE32	14	2800	1486
AQ90(AQ60I)	33,2	1350	PE32	17	3400	1804

SLINKY - sandrock below ground water level 20m²/kW

HP Type	H.Cap. B0W35 [kW]	Soil Area [m ²]	Pipe Dimension	200m Loops	Pipe Length [m]	Circuit Volume [l]
AQ17	6,6	150	PE32	2	400	212
AQ22(AQ22I)	7,8	200	PE32	3	600	318
AQ26	10,1	250	PE32	4	800	425
AQ30(AQ30I)	11,4	250	PE32	4	800	425
AQ37	14,1	300	PE32	5	1000	531
AQ45	17,2	350	PE32	6	1200	637
AQ50	18,5	400	PE32	7	1400	743
AQ60(AQ45I)	22,8	500	PE32	8	1600	849
AQ75	27,8	600	PE32	10	2000	1061
AQ90(AQ60I)	33,2	700	PE32	10	2000	1061

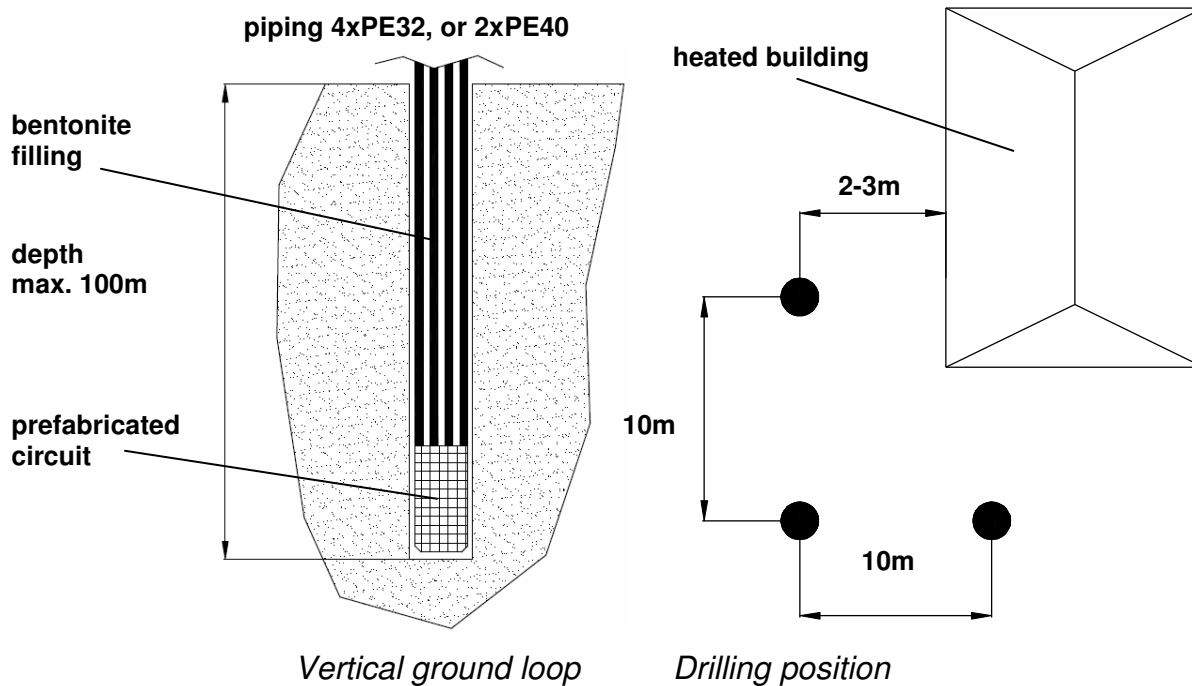
4.2.4 Vertical Ground Loop

This is an earth heat exchanger in the shape of single or double U which is located inside the ground drill hole. Maximum recommended depth of one drill hole is 100m. In the case more energy is required for the heat pump, heat is drawn from more drill holes. Minimum spacing of drill holes is 10m.

Heat output per 1m differs depending on the subsoil quality. The dimensioning is also necessary to perform depending on the heat loss of the building.

Type of subsoil	Output per 1m of drill hole depth	Drill hole depth for 1kW for building peak heat demand
Dry sediments	30W/m	25m
Clay, slate	60W/m	13m
Rock, rocky ground	80W/m	10m

Hydrogeological survey must be carried out before the drill hole is made. The survey shall determine the subsoil and its heating properties. The drill holes are carried out by specialized drilling companies. A certified prefabricated pipe probe must be used for the drill hole armature.



The following table lists recommended configurations of vertical collectors:

drills - dry subsoil 25m/kW								
HP Type	H.Cap. B0W35 [kW]	Total Depth [m]	Pipe Dimension	No of Drills Loop type		Depth 1 Drill [m]	Pipe Length [m]	Circuit Volume [l]
				4x	2x			
AQ17	6,6	166	PE25	2	-	83	664	208
AQ22(AQ22I)	7,8	196	PE32	2	-	98	784	416
AQ26	10,1	254	PE32	3	-	85	1016	539
AQ30(AQ30I)	11,4	286	PE32	3	-	95	1144	607
AQ37	14,1	354	PE40	-	4	89	708	569
AQ45	17,2	430	PE40	-	5	86	860	691
AQ50	18,5	464	PE40	-	5	93	928	746
AQ60(AQ45I)	22,8	570	PE40	-	6	95	1140	916
AQ75	27,8	696	PE40	-	7	99	1392	1119
AQ90(AQ60I)	33,2	830	PE40	-	8	104	1660	1334

Drill holes - Clay, Slate 13m/kW								
HP Type	H.Cap. B0W35 [kW]	Total Depth [m]	Pipe Dimension	No of Drills		Depth 1 Drill [m]	Pipe Length [m]	Circuit Volume [l]
				Loop type				
				4x	4x			
AQ17	6,6	86	PE32	1	-	86	344	183
AQ22(AQ22I)	7,8	102	PE25	2	-	51	408	128
AQ26	10,1	132	PE32	2	-	66	528	280
AQ30(AQ30I)	11,4	150	PE32	2	-	75	600	318
AQ37	14,1	184	PE32	3	-	61	736	391
AQ45	17,2	224	PE32	3	-	75	896	475
AQ50	18,5	242	PE32	3	-	81	968	514
AQ60(AQ45I)	22,8	298	PE40	-	4	75	596	479
AQ75	27,8	362	PE40	-	5	72	724	582
AQ90(AQ60I)	33,2	432	PE40	-	6	72	864	695

Drill holes - rocky ground 10m/kW								
HP Type	H.Cap. B0W35 [kW]	Total Depth [m]	Pipe Dimension	No of Drills		Depth 1 Drill [m]	Pipe Length [m]	Circuit Volume [l]
				Loop type				
				4x	4x			
AQ17	6,6	66	PE32	1	-	66	264	140
AQ22(AQ22I)	7,8	78	PE32	1	-	78	312	166
AQ26	10,1	102	PE32	2	-	51	408	217
AQ30(AQ30I)	11,4	114	PE32	2	-	57	456	242
AQ37	14,1	142	PE32	2	-	71	568	301
AQ45	17,2	172	PE32	3	-	57	688	365
AQ50	18,5	186	PE32	3	-	62	744	395
AQ60(AQ45I)	22,8	228	PE40	3	-	76	912	484
AQ75	27,8	278	PE40	-	4	70	556	447
AQ90(AQ60I)	33,2	332	PE40	-	4	83	664	534

4.3 Caution

This dimensioning of heat exchangers assumes standard heating season for a family house in CR of average length 230 days and a year-round preparation of domestic hot water (DHW) for 4 persons. For the following cases the collector must be designed by a specialist and for example the drill holes are regenerated by solar collectors:

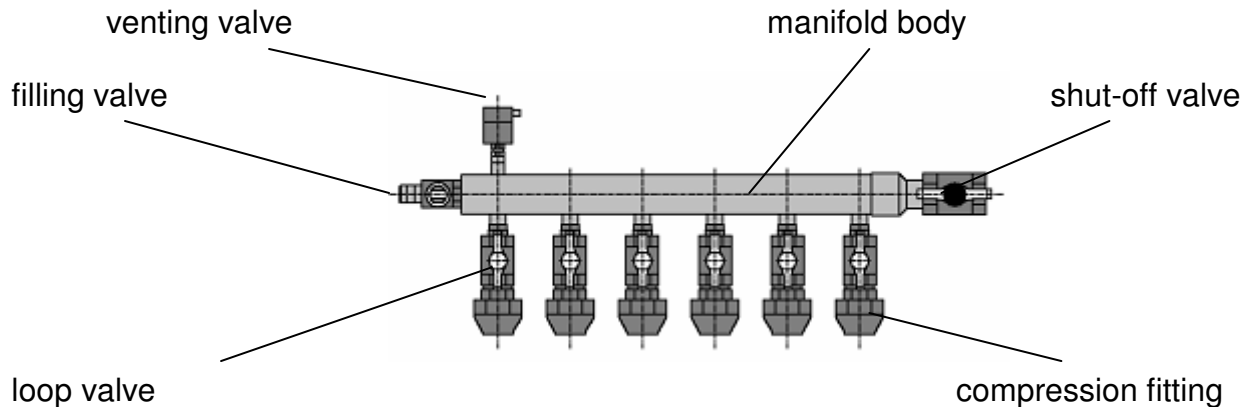
- Heating season exceeding 250 days, typical for mountain and submountain areas
- Pool heating, especially indoor
- High demands on DHW preparation

4.4 Piping

For the exchanger is used thin-wall PE piping of outer diameter 32 or 40mm. We recommend piping from the PE100 material, pressure line PN16. This piping can be connected only using electrofusion welding or compression fittings. For the armature of drill holes we recommend using only prefabricated and certified probes.

4.5 Manifolds

The distributor and collector connect single loops of the ground loop heat exchanger. Its proper design is important for filling and venting the piping system. We recommend using professional prefabricated distributors.



Manifold description.

Following guidelines apply:

- Each loop must be fully closable, closing armatures must have both distributor and collector, otherwise the system cannot be vented
- The loop should have the same position both on the distributor and collector
- Both the distributor and collector must have the draining/filling valve with a cap
- Dimension of the inlet valve should match the dimension of loops
- Diameter of distributor/collector body should be dimensioned for max. flow speed 0,5m/s

4.6 Manifolds Location

There are 2 kinds of distributor positions.

4.6.1 Manifolds in the Collection Shaft

It is usually used in places where there is a big distance between the collector system and the heat pump unit, or in places with lack of space inside the building. The advantage is that only 1 pair of piping is connected to the building, but with bigger dimensions.

When looking for the place for the shaft we must pay attention to the following:

- Water connection availability (within reach of a hose from the building)
- Electric connection availability (by a extension cord from the building)
- Easy access to the shaft

4.6.2 Manifolds inside the Building

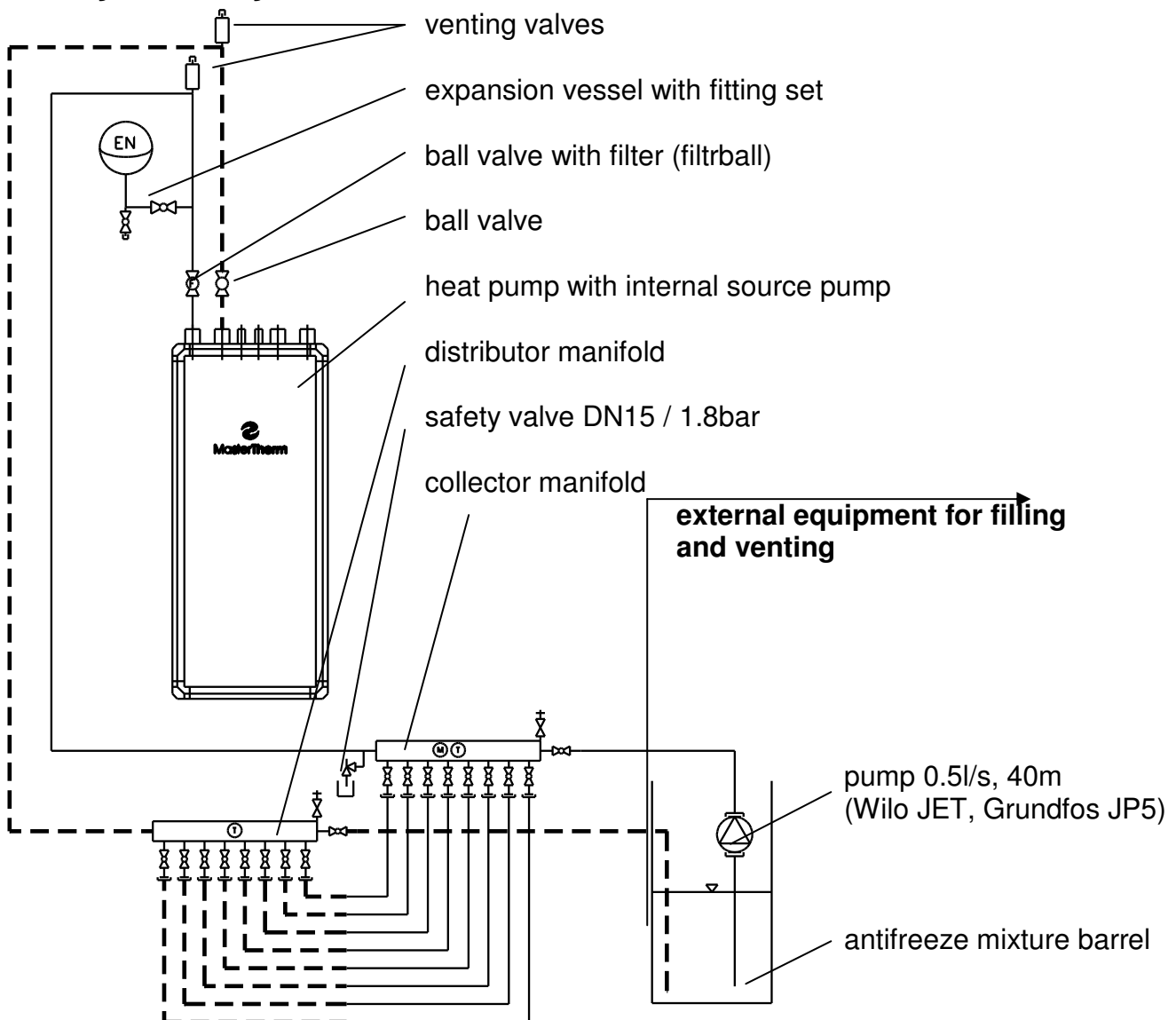
Advantage of this position is easy accessibility, handling, operation inspection, and relatively small dimension of connection with the heat pump unit. The disadvantage is the necessity of perfect insulation and holes needed for all loops of the ground source.

4.7 Manifolds and Heat Pump Connection

The connection can be made using plastic PE piping, or Cu piping of sufficient dimension. The following table lists maximum piping lengths depending on connection dimension for various heat pumps:

HP type	capacity B0W35 [kW]	maximum pipe length (both directions) [m]			
		Cu28x1	Cu32x1.5	Cu42x2	Cu54x2
		PE32	PE40	PE50	PE63
AQ17	6,6	12	40	120	300
AQ22(AQ22I)	7,8	10	30	100	250
AQ26	10,1	3	20	60	180
AQ30(AQ30I)	11,4	-	20	60	150
AQ37	14,1	-	10	30	120
AQ45	17,2	-	4	20	80
AQ50	18,5	-	-	20	70
AQ60(AQ45I)	22,8	-	-	12	50
AQ75	27,8	-	-	6	30
AQ90(AQ60I)	33,2	-	-	4	25

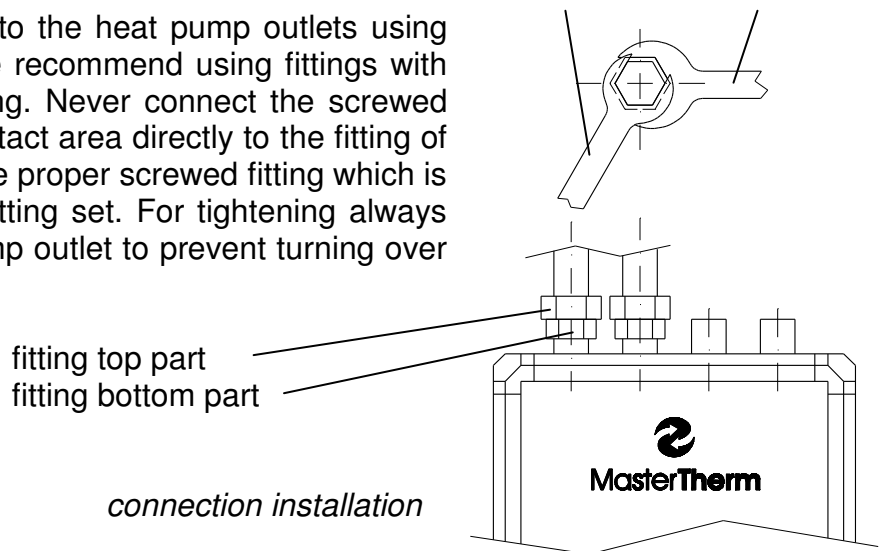
4.8 Hydraulic system schematic



4.9 Piping Connection

The piping must be connected to the heat pump outlets using connection screwed fittings. We recommend using fittings with cone contact area and an O-ring. Never connect the screwed fitting with cap nut and front contact area directly to the fitting of the heat pump outlet, always use proper screwed fitting which is usually a part of the screwed fitting set. For tightening always use the wrench on the heat pump outlet to prevent turning over or twisting off the outlet.

!!! use 2 spanners !!!



connection installation

4.10 Pressure and Leak Test

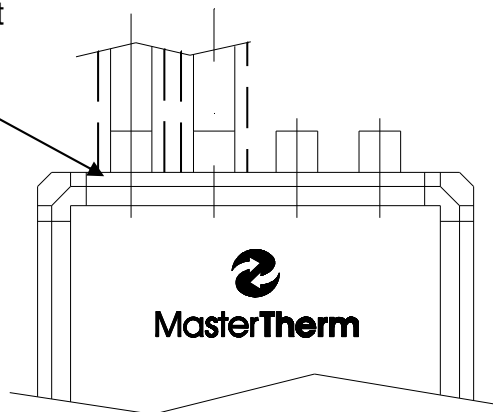
Before backfilling the collector system a Pressure and Leak Test must be performed. We recommend testing all the individual loops by surplus pressure of 6 bars. The exception is with certified probes in drill holes which were tested by the manufacturer. If in doubt, follow instructions of the piping manufacturer. After the system completion the leak test of the whole unit is performed by surplus pressure of 2,5 bars. The test is performed by filling the system with water and pressuring it by air. The heat pump is disconnected during the test by closing the valves. A written report about the test is made out.

4.11 Heat Insulation

After the Pressure and Leak Test is performed, heat insulation of earth collector piping inside the building is performed. Always use insulation based on PUR, for example Armaflex, Kaiflex etc. Recommended minimum wall thickness of insulation is 9mm.

The insulation must be "hermetical". All joints of the insulation must thus be bonded using special glue, or be taped over by self-adhesive insulation tape. The piping must be insulated down to the heat pump cabinet. In the case the insulation is made in bad quality, the condensate leaks into the heat pump cabinet and the cabinet corrodes. The underground piping outside is insulated using PE insulation to a distance of app. 1m from the entry point (do not use PUR insulation unless the piping is in the pipe sleeve).

insulation down to the cabinet



Heat insulation construction and closing

4.12 Anti-Freeze Mixture

Mixtures based on Ethyleneglycol, Propyleneglycol or Ethanol can be used as anti-freeze mixture. Special mixture for heat pumps must be used. The mixture must be mixed for freezing point of at least -15°C. The correct concentration is to be found in the concentrate manufacturer documentation. Regular tap water should not be used for the anti-freeze mixture. Distilled water is the ideal solution. If in doubt, follow the concentrate supplier instructions.

4.13 Filling and Venting the Ground Loop

Equipment as per scheme from Chapter 4.8 is required for Filling and Venting. Use barrel for mixing anti-freeze mixture, garden rust-free pump, and garden hose with ends for connecting the pump.

Natural venting is not possible due to the design of the piping system. The venting must be thus made by “pressuring” - rapid circulation of the anti-freeze mixture inside the loop which will press the air out of the piping collector.

Filling and venting procedure:

- Prepare sufficient volume of the concentrate which is calculated from the total length of the piping
- Pour the concentrate into the barrel
- Close valves connecting the heat pump with the distributor and collector
- Leave only 1st loop open, close the others on the distributor and collector
- Measure volume of concentrate to fit in 1 loop (a little less)
- Turn the pump on and start filling the loop with the concentrate, leave to run the pressed out water outside the barrel, turn the pump off after filling the measured volume
- Close the loop and open the next one in line, repeat the process above
- After filling the required volume of concentrate for the entire collector (app. 1/3 of loops) refill the barrel with water (only as much as we need, refilling as needed)
- Close all loops and return to the 1st loop, open it
- Put the “waste” hose into the barrel and turn the pump on, leaving the mixture to circulate and refill water to the barrel as needed till all air is removed from the loop
- Repeat this procedure for each loop individually
- After venting all loops, open all loops and leave the mixture to circulate through all the loops to mix the anti-freeze mixture properly
- The barrel has to be refilled when mixing the mixture based on Ethanol, because the total volume decreases due to mixing water and ethanol
- Next we vent the distributors connection with the heat pump by closing all loops and open only the connections, using same method as with the loops
- Pay attention to the correct flow direction, we must fill the heat pump with the mixture through the filter !!!
- Now correct circulation can be tested by the inbuilt circulation pump
- Measure and verify the freezing point of the anti-freeze mixture to at least -15°C, using the refractometer
- If all is correct, disconnect the filling set and leave the rest of the mixture for contingent future refills

ATTENTION:

**It is impossible to perform proper venting using the inbuilt circulation pump !!!
Proper venting and mixing the mixture is essential for correct and flawless operation of the ground source heat pump.**

5 Connestion to the Heating System

The heat pump must be connected to a suitable, low-temperature heating system. From the perspective of optimum efficiency the floor heating is ideal, then the wall heating, and the least convenient are radiators dimensioned to temperature gradient, typically of 50/40°C, maximum 55/45°C. It is the responsibility of the architect, installation company, and the investor to choose the type of heating system.

5.1 Heating System – WARNING

Heating system dimensioned on temperature gradient higher than 55/45°C cannot be used for the heat pump. If the case is reconstruction of the boiler – machinery room, technical expertise is required to determine if the heating system is suitable for usage with the heat pump.

5.2 Water Quality -Hardness dH and pH value

Following requirements are valid according to the nominal capacity and relative volume:

Capacity kW (relative volume l/kW)	Maximum Hardness dH	pH value
<50kW (<20l/kW)	16	8-9
<50kW (>20l/kW)	11	8-9
>50<=200kW	11	8-9
>200<=600kW	8	8-9
>600kW	0.11	8-9

5.2.1 Corrosion Inhibitors

It is necessary to check water quality before filling the system and add corrosion inhibitors. Type of heating system components material must be taken into consideration and use suitable corrosion inhibitor. Concentration of corrosion inhibitors must be annually checked and refilled when necessary. To check inhibitor concentration, use indicators supplied by inhibitor manufacturer/distributor.

Warning: When corrosion inhibitors are not used and dH/pH is not adjusted, metal materials are dissolving into heating water. Dissolved metals are later sedimenting in heat exchangers, flexible hoses, pumps and other components, causing possible damage of the heat pump system. This kind of damage is EXCLUDED from warranty.

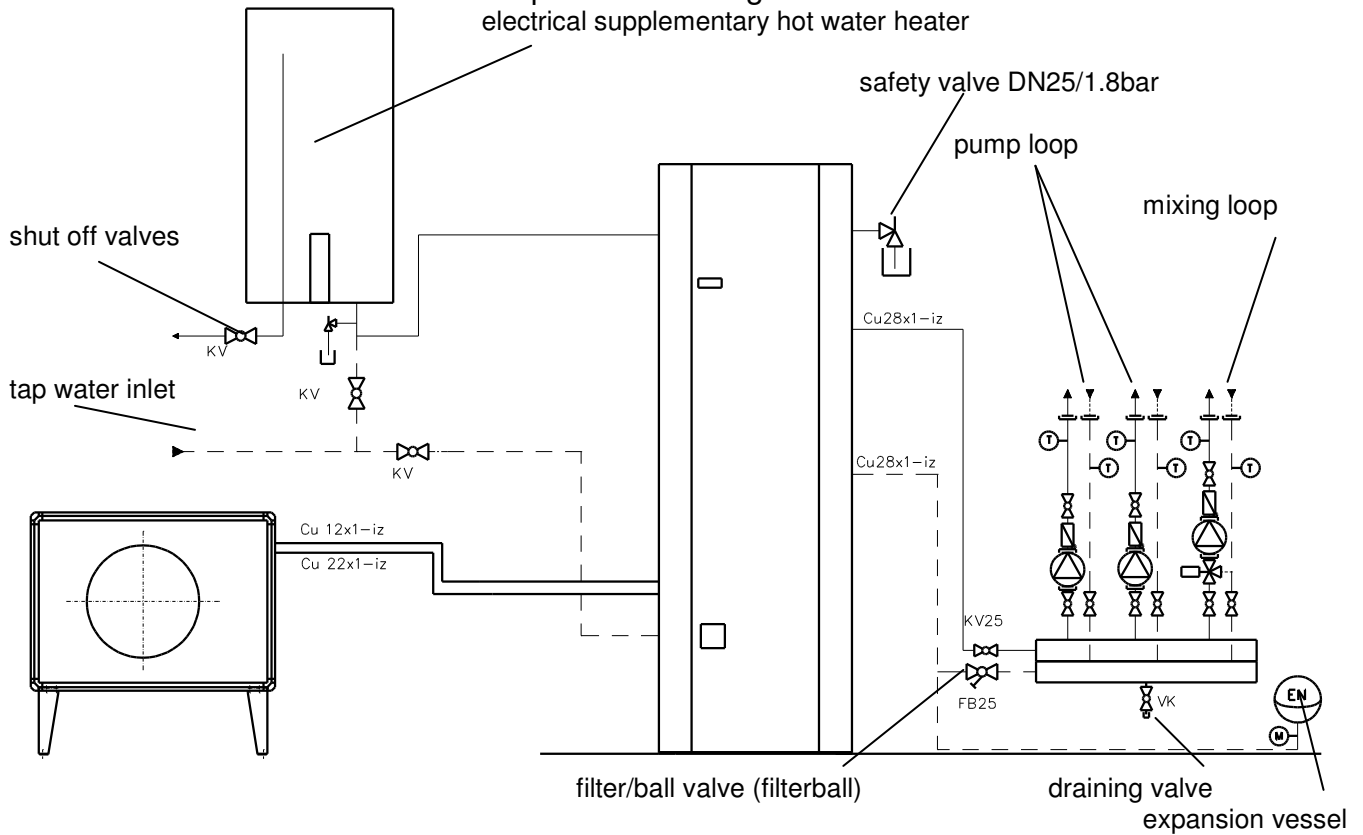
5.2.2 Bacterial and mould protection

In case of low temperature applications like UFH, typical for heat pumps, we recommend to use antibacterial inhibitors as well.

5.3 Connection of Heat Pumps “AKU” – AM

The AKU heat pumps have the accumulation vessel of the heating system already installed. Their connection is thus easy and fast.

The AKU unit must be connected as per the following scheme:



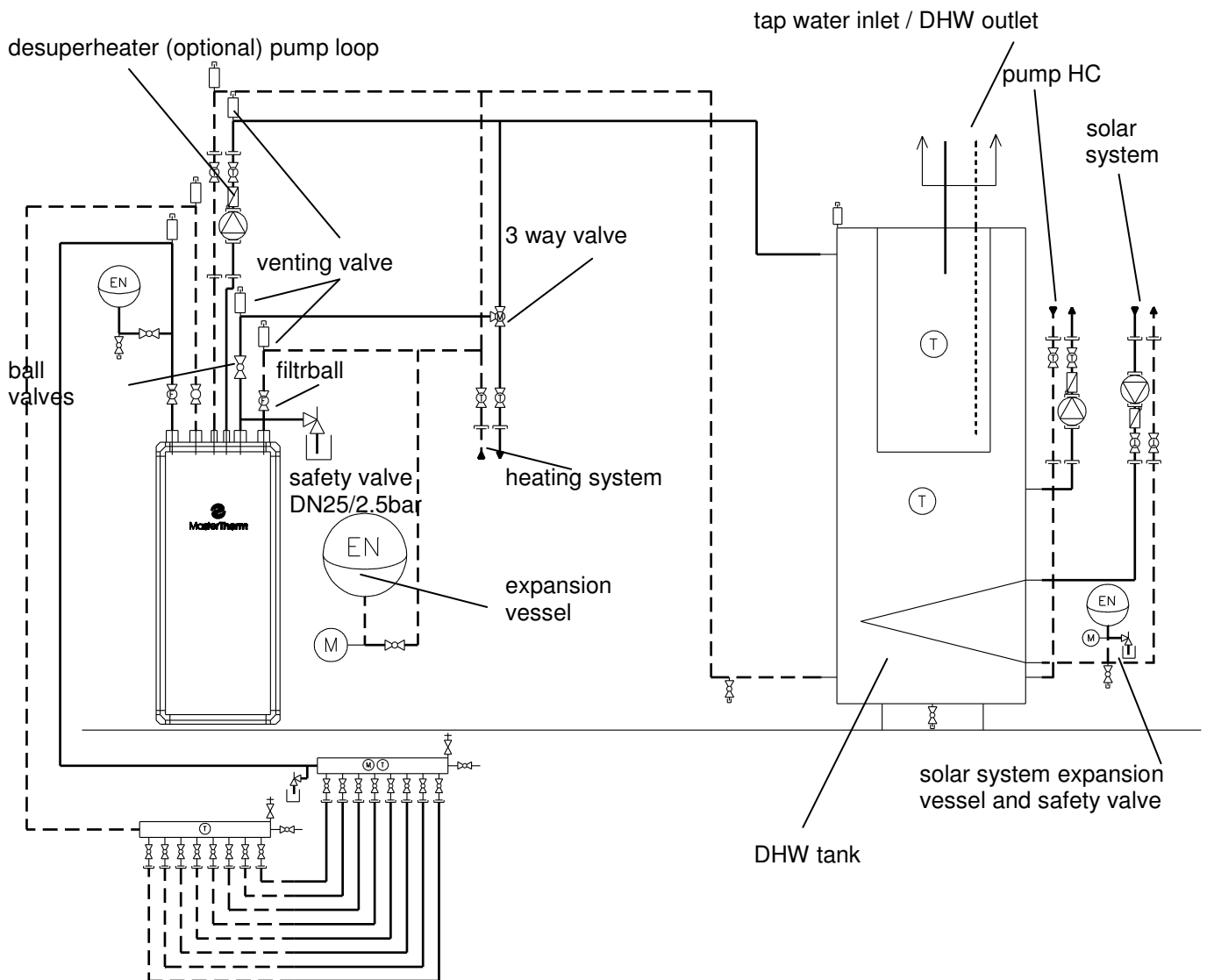
Hydraulic scheme of AKU unit connection

5.4 Connection of AQ Heat Pumps

These are units of the “MINI” type which is not equipped with an accumulation vessel.

5.4.1 AQ Single-circuit Heating System

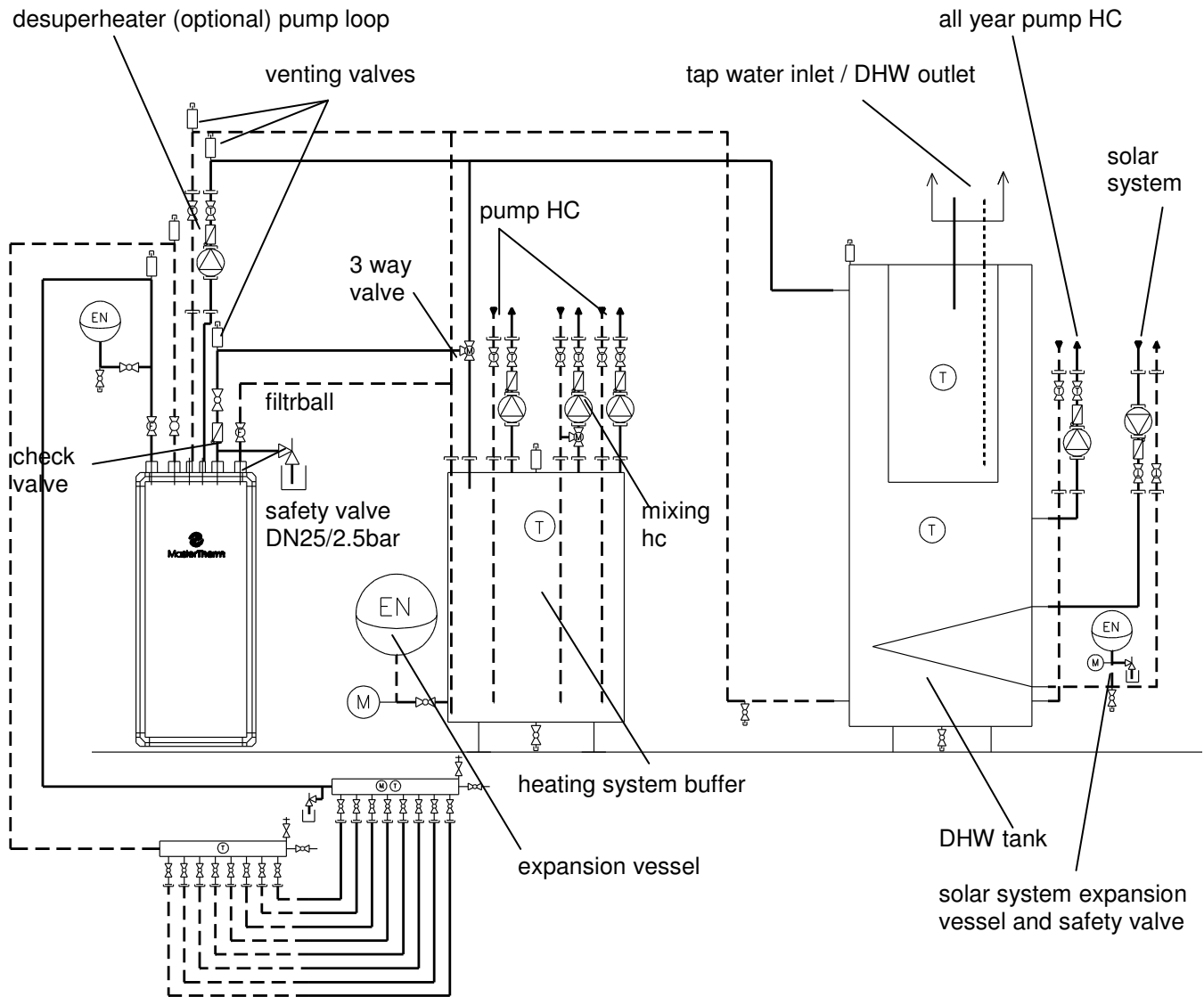
Typical usage is for floor heating, except for “dry system of floor heating”. In this method of direct connection of the heat pump to the heating system, maximally 30% of the heating system can be equipped by local regulation. In the case of usage for radiators it is also necessary to comply with the requirement of minimum heating water volume of 15 l/kW of the heating output of the heat pump at B0W35. The DHW heating is provided by a 3-way switching valve. Regarding the type of DHW tank follow instructions in Chapter “Preparation of Domestic Hot Water”.



AQ machinery room for single-circuit heating system

5.4.2 AQ Multi-circuit heating system – Switchable Heating of DHW

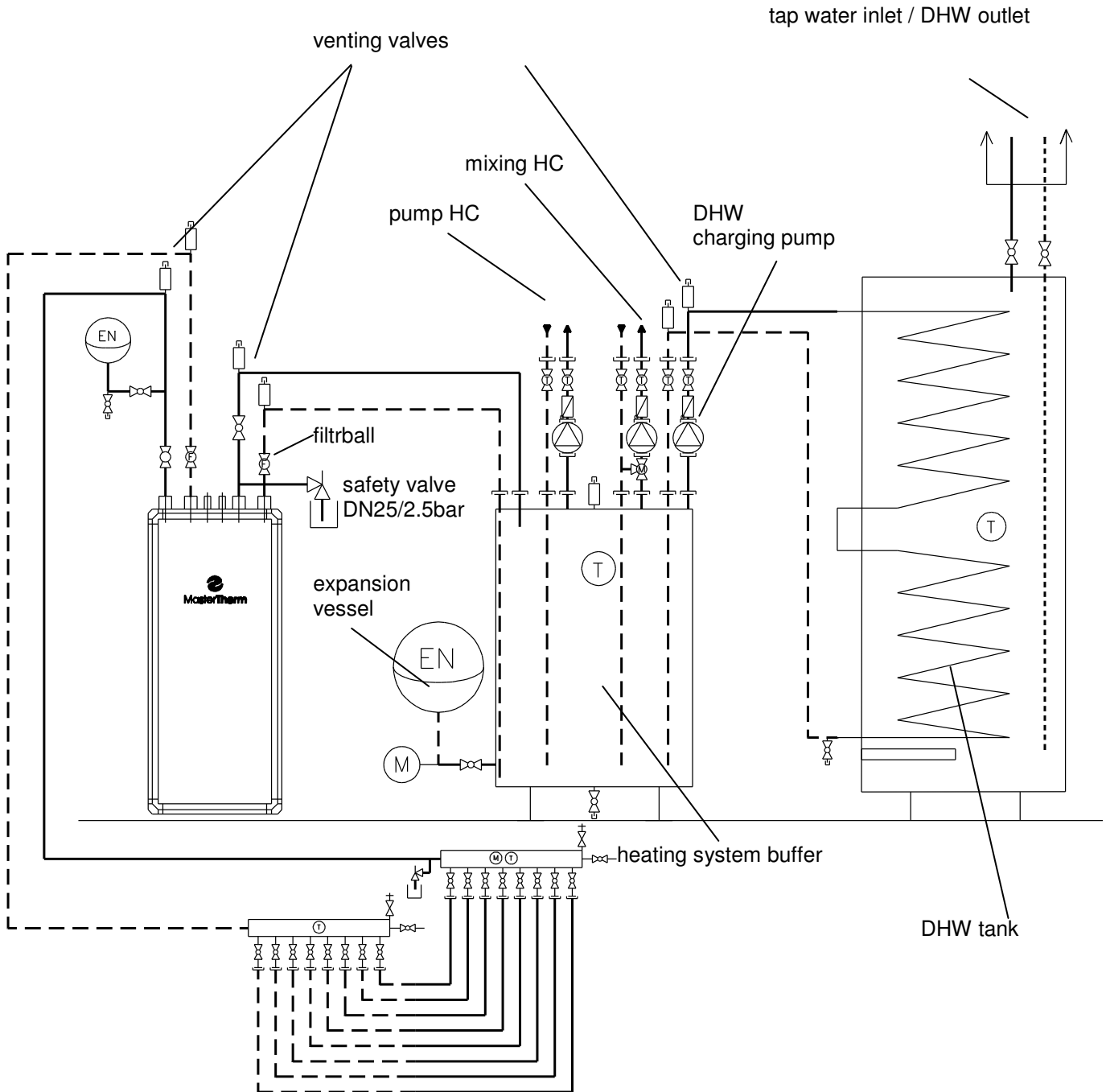
Universal scheme for multi-circuit heating systems with accumulation vessel. Local regulation can be applied here for 100% of heating output. The volume of the accumulation vessel is determined for 15 l/kW of heating output of the heat pump for B0W35. Heating of DHW is also provided by a 3-way switching valve. Regarding the type of DHW tank follow instructions in Chapter “Preparation of Domestic Hot Water”.



AQ machinery room for multi-circuit heating system – switchable heating of DHW

5.4.3 AQ Multi-circuit Heating System – DHW Heating Using Charge Pump

Universal scheme for multi-circuit heating systems with accumulation vessel. Local regulation can be applied here for 100% of heating output. The volume of the accumulation vessel is determined for 15 l/kW of heating output of the heat pump for B0W35. Heating of DHW is provided by a charge circulation pump from the accumulation vessel of the heating system. Regarding the type of DHW tank, follow instructions in Chapter “Preparation of Domestic Hot Water”.

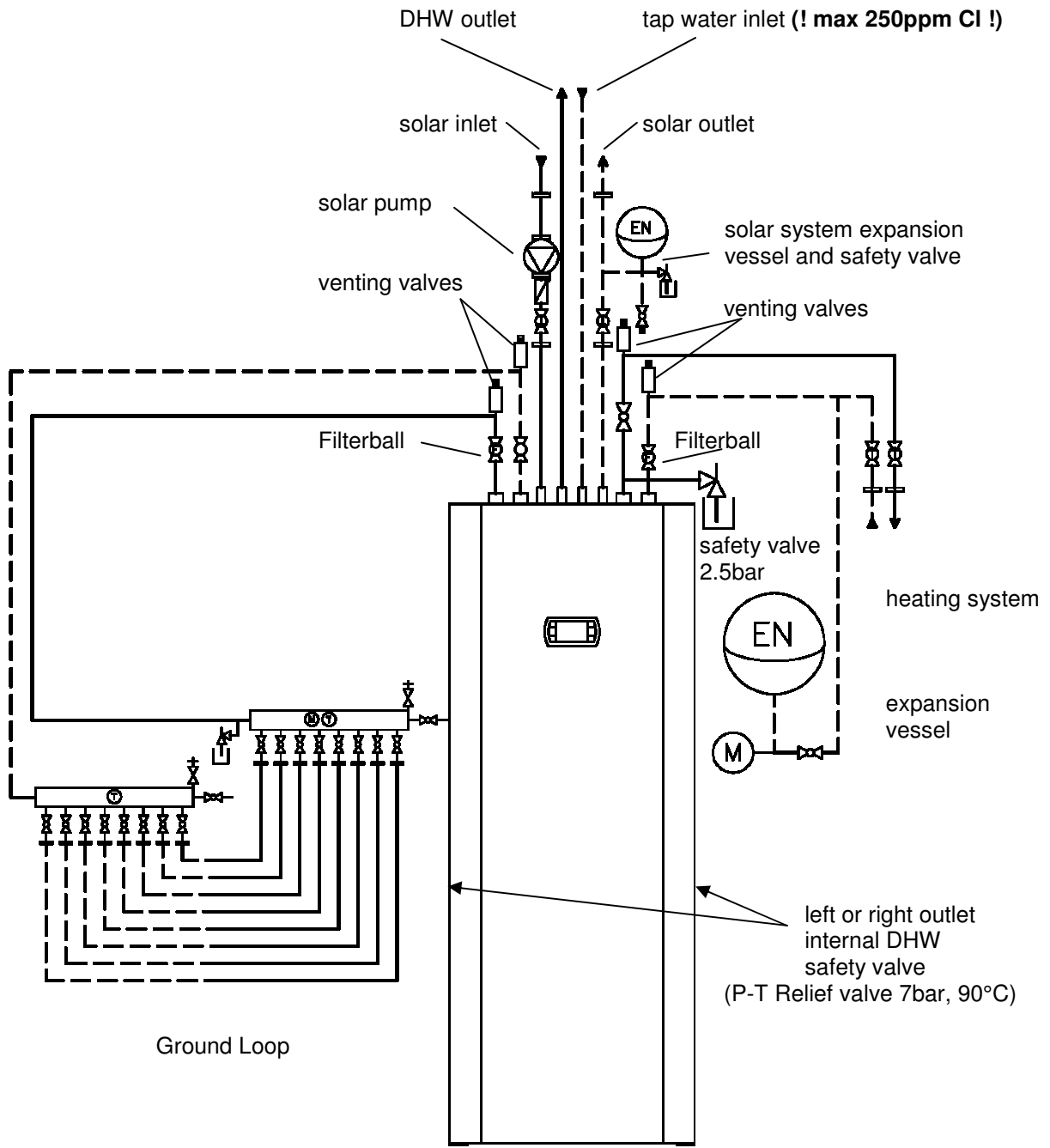


AQ machinery room for multi-circuit heating system – charge heating of DHW

5.4.4 AQxxIC (combi) units recommended connection

Typical usage is for floor heating, except for “dry system of floor heating”. In this method of direct connection of the heat pump to the heating system, maximally 30% of the heating system can be equipped by local regulation. In the case of usage for radiators it is also necessary to comply with the requirement of minimum heating water volume of 15 l/kW of the heating output of the heat pump at B0W35. Unit is equipped with stainless steel DHW tank volume 170l.

Important Note: Due to the stainless steel DHW tank, maximum Cl content of the tap water could be 250ppm.



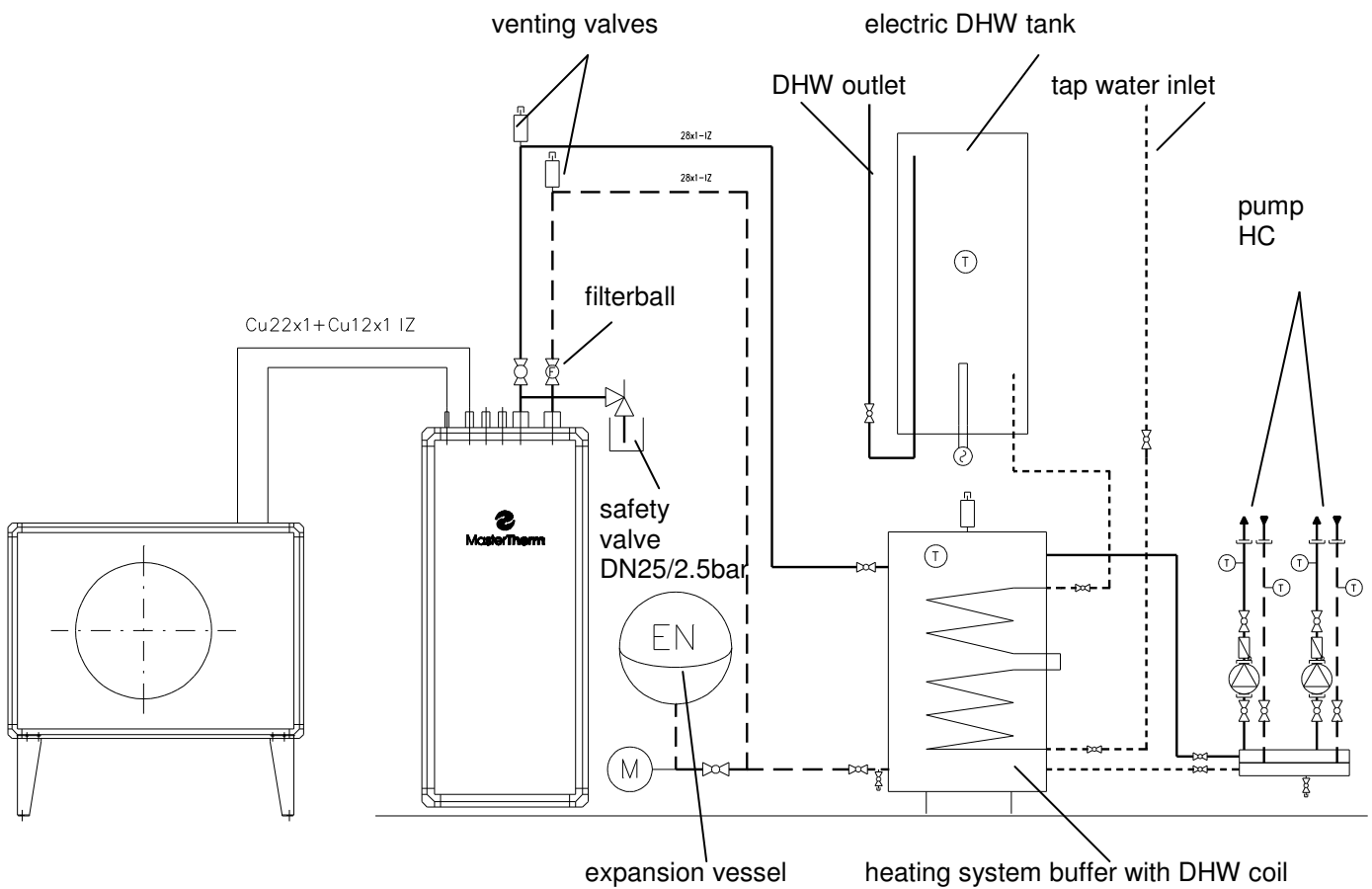
AQxxIC machinery room

5.5 Connection of AM MINI, EM Heat Pumps

These are "MINI" type units which do not have the accumulation vessel.

5.5.1 Heating System with Pump Circuits and Through-flow Pre-heating of DHW

This is the simplest connection of the air/water heat pump machinery room, which is suitable especially for reconstructions. The heat pump heats the accumulation reservoir to which the pump heating circuits are connected. Each circuit has its own spatial thermostat which switches the circulation pump. The vessel temperature is maintained equithermally depending on the outside temperature. The DHW is flow-through heated in the Cu exchanger of the accumulation vessel with subsequent electric accumulation after-heating.

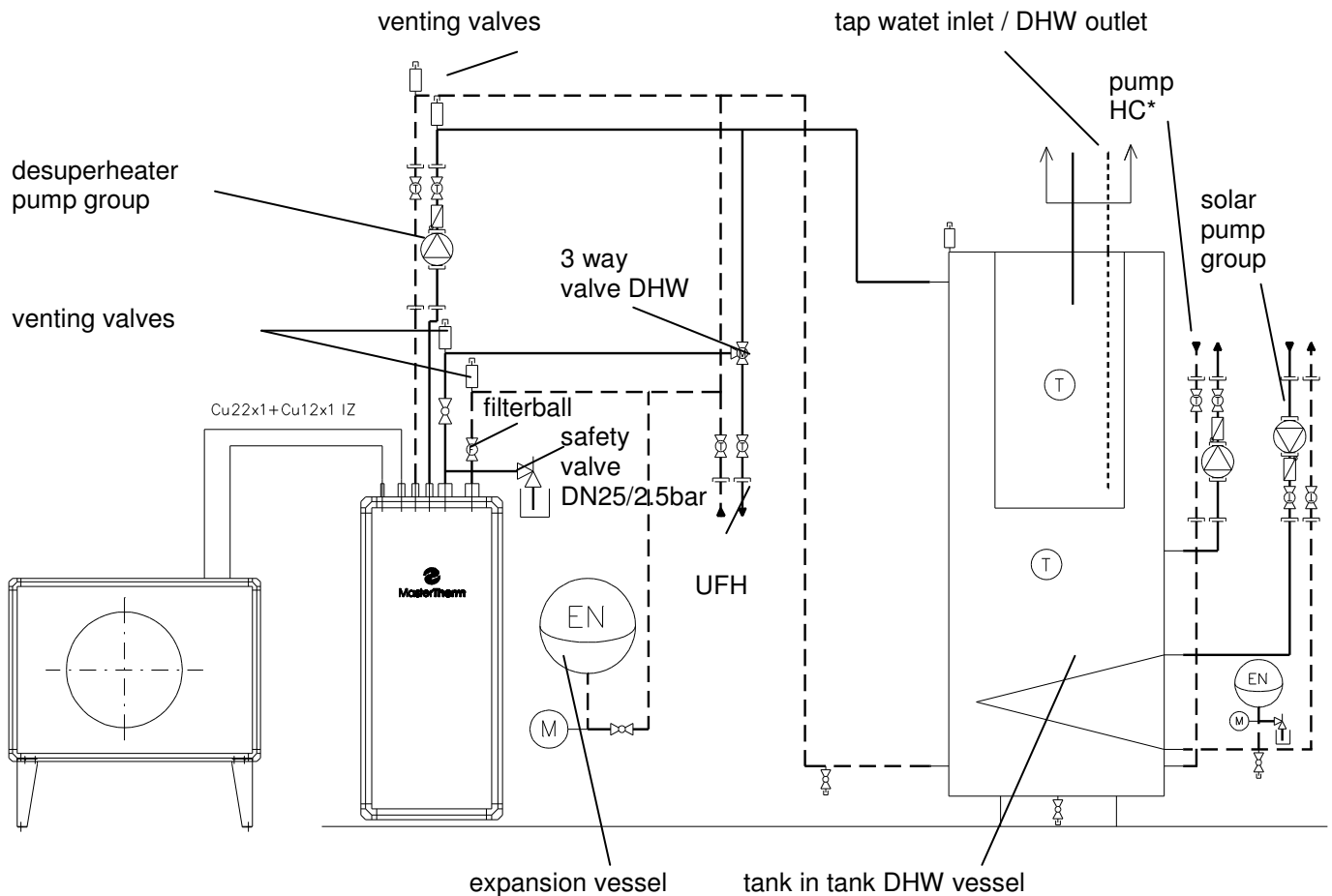


AM MINI, EM machinery room for pump heating circuits and with through-flow DHW preheating

5.5.2 AM MINI, EM Single-circuit Heating System

Typical usage is for floor heating, except for “dry system of floor heating”. This connection is not suitable for radiators. In this method of direct connection of the heat pump to the heating system, maximally 30% of the heating system can be equipped by local regulation. The DHW heating is provided by a 3-way switching valve. Regarding the type of DHW tank follow instructions in the chapter “Preparation of Domestic Hot Water”.

Warning: for good operation 10-15% propylene glycol is required, due to the 20°C antifreeze protection of the heat pump inlet when pure water is used.

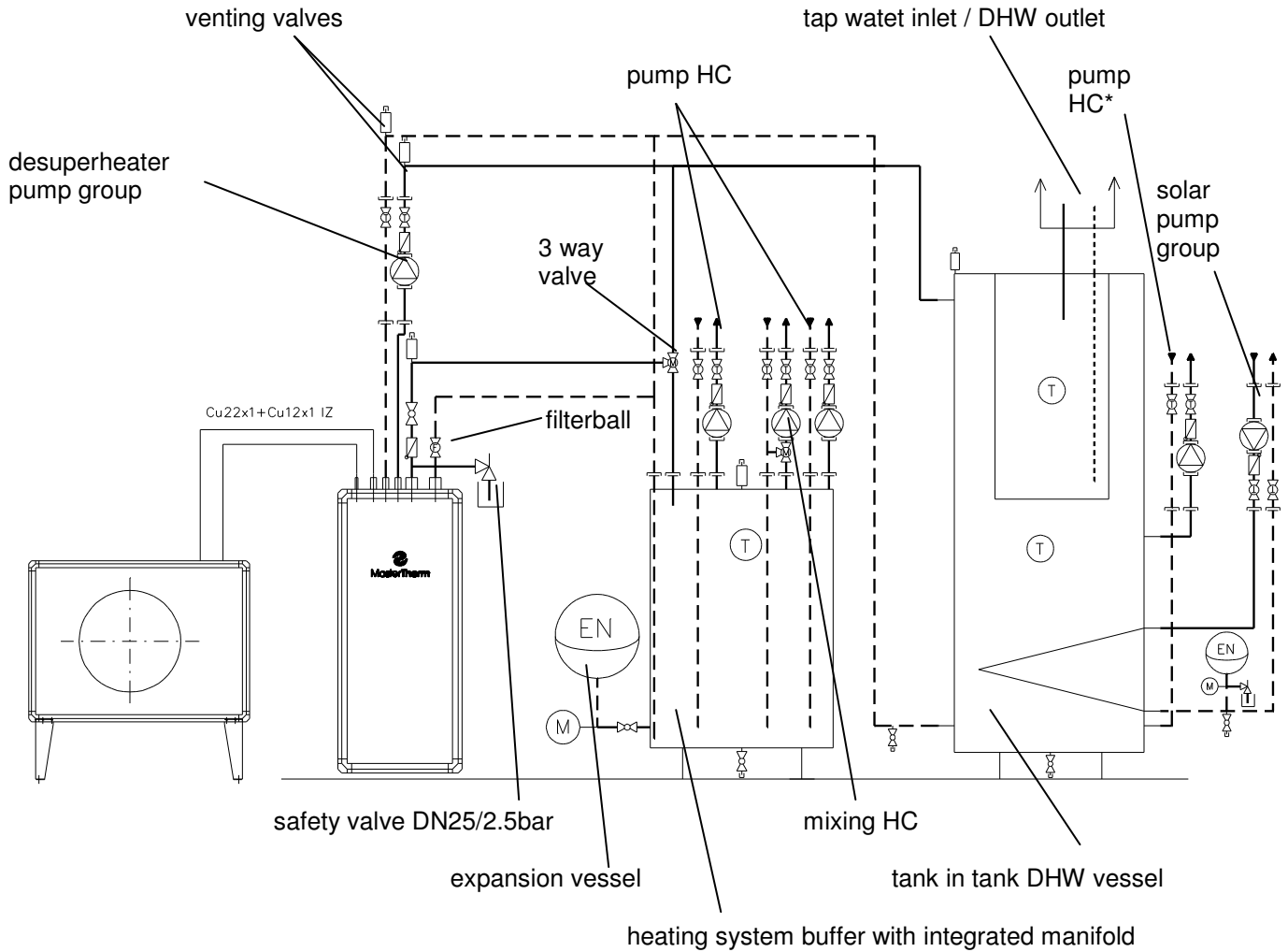


* it could be used for towel radiators

AM MIN/EM machinery room for single-circuit heating system with switchable heating of DHW

5.5.3 AM MINI, EM Multi-circuit Heating System - Switchable Heating of DHW

Universal scheme for multi-circuit heating systems with accumulation vessel. Local regulation can be applied here for 100% of heating output. The volume of the accumulation vessel is determined for 15 l/kW of heating output of the heat pump for A7W35. Heating of DHW is also provided by a 3-way switching valve. Regarding the type of DHW tank, follow instructions in Chapter "Preparation of Domestic Hot Water". **Warning: non-direct heating boiler for DHW cannot be used !!!**

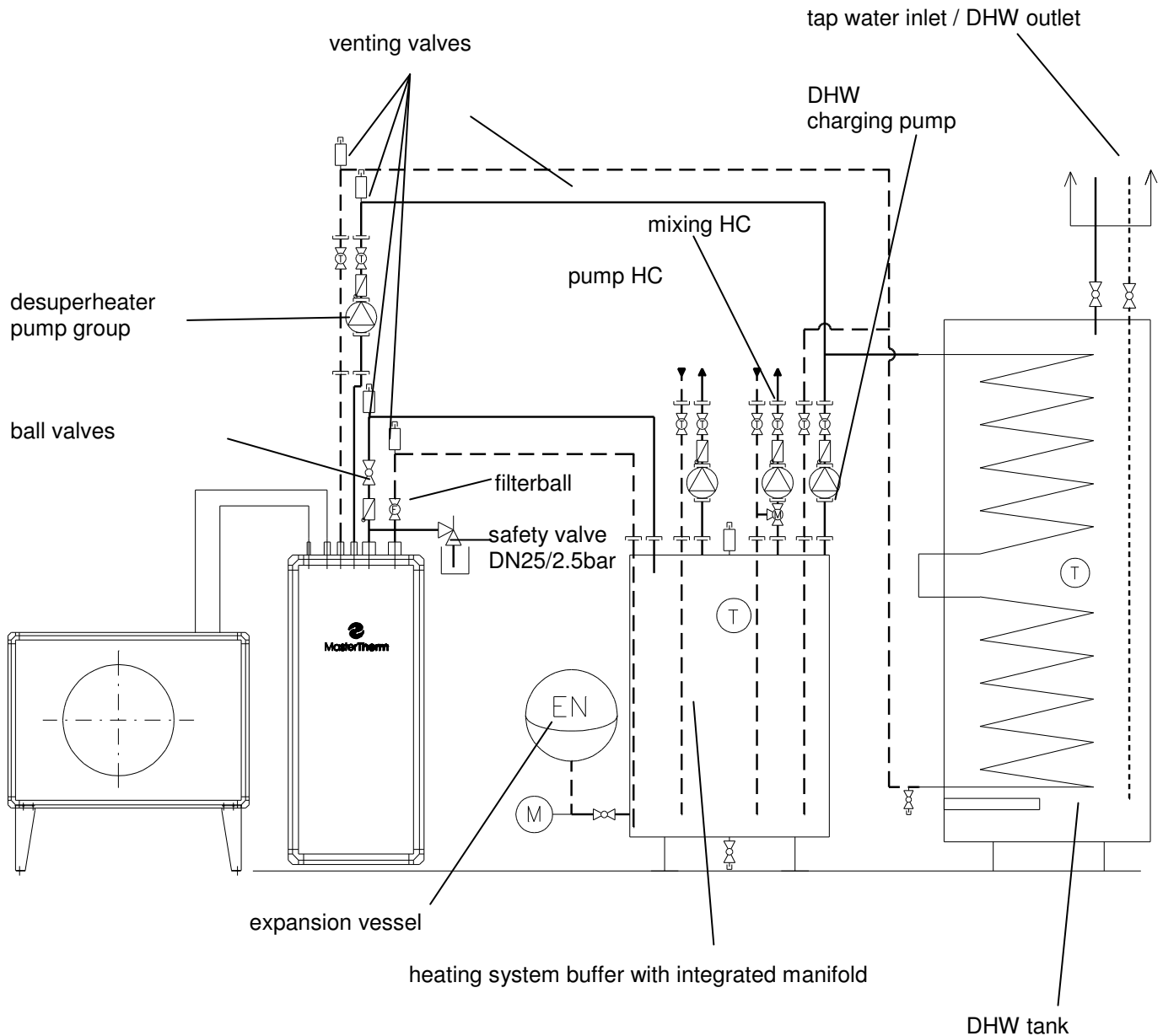


* it could be used for towel radiators

AM MIN/EM machinery room for multi-circuit heating system with switchable heating of DHW

5.5.4 AM MINI / EM Multi-circuit Heating System - DHW Heating Using Charge Pump

Universal scheme for multi-circuit heating systems with accumulation vessel. Local regulation can be applied here for 100% of heating output. The volume of the accumulation vessel is determined for 15 l/kW of heating output of the heat pump for A7W35. Heating of DHW is provided by a charge circulation pump from the accumulation vessel of the heating system. Regarding the type of DHW tank follow instructions in Chapter "Preparation of Domestic Hot Water".



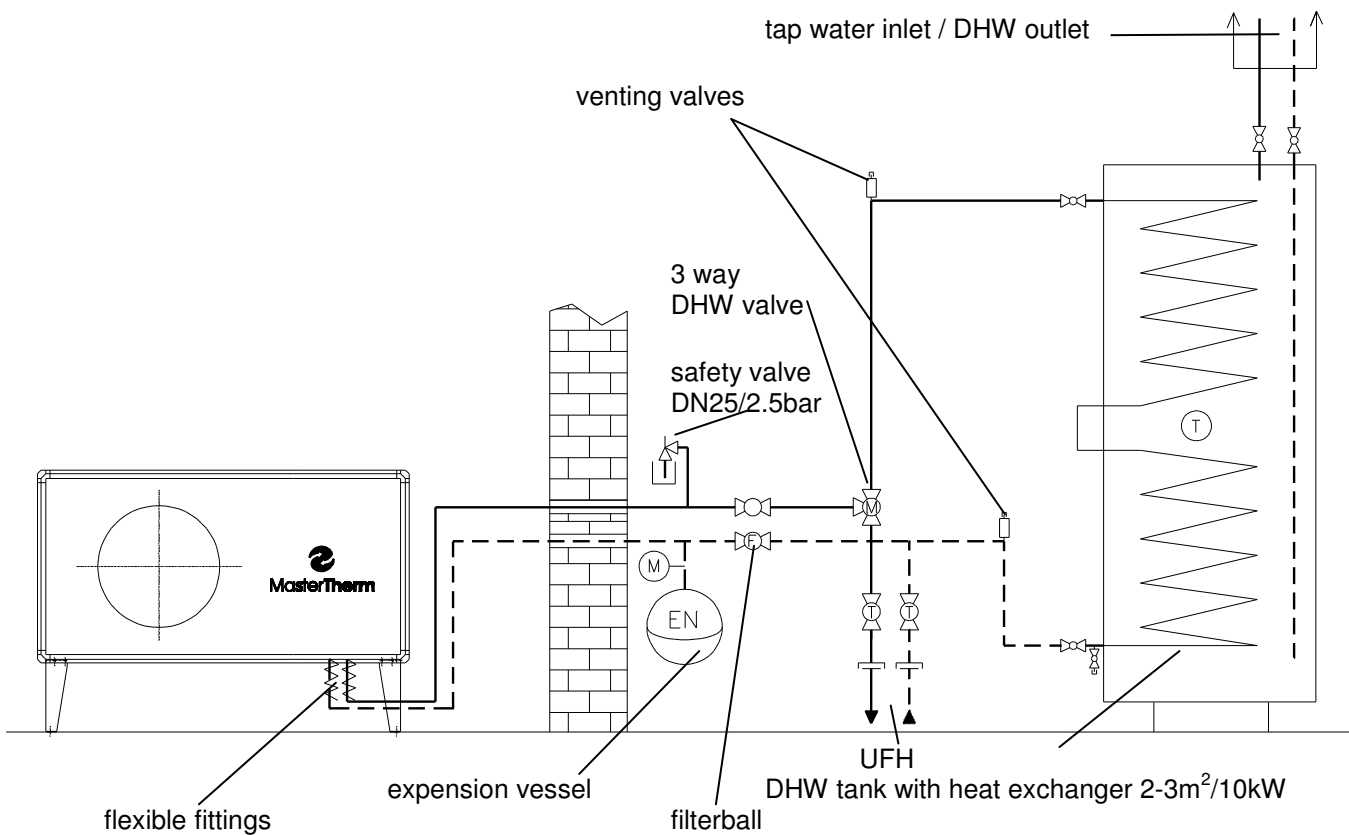
AM MIN/EM machinery room for multi-circuit heating system with charging heating of DHW

5.6 BoxAir and BoxAir Inverter system connection

BoxAir heat pumps are dedicated for outdoor installation. Heating system piping has outdoor installation, therefore antifreeze must be used for heating system filling.

5.6.1 Single loop heating system

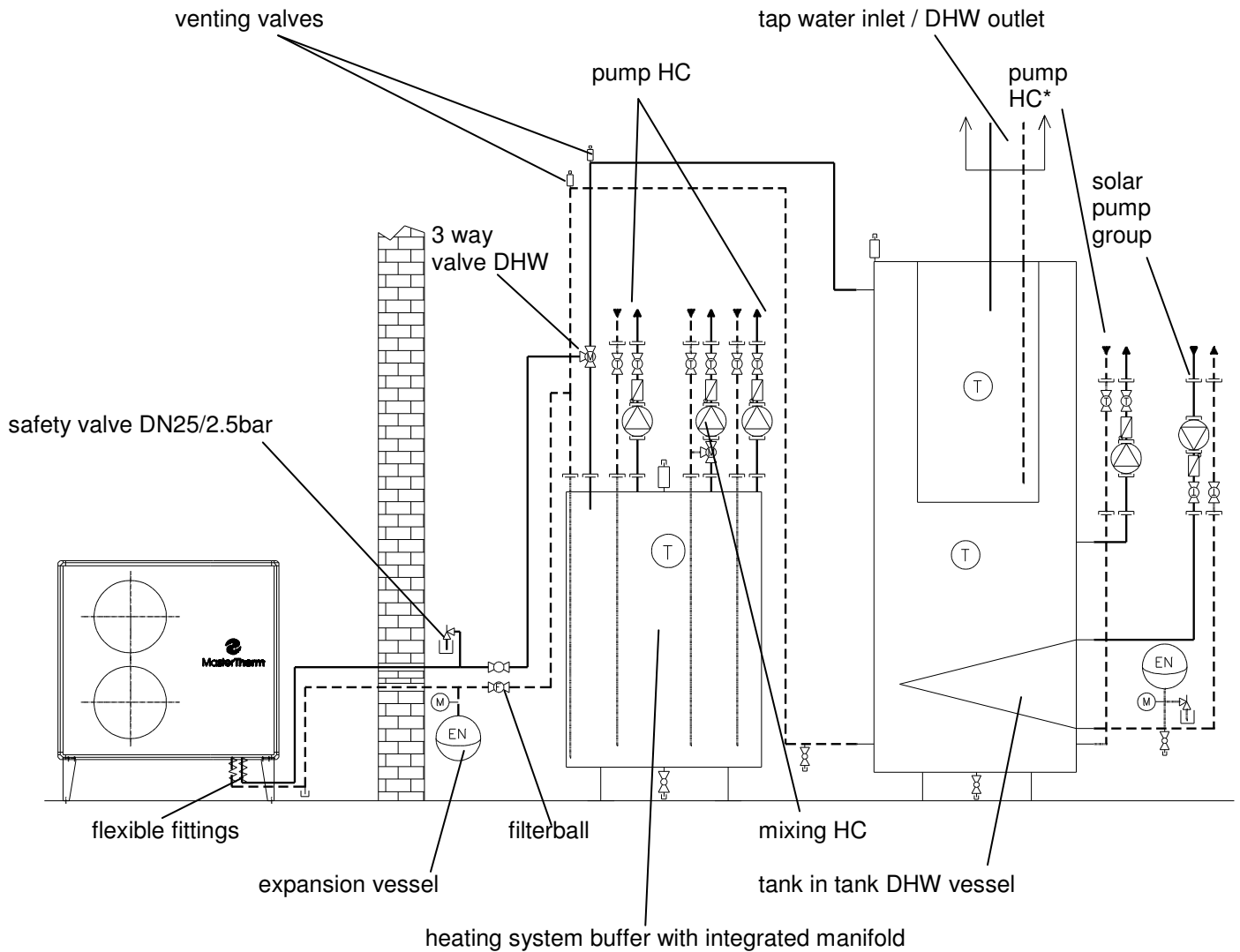
Typical usage is for floor heating, except for “dry system of floor heating”. In this method of direct connection of the heat pump to the heating system, maximally 30% of the heating system can be equipped by local regulation. In the case of usage for radiators it is also necessary to comply with the requirement of minimum heating water volume of 15 l/kW of the heating output of the heat pump at B0W35. Heating of DHW is provided by a 3-way switching valve. Regarding the type of DHW tank, follow instructions in Chapter “Preparation of Domestic Hot Water”.



BoxAir machinery room for single loop heating circuit with DHW

5.6.2 BoxAir and BoxAir Inverter multi-circuit system with DHW

Universal scheme for multi-circuit heating systems with accumulation vessel. Local regulation can be applied here for 100% of heating output. The volume of the accumulation vessel is determined for 15 l/kW of heating output of the heat pump for A7W35. Heating of DHW is provided by a 3 way valve. Regarding the type of DHW tank follow instructions in Chapter "Preparation of Domestic Hot Water".

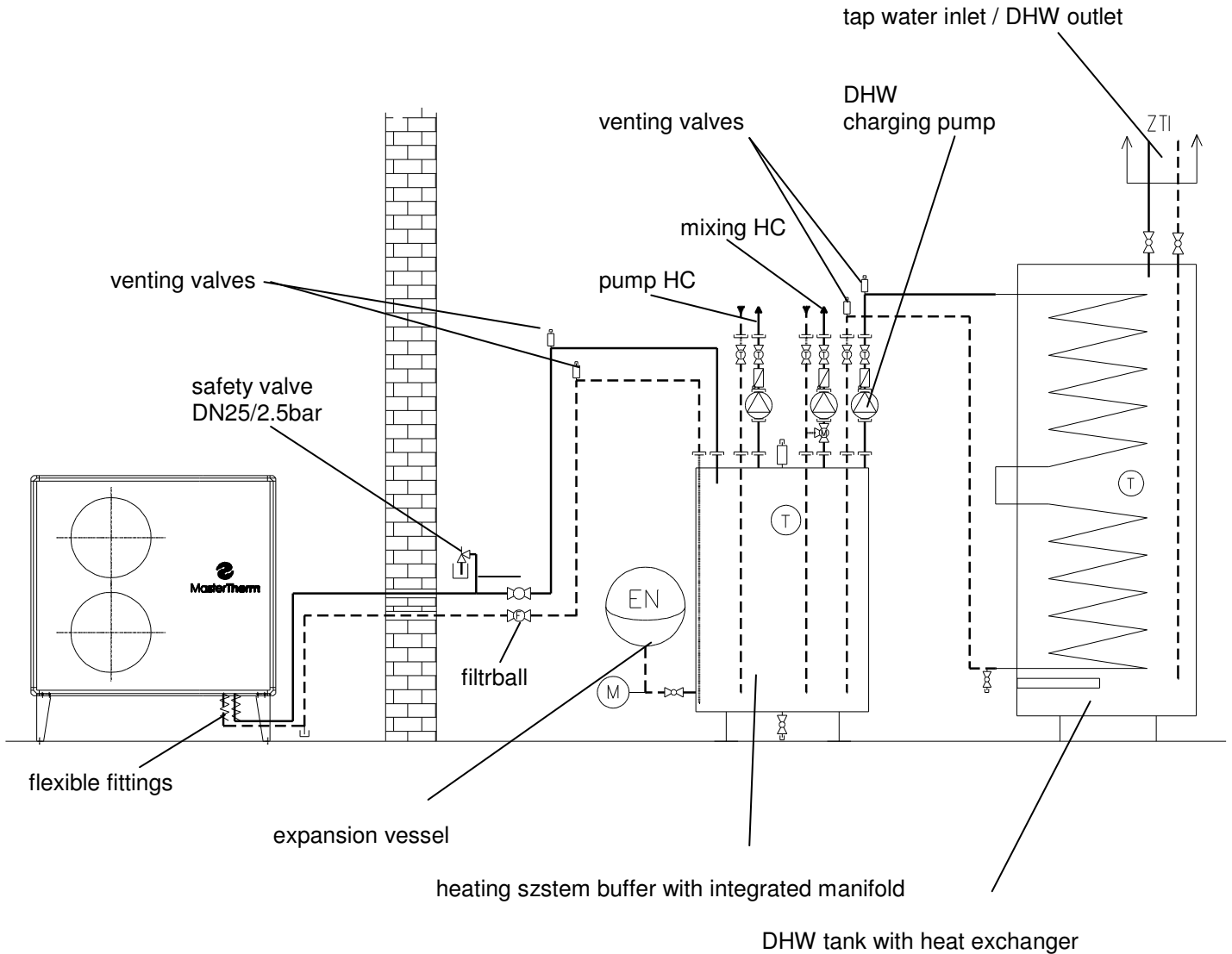


* it could be used for towel radiators

BoxAir / BoxAir Inverter machinery room for multiplecircuits and DHW

5.6.3 BoxAir / BoxAir Inverter multi-circuits, charging pump DHW

Universal scheme for multi-circuit heating systems with accumulation vessel. Local regulation can be applied here for 100% of heating output. The volume of the accumulation vessel is determined for 15 l/kW of heating output of the heat pump for A7W35. Heating of DHW is provided by a charge circulation pump from the accumulation vessel of the heating system. Regarding the type of DHW tank follow instructions in Chapter "Preparation of Domestic Hot Water".



BoxAir / BoxAir Inverter machinery room for multiple circuits and charging DHW

5.6.4 Heating system charge for BoxAir and BoxAir Inverter

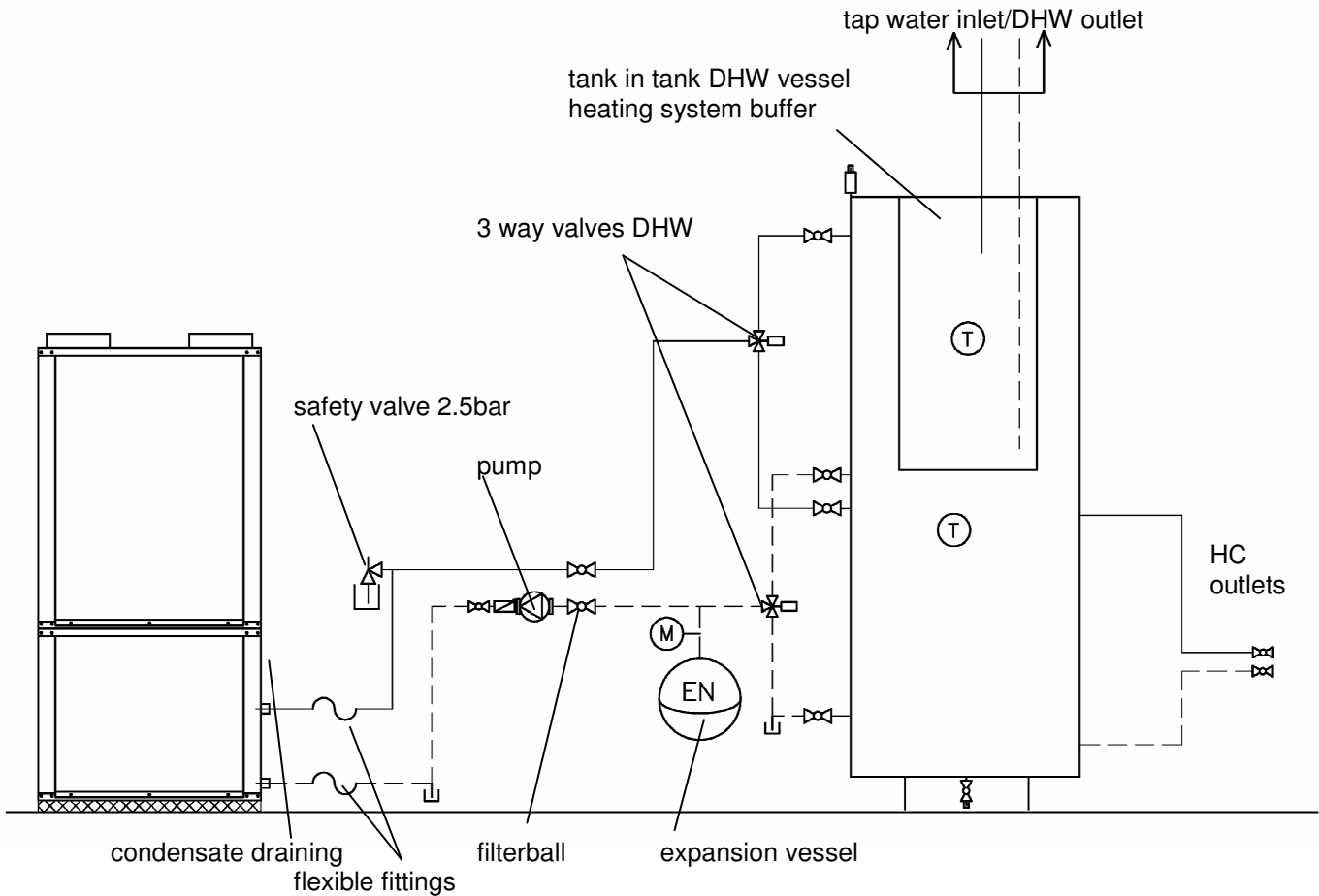
Antifreeze mixture of propylene glycol with freezing point -20°C is required, due to outdoor installation. When lower (or higher) minimum ambient temperatures during winter are supposed, adjust freezing point of the mixture.

5.6.5 Venting the system for BoxAir a BoxAir Inverter

BA units require proper venting, therefore venting valve is installed on the top of inbuilt auxiliary heater.

5.7 ASW units connection

These units are not equipped with pump nor the auxiliary heater. ASW units are dedicated for connection to the DHW tank and heating system buffer. Controller is not designed for heating circuits control.



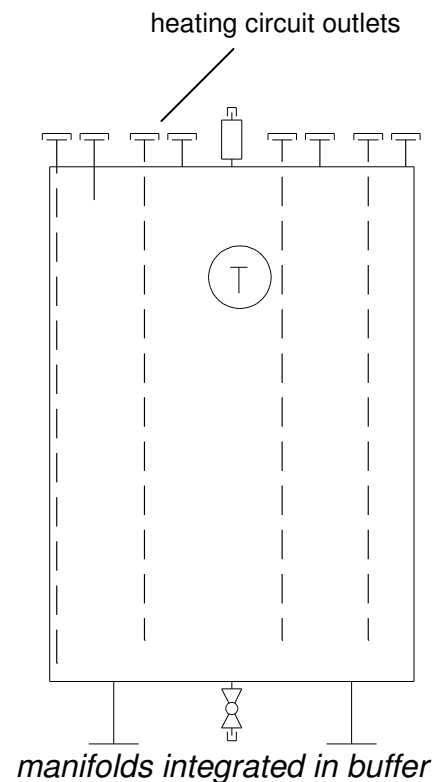
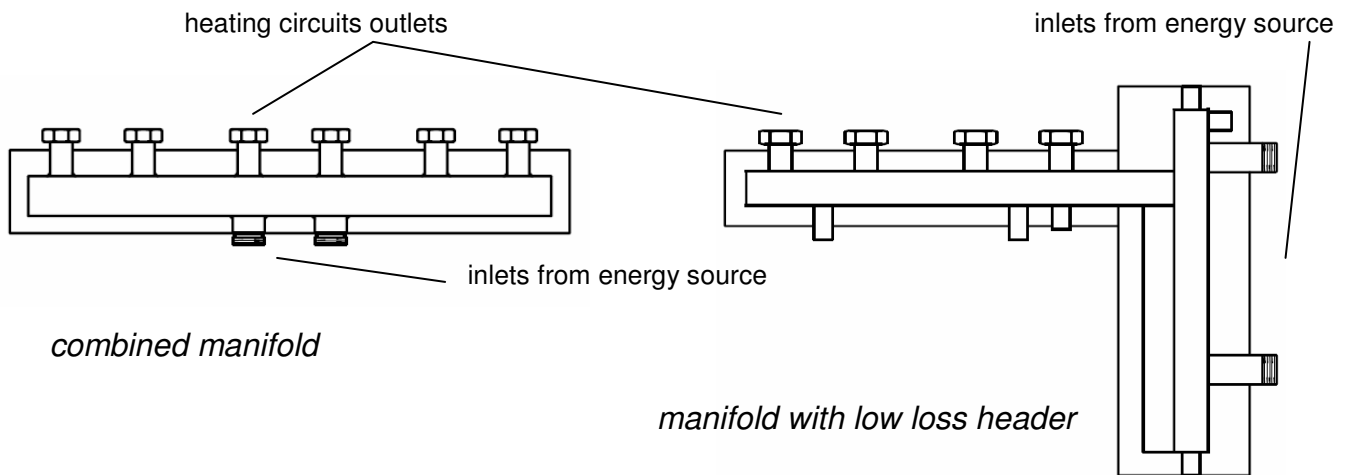
ASW machinery room with tank in tank DHW configuration

5.8 Heating Circuits

There are two types of heating circuits: pump and mixing. They must be carefully designed and installed, especially in the case of using more heating circuits.

5.8.1 Manifolds

This is a piping element designed in such way that the individual heating circuits affect each other as little as possible. The flow speed of heating water inside the distributor / collector should not exceed 0,5m/s. The distributors can be independent with integrated thermohydraulic distributor, or integrated in the accumulation vessel. We recommend using manufactured distributors which make the installation faster and easier. Typical implementation in the following images.

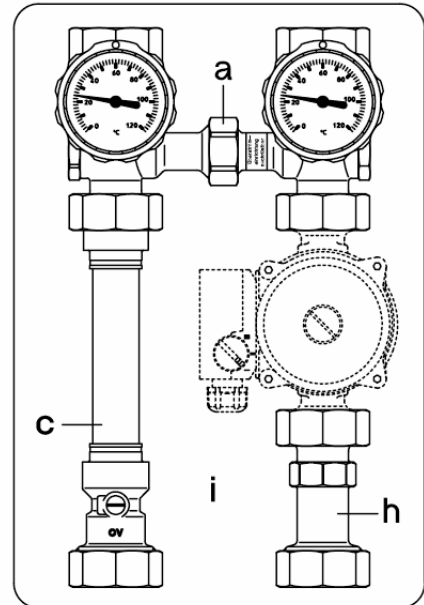
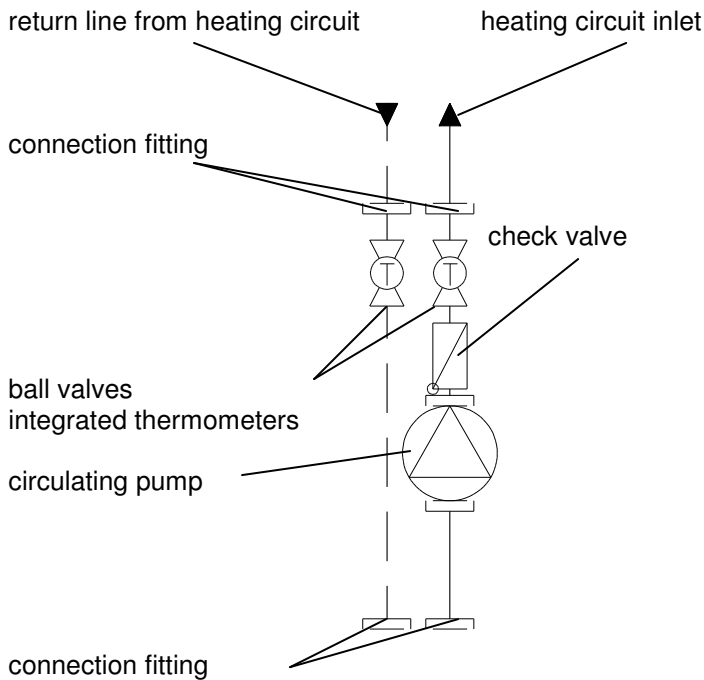


Recommended manifold dimensions:

total heating capacity [kW]	pipe dimension [mm]
10	DN32
15	DN40
20	DN40
25	DN50
30	DN50
40	DN65

5.8.2 Pump heating circuits

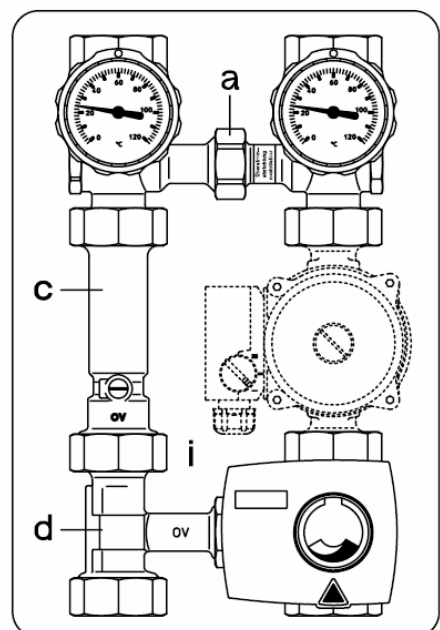
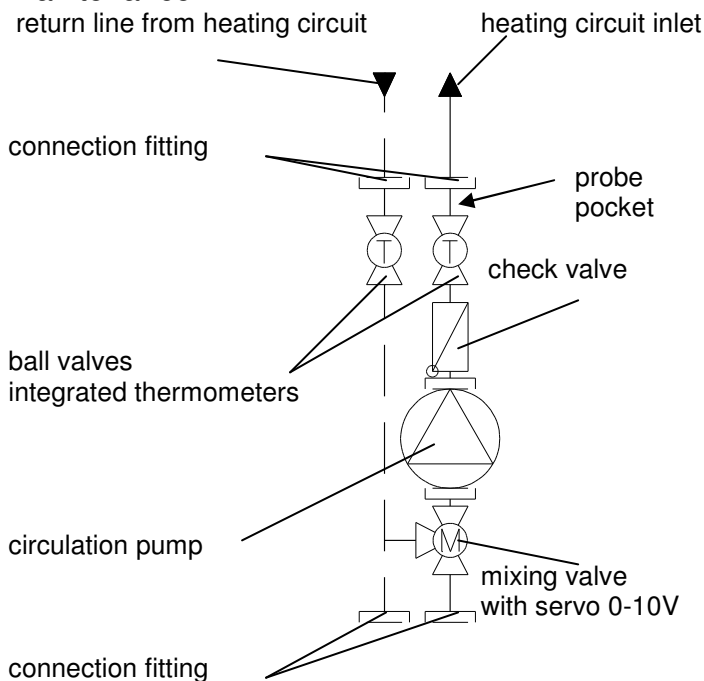
Usually they are used for radiators, heating pools, etc. The following image describes the components of a typical pump circuit which are required for flawless operation and maintenance.



We recommend using pump sets which make the installation faster and easier.

5.8.3 Mixing heating circuits

Typical usage is in projects where more heating circuits with different operating temperatures need to be combined. Typical application is thus floor heating. The following image describes the components of a typical mixing circuit which are required for flawless operation and maintenance.



We recommend using pump sets which make the installation faster and easier.

5.9 Preparation of Domestic Hot Water (DHW)

There are several ways to prepare DHW using the heat pump. Following table lists options for individual heat pumps.

heat pump type/model	3 way valve tank in tank	3 way valve tank with heat exchanger	charging pump tank with heat exchanger	partial heating in buffer, supplementary electric
AM AKU, LM	no	no	yes	yes
AM MINI, EM	yes	no (yes ^{***})	yes	yes
AQ	yes	yes [*]	yes	yes
BA, BAxxl(C),	yes	yes ^{**}	yes	yes

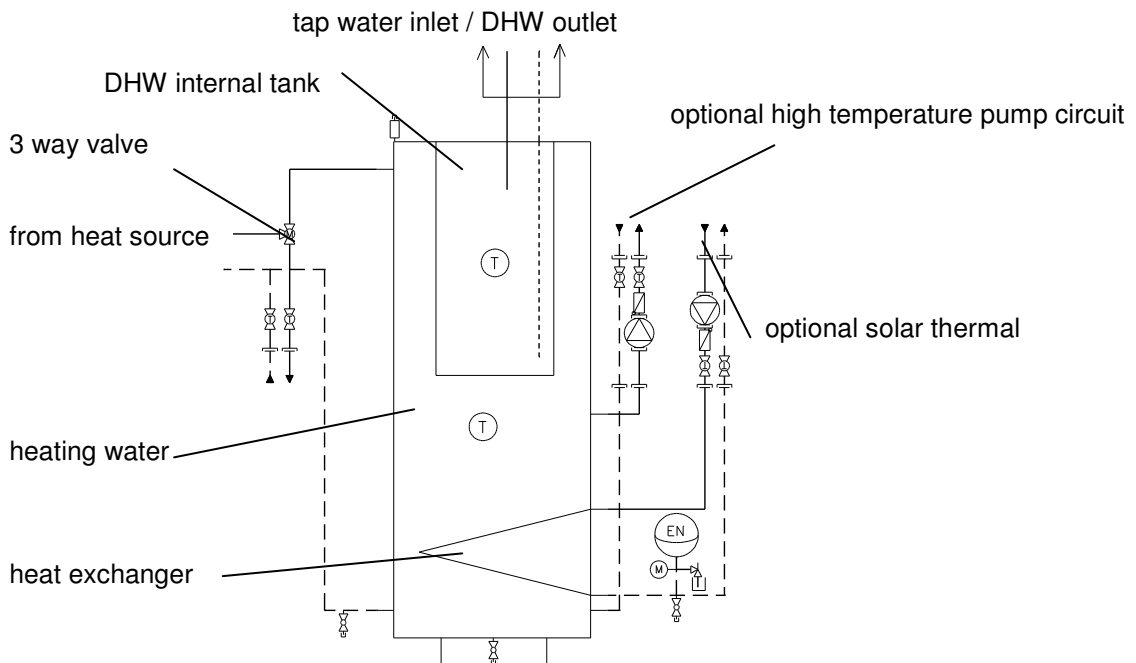
* minimum heat transfer area of 2-3m²/10kW of the heating output of the heat pump

** deactivation of DHW in defrost mode must be activated in heat pump controller

***it is possible with pCO5 controller, although it is not recommended, deactivation of DHW in defrost mode must be activated

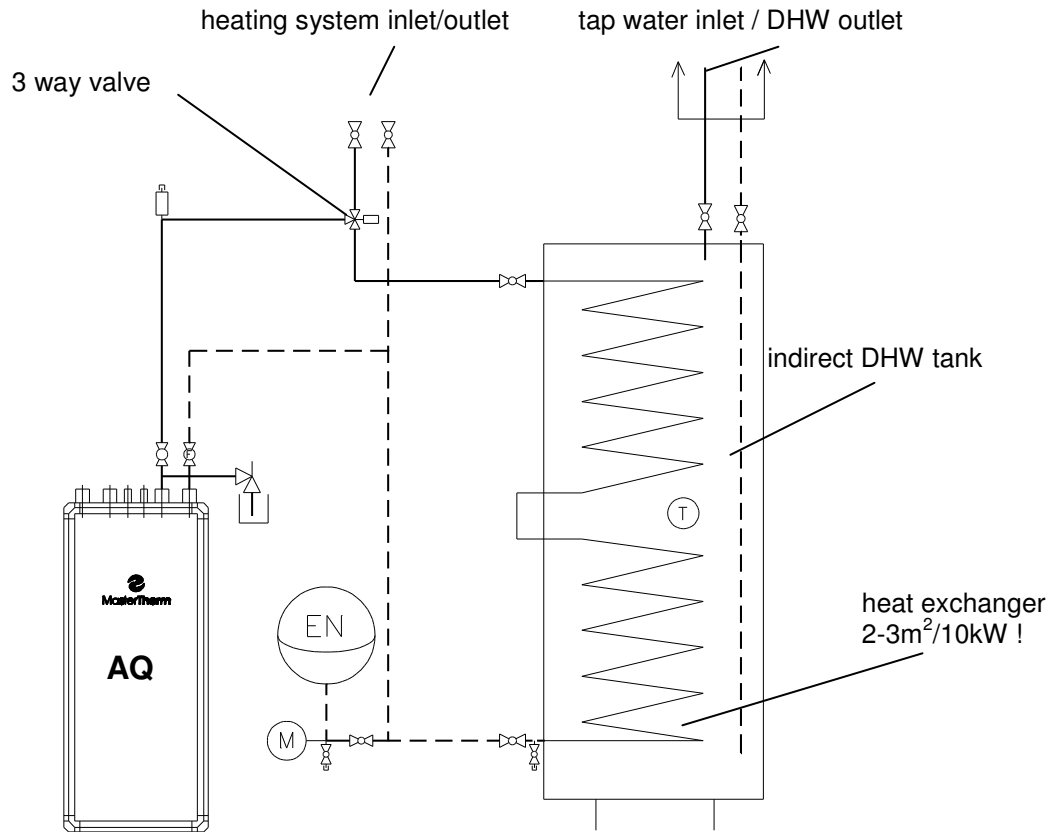
5.9.1 3 way valve tank in tank

This type of heating is universal for all MINI units. The advantage is higher temperature of DHW achieved than in the non-direct heating boiler, typically 50 to 55°C. Another advantage is easy connection to hot water solar collectors and using the higher temperature of heating water for the circuit of towel radiators or seasonal heating of a pool.



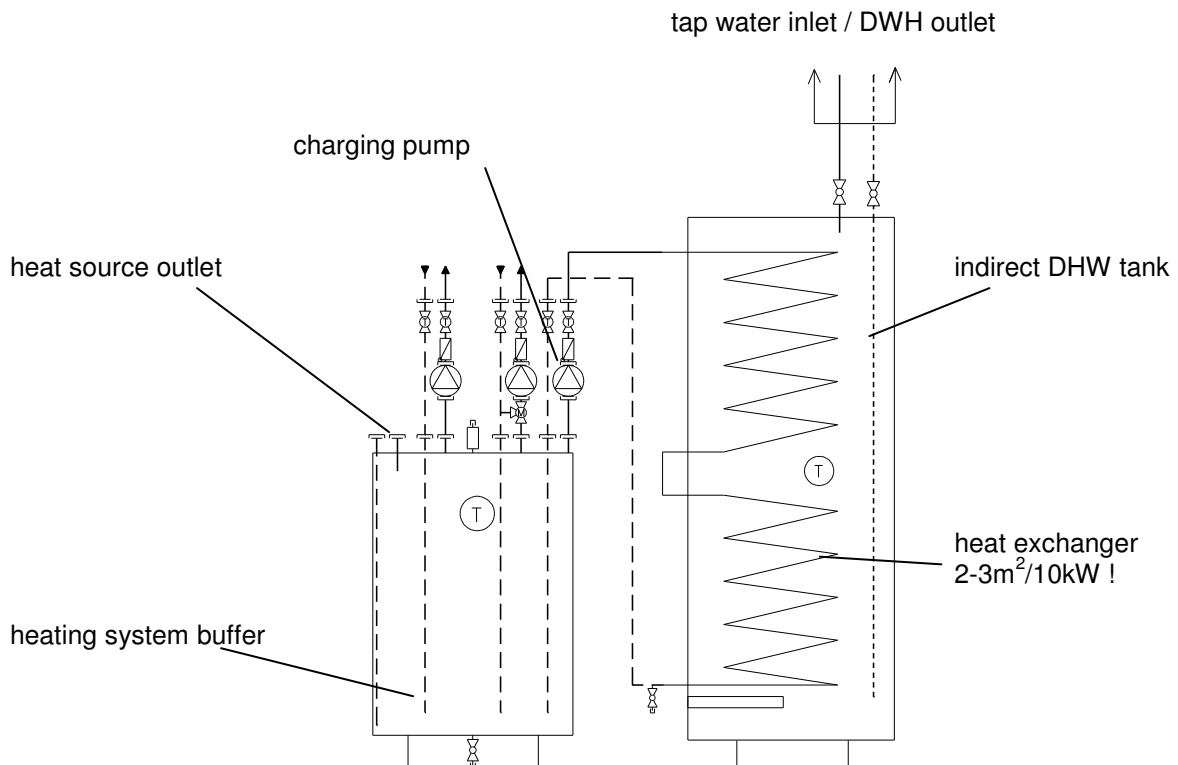
5.9.2 3 way valve with tank with heat exchanger (indirect, non-direct)

Using the heat pump with non-direct heating tank can usually achieve temperature 45 to 50°C. The limiting factor is mainly the heat transfer area of the exchanger which must be sufficient for heating output of the heat pump. The minimum area is 2-3m²/10kW of heating output of the heat pump. Therefore the usage is limited for commonly available types of exchangers. For heat pumps **AM, EM, BoxAir** a **BoxAir Inverter** deactivation of DHW in defrost mode must be activated in heat pump controller.



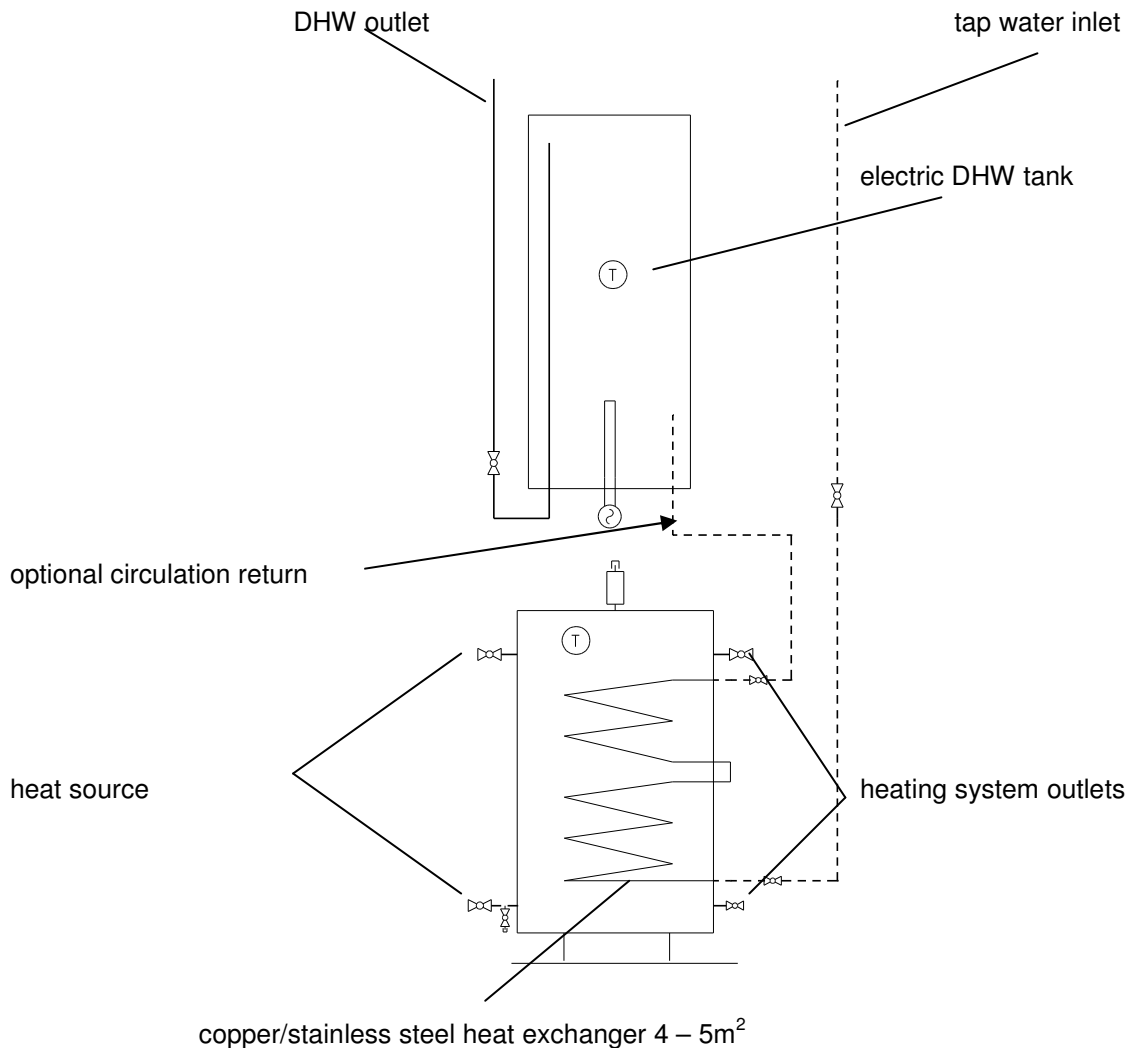
5.9.3 Charging pump for tank with heat exchanger

Universal scheme usable for all types of heat pumps. The Charge Pump draws heating water from accumulation boiler of the heating system and heats DHW. Recommended heat transfer area of the exchanger is 2m²/300l of the boiler volume. During preparation of DHW the control system automatically cancels the equithermal control and sets the required value of heating water to maximum.



5.9.4 Preheating in Accumulation Vessel of the Heating System and Electric Afterheating

This scheme is also universally usable for all heat pumps. It is especially suitable for reconstructions with pre-installed electric or gas heater of DHW. It is not suitable for high demand of DHW. The DHW is preheated in the accumulation vessel with large-area copper heat exchanger to a temperature nearing the actual temperature of heating water. Subsequently, accumulation of through-flow afterheating to required temperature is performed. Typical area of exchanger is 4 to 5m². This kind of heating does not cause bacterial risk in the low-temperature part of heating. This system requires no control, it is self-regulating.



5.9.5 Safety / PT relief valve outlet

Safety overpressure (and overtemperature) relief valve must be installed on each DHW tank. During charging of the DHW, water leak occurs from safety valve due to water thermal volume expansion. **Therefore draining to the waste must be provided in the area of DHW tank installation.**

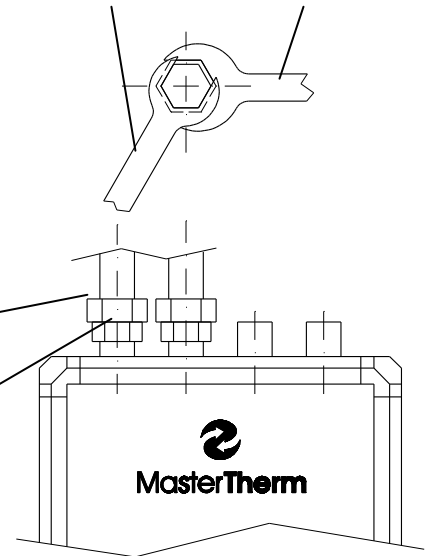
5.10 Piping Connection

The piping must be connected to the heat pump outlets using connection screwed fittings. We recommend using fittings with cone contact area and an O-ring. Never connect the screwed fitting with cap nut and front contact area directly to the fitting of the heat pump outlet, always use proper screwed fitting which is usually a part of the screwed fitting set. For tightening always use the wrench on the heat pump outlet to prevent turning over or twisting off the outlet.

connection fitting – nut

connection fitting – threaded extension

!!! use 2 spanners !!!



Outlets connection

5.11 Pressure and Leak Test

After connecting the heat pump and heating system the pressure and leak test must be performed, typically by overpressure of 3.5bar. A written report about the test is made out.

5.12 Heat insulation

After the Pressure and Leak Test is performed, heat insulation is performed. Unlike for the ground loop, common insulation materials based on PE (mirelon), or mineral wool (isover) can be used for heating system.

5.13 General Instructions

After connecting the heating system the following instructions need to be followed:

- Filter with 0,5mm sieve must be installed at inlet
- Safety valve must be installed at the heat pump output, as per the project
- Between the heating source (heat pump) and the safety valve must not be closing armature (ball valve etc.)
- Closing valves (ball) must be installed at the connecting piping to allow for disconnecting the heat pump from the heating system if needed
- Venting valves must be installed at the highest point of the piping
- Discharge valves must be installed at the lowest point of the piping
- If there is a combination of more heating sources or more heating circuits, clack valves must be installed at all circuits.

6 Electric Power Connection

Při provádění elektroinstalace vždy nahlédněte do elektrického schématu zapojení, které je součástí dodávky tepelného čerpadla.

6.1 Hlavní napájení

Heat pumps are always provided with a main switch and current zero and grounding terminal. Connect the power supply cable to the main switch connectors and current zero and grounding terminal. For heat pumps with outer part (AM, EM, BA), special attention must be paid to protection against contact voltage. This can be made two ways. First one is installation of earth leakage circuit breaker (RCD) (**Not recommended for Inverter models**). The second possibility is installation of additional connection using conductor with cross-section of 6 to 10mm². Recommended protection of power supply is in the following table:

heat pump type	no aux. heater	aux. heater (kW)		
		4,5	6	7,5
3x400V				
AQ9Z1	-	16A“B“	-	-
AQ17Z	9A“C“	16A“B“	16A“B“	20A“B“
AQ22Z	9A“C“	16A“B“	20A“B“	20A“B“
AQ22I	-	20A“B“	20A“B“	-
AQ26Z	13A“C“	20A“B“	20A“B“	20A“B“
AQ30Z	13A“C“	20A“B“	25A“B“	25A“B“
AQ30I	-	20A“B“	20A“B“	-
AQ37Z	16A“C“	25A“B“	25A“B“	25A“B“
AQ45Z	16A“C“	25A“B“	25A“B“	25A“B“
AQ45I	16A“B“	25A“B“	25A“B“	25A“B“
AQ60Z	25A“C“	32A“C“	32A“C“	32A“C“
AQ75Z	25A“C“	32A“C“	32A“C“	32A“C“
AQ90Z	32A“C“	40A“B“	40A“B“	40A“B“
1x230V				
AQ9Z1D	10A“C“	32A“B“	-	-
AQ17Z1	16A“C“	40A“B“	50A“B“	-
AQ22Z1	20A“C“	40A“B“	50A“B“	-
AQ22I	20A“B“	40A“B“	50A“B“	-
AQ26Z1	25A“C“	50A“B“	50A“B“	-
AQ30Z1	32A“C“	50A“B“	63A“B“	-
AQ30I	25A“B“	50A“B“	63A“B“	-
AQ37Z1	32A“C“	50A“B“	63A“B“	-

heat pump type	no aux. heater	aux. heater (kW)		
		2x4,5	2x6	2x7,5
3x400V				
AM3015Z	9A“C“	16A“B“	16A“B“	25A“B“
AM3021Z	9A“C“	16A“B“	20A“B“	25A“B“
AM3030Z	13A“C“	20A“B“	20A“B“	25A“B“
AM3038Z	16A“C“	20A“B“	25A“B“	25A“B“
AM3045Z	16A“C“	25A“B“	25A“B“	25A“B“
1x230V				
AM3015Z1	16A“C“	50A“B“	63A“B“	-
AM3021Z1	20A“C“	50A“B“	63A“B“	-
AM3030Z1	32A“C“	50A“B“	63A“B“	-
AM3038Z1	32A“C“	50A“B“	63A“B“	-

heat pump type	no aux. heater	aux. heater (kW)		
		2x4,5	2x6	2x7,5
3x400V				
EM26Z	13A“C“	20A“B“	20A“B“	25A“B“
EM30Z	13A“C“	20A“B“	20A“B“	25A“B“
EM37Z	16A“C“	20A“B“	25A“B“	25A“B“
EM45Z	16A“C“	25A“B“	25A“B“	25A“B“
EM60Z	25A“C“	-	-	40A“B“
EM75Z	25A“C“	-	-	40A“B“
1x230V				
EM26Z1	25A“C“	50A“B“	63A“B“	-
EM30Z1	32A“C“	50A“B“	63A“B“	-
EM37Z1	32A“C“	50A“B“	63A“B“	-

heat pump type	no aux. heater	aux. heater (kW)		
		2x4,5	2x6	2x7,5
3x400V				
ASW036	10A“C“	-	-	-
BA17Z	-	16A“C“	-	-
BA22Z	-	16A“C“	-	-
BA22I, BA22IC*	-	16A“B“	-	-
BA26Z	-	20A“C“	25A“B“	25A“B“
BA30Z	-	20A“C“	25A“B“	25A“B“
BA30I*	-	25A“B“	25A“B“	-
BA37Z	-	25A“C“	25A“C“	25A“C“
BA45Z	-	25A“C“	25A“C“	25A“C“
1x230V				
BA17Z1	-	40A“B“	-	-
BA22Z1	-	40A“B“	-	-
BA22I, BA22IC*	-	40A“B“	-	-
BA26Z1	-	50A“B“	63A“B“	-
BA30Z1	-	63A“B“	63A“B“	-
BA30I*	-	50A“B“	63A“B“	-
BA37Z1	-	63A“B“	63A“B“	-

* BA22I and BA30I, it is possible to use 1x230V+N+PE and 3x400V+N+PE as well

6.2 Tariff signal, remote on/off signal

Units with pCO5 controller are equipped with digital input for dry contact external relay, used for remote on/off. We recommend to use relay with manual control. Please check wiring diagram delivered with heat pump for terminals location and connection example.

6.3 AM/EM indoor and outdoor unit electrical interconnection

Check wiring diagram for correct terminal numbers. 2 cables are necessary for units interconnection. We recommend using CYKY7x1.5 for high voltage and CYKY5x1.5 for low voltage. When RCD is not used, additional earth wire cross section 6 to 10mm² must be used.

6.3.1 EM60Z/EM75Z , 1OEM26-45VK, 1OEM60-75VK additional connection

Additional shielded cable 4x1.5mm² is required for Electronic Expansion Valve for these units or special models.

6.4 External components (pumps, valves)

Use wiring diagram supplied to connect external components. If expansion card is used, use X3 terminals. Temperature probes connect directly to expansion card terminals J9 a J10.

7 Control and measurement

Heat pumps are equipped for control of different systems. It depends if standard unit is used, or optional equipment is ordered. Please see possibilities in following tables.

7.1 Standard unit

Units with standard delivery.

heat type	pump	main HC (buffer)	mixing / pump HC	DHW control	solar control**
AQ		yes	2/-(2)*	yes	yes
AM		yes	2/-(2)*	yes	yes
EM		yes	2/-(2)*	yes	yes
LM		yes	2/-(2)*	yes	yes
BA		yes	2/-(2)*	yes	yes
BA Inverter		yes	2/-(2)*	yes	yes

* if mixing is not used, pump could be used

** -solar panel probe is not the part of delivery and it must be ordered separately (Pt1000)
 -whes solar control is used, 1 pump circuit is lost

7.2 Optional „Expansion Card“

It is optional equipment. It must be ordered together with heat pump. Expansion card is delivered like separated wall mounted box, including all probes and terminals.

heat type	pump	main HC (buffer)	mixing / pump HC	DHW control	solar control**
AQ		yes	3/3(6)*	yes	yes
AM		yes	3/3(6)*	yes	yes
EM		yes	3/3(6)*	yes	yes
LM		yes	3/3(6)*	yes	yes
BA		yes	3/3(6)*	yes	yes
BA Inverter		yes	3/3(6)*	yes	yes

* if mixing is not used, pump could be used

** -solar panel probe is not the part of delivery and it must be ordered separately (Pt1000)
 -whes solar control is used, 1 pump circuit is lost

7.3 Probes connection

Each heating circuit requires temperature probe. Temperature probas are always part of delivery. Please check wiring diagram supplied with the heat pump.

7.4 *Mixing valves servo*

Mixing valves are wired to heat pump terminals or X3 terminals in case of expansion card. Only servos with 0-10V control signal and 24VAC power supply must be used. Power supply is directly available from terminals.

Using of 3 point servo for mixing heating circuit is not possible.

Please see wiring diagram delivered with heat pump for terminals numbers and connection examples.

7.5 *Circulating pumps*

Pumps are wired to heat pump terminals or X3 terminals in case of expansion card. Please see wiring diagram delivered with heat pump for terminals numbers and connection examples.

7.6 *pAD room terminals*

We recommend to use of pAD room active communicating terminals. pAD could be used for each heating/cooling circuit. pAD requires 4 wire + shielding connection (SYKFY2x2x0.5).

Please see wiring diagram delivered with heat pump for terminals numbers and connection examples.

8 Commissioning

The heat pump controller must be configured for the heating system before the commissioning. The description of the control system and the manual for its setting is in a separate document supplied with the heat pump. Further, the system must be inspected per following items.

8.1 Mechanical Installation Inspection

- suitable unit location inside/outside if the building

8.2 Piping Network Inspection

- inspection of pressure and leak test according to local regulations
- safety equipment complies with local regulations and standards, between safety valve and heating equipment must not be any closing armature
- dimension inspection of piping on the side of the ground loop and the heating system, flow speed must not exceed 1m/s for connection length of up to 3m, in the case connection of up to 10m the speed must not exceed 0,6m/s. In the case the connection is longer, hydraulic resistance of external pressure of circulation pumps used or circulation pumps inside the heat pump unit must be surveyed
- liquid circuits pressure inspection
- gas filling of expansion vessels inspection
- filters on the unit inlet
- heating circuit inspection
- ground loop venting inspection, liquid must flow through all loops, inspection by closing the ball valve of each loop – immediately before closing a strong hydraulic noise is heard
- inspection of mixing of anti-freeze mixture by closing one loop at a time for half the time required for a full circle of the entire volume of anti-freeze mixture
- flow sensor inspection, or modification of its setting
- inspection of hydraulic connection – preventing the hot heating water from entering the heat pump, typically from gas boilers and solid fuel boilers

8.3 Electrical wiring check

- inspection of initial revision of electric connection
- dimensioning of main switchboard and supply cable
- inspection of setting and operation of operating thermostats of bivalent sources in relation to heat pump operating requirements
- inspection of emergency thermostats with manual reset under the cover which is difficult to remove, typically for electric radiators located in accumulation reservoirs
- inspection of correct phasing
- presence of current guard, in the case outer electric components are installed
- inspection of connection and switching of tariff control

8.4 Start-up and Filling of Start-up Protocol

It is allowed to start-up the heat pump after the inspection. Data is filled in the Start-up Protocol and the Service Book after stabilization of operating parameters. The Start-up Protocol and the Service Book are supplied with the heat pump.

9 Maintenance

9.1 Introduction

The following text describes regular maintenance operations of heat pumps.

9.2 Personnel Qualification

The heat pumps are refrigeration equipment and for this reason the maintenance described in italics can be performed by a specialist, service technician of cooling and air-conditioning equipment with approved qualification according to the local regulations.

All work on inner components of the unit can be performed when it is turned off, the main switch in position "0".

The Investor can choose any servicing organization approved by Master Therm company.

9.3 Quarterly Maintenance

This maintenance does not require special skills, is performed by the user.

- **mechanical check**
 - remove contingent dirt on the unit using wet cloth
 - visual inspection of external condition of the inner unit, piping, cables
 - visual inspection of the condition of the outer unit and its surrounding (vegetation)
- **inspection of hydraulic circuit**
 - inspection of overpressure and sufficient filling of hydraulic circuits
 - inspection and cleaning of filter sieves
 - inspection of anti-freeze mixtures (if used as the filling)
 - inspection of venting

9.4 Annual Maintenance

- **inspection of refrigeration circuit during operation, temperatures and operating pressures:**
 - *condensation pressure*
 - *evaporating pressure*
 - *expansion valve setting*
 - *compressors suction temperature*
 - *compressors discharge temperature*
 - *temperature of liquid coolant*
 - *incoming temperature of liquid circuits*
 - *outgoing temperature of liquid circuits*
 - *inspection of control system settings*
 - *inspection of protection settings of the cooling circuit*
 - *inspection of operating current of all components on each phase*
 - *inspect tightness of service valves and tightness of other components*
- **inspection of electric connection**
 - *disconnect the unit from power supply and tighten the connectors and remove dust from all components, especially: terminal boards, contactors, circuit breakers, overcurrent relays, and electric motors*
 - *inspection of operation and setting of circuit breakers*
- **inspection of hydraulic circuit**
 - *inspect correct flow of heat exchangers*
 - *inspect tightness of liquid circuit components*

9.5 Warranty

The guarantee of the manufacturer (importer) does not cover damage resulting from force majeure, or improper handling, or connection to incorrect power supply, or use of not approved liquids, or improper usage of the equipment.

The guarantee of the manufacturer (importer) applies provided the regular maintenance in accordance with this manual is performed, and maintenance records are maintained in the operating diary of the unit.

10 Legislation

This manual does not replace the project documentation. Detailed heating and hydraulic calculations in accordance with applicable standards must be performed, and operating project documentation prepared for each installation.

European and national standards and other locally applicable regulations must be observed during design and installation.

Building permit is usually required for installation of the heat pump.

The Master Therm company is not liable for proper operation of the equipment in the case directions and recommendations from this manual are not respected.

Designated trademarks and brands are the property of their respective owners.

11 Revision history

23.05.2011 – units AQ9Z1D, AQ17ZD, AQ22ZD, EM60Z and EM75Z.

29.08.2011 – units BAxxZ, BAxxI a BAxxIC

26.04.2013 - "EM indoor split", pCO₂ control, water quality

01.09.2013 - ASW

28.07.2014 - AQxxIC

