District heating of buildings
Regulations and guidelines

Publication K1/2013

Finnish Energy

District heating

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NOTE:
This publication is a translation of the corresponding recommendation in Finnish. In any cases of ambiguity in interpretation, the Finnish-language instructions shall be complied with.

Finnish Energy
District Heating Substation Group

Publication K1/2013
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District heating of buildings. Regulations and guidelines

The compliance of the regulations and guidelines in this publication is determined in the private-law contract between the customer and the heat vendor.

Correctly dimensioned and selected equipment installed and adjusted to a high standard guarantee energy efficiency in the customer's use of heat and also in the production and distribution of district heat.

District heating is the most common method of heating buildings in Finland. Its market share is almost half of the heating energy. District heating in Finland started as early as the 1950s. From the start, customers have been connected to the district heating network mainly through indirect connection. Finnish Energy (ET) drew up the first recommendation about the connections of consumer equipment in 1973. Even before that, in 1967, it had issued guidelines on the dimensioning and structure of heating devices. The recommendations and guidelines have gradually become standard practice throughout the country.

Uniform guidelines for the entire country are in the interest of all those operating in the sector. Appropriate equipment and quality control guarantee a high quality and safety of heating energy purchased by customers. Uniform requirements for the functions and fittings of the devices reduce costs and increase competitiveness in district heating. This publication replaces ET's publication K1/2003 'Rakennusten kaukolämmitys, määräykset ja ohjeet.'

The publication has been drawn up in such a way that the regulations will not restrict development in the field and that they will provide designers with an opportunity to apply the latest knowledge.

The publication will enter into force on 1 September 2013 and it will be applied to deliveries taking place after 1 January 2014. However, in connections to single-family houses, it is possible to apply rated temperatures in heat exchangers for heating and domestic hot water complying with the 2007 regulations until 1 January 2015.

District Heating Substation Group

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1 SCOPE OF APPLICATION, PURPOSE AND CRITERIA

1.1 Scope of application

Compliance of these regulations shall be agreed on in a private-law contract drawn up with the district heat customer. The regulations and guidelines are complied with in the design and installation of (the customer's) district heating equipment in a building that is to be connected or that has already been connected to water-based district heating, and in any repairs and modification work carried out on it.

The equipment used must meet the requirements presented in this publication.

1.2 Purpose

These regulations and guidelines define the basic requirements for the design, installation and devices of the district heating equipment in a building, the implementation of which guarantees efficient operation of the customers' equipment and the heat vendor's district heating system.

1.3 Approval of equipment

The equipment and fittings used must be type tested and approved in accordance with the international and national legislation, regulations, decrees and standards and the regulations, recommendations and guidelines issued by ET valid at any given time.

1.4 Other regulations and guidelines in the sector

- Pressure vessel regulations
- National Building Code of Finland (RakMk)
- Asumisterveysohje (Housing health guidelines) issued by the Ministry of Social Affairs and Health (2003)
- Electricity, fire, asbestos etc. regulations
- EN standards, SFS standards
- Regulations by local water companies
- Talotekniikan rakentamisen yleiset laatuvaatimukset TalotekniikkaRYL (General specifications for building technology).

1.5 Definitions

The heat vendor is the name used for the heat supplier in this publication.

The customer is the name used for the building/s heated with district heat or their owner/occupier.

Heating capacity demand is the amount of energy needed for maintaining indoor climate conditions and for heating domestic hot water.

The district heating equipment of a building is a set of heating equipment consisting of the customer's district heat and heating devices.

The district heating devices of a building are the devices in which the district heating water flows or which regulate the flow of district heating water circulating through the customer's heating system.

The heating devices of a building are the devices that distribute the thermal energy from the heat exchangers to the places of use. Essential devices with respect to district heating are devices and connections that have a direct impact on the cooling of the district heating water.

The substation is a set of devices connected to the heat vendor's metering centre, the domestic hot water and heating networks and the expansion vessels. It includes the heat exchangers, the primary side and possibly the control devices for the secondary side, the pumping devices, valves and fittings, and the necessary pipework. See the scope of delivery of the substation. The substation of a small house also includes the expansion vessel of the heating network in addition to the above. See the scope of delivery of the substation for a small house.

The technical specification is a list of the set of equipment delivered to the customer, including the rated values, drawn up by the supplier of the substation.

Instructions for the use and maintenance of the building is a property-specific set of documents that includes the initial data, targets, tasks and guidelines for the care, maintenance and repair of the property. /RakMK A4/

A small house in this publication is a building consisting of a maximum of two dwellings or other building with a maximum heating load of domestic hot water of 120 kW and with a maximum need of heating load for the premises of 30 kW.

The branch line is the heat vendor's district heat supply line from the district heating network to the substation equipment room (metering centre).

The metering centre is the heat vendor's heat metering equipment which, in addition to the metering devices, includes the shut-off valves and strainers of the branch line, as well as possible devices for restricting the flow. The customer's pipework starts from the metering centre.

The substation equipment room is a separate facility in a building, housing the substation.

The technical utility room is a separate facility that may house other equipment required by community technology (e.g. water, electricity and data communication system devices) in addition to the substation.

Contracted capacity means the highest hourly heating capacity reserved for the customer's use. The unit of measurement for contracted capacity is kW.

Contracted water flow means the highest hourly flow of district heating water reserved for the customer's use. The unit of measurement for contracted water flow is m^3/h.

Hourly capacity/water flow means average capacity/water flow over a sliding period of one hour.

The primary side consists of the piping and equipment or parts of the equipment in which the district heating water flows or which its pressure has an impact on.

The secondary side consists of the pipework and equipment or parts of the equipment in which the liquid to be heated in the heat exchangers flows or which its pressure has an impact on.

In the district heating supply pipe, the district heating water from the heat vendor arrives from the production plant into the customer's substation.

In the district heating return pipe, the district heating water returns from the customer's substation to the production plant.

In the heating network supply pipe, the secondary water flows to the heating devices of the building.

The water returning to the substation flows in the heating network return pipe.

The heat contractor is a company that carries out installation of district heating equipment and is approved by the heat vendor.

1.6 Conditions

The materials used in district heating equipment shall be such that, under normal operating conditions and appropriately maintained, the equipment will meet the requirements set for it for the duration of its lifetime.

The design temperature of district heating equipment (highest temperature inside) is 120°C. The equipment and fittings must withstand the design temperature of the network in question (heating, ventilation, domestic hot water) in continuous use.

The design pressure (highest operating pressure) of the equipment is

- primary side 1.6 MPa
- domestic hot water networks 1.0 MPa
- heating networks 0.6 MPa.

The designer shall check with the heat vendor the differential pressure of the circulating district heat water and its limits of variation. The differential pressure after the metering centre is at least 60 kPa.

1.7 Conversion factors between various units

1 kWh	= 3,600 kJ	= 0.860 Mcal
1 Mcal	= 1.163 kWh	= 4.187 MJ
1 kJ	= 1 kWs	= 0.278 Wh
1 kW	= 0.860 Mcal/h	= 102 kpm/s
1 kPa	= 0.010 bar	= 0.102 mvp
1 bar	= 10.197 mvp	= 100 kPa
1 m^3/h	= 0.278 dm^3/s	= 0.278 l/s

2 TECHNICAL UTILITY ROOM

2.1 Situation of the technical utility room

The situation of the technical utility room and the district heating pipes entering the room is established and agreed on with the heat vendor in the early stages of the design process.

The principles of situating the technical utility room in a new building include

- Connections of utility systems (district heat, water, electricity, data communications, etc.) focused on one area in the building. Thus, in order to save costs, the branch lines and cables can be installed in one excavation, and the equipment managed and controlled by different operators will be situated in a room with a common external entrance.
- In the building, the situation of the technical utility room shall be chosen to ensure that the branch line from the district heating network to the technical utility room is as short as possible. Installation of district heating pipes under or inside the building should be avoided where possible.
- When designing the situation of the technical utility room, the noise emitted by the equipment shall be taken into account so that the permitted noise level in the living areas is not exceeded.

In new buildings, the technical utility room shall be accessed directly from the outside. The door to the technical utility room shall be marked with the sign 'Substation' or 'Technical utility room'.

Access to facilities housing the heat vendor's equipment shall be arranged in a way approved by the heat vendor.

2.2 Size of the technical utility room

The technical utility room shall be dimensioned according to the space requirement of the equipment to be installed in it. In small residential buildings and other small buildings, all technical appliances may be installed in the same room, taking their special requirements into account.

In the technical utility room, sufficient space shall be reserved for the equipment enabling its appropriate positioning while taking into account the needs of operation and maintenance. The situation of equipment is presented in the district heating plan.

Table A. Indicative space requirement for the district heating equipment. Sufficient extra room must be reserved for other equipment to be situated in the same room.

Volume of the residential building m^3	Number of heat exchangers	Space requirement for district heating equipment m^2	Space requirement for other equipment m^2
500	2	2	determined on the basis of space requirement for equipment and added to the space requirement for district heating equipment
500	3	2.5	
1,000	3	3	
1,000	4	4	
10,000	4	5	
20,000	4	5	

If, for example, a main distribution board, central vacuum cleaning system, air conditioning equipment or other devices are situated in the same space with district heating equipment, sufficient additional space must be reserved for them.

2.3 Situation of the equipment and maintenance facility

The heat vendor shall determine the situation and space requirement of the metering centre.

The metering centre shall be situated in the most advantageous place in terms of the branch line. A total of 800 mm of free maintenance space shall be reserved in front of the metering centre along its entire length. The height of the maintenance facility must be at least 2,000 mm.

Free maintenance space of at least 600 mm must be allowed by the substation sides that require maintenance.

A maintenance space in accordance with the electrical safety regulations must be reserved for electrical appliances.

2.4 Heating and ventilation

The indoor temperature of the technical utility room must be over 10°C. The temperature must not rise to over 35°C.

The technical utility room shall be equipped with sufficient ventilation, which can be adjusted if necessary. A temperature rise is prevented mainly by heat insulation of pipes and devices.

2.5 Water supply point and drainage

The technical utility room and any separate room for the heat metering centre shall be equipped with a drain. Hot and cold water supply points are installed in the technical utility room, the plumbing fixture is equipped with a hose connection.

2.6 Lighting and electric socket

The technical utility room shall be equipped with an earthed electric socket and fixed lighting with illuminance of at least 150 lux measured in the vicinity of meters and control devices.

2.7 Data transmission

The heat vendor is entitled to install in the building any equipment and systems necessary for the monitoring of heat consumption and the functioning of district heating equipment.

The customer shall find out whether they would need to provide the heat vendor with a data transmission connection and, if necessary, if it is possible to transmit energy metering data also to the customer's own systems.

2.8 Electrification of the heat meter

The electrification of the heat meter is carried out according to local guidelines.

General guidelines:

The MMJ 3 x 1.5 mm^2 S conductor is used as the branch circuit for the heat meter. It is not permitted to connect other consumption instruments to the branch circuit and it must not have any extensions or intermediate sockets.

The branch circuit must be protected with a 10 A sealable fuse, which is mainly situated in the main distribution board.

In existing properties or when the main distribution board is far from the technical utility room, it is possible to connect the branch circuit from the utility room to the final circuit board of the technical utility room.

A temporary supply cable during the construction stage can be connected to the final circuit board of the substation before the main switch.

The fuses of the heat consumption meter and the branch circuits of the automation in the substation must be connected to the same phase regardless of where the fuses are located.

3 HEATING SYSTEMS IN BUILDINGS

3.1 Basic requirements

The district heating systems of the building are designed and implemented to achieve a high quality of indoor climate in all areas and conditions. The objective is to gain as efficient use of energy as possible, in which case the energy consumption and capacity demand are as low as possible.

The following requirements are taken into account in the dimensioning and selection of district heating equipment:

- the control systems are able to adjust energy procurement so that thermal loads produced by solar radiation, people, lighting etc. will be utilised in each space in the heating of the building
- the operating temperatures in the flow circuits can be adjusted and they are kept as low as possible
- the equipment runs smoothly in the changing differential pressure conditions
- optimisation of energy and capacity demand is possible
    - ♦ e.g. when the capacity demand for domestic hot water is at its maximum, the load going to the heat exchanger is reduced temporarily.

3.2 Starting points of design and dimensioning

In the design process, the district heating equipment must always be examined as a whole also in connection with equipment replacements. The dimensioning of the equipment must be based on calculations or actual measured operating values.

The heating system is designed so that heating in different types of spaces (e.g. living areas, semi-heated rooms, wash rooms) can be controlled separately for each space. In existing buildings, it is recommended to find out the possibilities of improving the operation of different sections of the heating network.

In mechanical supply and exhaust ventilation, cold supply air can be heated in the heat recovery equipment with the thermal energy obtained from exhaust air. A water-circulating post-heating radiator is recommended for the ventilation machine as it is the most advantageous solution for the customer in terms of its lifecycle costs.

The technical data of the heating system and the data according to the substation tables shall be submitted to the heat vendor for determining the district heat output and district heating water flow and for estimating the energy consumption (instructions for completing the tables are presented in section 14).

3.3 Heating capacity requirement

The required heating and ventilation capacity in new buildings is calculated in accordance with the RakMK regulations and guidelines.

In other than new buildings, the heating capacity demand is calculated on the basis of available consumption and metering data. In the dimensioning, it is taken into account whether the building and heating equipment have been used correctly (e.g. indoor temperatures, operating times of ventilation, air flows).

3.4 Rated temperatures

3.4.1 New buildings

Rated temperatures of heating systems in new buildings are selected so that the heat losses in heat distribution are as small as possible. The maximum temperature values in a heating network are presented in Table B.

The heating systems of extensions are dimensioned in the same way as in new buildings.

Table B. The rated temperatures for the heat exchangers of heating and ventilation in rated outdoor temperatures – new buildings

	RATED TEMPERATURES OF HEAT EXCHANGERS °C			
	PRIMARY		SECONDARY	
	SUPPLY	RETURN	RETURN	SUPPLY
Heat exchangers of heating, radiator heating - recommended	115	33 (max)	30 (max)	45 (max)
Heat exchangers of heating, radiator heating - exceptions	115	33 (max)	30 (max)	60 (max)
Heat exchangers of heating, underfloor heating	115	33 (max)	30 (max)	35 (max)
Comfort underfloor heating for wet rooms	70	28 (max)	25 (max)	30 (max)
Heat exchangers of ventilation	115	33 (max)	30 (max)	60 (max)
Note	The return temperature on the primary side may be a maximum of 3°C higher than that of the secondary side			

In radiator heating, the recommended supply temperature is as low as possible due to the good adjustability and energy efficiency of the heating network. In exceptional situations, a supply temperature of 45–60°C may be used. A value higher than the recommended temperature of 45°C may only be used when the dimensioning of the radiators would otherwise result in unreasonable installation and situation problems with the radiators and pipes. The maximum rated value of the return temperature in the radiator network is 30°C.

The rated temperatures of heat exchangers in comfort underfloor heating are only used when the objective is to maintain the floor surface temperature at a comfortable level. When underfloor heating is also the actual heat distribution system in the premises, underfloor heating shall be dimensioned in the same way as a normal underfloor heating network.

Table C. Rated temperatures of heat exchangers for domestic hot water

	RATED TEMPERATURES OF HEAT EXCHANGERS °C			
	PRIMARY		SECONDARY	
	SUPPLY	RETURN	COLD WATER	HOT WATER
Heat exchangers for domestic hot water	70	20 (max)	10	58

If necessary, the sufficiency of the heat exchanger capacity must also be checked in other operating points at their normal temperatures. The heat vendor shall provide information about the district heat supply temperature with different outdoor temperatures as a basis for the calculation. If this information is not available, the following values may be used as the supply temperature on the primary side:

Outdoor temperature t_x	District heat supply temperature if no locality-specific information is available
• higher than 8°C	70°C
• maximum 8°C	$115\,°C + (t_u - t_x) \times \frac{45\,°C}{(8\,°C - t_u)}$

t_u = rated outdoor temperature in the locality, °C
t_x = examined outdoor temperature, °C

3.4.2 Existing buildings

The operating values (temperatures, flows) of the heating systems in an existing building are measured. The measured values act as a basis for determining new rated values. When examining the operating values and selecting new values, it must be taken into account whether the building has been used in a systematic and appropriate way (e.g. indoor temperatures, ventilation operating times, air flows). When selecting temperature, the return water temperature should be as low as possible.

A table on the maximum values for the rated temperatures in the heating system is presented in Table K in section 14.3.

The heat exchangers for domestic hot water are dimensioned in the same way as in new buildings (Table C).

3.4.3 Ventilation radiators

In new buildings, ventilation radiators are dimensioned with temperatures of 50/30°C, in existing buildings they may also be dimensioned with temperatures of 60/40°C in the rated outdoor temperature. If necessary, the sufficiency of ventilation radiator output must also be checked at a full ventilation outdoor temperature with secondary network temperatures presenting in the situation in question.

3.5 Rated pressure losses

The highest permitted pressure losses of heat exchangers, pipework and equipment are as follows:

	primary	secondary
• heat exchangers for domestic hot water	20 kPa	50 kPa
• other exchangers	20 kPa	20 kPa
• pipework and equipment with the exception of control valves	5 kPa	5 kPa

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RATING TABLE 1
Technical specifications for heating

Intended use of the building								
Number of buildings								number
Cubic volume of buildings (SFS 5139)								m^3
Heated net area (RakMK part D3)								m^2
Indoor temperature(s)								^oC
Number of dwellings (number of business premises, etc.)								number
Rated flow of domestic hot water (DHW)								dm^3/s
HEATING CAPACITY OF DISTRICT HEATING SPECIFIED BY GROUP OF DEVICES		SPECIFICATION OF HEATING CAPACITY (kW)						
		Other operating point that defines max power demand - ____ ^oC			In the rated outdoor temperature of the locality - ____ ^oC			
Group of devices	Dimensioning ^oC - ^oC	Conduction and leakage	Ventilation	Total	Conduction and leakage	Ventilation	Total	
Heating devices in DHW circuit	-							
Radiators	-							
Underfloor heating	-							
Radiators, air circulating heaters ____ number	-							
Radiators, ventilation ____ number	-							
Post-heating radiators ____ number	-							
	-							
	-							
REQUIRED DISTRICT HEATING CAPACITY								
+ Capacity from heat recovery								
+ Other heating capacity								
HEATING CAPACITY IN TOTAL								
District heating water flow (without domestic hot water)				dm^3/s			dm^3/s	
Consumption of district heat energy / year							MWh/a	
FURTHER INFORMATION								

Contractor's notes	Heat vendor's notes

Site identification data (Title screen)

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RATING TABLE 2
District heat substation

Site							
HEAT EXCHANGERS		Domestic hot water LS 1		Heating LS 2		Ventilation LS 3	
Manufacturer							
Model							
Output	kW						
		primary	secondary	primary	secondary	primary	secondary
Flow	dm3/s						
temperatures	^{o}C - ^{o}C	-	-	-	-	-	-
Pressure loss	kPa						
CONTROL VALVES		Domestic hot water TV 1		Heating TV 2		Ventilation TV 3	
Manufacturer							
Model							
Flow	dm^3/s						
Pressure loss	kPa						
Size / kvs value	DN / k_{vs}	/		/		/	
Control centre							
WATER CIRCULATION PUMPS		Domestic hot water P 1		Heating P 2		Ventilation P 3	
Manufacturer							
Model							
Flow	dm^3/s						
Head	kPa						
Power drawn by the motor	W						
NETWORK, EXPANSION AND SAFETY DEVICES				Heating network		Ventilation network	
Network volume / pressure loss		dm^3 / kPa		/		/	
Volume of expansion vessel / pre-pressure		dm^3 / kPa		/		/	
Size / opening pressure of safety valve		DN / kPa		/		/	
DIFFERENTIAL PRESSURE REGULATOR							
Manufacturer / model		/					
Flow / pressure loss	dm^3/s / kPa	/					
Size / kvs value	DN / k_{vs}	/					
Set value	kPa						

N:o	number	Device	Dimensioning

FURTHER INFORMATION:

DIFFERENTIAL PRESSURE	Available differential pressure with variation limits given by the heat vendor	-	kPa

4 HEAT EXCHANGERS

4.1 Dimensioning principles

Heat exchangers are dimensioned to meet the heating capacity demand. Dimensioning shall aim for as efficient cooling of district heating water as possible in all operating situations.

The entire water flow of the primary and secondary side of the heat exchangers shall be directed through the heat surfaces.

4.2 Rated capacity of heat exchangers

4.2.1 Heat exchanger for domestic hot water

The rated flow of the service line for domestic hot water in section D1 of the RakMK guidelines 'Kiinteistöjen vesi- ja viemärilaitteistot' (Water supply and sewage equipment in properties) shall be used as the rated flow for domestic hot water. The exchanger output shall be dimensioned so that the temperature of the hot water obtained from it is 58°C with the rated flow. The domestic hot water equipment (incl. the circulation pipe for domestic hot water) shall be designed so that the water temperature in the equipment is at least 55°C.

The rated flow of the domestic hot water is at least 0.3 dm^3/s, which corresponds with a 60 kW thermal capacity of the heat exchanger.

4.2.2 Heat exchangers for heating and ventilation

Heat exchangers are dimensioned with temperatures in accordance with the greatest prevailing heating capacity demand. In connection with periodic heating, the peak demand after a period of non-use must be stated as actual rated capacity. Examination of the functioning of the exchanger in an operating situation where the flows of the exchanger are the greatest (e.g. in old buildings in the lowest temperature of full ventilation) must also be presented in the plans.

Heating circuits with different rated or operating temperatures or operating times are implemented with separate heat exchangers and regulating automation.

If a possible capacity reservation is taken into account in the selection of the heat exchanger, the operating values corresponding to the ultimate capacity are stated in the plan as additional information. The scope of the capacity reservation and the schedule for its deployment are presented as additional information.

Flows on the primary side are calculated and reported in accordance with the actual cooling of the heat exchanger.

If other than water, for example, glycol-water solution, is used as heat transfer fluid on the secondary side, the properties of the solution in heat transfer are taken into account in the dimensioning of the exchanger. The mixture ratios and properties of the solution are presented in the plan.

4.3 Structural materials

The materials used must maintain their mechanical properties under normal operating conditions, and they must not show any corrosion or other damage that would impair the technical properties of the heat exchanger.

A long-term manufacturer's warranty must be obtained for the maintenance of the elastic properties of elastic gaskets and materials. The equipment manuals must include a statement on the service life and replacement need of materials. Rubber-based material can be used in special cases only.

The designer must find out the quality of domestic hot water and take account of the subsequent requirements.

The use of carbon steel is banned on heat transfer surfaces and on the secondary side of the heat exchangers for domestic hot water. Durable materials on heat transfer surfaces include stainless steel (e.g. AISI 304), acid-resistant steel (e.g. AISI 316) and copper.

4.4 Data provided on heat exchangers

The manufacturer/importer of the heat exchanger must provide, on request, the technical specifications for heat transfer, time constants and dimensioning calculations for the exchanger it offers. The information must give the operating values of the heat exchanger in various load situations.

The manufacturer/importer must provide, on request, an account of all materials and material analyses used in the heat exchanger.

4.5 Approval by the authorities, type testing

The heat exchangers to be connected to the district heating network must comply with the pressure equipment regulations. The heat exchangers and dimensioning methods must be type tested in accordance with the existing standards, regulations and guidelines.

5 CONTROL DEVICES

All the regulations and guidelines presented here apply to the control devices on both the primary and the secondary side unless otherwise stated.

5.1 Control systems

The objective of the regulations and guidelines of this publication is to achieve a good control result in the operating situation and condition prevailing at any given time. The result can be achieved in several different ways, which are not limited or ranked by order of priority in this publication.

The following targets are set for the operation of the control and monitoring systems in a building heated with district heat:

- The control systems for heating and ventilation in a building take into account the heat dynamics of the building, the thermal loads to be utilised, etc. as accurately as possible so that all the rooms in the building have a good, healthy and comfortable indoor climate and the lowest possible capacity demand and energy consumption.
- The operation of the control devices for domestic hot water guarantees a constant temperature of domestic hot water in all designed situations.
- The control valves, regulating motors and temperature sensors of the substation are part of the substation manufacturer's delivery and they are located in the same room as the substation. If this is not possible, the substation must be equipped with local displays showing its operation to a sufficient extent.
- The control devices can be calibrated according to the situation and requirements at any given time to achieve a good control result.
- The customer may optimise the district heat output they require within the scope of the options of the tariff they are using.

5.2 Operating requirements for control

The control systems for each control circuit are designed, selected, dimensioned, installed and calibrated so that the desired end result is achieved in all operating situations.

A control system installed at the customer's premises shall meet the following requirements under the operating conditions reported by the heat vendor:

1.	Maximum permanent deviation from the set value	+/-2°C
	Permitted resetting time from the start of the change to the moment when the above requirement is met	2 minutes
2.	Maximum momentary deviation from the set value	
	control systems for heating	+/-5°C
	control systems for domestic hot water	+7/-10°C
	other control systems	+/-10°C
3.	Permitted continuous ripple	
	control systems for domestic hot water	+/-2°C
	other control systems	+/-0.5°C

However, the temperature of domestic hot water at the point of use must not be higher than 65°C (RakMK D1).

5.3 Control valves

5.3.1 Selection of control valves

The control valves are dimensioned according to the flows of the rated values and capacities for the heat exchanger obtained in accordance with section 4.2 and the temperatures in accordance with section 3.4, and the differential pressure prevailing under normal operating conditions. The minimum differential pressure complying with the terms of contract for district heat is 60 kPa. For dimensioning, the heat vendor shall provide information about the differential pressure available to the customer in the operating conditions, including the limits of variation.

The rated differential pressure for the control valve is calculated with the following formula:

$$\Delta p = \Delta p_{ilm} - \Delta p_{siirrin} - \Delta p_{putkisto}$$

Δp = rated differential pressure of the control valve [bar]
Δp_{ilm} = available differential pressure given by the heat vendor
$\Delta p_{siirrin}$ = pressure loss of the exchanger
$\Delta p_{putkisto}$ = pressure loss of the pipework

The k_v value of the control valve is calculated with the following formula:

$$k_v = \frac{q_v}{\sqrt{\Delta p}}$$

q_v = rated flow of the primary side of the heat exchanger [m^3/h]
Δp = rated differential pressure [bar]

A valve most suitable with respect to its k_{vs} value is selected as the valve. Normally, the next valve with a smaller k_{vs} value is selected as the control valve for domestic hot water and the next valve that is higher is selected as the control valve for the heating circuit.

The actual pressure loss caused by the selected valve can be solved with the formula for the k_v value

$$\Delta p_{sv} = \left(\frac{q_v}{k_{vs}}\right)^2$$

q_v = rated flow [m^3/h]
Δp_{sv} = actual pressure loss [bar] caused by the selected valve

The pressure loss of the control valve must be at least half of the total pressure loss of the substation control circuit in question, i.e. the authority of the control valve, or the indicated efficiency β is higher than 0.5.

$$\beta = \frac{\Delta p_{sv}}{\Delta p_{mit}}$$

Δp_{sv} = pressure loss caused by the selected control valve with the rated flow
Δp_{mit} = available differential pressure given by the heat vendor.

5.3.2 Use and dimensioning of two control valves

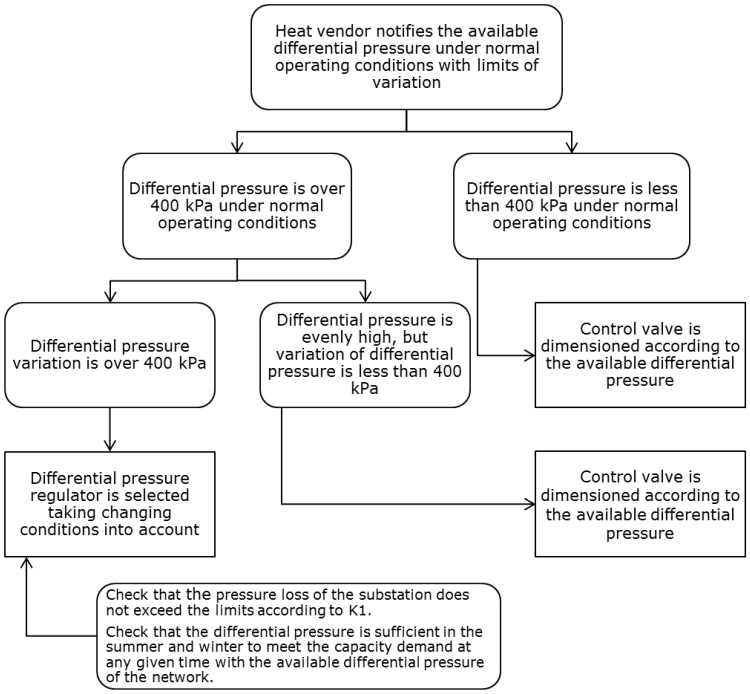
With the exception of small houses, two or more parallel-connected control valves are used when the controlled capacity varies in a wide range. The use of two control valves is recommended if the k_{vs} value of the control valve would be higher than 6.3.

A smaller valve is dimensioned with a flow corresponding to a maximum rated capacity of 30 per cent. The operation of the valves is controlled in an optimal way with respect to the end result.

5.3.3 Differential pressure regulator

If the differential pressure in the district heating network given by the heat vendor fluctuates by more than 400 kPa, we recommend using a differential pressure regulator. The differential pressure regulating devices are dimensioned so that the differential pressure can be controlled at about 150 kPa, depending on the dimensioning of the control valve. The differential pressure regulation is carried out on the entire substation. The need for a differential pressure regulator is examined under different conditions in accordance with the following formula.

The differential pressure valve is dimensioned so that the substation flows are calculated when the differential pressure is at its lowest and highest (e.g. summer and winter situation). The DN size and spring of the valve are selected so that the differential pressure can be limited to about 150 kPa during highest differential pressure. The pressure loss caused by the selected differential pressure valve and the authority of the control valve are checked with a flow during lowest differential pressure, during which the differential pressure valve is fully open.



The differential pressure regulator is part of the substation if the heat vendor notifies the designer of its need already in the design stage.

To eliminate pressure ripple in the district heating network, differential pressure regulators must not be installed one after the other to regulate, for example, in the heat supply line and the metering centre.

5.3.4 Structural requirements

The control valves on the primary side must be 2-way valves. The forward pressure requirement with its regulating units is 1.0 MPa. The maximum permitted leakage of the control valve is 0.05% of the k_{vs} value.

The structure and function of the control valves must be such that the impurity particles present in the district heating network, which pass through the strainer filter, will not cause a damage or blockage in the valve.

The valves must have a flange or they must be installed between flanges. The structure of the external thread joint with a gasket corresponds with a flange joint. Control valves in small houses can be installed with screw-type couplings up to size DN 20.

5.3.5 Structural materials

The control valves must withstand operating conditions so that no chemical or structural changes will take place in their structural materials. The manufacturer/importer must provide, on request, an account of the materials and material analyses used.

Durable materials on control valve seating plates include, e.g. stainless steel (e.g. AISI 304) and acid-resistant steel (e.g. AISI 316). It is also possible to use EPDM rubber in the self-operated control valve for domestic hot water in a small house.

5.3.6 Manually operated devices and position indicators

Control valves are equipped with an easy-to-use and fail-safe manual control device that can be used for permanently setting the valve to the desired position without using tools. The device must have operating instructions for manual control.

If manual operation requires disconnection of the valve from automated control, the substation shall be equipped with a switch for that purpose.

The control valves shall be equipped with an easy-to-read indicator of the control position. The extreme positions of the valve are marked with the text ‘OPEN’ and ‘SHUT’ or with unequivocal markings.

5.3.7 Situation of control valves

Control valves are installed and situated so that they will not collect impurities. Durability and the need for operation and maintenance shall also be taken into account in the situation. It is recommended that control valves shall be situated on the return side. The valve markings must be easy to read.

5.4 Temperature sensors

Temperature sensors may be either immersion sensors installed in thermowells or level sensors firmly installed on the surface of the pipe. Temperature sensors on the secondary side can be installed without a thermowell if its normal maintenance measures can be carried out without discharging the network.

The temperature sensor of supply water must be installed immediately after the heat exchanger at a place where the temperatures have levelled to a sufficient extent and the measurement result corresponds with the actual value.

An outdoor temperature sensor is primarily installed on the northern wall of the building.

It must also be possible to utilise the measurement data of temperature sensors connected to the regulator in other systems, such as in monitoring and alarm systems.

The substation must be equipped with local displays showing its operation to a sufficient extent.

The material of the thermowell in the temperature sensor must be durable in operating conditions so that it will not show chemical or structural changes. Durable materials include, e.g. stainless steel (e.g. AISI 304) and acid-resistant steel (e.g. AISI 316).

5.5 Regulators

The set values of control (outdoor temperature sensor and restrictions) must be shown by the regulator and they must be legible with an accuracy of at least 1°C.

The regulator must unambiguously show the operating status and direction of movement of control.

During a power cut, the software and set values installed in the regulators must be retained in the memory for at least 48 hours.

5.6 Data transmission

It is recommended that the thermal energy measurement devices and control devices are equipped with a data transmission option. Measures related to the efficient use of energy and the optimisation of capacity demand can be automated and made more efficient in buildings equipped this way. The heat vendor shall carry out all installations on the measuring devices, including connections required by data transmission. The customer must not be able to alter the metrological values or parameters of the meter through the data transmission connection provided for the customer. The customer shall also be able to monitor their heat consumption data through an online service provided by the heat vendor.

Measures in which data transmission can be utilised are listed in the following:

- The heat vendor may read the thermal energy measurement readings through the data transmission network.
- The heat vendor may monitor the customer’s chosen district heating capacity and operating temperature through the data transmission network. The information can be utilised, e.g. in advisory services in energy use.
- The customer may monitor the consumption and capacity demand of district heat energy and the metering and alarm data of temperature sensors connected to the regulator.
- The customer may utilise the metering data in the optimisation of energy and capacity use.
- The customer may utilise the metering data in condition monitoring and maintenance.

6 PIPING AND JOINTS ON THE PRIMARY SIDE

The primary side consists of the pipework and equipment or parts of the equipment in which the district heating water flows or which its pressure has an impact on.

The rated temperature (highest temperature of contents) of the primary side is 120°C and the rated pressure (highest operating pressure) is 1.6 MPa.

This chapter defines the requirements for pipes and joints on the primary side, which are installed on the customer's side of the heat vendor's substation located in the technical utility room and which are the customer's responsibility.

6.1 Pipe materials on the primary side

6.1.1 Welded steel pipes on the primary side

Seamless steel pipes (DIN 2448/17175) manufactured in accordance with SFS-EN 10216-2 or longitudinally or spirally welded steel pipes manufactured in accordance with SFS-EN 10217-1, SFS-EN 10217-2 and SFS-EN 10217-5 shall be used as steel pipes.

Table D. Types of steel pipe, referenced standards and materials

Type of pipe	Outer diameter	EN standard	Material
Seamless	All	EN 10216-2	P235GH TC 1
High frequency resistance welded	≤ 323.9 mm	EN 10217-1 or EN 10217-2	P235TR1 or P235TR2 or P235GH
High frequency resistance welded	≥ 323.9 mm	EN 10217-2	P235GH
Submerged arc welded	All	EN 10217-5	P235GH

6.1.2 Threaded steel pipes on the primary side

Threaded steel pipes can only be used up to size DN 20.

Threaded steel pipes, material 195 T, complying with standard SFS-EN 10255S shall be used as pipes.

6.1.3 Copper pipes on the primary side

Copper pipes complying with standard SFS-EN 1057 hard (R 290) shall be used as copper pipes.

6.2 Pipe joints on the primary side

The type of joint used must be approved for the rated values 120°C and 1.5 MPa for the primary side.

Welded and flange joints complying with the SFS-EN standard shall be used for the steel pipes.

Flanges complying with standard SFS-EN 1092-1 are used as steel flanges. The measurements of the flanges must be equivalent to the pipes connected to them. The structure of the external thread joint with a gasket corresponds with a flange joint.

The joints of the threaded steel pipes are carried out with threaded joints. Wrought-iron pipe fittings must be used in the joints. The use of wrought-iron annealed pipe fittings is not permitted.

The copper pipe joints are carried out with capillary brazing.

6.3 Pipe bends and reducers on the primary side

Prefabricated components shall be used as bends and reducers on the primary side.

Seamless or longitudinally welded pipe bends are used as the bends for the steel pipes. The welded bends must be manufactured to standard SFS-EN 10253-2, material P235GH.

The reducers of the steel pipes EN 10253-2 material P 235GH.
The T-heads of the steel pipes EN 10253-2 material P 235GH.

6.4 Dimensioning of pipes on the primary side

Pipes on the primary side are dimensioned so that the permitted total pressure loss of the piping is not exceeded.

In most common cases where the substation is close to the metering centre, the pipes on the primary side are dimensioned in accordance with Table E. The dimensioning in the table is based on a pressure loss of 0.5 kPa/m in one pipe (welded steel pipes).

The flow is calculated according to the greatest simultaneous momentary flow present in the pipe.

Table E. Dimensioning of steel pipes on the primary side in the technical utility room when the dimensioning of the technical utility room complies with section 2.2

Nominal size DN	Maximum calculated water flow	
	dm^3/s	m^3/h
20	0.3	1.1
25	0.6	2.2
32	1.2	4.3
40	1.7	6.1
50	3.2	11.5
65	6.4	23.0
80	10.0	36.0
100	19.0	68.0
125	35.0	126.0
150	60.0	216.0

6.5 Inspection of connections on the primary side

The sealing of connections is inspected with a leakage test (see section 13.2.1.1). The connections are also inspected visually.

The pipework must not be isolated or covered before the inspection. The connections must be visible.

Seals rejected due to a leak in the welding seal or a defect detected in the visual inspection are repaired by removing the weld metal and carrying out the welding again.

6.6 Flexible connectors on the primary side

The use of flexible silencers, etc. in the pipes on the primary side is not permitted.

6.7 Settling of thermal motion on the primary side

Thermal motion is settled normally with so-called natural compensation. Expansion joints etc. are used only in special cases.

6.8 Customer's underground pipes on the primary side

Rigid pre-insulated pipe systems in accordance with ET's recommendation L1/2010 or flexible pipe systems in accordance with standard SFS-EN 15632-4 shall be used as underground pipes.

Products that are used for building the district heating network must meet the set quality requirements in all respects. The installation work of the district heating pipes is the most important stage in terms of the network lifetime. Persons carrying out welding in the installation work must have a valid certificate on their qualification, and the connection contractor must have a valid right to install the connection.

7 PIPEWORK AND JOINTS ON THE SECONDARY SIDE

The secondary side consists of the pipework and equipment or parts of the equipment in which the liquid to be heated in the heat exchangers flows or which its pressure has an impact on.

The design temperature (highest temperature of contents) on the secondary side is 80°C in the heating network and 65°C in the domestic hot water network. The design pressure (highest operating pressure) is 0.6 MPa in the heating network and 1.0 MPa in the domestic hot water network.

Quality-tested and inspected materials suitable for the purpose of use shall be used as the materials for the domestic hot water system in accordance with the building regulations.

7.1 Pipe materials and types of joint on the secondary side

7.1.1 Heating network

Table F. The most commonly used pipe materials and joints in the heating network

Pipe material	Connection	Note
steel pipes and stainless and acid-resistant steel pipes	welding, flange, thread, press	SFS-EN 10216-2 SFS-EN 10217-1 SFS-EN 10217-2 SFS-EN 10217-5 SFS-EN 10217-7 SFS-EN 10255
copper	soldering, compression, press, flange	SFS-EN 1057
plastic • PE-X • multilayer pipes	press	Connections are made using couplings recommended by the pipe manufacturer.

A maximum 54 mm copper pipe is recommended for use in substations.

The method of connection used must be approved for the design values for the secondary side.

7.1.2 Domestic hot water network

Table G. The most commonly used pipe materials and connections in the domestic hot water network /RakMK D1/

Pipe material	Connection	Note
copper	soldering, compression, press, plug, flange	SFS-EN 1057
stainless steel	welding, thread, press	EN 1.4401, AISI 316
plastic • PE • PE-X • PP • multilayer pipes	 press, plug, welding, flange press press, welding press	Connections are made using couplings recommended by the pipe manufacturer.

The method of connection used must be approved for the design values for the secondary side.

8 VALVES AND FITTINGS ON THE PRIMARY SIDE

The primary side consists of the piping and equipment or parts of the equipment in which the district heating water flows or which its pressure has an impact on.

The design temperature (highest temperature of contents) on the primary side is 120°C and the design pressure (highest operating pressure) is 1.6 MPa.

All the regulations in this chapter 8 apply to valves and fittings on the primary side.

8.1 Structural materials on the primary side

The materials of valves, thermowells and other fittings must last a sufficiently long renewal period suitable for the device in the operating conditions without causing a decline in the strength of the device or hamper its operational capacity.

Durable materials in thermowells and the seating plates of valves include, e.g. stainless steel EN 1.4301 and acid-resistant steel EN 1.4404.

The manufacturer/importer must provide, on request, an account of the materials and material analyses used.

8.2 Shut-off valves on the primary side

Shut-off valves must be weldable or flanged ball valves. Those with a maximum size of DN 20 may also be threaded ball valves.

The flow-through opening of the ball valve must meet at least the above DN size. The valves must be of the same DN size as the pipe connecting to them.

8.3 Strainers on the primary side

The filter mesh size of the strainers must not exceed 1.0mm.

The material of the filter mesh is stainless steel EN 1.4301 or acid-resistant steel EN 1.4404.

The DN size of the strainer must be at least the same size as the pipe.

The strainer must be able to be cleaned.

8.4 Air release and drain valves on the primary side

Air release valves shall be installed so that air can be released from all parts of the installation. Ball valves are used as air release valves.

The drain valves are installed in places that enable complete drainage of the substation. Ball valves are used as drain valves.

Air release valves and, if necessary, drain valves are equipped with a discharge pipe led to a height of 300mm from the floor. The free end of the valves and discharge pipes is bent to 30 degrees and fitted with an end plug for safety reasons.

8.5 Thermometers on the primary side

The thermometers shall be robust column thermometers. The measuring range of the thermometers is 0-120°C with an accuracy of at least 2°C.

The thermometers must meet the accuracy requirements of EN 13190.

Stainless steel EN 1.4301 or acid-resistant steel EN 1.4404 shall be used in thermowells.

Thermometers fitted with remote indication must be easy to read. Their measuring result must meet the accuracy requirements of EN 13190. It must be possible to read the temperatures from the substation equipment room.

8.6 Pressure gauges on the primary side

Pressure gauges are equipped with an MPa or bar scale and have a diameter of 100mm (in small houses at least 40mm). The spacing of the scale is 0.05 MPa, measuring range 0-2.5 MPa.

The pressure gauges must meet the accuracy requirements of standard SFS-EN 837. When the face diameter is 100mm, accuracy must be at least 1.6%. When the face diameter is less than 100mm, accuracy must be at least 2.5%.

The pressure gauges must withstand the design conditions of 120°C and 1.6 Mpa for the primary side, and these must be marked on the meter.

Pressure gauge connections are fitted with shut-off valves.

The shut-off valve of the pressure gauges is kept shut in normal use. The shut-off valve is opened when reading the pressure gauge.

9 VALVES AND FITTINGS ON THE SECONDARY SIDE

The secondary side consists of the pipework and equipment or parts of the equipment in which the liquid to be heated in the heat exchangers flows or which its pressure has an impact on.

The design temperature of the secondary side (highest temperature of contents) is 80°C in the heating network and 65°C in the domestic hot water network. The design pressure (highest operating pressure) is 0.6 MPa in the heating network and 1.0 MPa in the domestic hot water network.

All the regulations in this chapter apply to valves and fittings on the secondary side.

Guidelines and regulations in accordance with RakMK D1 must be complied with in the domestic hot water pipes on the secondary side.

9.1 Structural materials on the secondary side

The materials of valves, thermowells and other fittings must last a sufficiently long replacement period suitable for the device in the operating conditions without causing a decline in the strength of the device or hamper its operational capacity.

Durable materials in thermowells and the seating plates of valves include, e.g. stainless steel EN 1.4301, acid-resistant steel EN 1.4404 and brass.

The manufacturer/importer must provide, on request, an account of the materials and material analyses used.

9.2 Shut-off valves on the secondary side

DN 200 and smaller shut-off valves are ball valves or valves with corresponding properties. Ball valves are used primarily as larger shut-off valves, and butterfly valves or valves with a similar utility value are used secondarily.

Shut-off valves are threaded, weldable, equipped with a flange or installed between flanges.

A double regulating valve is also approved as a shut-off valve for the secondary side if it is suitable for the purpose in terms of its structure and the set value of control does not change when using it as a shut-off valve.

9.3 Double regulating valves on the secondary side

It must be easy to measure the pressure difference of a double regulating valve from the valve. To find out the flow that corresponds to the pressure difference, there must be unequivocal information available about the valve, provided together with the substation.

9.4 Strainers on the secondary side

The filter mesh size of the strainers must not exceed 1.0mm. The DN size of the strainer must be at least the same size as the pipe.

It must be possible to clean the strainer.

It is not necessary to install a separate strainer if another device includes a strainer that complies with the regulations.

9.5 Air release and drain valves on the secondary side

Air release valves shall be installed so that air can be released from all parts of the installation. Ball valves are used as air release valves and they can be equipped with automatic air releasing devices.

The drain valves are installed in places that enable complete drainage of the substation. Ball valves are used as drain valves.

Air release valves and, if necessary, drain valves are equipped with a discharge pipe led to a height of 300mm from the floor. The free end of the valves and discharge pipes is bent to 30 degrees and fitted with an end plug.

9.6 Thermometers on the secondary side

Thermometers can be either robust column thermometers or round meters. The measuring range of the thermometers is 0-120°C with an accuracy of at least 2°C. The thermometers must meet the accuracy requirements of standard EN 13190.

The thermowells are made of brass, stainless steel EN 1.4301 or acid-resistant steel EN 1.4404.

9.7 Pressure gauges on the secondary side

The pressure gauge of the network is installed so that it is easy to read when filling the network. The highest indication of the pressure gauge is selected for the closest possible value determined by the starting pressure of the safety valve.

The network pressure gauge is fitted with a shut-off valve and alarm switches or pressure transducer with the exception of small houses.

In small houses, pressure gauges are equipped with an MPa or bar scale and have a diameter of at least 40mm.

The range is in accordance with the design pressure: 0–1.0 MPa in the domestic hot water network and 0–0.6 MPa in the heating network.

In other than small houses, pressure gauges are equipped with an MPa or bar scale and have a diameter of at least 100mm. The range is in accordance with the design pressure 0–1.0 MPa in the domestic hot water network and 0–0.6 MPa in the heating network.

The pressure gauges must meet the accuracy requirements of standard SFS-EN 837. When the face diameter is 100mm, accuracy must be at least 1.6%. When the face diameter is less than 100mm, accuracy must be at least 2.5%.

10 PUMPS, EXPANSION AND SAFETY DEVICES

10.1 Circulation pumps for heating and domestic hot water

The noise generated by the operation of the pumps must not exceed in the living quarters the maximum noise levels and other requirements presented in section C1 of RakMK.

The pump is installed in the return pipe.

Any spare kit shall be delivered to the substation steadily fixed to a housing installed for the purpose.

10.1.1 Pump control and setting

The circulating pump for domestic hot water must be operating continuously.

The pumps are fitted with a manual option; instructions for its use are placed in the technical utility room.

Where possible, the control system must be such that when the heating or ventilation pump stops, the corresponding control valve on the primary side will close.

It is recommended that the heating pump is controlled so that the control system operates the pump at set intervals when the pump is stopped.

It is recommended that steplessly adjustable pumps are used in the heating and ventilation networks.

10.1.2 Dimensioning of pumps

The pumps are dimensioned with flows in accordance with the operating values of the heat exchanger. When replacing devices, the operating point of old pumps remaining in use must be presented in the plan with flows corresponding to the actual operating values of the heat exchanger.

Flow control of the circulating water on the secondary side must primarily be implemented with correct dimensioning of the pump.

The substation manufacturer is obliged to check that the pump heads correspond with the pressure losses of the selected exchangers.

10.2 Expansion and safety devices

10.2.1 Expansion systems

A closed system is used as an expansion system.

A membrane expansion vessel and a gas-filled expansion vessel are suitable for an expansion system where the maximum vessel pressure is 600 kPa.

A compressor- or pump-controlled closed system suitable for the purpose shall be used as the expansion system for tall buildings.

10.2.2 Expansion and refilling pipe

The expansion pipe is connected to the return pipe on the inlet side of the pump between the heat exchanger and the shut-off valve.

If, contrary to the above, the expansion pipe has been installed before the shut-off valve, an extra safety valve must be installed between the shut-off valve and the heat exchanger.

In other than small houses, it is recommended that a shut-off valve is installed in the expansion pipe on the side of the expansion vessel with respect to the safety valve. To prevent incorrect use, the handle of the shut-off valve is removed and attached to the expansion pipe in the vicinity of the shut-off valve.

The network refilling pipe is connected so that there is no valve that can be closed between the connection point and the safety valve in the expansion pipe.

10.2.3 Safety valves and accessories

Safety valves are installed in the expansion pipe or close to the expansion pipe connection. The discharge connection of the safety valves is led to a distance of 100mm from the floor. Every safety valve is connected to its own discharge pipe. The size of the discharge pipe corresponds to at least the size of the discharge opening of the safety valve.

The size of the safety valves must be at least DN 15. It is recommended to use two safety valves. The size of the safety valve included in the district heating substation is determined according to Table H:

Table H. Safety valve dimensioning guidelines

Heat exchanger capacity kW	Safety valve DN
….200	15
200…800	20
800…	25

The DN size and starting pressure must be marked on the safety valve.

10.2.4 Expansion vessel

Regulations concerning pressure equipment are complied with in the dimensioning of a closed expansion vessel.

In the dimensioning of the expansion vessel, a change of 2–2.5% in the volume of water in the heating system must be provided for, depending on the rated temperatures. The dimensioning of the expansion system is presented in the Building Information Foundation’s instruction card LVI 11-10472.

The expansion vessel is fitted with a discharge valve if the expansion pipe has a shut-off valve.

11 CONNECTIONS AND SUBSTATIONS

11.1 Substation connections and areas of application

In basic connections, the components are presented in the recommended places, but for structural reasons they can also be connected to another place. The measurements describing the system operation in basic connections (e.g. flow, temperature and pressure measurements) are presented as separate components. It is also possible to implement similar functions as integrated in other systems.

Table I. Instruction: selection of various connection options

Selected connection	**Building**
Basic connection	• A building with the heating capacity requirement for the premises of over 30 kW or domestic hot water capacity of over 120 kW and the temperature of district heating water returning from the heating or ventilation exchanger cannot be utilised in the domestic hot water exchanger to improve cooling.
Small house connection	• A building with the maximum heating capacity demand for the premises of 30 kW and maximum domestic hot water capacity of 120 kW.
2-step connection	• A building where the temperature of district heating water returning from the heating or ventilation exchanger can be utilised in the domestic hot water exchanger to improve cooling.

11.1.1 Basic connection, area of application

With the exception of small houses, basic connection is used in all new buildings and in the majority of existing buildings. In the basic connection, the temperature of district heating water returning from the heating or ventilation exchanger cannot be utilised in the domestic hot water exchanger to improve cooling of the district heating water.

11.1.2 Small house connection, area of application

Small house connection is used in buildings where the maximum space heating capacity demand is 30 kW and the maximum rated capacity of domestic hot water is 120 kW.

The connection diagram for small houses presents one solution model for ensuring a control result for domestic hot water temperature. A balancing tank of 10–15 litres has been added to the domestic hot water pipe leaving from the heat exchanger. The materials used in the tank must be approved for the domestic hot water system. The substation manufacturer can also use other methods that deviate from the one presented in the connection model in order to achieve the operating requirements of the control result.

11.1.3 2-step connection, area of application

2-step connection is used in buildings where the return temperature of district heating water in the heating or ventilation exchangers can be utilised in the domestic hot water exchanger to improve cooling. 2-step connection is used when the domestic hot water capacity is over 120 kW and the temperature of water returning from the heating or ventilation exchanger is over 45°C. If the temperature of district heating water returning from the exchanger is 40–45 °C, 2-step connection is used when the domestic hot water exchanger capacity is 300 kW or higher.

11.1.4 Components in basic connections

The substation includes at least the components and devices presented in basic connections. If any components are added, they must be added to the connection diagrams.

The control system for the domestic hot water in a small house may also be self-operated.

It must be possible to reliably measure the flow in the heating network from the double regulating valve or to verify it from the pump display or its remote control.

11.2 Pipe connections for air circulating heaters and ventilation devices

11.2.1 Air circulating heater

Air circulating heaters and other similar radiators cooled with a fan are fitted with a control or solenoid valve, shut-off and double regulating valves and thermometers for supply and return water.

The control of the operation of several air circulating heaters installed for the primary heating use of the room space is implemented with one room thermostat.

When the fan stops, the control valve must close. Any control valve bypass pipe is fitted with a double regulating valve. The preset control value for the double regulating valve is stated in the plan.

An example connection of the air circulating heater is presented in section 15.6.

11.2.2 Ventilation device

The connection and control of the ventilation device can be implemented with either a 3-way or a 2-way valve in accordance with the pipe connections for the ventilation device presented in section 15.6. A 3-way valve is used when there is no main pump in the network.

In order to balance capacity changes, it is recommended to start and stop the ventilation devices in stages.

The operating descriptions for ventilation devices are presented in the connection drawings of the devices in question.

11.3 Connection drawing

The substation connection diagram and rating tables, etc. are presented in the same connection drawing in accordance with the instruction on page 36. The drawing symbols and linewidths must be clear to read.

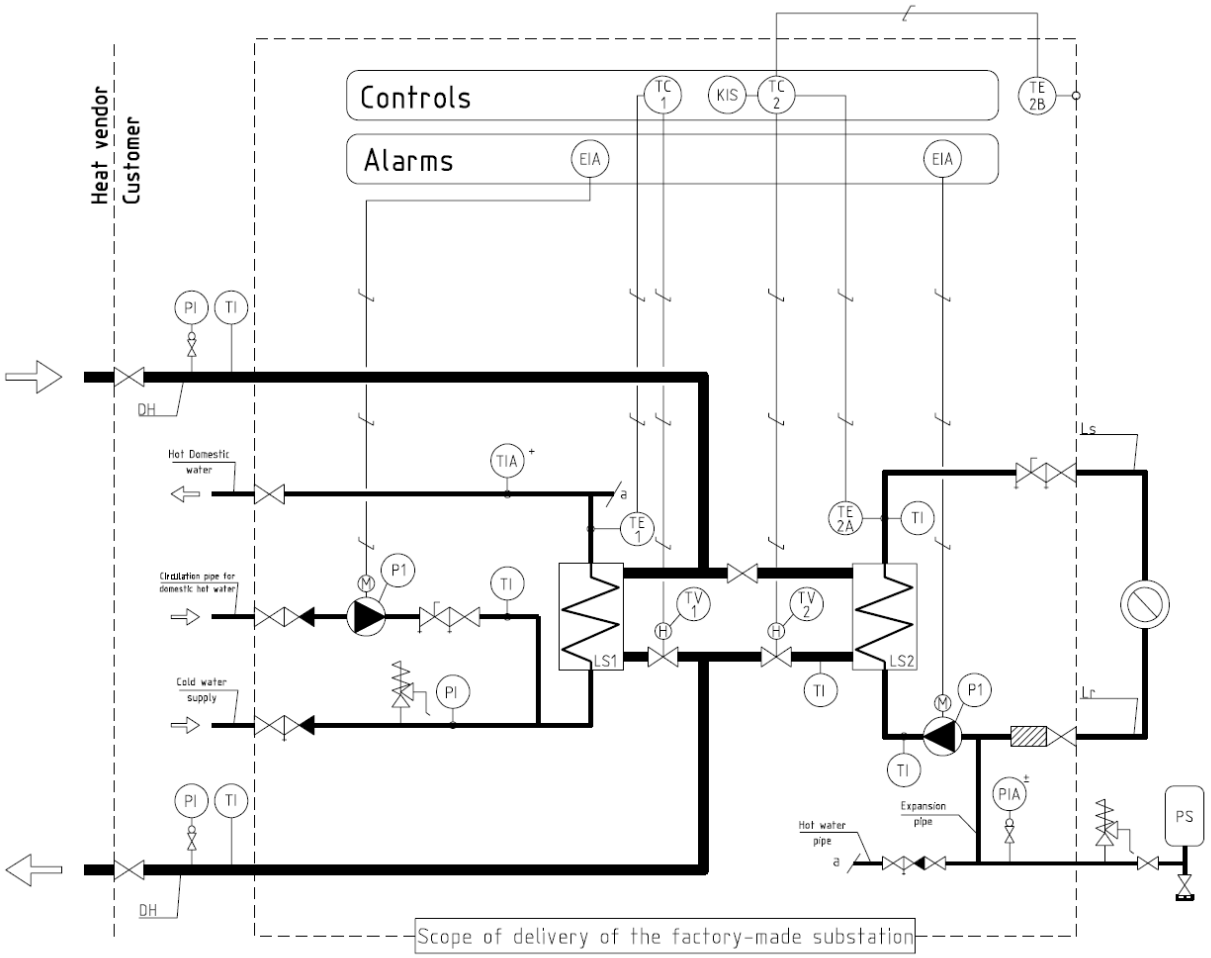
The plan of the technical utility room is attached to the connection drawing. The plan is presented in the scale 1:50 or 1:20.

11.3.1 Operating temperatures of the heating network presented in the connection drawing

The designed operating values of the supply and return water temperature in the control devices on the primary side of the substation as a function of the outdoor temperature (= control curves and any restrictions) are presented in the connection drawing.

11.3.2 Operating descriptions of the connection drawing

The operating descriptions of the substation devices are presented in the connection drawing.



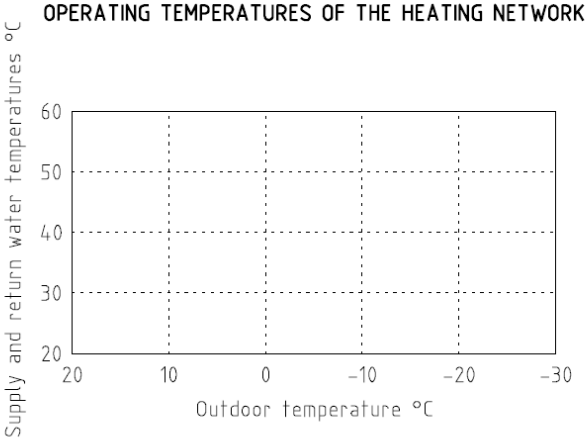
CONTROL OF DOMESTIC HOT WATER TEMPERATURE

Control centre TC1 steers the regulation valve TV1 on the basis of domestic hot water temperature sensor TE1 and keeps the hot water temperature at the set value 58°C.

CONTROL OF HEATING NETWORK SUPPLY TEMPERATURE

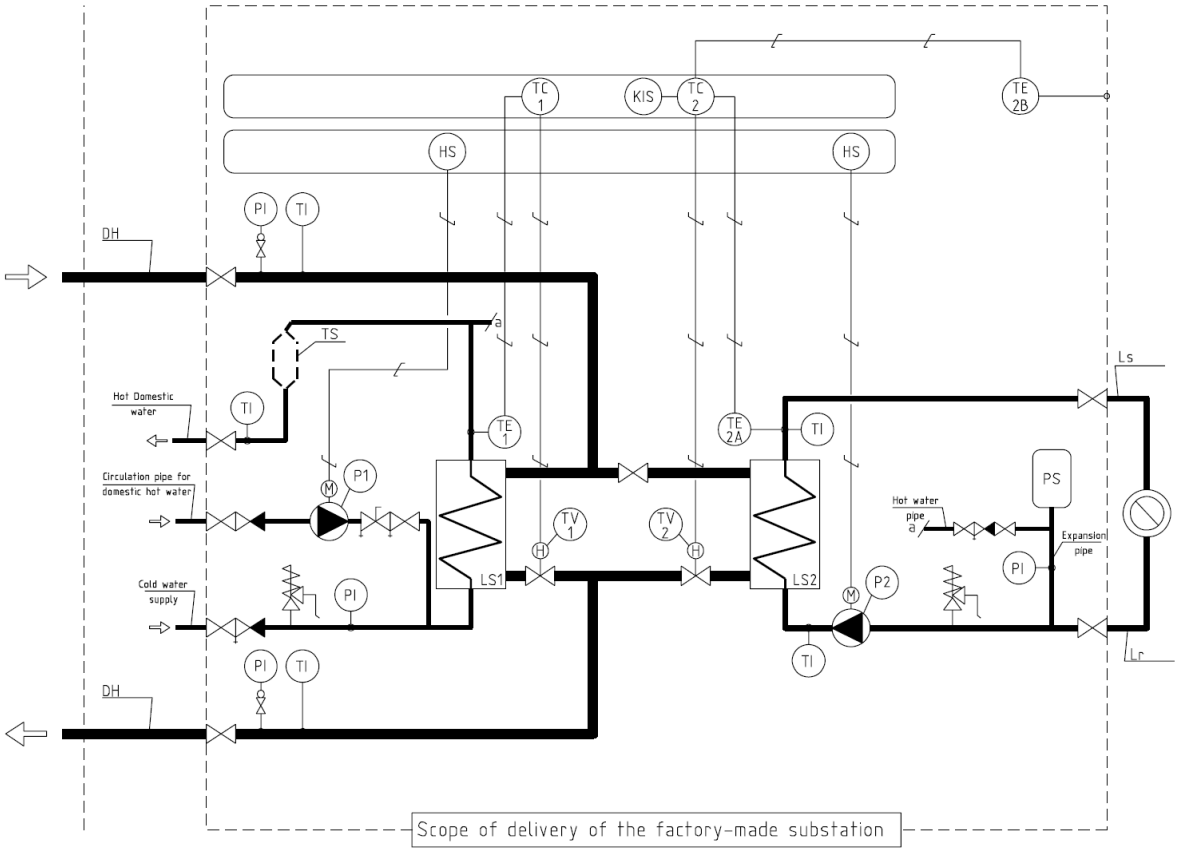
Control centre TC2 steers the regulation valve TV2 on the basis of supply water temperature sensor TE2A and outdoor temperature sensor TE2B and keeps the heating network supply temperature at the set value defined by the control centre.

OPERATING TEMPERATURES OF THE HEATING NETWORK



Finnish Energy
District Heating Substation Group

SMALL HOUSE CONNECTION



CONTROL OF DOMESTIC HOT WATER TEMPERATURE

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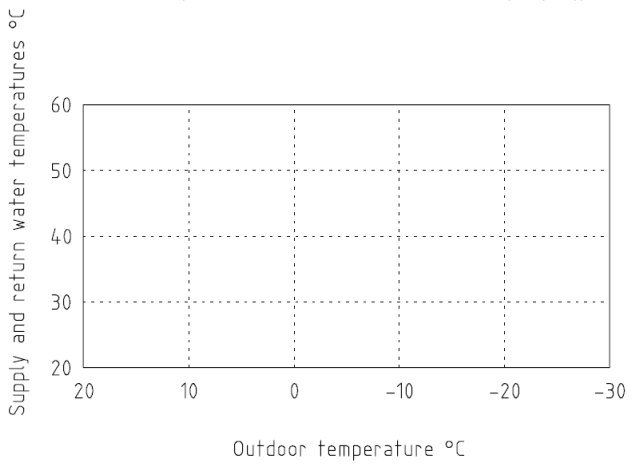
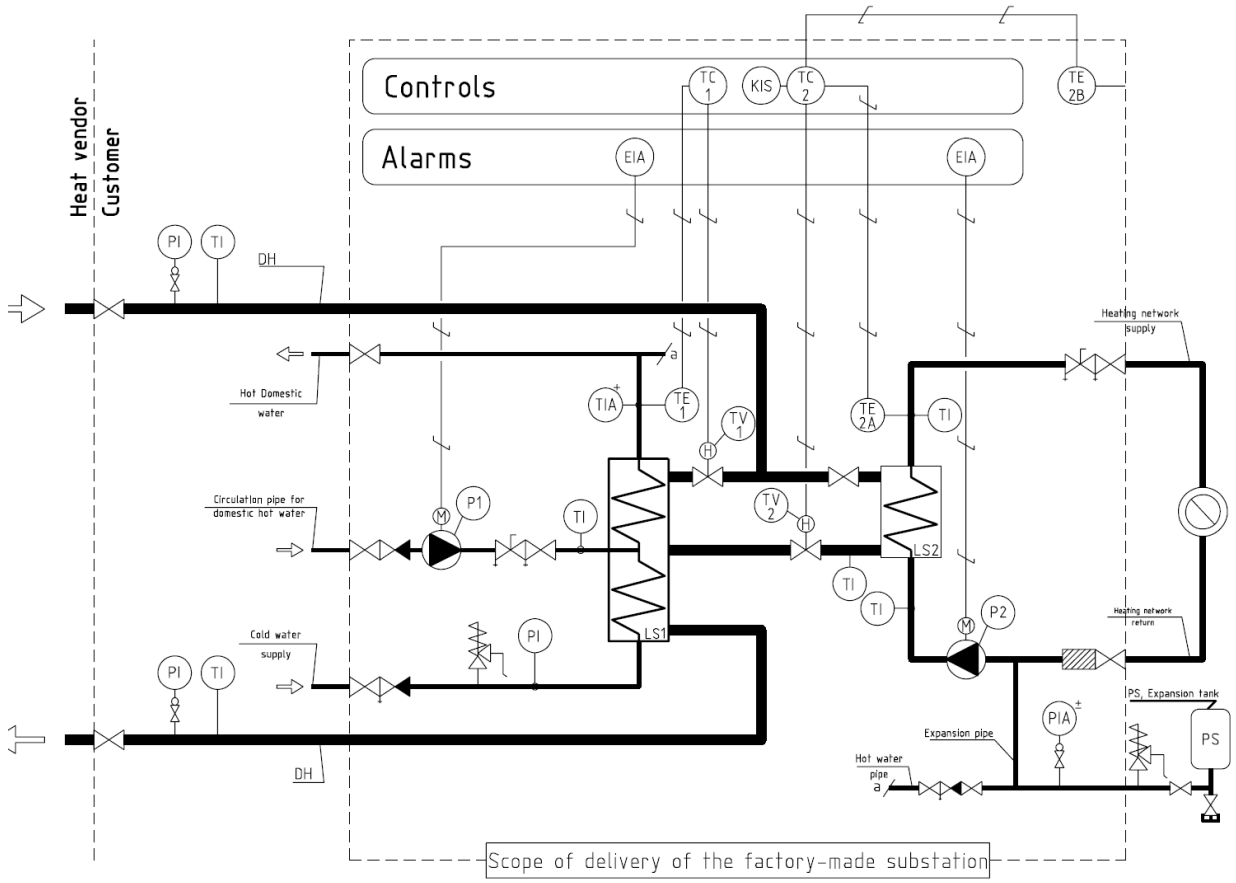
CONTROL OF HEATING NETWORK SUPPLY TEMPERATURE

Control centre TC2 steers the regulation valve TV2 on the basis of supply water temperature sensor TE2A and outdoor temperature sensor TE2B and keeps the heating network supply temperature at the set value defined by the control centre.

OPERATING TEMPERATURES OF THE HEATING NETWORK





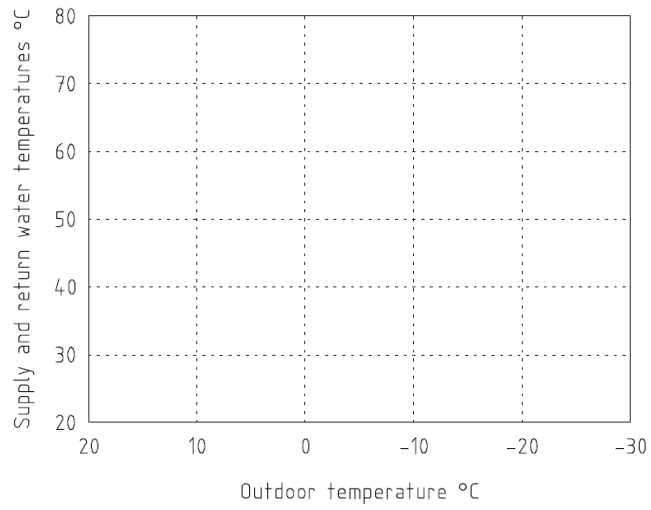
CONTROL OF DOMESTIC HOT WATER TEMPERATURE

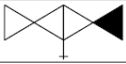
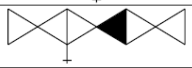
Control centre TC1 steers the regulation valve TV1 on the basis of domestic hot water temperature sensor TE1 and keeps the hot water temperature at the set value 58°C.

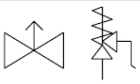
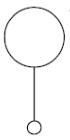
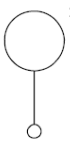
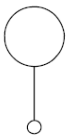
CONTROL OF HEATING NETWORK SUPPLY TEMPERATURE

Control centre TC2 steers the regulation valve TV2 on the basis of supply water temperature sensor TE2A and outdoor temperature sensor TE2B and keeps the heating network supply temperature at the set value defined by the control centre.

OPERATING TEMPERATURES OF THE HEATING NETWORK



Symbol	Symbol	Object
	LS	Heat exchanger
	TV	Control valve (2-way valve), automatic and manual control
	TV	Control valve (3-way valve), automatic and manual control
	MV	Solenoid valve
	P	Pump (and motor)
	PS	Expansion vessel
		Shut-off valve
		Non-return valve
		Double regulating valve with pressure measurement connections
		Valve combination (shut-off + port for presure gaude+non-return)
		Valve combination (shut-off + port for presure gaude+non-return+shut-off)
		Pressure reducing valve Standard pressure valve
		Relief valve/ flow from left to right
		Strainer
		Electronic signal wire
		Hydraulic signal line
		District heating pipe
		Heating network supply
		Heating network return
		Ventilation duct

Symbol	Symbol	Object
	L	Heat emitter (heating network)
	LP	Heat radiator
	SP	Gate valve/damper
	PU	Fan (and motor)
	VV	Safety valve
	TI	Thermometer
	TIA	Thermometer with alarm
	PI	Pressure gauge
	PIA	Pressure gauge with alarm
	TE	Temperature sensor
	TE±	Temperature sensor (limitation)
	TC	Control centre
	KIS	Time switch
	HS	Switch
	EIA	Relay switch (display + alarm)
	EY	Control relay
	FG	Damper actuator
	TAH	Antifreeze thermostat
	SC	Speed control
	TS	Pipe extension / balancing tank

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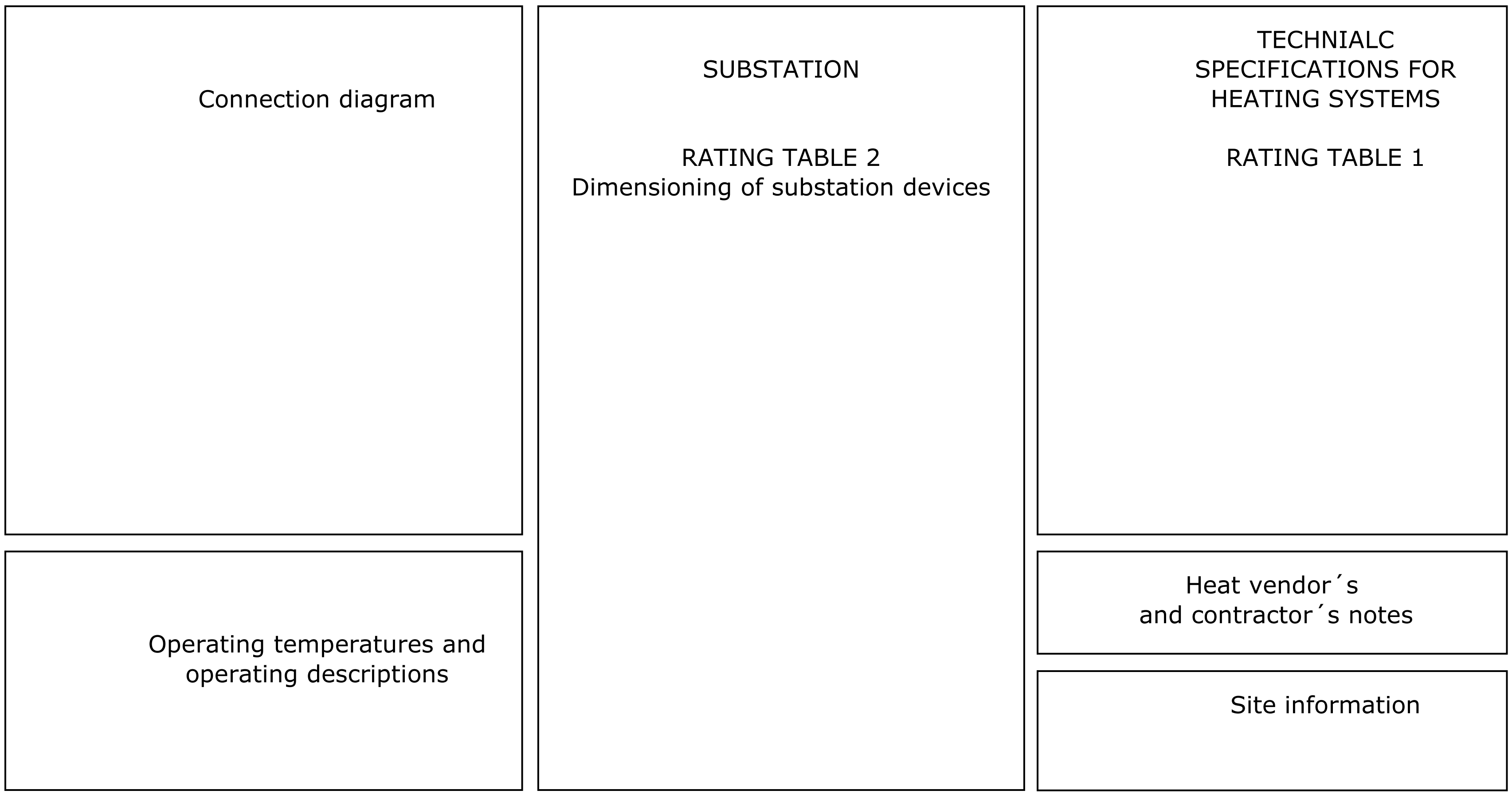
CONNECTION DRAWING INSTRUCTION



- In the connection diagram all the essential connections and devices besides the actual district heat substation are presented so that the overall operation can becomes clear
- The plan of the technical utility room is attached to the connection drawing to the left-hand side.

The connection drawing is fitted firmly in the technical utility room with a dampproof coating.

11.4 Substations

11.4.1 Scope of delivery and fittings of a factory-made substation

Standard delivery of a factory-made substation includes pipes and equipment in accordance with basic connections (see scope of delivery for basic connections) with ready-fitted electrical connections and equipped with the necessary air release and drain valves.

If the basic connections have not been used in the plans, the substation shall be delivered in accordance with the plan approved by the heat vendor.

The supply and return pipe of the substation must be of the same size. The pipes are dimensioned according to the flows. The valves and fittings must be of the same size as the pipe. The pressure losses of pipes and fittings on the primary and secondary side of the substation must not exceed 5 kPa. An indicative Table L on the dimensioning of pipes and fittings of the substation on the secondary side is presented in section 15.5. The substation manufacturer must provide on request an account of the dimensioning and pressure loss of the pipes and fittings when using sizes deviating from the table.

11.4.2 Measurement and control devices and systems of substations

The control valves, regulating motors and temperature sensors of the substation are part of the substation manufacturer’s delivery. The substation is equipped with single unit controllers or connected to the building automation system so that it has local operation properties corresponding to a system implemented with unit controllers.

Efforts should be made to fit the control devices in a prefabricated way so that they are ready to connect to the building supervision systems of the buildings.

The control devices must be pre-calibrated to ensure that the operation of the heating equipment will not cause any harm or hazard. If necessary, a temporary control system shall be installed in the building.

It is recommended that the control circuits with their devices and connections on the secondary side immediately connected to the substation are included in the delivery of a factory-made substation in order to standardise the connections.

Attention must be paid to the situation of the substation measuring equipment in order to ensure that the measuring results will provide a reliable picture of the operating values. For example, the temperature sensors must be installed in a place where the measurement result will sufficiently represent the average temperature prevailing in the location in question. The accuracy of flow measurement is ensured, e.g. on a sufficiently long undisturbed pipe section.

11.4.3 Control centre

The control centre of water circulation pumps and control devices includes all switches and devices complying with the electrical regulations as standard delivery. The control centre must be easy to use and connect to the electricity network.

The water circulation pumps must have a manual operation option with instructions.

11.4.4 Thermal insulation, surface treatments and markings

The substation must be insulated and coated.

Heat exchangers and the pipes on the primary side are insulated in the factory and delivered as insulated or separate elements to the installation place. In other respects, the substation can be insulated at the installation place, if necessary.

Permanent, clear and easy-to-read device- or group-specific markings are attached to the devices. When using group-specific markings, the devices are numbered in accordance with the markings in the connection diagram. Pipework is marked on top of the insulation with arrows and explanatory texts indicating the flow direction.

The marking of the devices is part of the substation delivery. The markings must be visible at an accessible place after the device has been installed in its place of operation. They must not be located in easily detachable covers or similar parts.

The markings of devices and accessories must clearly and unequivocally show the rated values and other technical data of the device.

11.4.4.1 Markings of heat exchangers

The markings of heat exchangers shall include the following information:
- manufacturer's name
- marking identifying the model and series or batch
- CE marking and the last two numbers of the year of attaching it (not in pressure vessels of class 1, i.e. in accordance with sound engineering practice)
- year of manufacture if not CE marking
- highest and lowest operating temperature (^{o}C)
- highest operating pressure (bar)
- volume space-specifically (L)
- thermal capacity (kW)
- design and rated temperatures (^{o}C)
- pressure losses space-specifically (kPa)
- flow, on the primary and secondary side (dm^3/s).

In the connection points, it must be clearly stated with texts and markings indicating the direction of flow which pipes they must be connected to.

11.4.4.2 Control valve markings

The control valve markings shall include the following information:
- manufacturer
- model
- kvs value
- nominal size
- pressure class.

11.4.4.3 Pump markings

The pump markings shall include the following information:
- manufacturer
- model, size

11.4.5 Alarms

The substation is equipped with at least the alarm switches presented in the basic connections.

11.4.6 Substation installation

Good engineering practice and care must be complied with in the installation work. Factory-made parts shall be used in installations carried out at the place of installation.

11.4.7 Noise

The noise produced by the substation devices must not be disturbing under the operating conditions notified by the heat vendor. The noise level must not exceed in living quarters the values given in part C1 of the National Building Code of Finland. The maximum permitted noise level caused by the HVACE equipment of the building is 38 dB in the kitchen and 33 dB in other living areas. The maximum average noise level requirements are 33 dB in the kitchen and 28 dB in other living areas.

11.4.8 Operating and maintenance instructions

The operating and maintenance instructions and the connection diagrams of the electrical and control devices are delivered to the customer together with the substation in the native language preferred by the customer. For that purpose, an appropriate storage place is installed in the technical utility room for tidy storage of the instructions. The documents are also attached as part of the operation and maintenance instructions of the building referred to in part A4 of the National Building Code of Finland.

11.4.9 Substation warranty

The substation must have a so-called full warranty for at least two years, which also includes direct installation costs. The warranty period starts on reception of the equipment. The material warranty of the heat exchangers must be at least 5 years.

11.4.10 Substation as pressure equipment

The heat exchangers and expansion vessels are pressure equipment. Legislation concerning pressure equipment is based on the EU directive 97/23/EC. The legislation emphasises the manufacturer’s liability related to the placing on the market of the pressure equipment and the liability of the owner and possessor of the pressure equipment during operation.

The manufacturer of the pressure equipment or the set of equipment must provide an EC declaration of conformity and attach a CE marking on it

- With the CE marking, the manufacturer declares that the pressure equipment or the set of equipment has been designed and manufactured in accordance with the pressure equipment directive
- it is not permitted to attach the CE marking on pressure equipment or sets of pressure equipment that comply with the so-called good engineering practice / Section 6 of the Decision of the Ministry of Trade and Industry (938/1999)/.

12 REPLACING THE DISTRICT HEATING EQUIPMENT

12.1 Contact with the heat vendor

The customer or their representative must contact the heat vendor already in the planning stage of equipment replacement, in which case it is possible to establish the equipment dimensioning on the basis of, e.g. the heat consumption data. The replacement and modification need of the heat vendor's equipment in the building will also be established at the same time.

12.2 Principles of implementing the equipment replacement

The maintenance periods of the structures and technical systems as well as the inspection and maintenance programmes are defined in the operation and maintenance instructions of the building. A long-term maintenance plan (LTP) is attached to the maintenance log, presenting, for example, the maintenance repairs to be carried out over the next ten years and cost estimates for the repairs.

The maintenance log is updated with regular intervals and the necessary condition assessments are carried out. The condition assessment of district heating equipment is based, e.g. on the consumption reports provided by the heat vendor (changes compared to previous years, comparison with other similar buildings), the functioning of heating and domestic hot water controls and the condition and functioning of pumps and equipment.

It is in the interests of the customer and heat vendor as well as the designers and installation contractors that the substation or a part of it is modernised in a controlled way at the end of its economic lifetime. That way it will be possible to carefully prepare the funding, planning and installation tasks and their schedules.

When planning the time of equipment replacement, it is also worth noting the functional disadvantages of equipment breakdown: an interruption to the heating and hot water supply of the building reduces living comfort and may also result in financial losses.

Control valves and pumps are mechanical devices that wear out in use and especially under abnormal conditions. It is often necessary to replace them separately. It is not worth replacing individual parts in a substation that is over 20 years old; as a rule, its replacement should be carried out as total replacement of the substation.

12.3 Implementation and scope of equipment replacement

Uncertain, faulty and deficient equipment in terms of the functioning of the substation are replaced to comply with the current requirements also in connection with partial equipment replacements.

In connection with the replacement of heating and ventilation exchangers, it is established whether it is necessary to replace the equipment and connections on the secondary side.

An asbestos survey is carried out over the entire area in cooperation with the heat vendor in connection with equipment replacement. Removal work is commissioned in accordance with regulations concerning asbestos removal.

The energy efficiency of the heating system can be improved with the balancing of the heating network.

12.4 Planning and installation of equipment replacement

12.4.1 Starting points of design and dimensioning

The dimensioning of the equipment is based on actual operating values. The system is always examined as a whole. Energy use data required in the dimensioning of equipment is available from the heat vendor, if necessary. The heat vendor will provide the necessary information to the designer or contractor representing the customer when they have the customer's authorisation to hand over the information in question.

The methods and experiences of using the building are established with the users of the building. Actual temperatures of supply and return water on the secondary side are established with measurements, if necessary. Building technology data (cubic volume of buildings, number of dwellings/residents, etc.) is established.

12.4.2 Plan, operating diagram

The plan concerning the retrofit includes a harmonious and clear operating diagram stating the operation of the district heating equipment in the building after the modification and the technical values of the equipment also with respect to equipment that remains in use. The technical values of old equipment remaining in use are presented as actual operating values.

Other drawings and a work specification are drawn up when necessary.

12.4.3 Heat exchangers, substations

In most cases, the rated capacity of heat exchangers in heating can be calculated on the basis of energy consumption data.

In order to establish the capacity demand of a heat exchanger in the ventilation network, the operation of the ventilation equipment must be examined and, if necessary, measured. The replacement need of ventilation equipment is also established at the same time.

The domestic hot water exchanger is dimensioned in accordance with section 4.2.1 regardless of its former dimensioning.

Control equipment and connections to be replaced on the secondary side are included in the substation in a centralised way where possible.

12.4.4 Control valves, temperature sensors

The designer shall obtain from the heat vendor information about the available pressure difference with its limits of variation for the dimensioning of the control valves.

The control valves are dimensioned and selected according to actual operating values also when only the control valve is replaced.

The location of the temperature sensor of supply water is checked and, if necessary, re-installed in accordance with section 5.4. The situation of the outdoor temperature sensor is checked.

12.4.5 Pumps

The pumps are dimensioned according to actual operating values. This will ensure maintained balance of the heating network.

The operation and condition of old pumps remaining in use are checked. The operating point is presented in the plan.

The chosen flow and pressure difference are implemented primarily with correct dimensioning and control of the pump, secondarily with throttling of flow.

12.4.6 Expansion and safety devices

The dimensioning of expansion and safety devices is checked and presented in the plan even when they are not replaced. The pre-pressure of the expansion tank must always be checked.

Open expansion systems are replaced with closed systems if there is no justifiable reason to carry on using an open system.

The admissible pressure and condition of the old heating system are taken into account when selecting the opening pressure of safety devices.

The old filling valves in the heating and ventilation network are removed. New filling valves are installed in the substation.

12.4.7 Shut-off valve and pipes

Valves with grease retainers and old shut-off valves surplus to requirement are removed even in connection with partial replacement work.

The condition and operation of valves remaining in use are checked.

Old pipes and devices surplus to requirement are dismantled.

12.4.8 Thermometers and pressure gauges

The thermometers and meter sleeves and the pressure gauges with their closures are replaced in connection with modification work.

Metering is carried out in the same way as in the new substation, meters that are surplus to requirement are removed and missing ones are added.

In connection with even partial equipment replacement, the missing thermometers and pressure gauges are added to the supply and return pipe of the district heating pipe after the customer’s main valves even if they are included in the heat vendor’s metering centre.

12.4.9 Documentation

Documents created during equipment replacement (plans, operating diagrams, control reports, operating and maintenance instructions for the devices) are enclosed with the maintenance log of the building.

12.5 Heat vendor's equipment

The customer or their representative shall contact the heat vendor in good time before starting the equipment replacement work in order to find out the replacement need of the heat vendor's equipment located in the building. That way, for example, any replacement of the metering centre can be adapted to the replacement of the building's equipment.

It is appropriate to remove any asbestos insulation also with respect to the heat vendor's equipment and pipes in connection with the removal of asbestos. This matter and the allocation of costs must be agreed on with the heat vendor before starting the removal work. Re-insulation shall also be agreed on at the same time.

Any removals of the heat vendor's pipes and equipment are ordered in writing from the heat vendor in good time before the need of removal. The methods have been agreed on in the terms of contract for district heat.

13 QUALITY CONTROL AND INSPECTIONS

Quality control and inspection operations aim to safeguard a high-quality and safe heating system for district heat customers. At the same time, the heat vendor ensures efficient functioning of the district heating network.

The procedure related to quality control and inspection, presented in this chapter, is based on the private-law contract (heat contract, terms of contract) between the heat vendor and the customer. A model and method of implementation for a partnership agreement between heat contractors carrying out substation installations and heat vendors is presented in ET's recommendation K2.

13.1 District heating and HVAC plans

The district heating plan is part of the HVAC plan of the building. The HVAC designer is responsible for the correctness of the plans. The dimensioning and installation plans with regard to heating technology for a building to be connected to the district heating network in as far as they are related to the selection and installation of district heating equipment are presented in the district heating plan. The qualification requirements for the design tasks of the building's plumbing and sanitary equipment in accordance with A2 of the National Building Code of Finland shall be applied to the HVAC designer.

The heat vendor needs the information presented in the plans, e.g. for the following purposes:

- determining the grounds for the heat contract
    - contracted capacity and/or water flow
- estimating the energy consumption
- designing the district heat connection (dimensioning, scheduling of construction work).

District heating plans, reports and drawings are delivered on paper or electronically for the use of the heat vendor.

The district heating plan includes the following information, which various parties (designer, equipment supplier, heat contractor, control device contractor) will specify further during the construction process:

- technical specifications for heating
- dimensioning of the secondary network
- dimensioning of the substation
- operating values of heating circuits
- connections (also secondary circuits)
- operating descriptions of devices
- situation picture of devices and pipes
- site plan.

13.1.1 Tasks of the HVAC designer

The district heating plan drawn up by the HVAC designer includes:

- The rating table 1 'Technical specifications of the heating system'
    - basic information about the building
    - heating capacity and rated temperatures per each group of devices
- annual consumption of district heat energy
    - the data on the method of use and operating time of devices for the purpose of calculating the need for energy and heat capacity

- Rated data of devices (rating table 2 'Substation')
  - flows, operating temperatures and pressure losses of exchangers, valves and pumps and the preliminary dimensioning of these devices
  - network, dimensioning of expansion and safety devices
  - available pressure difference, rated data of any differential pressure regulator
- Operating values of heating circuits, preliminary data for the tuning record
  - heat capacity data in different outdoor temperatures
  - flows in different circuits with the rated values of the heat exchangers
  - designed operating temperatures as outdoor temperature function
- Connections
  - substation connection
  - any connections in the secondary circuits (air circulating heaters, ventilation devices)
- Operating descriptions of regulating and control processes
- Situation picture of devices and pipes and the maintenance route related to the use of the devices
  - separate floor plan of the technical utility room only if necessary
- Site plan
  - also includes the preliminary situation of the branch line agreed with the heat vendor.

13.1.2 Tasks of the equipment suppliers

The equipment supplier shall dimension and select the substation and equipment for the building on the basis of the district heating plan. The equipment supplier shall complete and check the equipment data to ensure that the preliminary rating table 2 for the substation, drawn up by the HVAC designer, corresponds with the equipment selected for the site.

The equipment suppliers shall complete the following sections in the district heating plan:

- Rating table 2 'District heat substation'
  - heat exchangers: manufacturer, models, output, temperatures, pressure losses
  - control system: manufacturers of control valves, models, pressure losses, regulator, regulating units, differential pressure regulator
  - water circulation pumps: manufacturers, models, flows, heads, power taken by the motors
  - extra accessories
  - dimensioning of devices and equipment located inside the scope of delivery of the substation
  - information about testing of heat exchangers in accordance with the EN standard
- Operating values of heating circuits, completion of preliminary data in the tuning record
  - information about control devices: control centre, control valves, regulating units
  - flows of domestic hot water and flow of the water circuit
  - flows and temperatures of the heating circuits as outdoor temperature function
- Substation connection
- Operating descriptions and instructions of devices in the national language required by the customer.

The equipment supplier shall send a technical specification of the substation, including the substation table or similar data, to the heat vendor immediately after confirmation of sale before delivering the substation to the customer so that it will

be possible to make any changes, which are required by the heat vendor, to the substation before delivery.

13.2 Installation and acceptance of the substation

The commissioning of the district heating equipment includes documented measures that are presented in Table J. The heat vendor may carry out the commissioning and supervision measures itself or, if it so wishes, give some of the tasks to be carried out by (certified) heat contractors or other service providers it has approved. A certified heat contractor must have a quality assurance system that has been found to be sufficient. The heat vendor shall monitor the quality of the certified contractor with spot checks.

Table J. Commissioning process of district heating equipment.

Measure	**Document**	**Carried out by**
Installation and operational inspection of equipment		Heat contractor
Commissioning of equipment, commissioning inspection	Installation record	Heat vendor, certified heat contractor or other service provider
Start of heat supply	Commencement notification	Heat vendor
Tuning of control devices and operating test of control devices	Tuning record	Equipment supplier (certified control device contractor)
Training of end user		Heat contractor
Completion of equipment installations, operating test, final inspection	Completion record	Heat vendor, certified heat contractor or other service provider

13.2.1 Commissioning of equipment, commissioning inspection

The equipment can be commissioned once the heat vendor or certified heat contractor has accepted the equipment installation in the commissioning inspection and drawn up an installation record on it. The certified heat contractor shall deliver a signed installation record to the heat vendor.

The following matters are inspected in the commissioning of equipment:
- tightness inspection of joints
- location and maintenance facilities
- heat exchangers (rated values)
- CE marking and declaration of conformity
- control valves (rated values)
- connection, primary and secondary
- expansion and safety devices
- valves etc. equipment and their joints
- air releases and drainage
- pressure gauges and thermometers
- control devices and temperature sensors

- pipe sizes and materials
- support for devices and pipes
- observation of heat expansion
- pumping devices
- heating and ventilation equipment
- power supply for the heat meter.

13.2.1.1 Tightness test

The tightness of the pipes and devices on the primary side and the heat exchangers is verified with a pressure test carried out with cold water. The test pressure is 1.3 x the greatest permitted operating pressure (= design pressure). Under normal circumstances, the test pressure is 2.1 MPa (1.3 x 1.6 MPa). The test pressure is maintained for at least 15 minutes, however so that it is possible to inspect all pressurised parts and joints during the test.

The design pressure of all devices that will remain in use must be taken into account when determining the test pressure.

13.2.2 Start of heat supply

The heat supply is always started by the heat vendor. Heat supply can be started when the customer's district heating equipment meets the technical requirements set by the heat vendor and the system is ready for the measurement of thermal energy.

13.2.3 Tuning and operating test of the control system

The control system of the substation is calibrated at the place of installation after heat supply has started. Tuning is carried out on the basis of initial values provided by the designer.

The heat contractor will deliver to the control device contractor the parts of the district heating plan that include the necessary basic information and design values of the devices:

- Equipment data
  - control centre
  - regulating units
  - valves
- Designer's rated data
  - heat capacity demands and their variations
  - flows
  - temperatures and pressure differences.

The tuning tasks include:

- tuning of measurement messages of sensors
- setting of working points and range of outlets
- setting of control parameters
- setting of the impacts of compensations
- setting of main controls and set values of limit controls
- inspections of scale readouts of control buttons
- drawing up of tuning records.

In the operating test for control circuits carried out by the control device contractor, it is ensured with step response tests that the control devices operate according to the requirements after tuning. In especially demanding areas of application, the step response tests must be carried out using a recording

instrument and a data logger. The results of the operating test are enclosed with the tuning record.

The tuning record is presented as part of the documents attached to the completion record.

13.2.4 Completion of district heating equipment in a building, final inspection

When the installation, modification or repair work has been completed, the completion of the district heating equipment of a building is verified in a final inspection carried out by a certified heat contractor. A completion record is drawn up of the final inspection. The certified heat contractor shall deliver the signed completion record to the heat vendor.

The reception of district heating equipment in new buildings must be accepted before the occupancy inspection.

The following are inspected in the final inspection of the district heating equipment in a building:

- rectification of errors and deficiencies stated in the installation record
- operation and maintenance rooms
- operation of exchangers
- operation of control devices
- pressure gauges and thermometers, and alarms
- thermal insulation
- marking of devices and pipes
- operating diagram of the plant (in the technical utility room)
- operation and maintenance instructions (in the technical utility room)
- control and tuning records
- operation of heating and ventilation machines
- ventilation, drainage and water supply point of the technical utility room
- lighting and communication connections
- maintenance route to the technical utility room
- instructions on use.

Operating diagrams and operation and maintenance instructions are enclosed as part of the operation and maintenance instructions of the building. /RakMK A4/

When the heat contractor considers that the installation work has been completed, the heat vendor or a certified heat contractor shall carry out an operating test on the district heating equipment of the building in accordance with section 13.2.4.1 in order to ensure correct operation of the district heating equipment. The results of the test are enclosed with the completion record to be drawn up.

A reinspection may be required on the basis of any errors or deficiencies detected in the inspection.

The heat vendor deems that the installation of the district heating equipment of the building has been completed when the heat vendor has received an approved completion record with its appendices.

After receiving the approved district heating equipment, the heat vendor will hand over the equipment to the customer.

13.2.4.1 Operating test of the district heating equipment

The operation of heat exchangers for heating and ventilation is tested with the capacities that are prevailing during testing, the heat exchanger for domestic hot water is loaded by turning on the water in a sufficient number of hot water taps. In the operating test, the domestic hot water flow must be at least 50% of the rated flow. However, the sufficiency of the exchanger dimensioning cannot be ensured until the heat exchanger is loaded with the flow that corresponds with the rated flow.

In the testing of the functioning of the control system, it is ensured that the values presented in the tuning record are valid and that the selected control curves correspond with the designed operating temperatures presented by the designer. At the least the following are checked with respect to the functioning and tuning of the control system in the operating test of the district heating equipment:

- the supply and return temperatures of heat exchangers on the primary and secondary sides
- outdoor temperature
- installation and connection of outdoor temperature sensor
- tuning values and set values
    - control curves (designed and set)
    - boundary values

The following are tested in the testing of heat exchangers:

- flow of the district heating water
- pressures on the primary and secondary sides of the heat exchangers using a precision pressure test gauge (the amount of pressure losses in the heat exchangers is inspected)
- temperatures in the supply and return pipes on the primary and secondary sides.

The measurement results are compared with the substation supplier's rated data at the operating point in question and with the requirements presented in section 5.2.

13.3 Quality assurance documentation

The customer shall store the documents created in connection with the commissioning process: the district heating plan, the installation record, the tuning record and the completion record. All documents related to the district heating equipment of the building (including the maintenance and operating instructions of devices) can be stored, e.g. in a cupboard located in the substation equipment room.

The heat vendor shall file in its own archives the documents on the district heating equipment of the building it deems necessary.

13.4 Maintenance log

The heat contractor shall complete the building-specific operation and maintenance instructions for its own part. /RakMK A4/

13.5 Measures during the warranty period

The contractor shall repair any errors, faults and deficiencies detected during the warranty period. A diary shall be kept and maintained on any works carried out

during the warranty period, and it is to be attached to the operation and maintenance instructions to supplement them.

The heat vendor is entitled to carry out a system load test as a spot check even after the equipment has been received in order to make sure that the equipment is working correctly.

13.6 Testing of the district heating equipment of the building in operating conditions

The heat vendor is entitled to test the operation of the district heating equipment of the building either in connection with commissioning or, if necessary, at a later date if the system is not functioning in accordance with the set requirements. In the test, the functioning of the district heating equipment is examined under normal operating conditions.

The functional test ensures the overall functioning of the equipment in changing load situations. The functional test of the substation in operating conditions is carried out in accordance with ET’s instruction (Recommendation K16/2003).

Finnish Energy
District Heating Substation Group

INSTALLATION RECORD

Property	Customer No.
Address	Representative of property
Contractor	Tel.No.
Designer	Tel.No.

Heat exchangers			Domestic hot water	Heating	Ventilation
Manufacturer					
Model					
Manufacturing number/year					
Heat capacity		kW			
Flow	prim. / sec.	dm^3/s	/	/	/
Temperatures	prim. / sec.	°C	- / -	- / -	- / -
Pressure loss	prim. / sec.	kPa	/	/	/
Heat exchangers are according to plan			☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
Control valves	Manufacturer				
	DN / k_{vs}		/	/	/
Control valves are according to plan			☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no

Substation (pipework, joints, equipment, installation), technical utility room

Primary side	yes	no	***Further clarifications***	yes	no
Broken, dusty asbestos visible			Operation and maintenance facilities sufficient		
Maintenance facility for heat vendor's equipment sufficient			Power supply for the heat meter installed		
Connections according to plan			DN sizes according to plan		
Required air releases and drainage			Accidental use prevented		
Required thermometers and pressure gauges			End plug fitted		
Control valves installed correctly			Unrestricted readability		
Temperature sensors installed correctly			Manual operations in order		
Stop valves, equipment and structural materials acceptable			Control devices in operating condition		
Installation work acceptable			Joints acceptable		
Flushing of pipework and exchangers carried out			Support sufficient		
Tightness inspection acceptable			Drainage from the floor level arranged		

Secondary side	Domestic hot water		Heating		Ventilation	
	yes	no	yes	no	yes	no
Connection and DN sizes according to plan						
Expansion and safety devices according to plan						
Required air releases and drainage						
Required pressure gauges and thermometers, and alarms						
Filling of network acceptable						
Stop valves, equipment and structural materials acceptable						
Pumping devices according to plan						
Control devices installed correctly						
Installation and support acceptable						
Air circulating heaters installed and connected correctly						

District heat substation	CE marking (if not a pressure vessel complying with good engineering practice)		

Notes:

Start date of heat supply	☐ **Equipment accepted for use** ☐ **Follow-up inspection to be carried out**
Date	Representative of property
Contractor's person in charge	Heat vendor's representative

Contact details of district heat company (Name, web address, postal address, street address, telephone, fax, business ID, domicile)

Finnish Energy
District Heating Substation Group

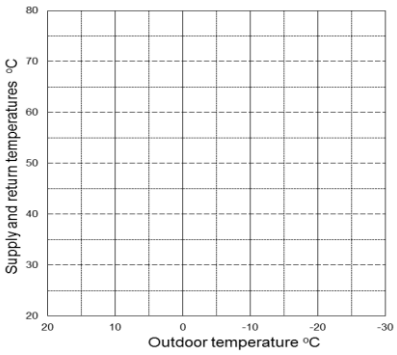
TUNING RECORD

Property	Customer No.
Address	Calibration ordered by
Heat contractor	Tel.No.
Control device contractor	Tel.No.

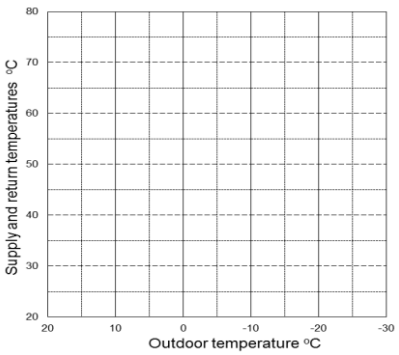
Control circuit *DHW LS 1*	**Control circuit** *Heating LS 2*	**Control circuit** *Ventilation LS 3*
Exchanger Manufacturer	**Exchanger** Manufacturer	**Exchanger** Manufacturer
Type	Type	Type
Controller Manufacturer	**Controller** Manufacturer	**Controller** Manufacturer
Type	Type	Type
Regulating u Manufacturer	**Regulating u** Manufacturer	**Regulating u** Manufacturer
Type	Type	Type
Valve Manufacturer	**Valve** Manufacturer	**Valve** Manufacturer
DN / kvs	DN / kvs	DN / kvs
Set and calibration values	**Set and calibration values**	**Set and calibration values**
Set value °C	Parallel offset °C	Parallel offset °C
P-area °C	Night set-back °C	Night set-back °C
I-time s	Morning warm-up °C	Morning warm-up °C
	Max. limit °C	Max. limit °C
	Min. limit °C	Min. limit °C

Special functions:

Detected installation errors:



Outdoor temperature	Supply temperature
°C	°C
°C	°C
°C	°C
°C	°C



Outdoor temperature	Supply temperature
°C	°C
°C	°C
°C	°C
°C	°C

Operating temperatures at the time of inspection, °C			
Domestic hot water	Hot water	Hot circulating water	Cold water
Heating	Supply	Return	Primary return
Ventilation	Supply	Return	Primary return

District heat water	
Supply °C	Return °C
District heat pressures with control valves shut	
Supply bar	Return bar
Outdoor temperature	°C

Representative of control device contractor

Finnish Energy
District Heating Substation Group

COMPLETION RECORD

Property	Customer No.
Address	Representative of property
Contractor	Tel.No.
Designer	Tel.No.

Operating temperatures at the time of inspection °C

District heat water		Domestic hot water	Hot water	Hot circulating water	Cold water
Supply	Return	Heating	Supply	Return	Primary return
Outdoor temperature		Ventilation	Supply	Return	Primary return
			Supply	Return	Primary return

Substation (pipework, joints, equipment, installation), technical utility room	yes	no
Deficiencies detected in the installation record have been corrected		
Situation of outdoor temperature sensor is accepted		
Thermometers, manometers and safety devices are in working order		
Operation of control devices is correct		
Tuning record has been handed over		
Insulation work has been carried out		
Air circulating heaters are correctly connected		
Operation and maintenance facilities for devices are sufficient and cleaning has been carried out		
Devices and pipes have been marked		
Connection diagram in the technical utility room		
Access to technical utility room is arranged		
Electrical connection for the heat meter is in order		
Instructions on the operation of the equipment given		
Operating instructions handed over to the property owner		

Notes:

☐ **Equipment approved**	☐ **Equipment approved when deficiencies corrected** ☐ **Follow-up inspection to be carried out**
Date	Representative of property
Contractor's person in charge	Heat vendor's representative

Contact details of district heat company (Name, web address, postal address, street address, telephone, fax, business ID, domicile)

Finnish Energy
District Heating Substation Group

EQUIPMENT REPLACEMENT RECORD

Property			Customer No
Address		Representative of property	
Contractor			Tel.No.
Designer			Tel.No.

Operating temperatures at the time of inspection °C

District heat water		Domestic hot water	Hot water	Hot circulating water	Cold water
Supply	Return	Heating	Supply	Return	Primary return
Outdoor temperature		Ventilation	Supply	Return	Primary return
			Supply	Return	Primary return

Heat exchangers			Domestic hot water	Heating	Ventilation	
Manufacturer						
Model						
Manufacturing number/year						
Power		kW				
Flow	prim./sec.	dm^3/s	/	/	/	/
Rated temperatures	prim./sec.	°C	- / -	- / -	- / -	- / -
Pressure loss	prim./sec.	kPa	/	/	/	/
Heat exchangers are according to plan			☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
Control valves	Manufacturer					
	DN / kvs		/	/	/	/
Control valves are according to plan			☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no

Substation (pipework, joints, equipment, installation), technical utility room

	yes	no		yes	no
Asbestos notification done			Accidental use prevented		
Situation of devices according to plan			End plug fitted		
Operation and maintenance facilities of devices sufficient			Water supply point and drainage acceptable		
Connections according to plan			Lighting and ventilation acceptable		
Control devices according to plan			Situation of outdoor temp. sensor accepted		
Pumps according to plan			Operation of control devices correct		
Required pressure gauges and thermometers			Calibration record has been handed over		
Required air releases and drainage			Insulation work carried out		
Expansion and safety devices according to plan			Air circulating devices correctly connected		
Expansion system and safety devices in working order			Devices and pipes marked		
Manual operations in order			Access to technical utility room arranged		
Tightness test accepted			Electrical connection for the heat meter installed		
Pipe installation and materials accepted			Metering centre according to plan		
Valves and pipe joints accepted			Operation Instructions of the equipment given		
Support of devices and pipes acceptable			Operating instructions handed over to the owner		

Notes:

☐ **Equipment accepted for use**	☐ **Follow-up inspection to be carried out**
Date	Representative of property
Contractor's person in charge	Heat vendor's representative

Contact details of district heat company (Name, web address, postal address, street address, telephone, fax, business ID, domicile)

Finnish Energy
District Heating Substation Group

EQUIPMENT REPLACEMENT RECORD
Self-monitoring by contractor

Property				Customer No.	
Address			Representative of property		
Contractor				Tel.No.	
Designer				Tel.No.	

Operating temperatures at the time of inspection °C

District heat water		Domestic hot water	Hot water	Hot circulating water	Cold water
Supply	Return	Heating	Supply	Return	Primary return
Outdoor temperature		Ventilation	Supply	Return	Primary return
			Supply	Return	Primary return

Heat exchangers			Domestic hot water	Heating	Ventilation	
Manufacturer						
Model						
Manufacturing number/year						
Output		kW				
Flow	prim./sec.	dm^3/s	/	/	/	/
Rated temperatures	prim./sec.	°C	- / -	- / -	- / -	- / -
Pressure loss	prim./sec.	kPa	/	/	/	/
Heat exchangers are according to plan			☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no
Control valves	Manufacturer					
	DN / kvs		/	/	/	/
Control valves are according to plan			☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no	☐ yes ☐ no

Substation (pipework, joints, equipment, installation), technical utility room

	yes	no		yes	no
Asbestos notification done			End plug fitted		
Situation of devices according to plan			Water supply point and drainage acceptable		
Operation and maintenance facilities of devices sufficient			Lighting and ventilation acceptable		
Connections according to plan			Situation of outdoor temp. sensor accepted		
Control devices according to plan			Operation of control devices correct		
Pumps according to plan			Calibration record has been handed over		
Required pressure gauges and thermometers			Insulation work carried out		
Required air releases and drainage			Air circulating devices correctly connected		
Expansion and safety devices according to plan			Devices and pipes marked		
Expansion system and safety devices in working order			Access to technical utility room arranged		
Manual operations in order			Electrical connection for the heat meter installed		
Tightness test carried out, date: _____			Connection diagram in the technical utility room		
Pipe installation and materials accepted			Metering centre according to plan		
Valves and pipe joints accepted			Operation Instructions of the equipment given		
Support of devices and pipes acceptable			Operating instructions handed over to the owner		
Accidental use prevented					

Notes:

Representative of property present ☐ **Yes** ☐ **No, record has been handed over**

Date	Representative of property	Name in block capitals
Contractor's person in charge		Name in block capitals

Contact details of district heat company (Name, web address, postal address, street address, telephone, fax, business ID, domicile)

14 DESIGN INSTRUCTIONS

14.1 Technical specifications for heating system, instructions for completing rating table 1

Intended use of the building: The principal purpose of use of the building is reported in the table in accordance with the classification of intended use.

Number of buildings: The number of buildings is given, if necessary, specified as the cubic volumes of buildings.

Cubic volume of a building: The cubic volume of a building is calculated and presented in the plans in accordance with standard SFS 5139 and specified if the building contains unheated rooms. The cubic volumes of buildings are specified in a plan concerning extensions.

Heated net area: The sum of heated floorplates calculated according to the outer walls surrounding the floor levels. The heated floorplate can also be calculated from the heated gross area deducted by the technical space of the outer walls (RakMK D3).

Indoor temperatures: If the building has rooms kept at different temperatures, they are specified with corresponding volumes.

Number of dwellings (number of business premises, etc.): The number of dwellings and business premises, etc. is given separately, business premises etc. in brackets. If necessary, the number of residents or employees etc. is given in the section for further information. In sports halls, educational buildings and other similar buildings, the number of showers is given as additional information when they determine the heating capacity demand for the water supply.

Heating devices connected to the domestic hot water circuit: The output capacity of heating devices connected to the domestic hot water circuit (e.g. bathroom radiators) is presented in accordance with the table.

Radiators: Heating capacity produced with radiators is specified in accordance with the table. The operating temperatures of the network are also presented. The capacities of heating circuits working in various operating temperatures (e.g. underfloor heating) as well as the capacities concerning an extension are given separately.

Radiators in air circulating heaters: The number of radiators in the air circulating heaters and the operating temperatures and capacity of their circulating water are given separately. Air circulating heaters connected to different heat exchangers are given as different groups.

Ventilation radiators and post-heating radiators: The radiators of ventilation machines are presented per each heating circuit in accordance with Table 1. The circulated water temperatures are reported as the rated temperatures. The capacity obtained by the devices form the circulating water-supply system is given as the heating capacity. The above data concerning ventilation machines that have or will be installed or which will be modified is itemised separately. If necessary, e.g. deviating running times etc. information is stated.

Required district heating capacity: Itemised capacities of heating device groups are added together into the required district heating capacity. The total capacity of the heating and ventilation exchangers must meet the values of the table.

Heat recovery devices: The capacity of the heat recovery devices is presented in accordance with the table. Further clarifications will be provided, if necessary.

Other heating capacity: Heating capacity brought into the property by other means than district heat is presented separately in accordance with the table.

Consumption of district heat energy: Calculated consumption of district heat energy is presented in this section. If some of the energy need of the building is met with other energy forms, an itemisation is presented in the section for further information or on a separate appendix.

Further information: The information that is significant in order to determine the consumption of district heat capacity or water flow and heating energy is presented in the section for further information.

The following type of information can be presented in this section:
- any reservations for extensions, etc.
- an itemisation on heat recovery of different heating circuits
- data transmission connections.

14.2 Dimensioning of district heat substation devices, instructions for completing rating table 2

The devices are dimensioned according to the capacity demands and operating values specified in accordance with section 3. The dimensioning and equipment solutions should aim for as high cooling of district heating water as possible under all operating situations.

The dimensioning instructions presented in this section act as a guideline for completing rating table 2. More detailed dimensioning principles are presented in the section concerning each device.

Rated capacity of heat exchangers: The rated flow of the service line for domestic hot water in section D1 of the RakMK guidelines 'Kiinteistöjen vesi- ja viemärilaitteistot' (Water supply and sewage equipment in properties) shall be used as the rated flow for domestic hot water.

The actual heating capacity demands shall be used as the rated capacity of heating and ventilation exchangers.

If a possible demand reservation is taken into account in the selection of the heat exchanger, the operating values corresponding to the final demand are stated in the table as additional information.

Heat exchanger flows: Flows are calculated and presented in accordance with the actual cooling of the heat exchanger.

Heat exchanger temperatures: Exchangers are dimensioned with temperatures in accordance with the greatest prevailing heating capacity demand. The actual operating temperatures of the selected heat exchangers are presented in the table. Examination of the functioning of the exchanger in an operating situation where the flows of the exchanger are the greatest (e.g. in the lowest outdoor temperature of full ventilation) are also presented in the table.

Pressure losses of heat exchangers: Pressure losses are presented with the rated flows according to the selected heat exchangers.

Water circulation pumps: The control position or the designed rotation speed of the pump is presented in the table. The sum of the pressure loss of the network and the substation is presented as the rated head. The power drawn from the electricity network by the motor is presented as its power. Any other necessary information is presented in other information.

Further information: Other devices of the substation and their dimensioning are presented in the table's list of devices, if necessary.

If other than water, for example, glycol-water solution, is used as the heat transfer fluid on the secondary side, the composition of the solution is given in further information.

14.3 Rated temperatures of heat exchangers in an existing building

The operating values of heating systems in an existing building are used as the basis for determining new rated values. Efforts are made to use temperatures as low as possible when selecting the temperatures.

The heat exchangers for domestic hot water are dimensioned in the same way as in new buildings.

Table K. Rated temperatures of heating and heat exchangers for ventilation – existing buildings

	RATED TEMPERATURES OF HEAT EXCHANGERS °C			
	PRIMARY		SECONDARY	
	SUPPLY	RETURN	RETURN	SUPPLY
Heat exchangers of heating, radiator heating	115	43 (max)	40 (max)	70 (max)
Heat exchangers of heating, radiator heating – old buildings	115	63 (max)	60 (max)	80 (max)
Heat exchangers of heating, underfloor heating	115	33 (max)	30 (max)	40 (max)
Comfort underfloor heating for wet rooms	70	28 (max)	25 (max)	35 (max)
Heat exchangers of ventilation	115	43	40	70
Remark		The return temperature on the primary side may be a maximum of 3°C higher than that of the secondary side		

If necessary, the sufficiency of heat exchanger capacity must also be checked in other operating points at their normal temperatures. The examination must be made, e.g. when the volume of ventilation is halved during the coldest periods.

14.4 Underfloor heating

In underfloor heating systems, the rated temperatures differ from radiator heating systems, the temperature of supply water is lower as is the rated temperature difference. When using plastic pipes, the maximum temperature of water entering the underfloor heating circuit is 40°C, in old buildings the temperature may be even 50°C at its highest. The dimensioning guidelines of pipe manufacturers or separate dimensioning programmes are used in the dimensioning of underfloor heating systems.

Underfloor heating in wet rooms is installed with water circulation and with its own heat exchanger and control automation.

If using plastic pipes in particular, the temperature of supply water in underfloor heating is limited with a limit thermostat, which will stop the water circulation pumps when the supply temperature rises too high.

An example of the connection of heat exchangers in underfloor heating is presented in section 15.6.

14.5 Dimensioning, control and thermal insulation of the circulation pipe for domestic hot water

The dimensioning of the circulation pipe for domestic hot water is based on the heat supply taking place in the network (heat loss of the pipes and heat emitters). On that basis, the water flows of the network are determined for each section and a pump with a characteristic curve that descends as sharply as possible when the water volume rises is selected.

The domestic hot water network is dimensioned (pipe sizes are selected) according to the water flow rates. The flow rate must not exceed 1.0 m/s in any part of the service and circulation pipe. The rated value used as the flow rate in a copper pipe is 0.5 m/s. /RakMK D1/

The circulation pipe for domestic hot water is dimensioned and regulated in new buildings so that the temperature of the water obtained from the water fittings and the temperature of the water returning to the heat exchanger is at least 55°C (RakMK D1). The circulation pipe is thermally insulated so that the thermal resistance of the insulation layer is at least 1 m^2K/W. /RakMK D1/

When connecting an existing building to the district heating network or when replacing the substation, 50°C can also be accepted as the return temperature if the domestic hot water system of the building is not replaced at the same time and it is not possible to reach a higher return temperature by adjusting the control systems.

15 Examples

15.1 Examples of technical utility rooms (only in Finnish version)

15.2 Selection of control valve, calculation examples (only in Finnish version)

15.3 Rating of substation for a commercial building (only in Finnish version)

15.4 Rating of substation for an old residential building (only in Finnish version)

15.5 Dimensioning of fittings and pipes

The pressure losses of pipes and fittings on the primary and secondary side of the the substation must not exceed 5 kPa. Table L presents examples on the dimensioning of pipes and fittings of the substation on the secondary side. The substation manufacturer must provide on request an acoount of the dimensioning and pressure loss of the pipes and fittings when using sizes deviating from the table.

Table A. Examples of dimensioning of pipes and fittings of the substation on the secondary side where the pressure loss remains under 5 kPa

Nominal size of fittings and pipes on the secondary side (pipe, strainer, deaerator, double regulating valve, shut-off valve) DN	Permitted water flow dm^3/s	
	Threaded fittings	Weldable/ flanged fittings
20	0,2	
25	0,3	
32	0,5	0,7
40	0,9	1,1
50	1,5	1,7
65		3,1
80		4,9
100		8,5
125		12,1
150		18,2
200		26,6

15.6 Connection examples

Example connection 1: Small house connection with two heat exchangers for space heating. This connection can be used when e.g. bathroom floors are heated with separate heat exchanger. This connection provides good functionality and living comfort.

Example connection 2: Small house connection to an old one-family house without domestic hot water circulation pipe. The steadiness of domestic hot water temperature is secured with a balancing tank of 10–15 litres. Materials used in producing the balancing tank are the same as accepted in the use of domestic water systems.

Example connection 3: Small house connection for underfloor heating, space heating control is steered on the basis of outdoor temperature. The supply temperature must not rise on too high level when using plastic pipes. With the safety control the maximum supply temperature is limited to 50°C. The steadiness of domestic hot water temperature is secured either with a balancing tank or by using high-quality regulating valve.

Example connection 4: 2-step connection with ventilation exchanger. The district heating return flow by-passes the domestic hot water pre-heater in order to avoid too high pressure loss.

Example connection 5: 2-step connection with differential pressure regulator and two regulating valves for heating network. This connection can be used when the district heating return flow is too big to be led through the domestic hot water pre-heater. Differential pressure regulator enables controlled operation.

Example connection 6: Connection for snow melting, principal diagram. The dimensioning temperatures the district heat supply and return temperatures prevailing with outdoor temperature 0°C. Both the outdoor temperature sensor and the rain sensor steer the control valve.

Example connection 7: Hybrid heating connection. These principal diagrams show alternatives to connect parallel heating sources with district heating. The connections have been prepared so that the district heating return water temperature doesn't rise unnecessarily. The parallel heating sources are often well suitable to be used in comfort underfloor heating systems (bathrooms etc) because of low temperature levels. Adding an accumulator should be considered especially when solar heat is utilized. But also in other cases the accumulator may increase the reliability and ability to maximally utilize the parallel heating sources.

Example connection 8: In this shunt connection, there are two space heating circuits on the secondary side carried out with 2-way control valve. The connection can be carried out also with 3-way control valve. Normally, the heating circuits are recommended to be supplied by separate heat exchangers and own control systems. This shunt connection may be used if there is a small heating circuit requiring different temperature level far away from the technical utility room.

Example connection 9: Connection of air circulating heater.

Example connection 10: Pipe connections of ventilation device.

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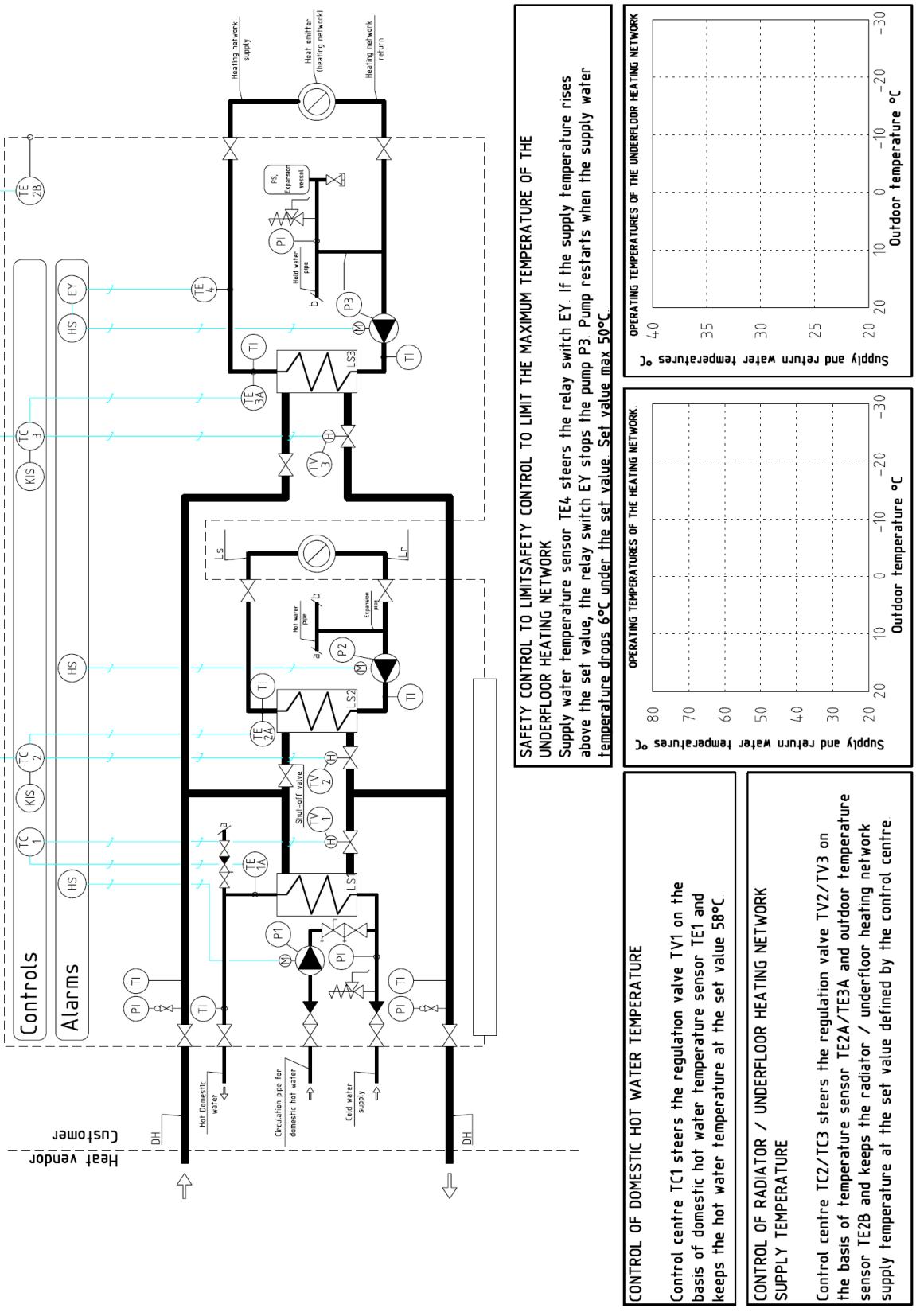
EXAMPLE CONNECTION 1
Small house connection with two exchangers for space heating



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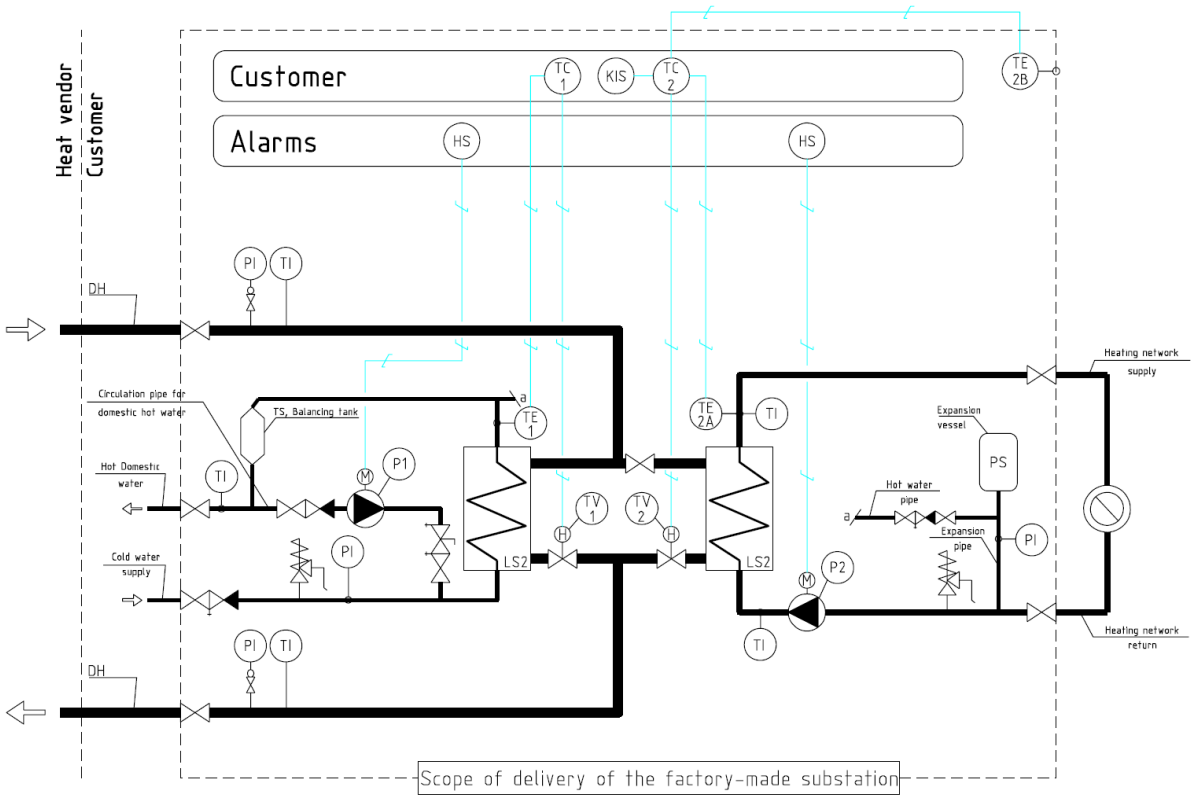
EXAMPLE CONNECTION 2

Small house connection to old one-family house without DHW circulation pipe



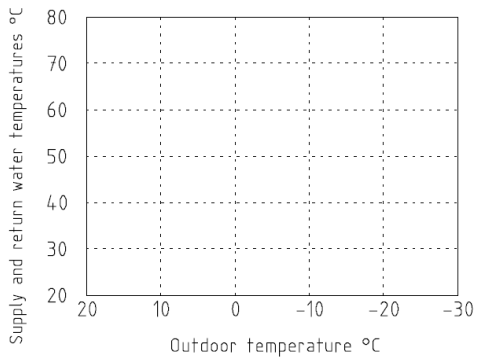
CONTROL OF DOMESTIC HOT WATER TEMPERATURE

Control centre TC1 steers the regulation valve TV1 on the basis of domestic hot water temperature sensor TE1 and keeps the hot water temperature at the set value 58°C.

CONTROL OF HEATING NETWORK SUPPLY TEMPERATURE

Control centre TC2 steers the regulation valve TV2 on the basis of supply water temperature sensor TE2A and outdoor temperature sensor TE2B and keeps the heating network supply temperature at the set value defined by the control centre.

OPERATING TEMPERATURES OF THE HEATING NETWORK



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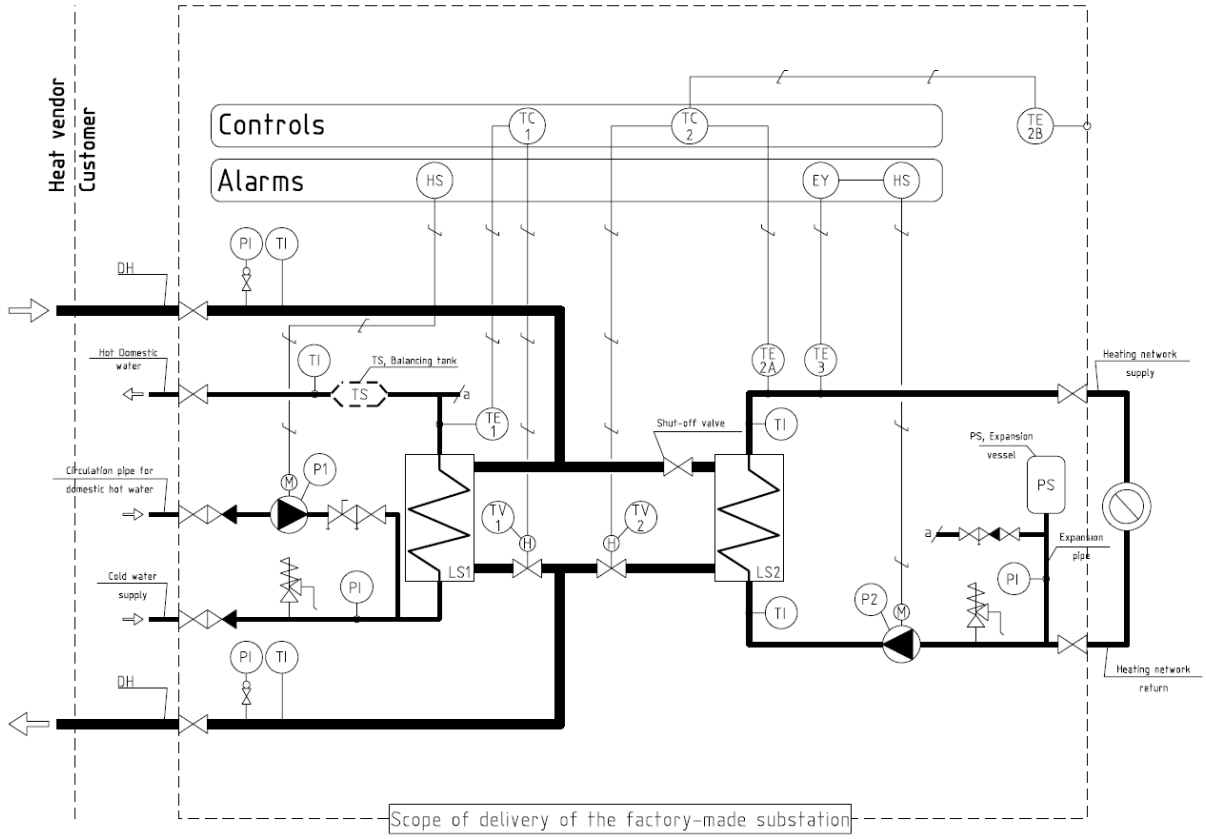
EXAMPLE CONNECTION 3
Small house connection,
underfloor heating



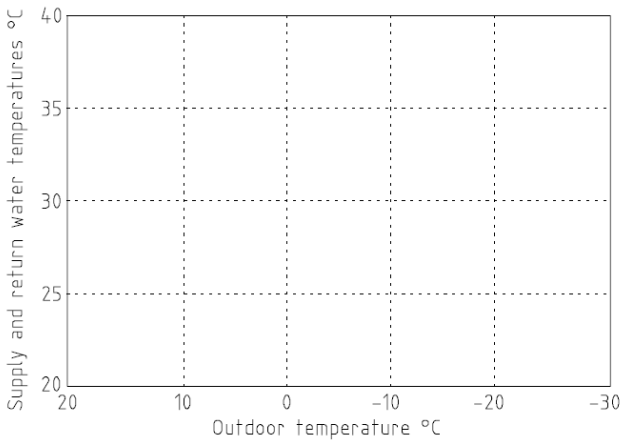
CONTROL OF DOMESTIC HOT WATER TEMPERATURE

Control centre TC1 steers the regulation valve TV1 on the basis of domestic hot water temperature sensor TE1 and keeps the hot water temperature at the set value 58°C.

CONTROL OF HEATING NETWORK SUPPLY TEMPERATURE

Control centre TC2 steers the regulation valve TV2 on the basis of supply water temperature sensor TE2A and outdoor temperature sensor TE2B and keeps the heating network supply temperature at the set value defined by the control centre.

UNDERFLOOR HEATING



SAFETY CONTROL TO LIMIT THE MAXIMUM TEMPERATURE OF THE UNDERFLOOR HEATING NETWORK

Supply water temperature sensor TE3 steers the relay switch EY. If the supply temperature rises above the set value, the relay switch EY stops the pump P2. Pump restarts when the supply water temperature drops 6°C under the set value. Set value max 50°C.

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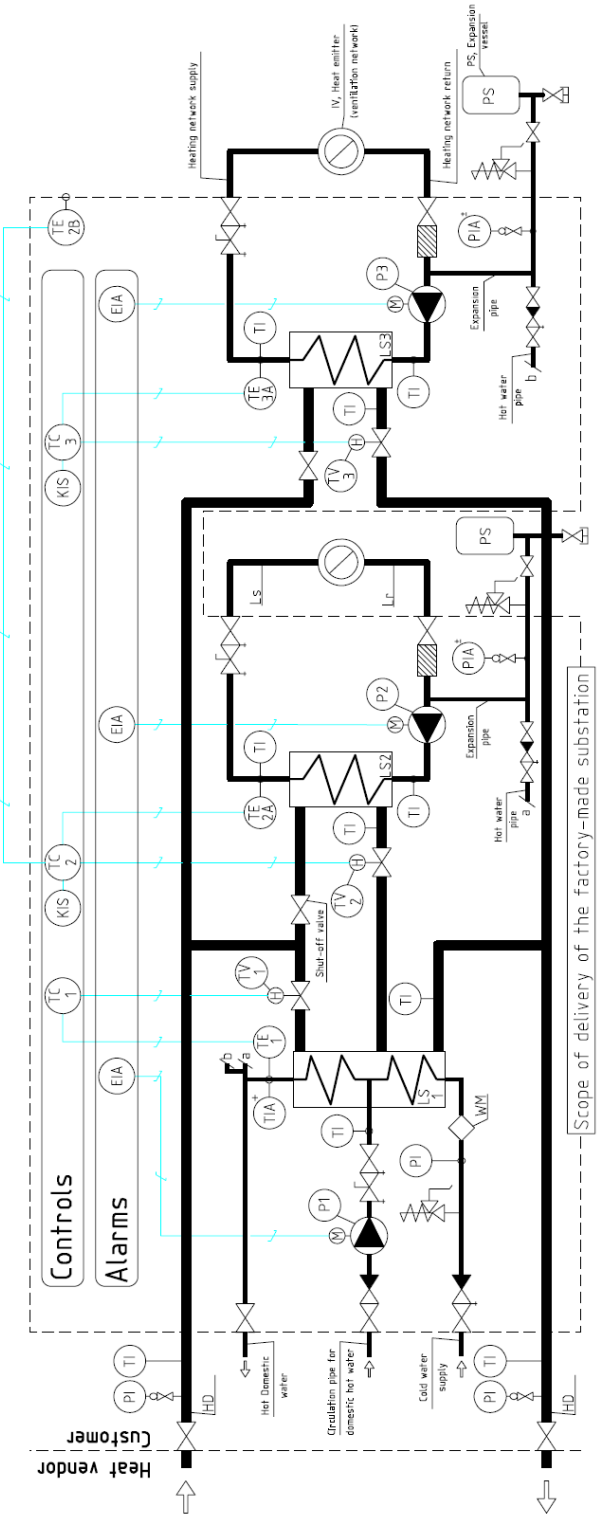
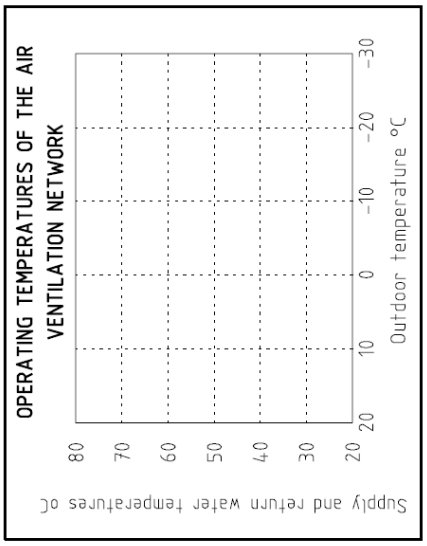
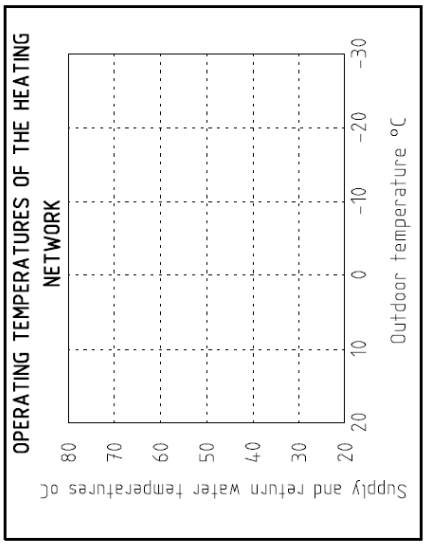
EXAMPLE CONNECTION 4
2-step connection where the return water from ventilation exchanger by-passes the DHW-pre-heater







CONTROL OF DOMESTIC HOT WATER TEMPERATURE

Control centre TC1 steers the regulation valve TV1 on the basis of domestic hot water temperature sensor TE1 and keeps the hot water temperature at the set value 58°C.

CONTROL OF HEATING NETWORK SUPPLY TEMPERATURE

Control centre TC2 / TC3 steers the regulation valve TV2 / TV3 on the basis of supply water temperature sensor TE2A / TE3A and outdoor temperature sensor TE2B and keeps the heating/air ventilation network supply temperature at the set value defined by the control centre.

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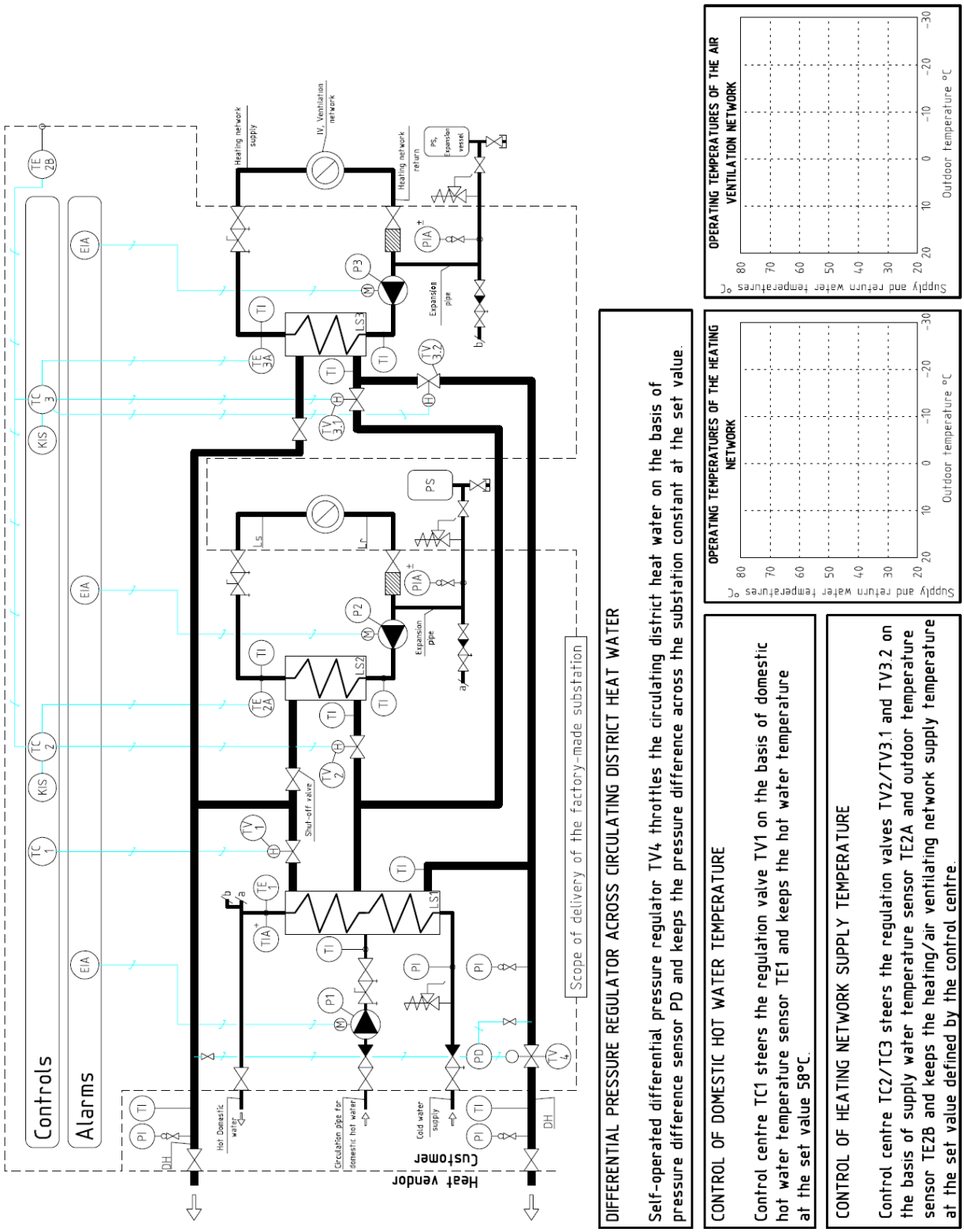
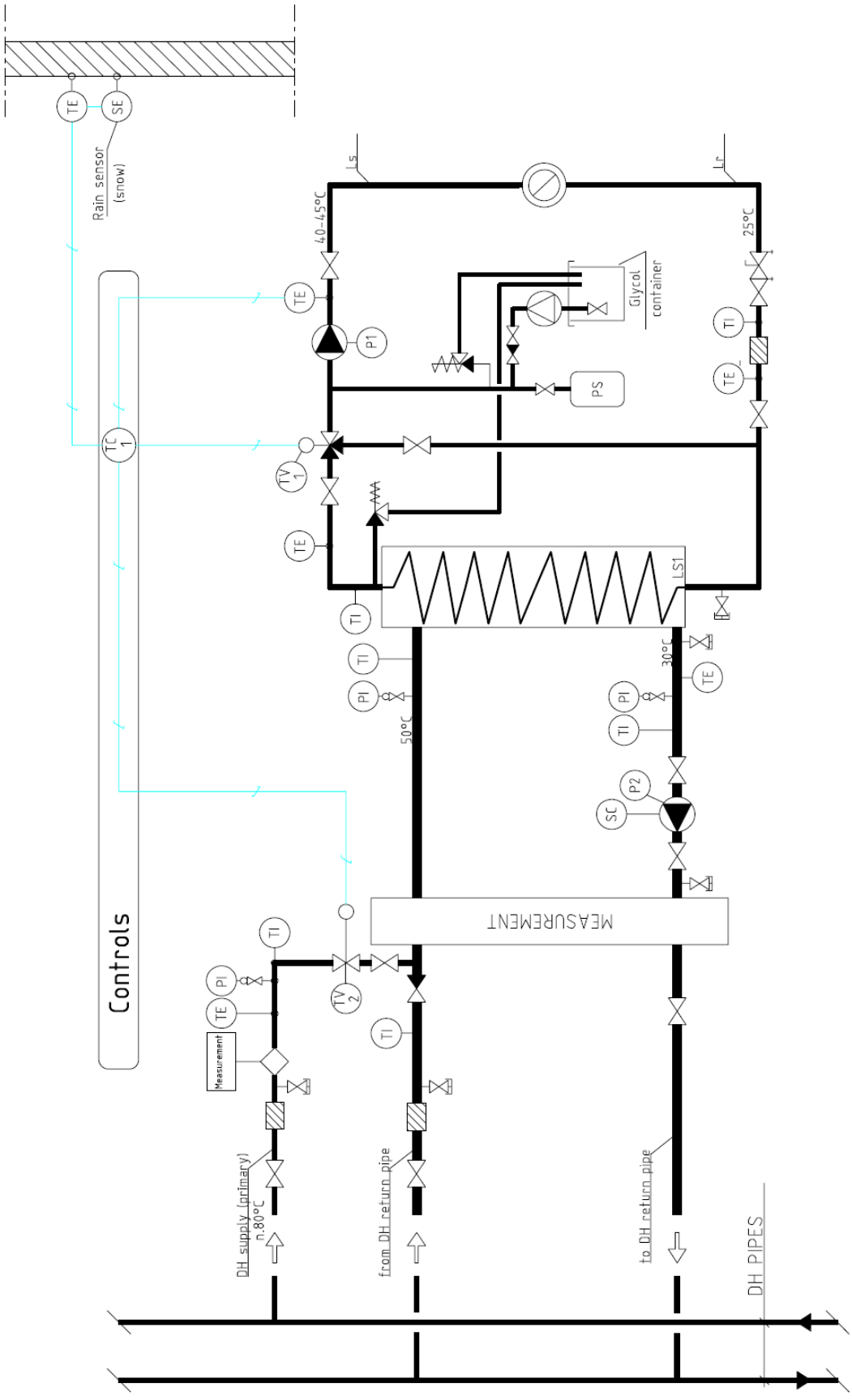
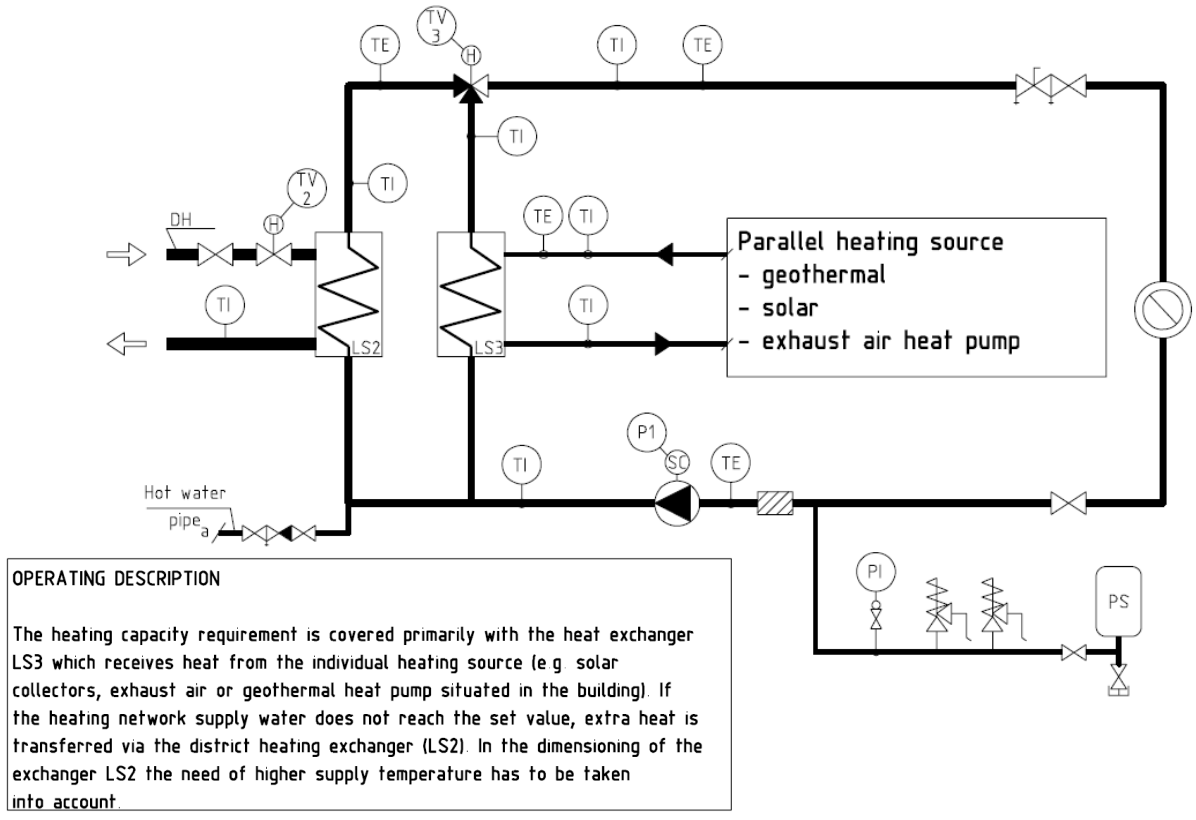
EXAMPLE CONNECTION 5
2-step connection with differential pressure regulator and two regulating valves for heating network




TE
SE
Rain sensor
(snow)
Ls
Lr
40-45°C
25°C
Glycol
container
TI
TE
P1
PS
TC
1
TV
1
LS1
30°C
50°C
PI
P2
SC
MEASUREMENT
Controls
TV
2
Measurement
DH supply (primary)
n.80°C
from DH return pipe
to DH return pipe
DH PIPES

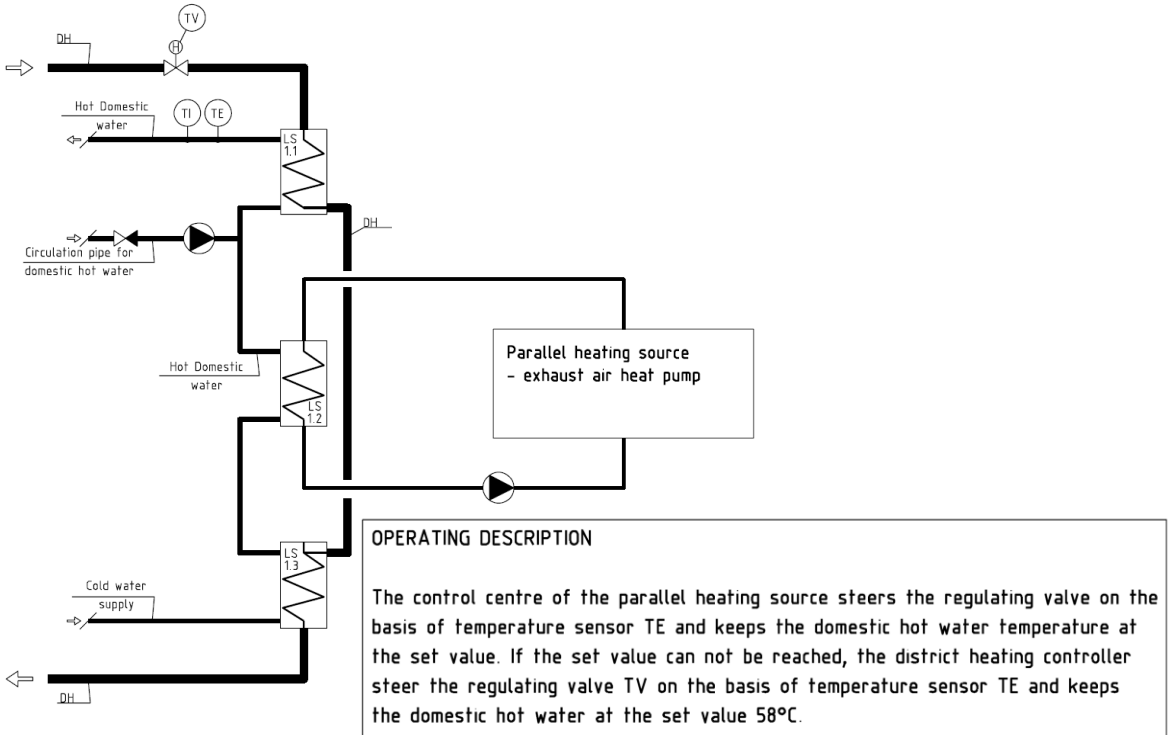
Connection of parallel heating source for space heating



OPERATING DESCRIPTION

The heating capacity requirement is covered primarily with the heat exchanger LS3 which receives heat from the individual heating source (e g. solar collectors, exhaust air or geothermal heat pump situated in the building). If the heating network supply water does not reach the set value, extra heat is transferred via the district heating exchanger (LS2). In the dimensioning of the exchanger LS2 the need of higher supply temperature has to be taken into account.

Connection of parallel heating source for domestic hot water heating



OPERATING DESCRIPTION

The control centre of the parallel heating source steers the regulating valve on the basis of temperature sensor TE and keeps the domestic hot water temperature at the set value. If the set value can not be reached, the district heating controller steer the regulating valve TV on the basis of temperature sensor TE and keeps the domestic hot water at the set value 58°C.

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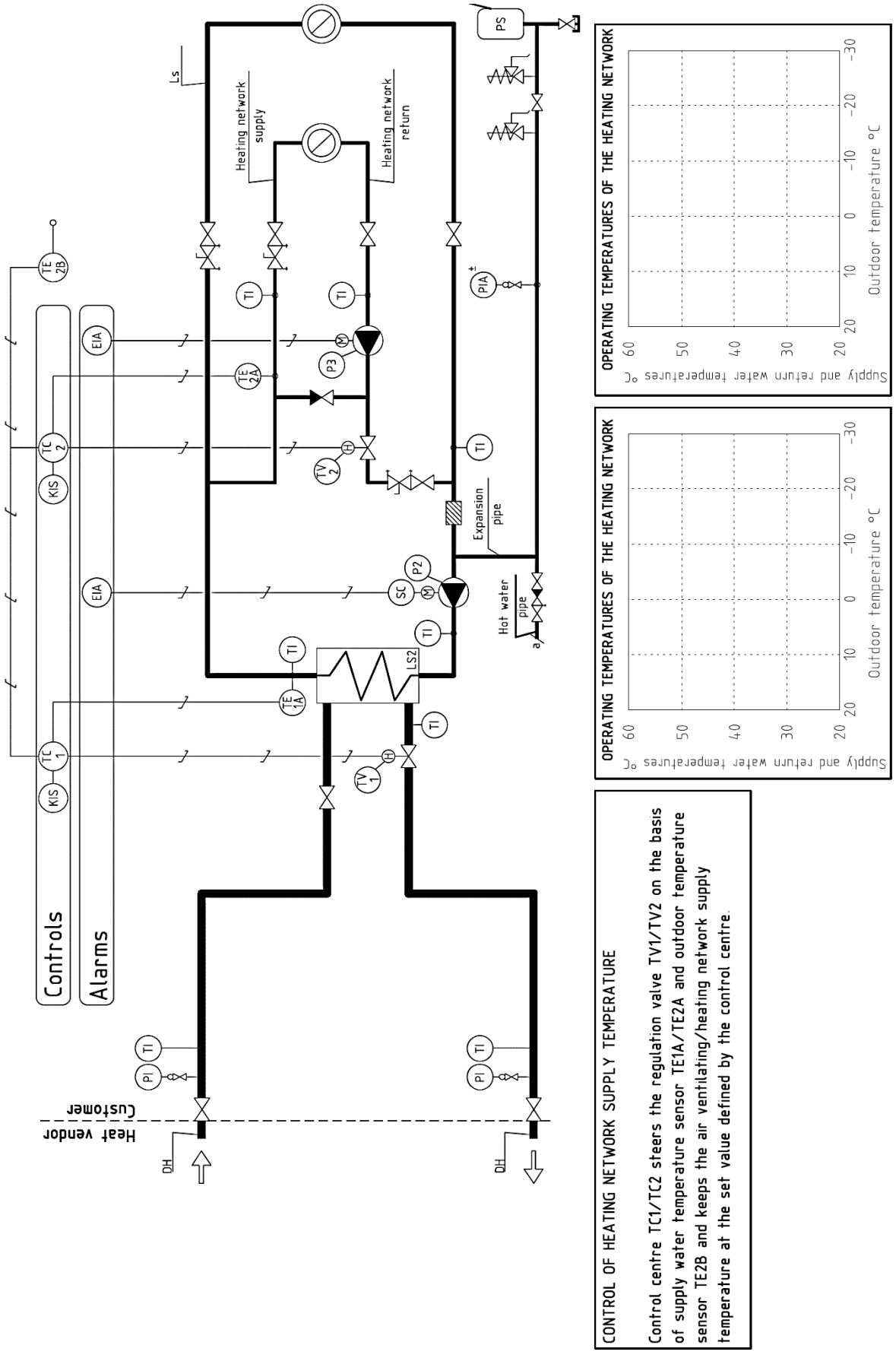
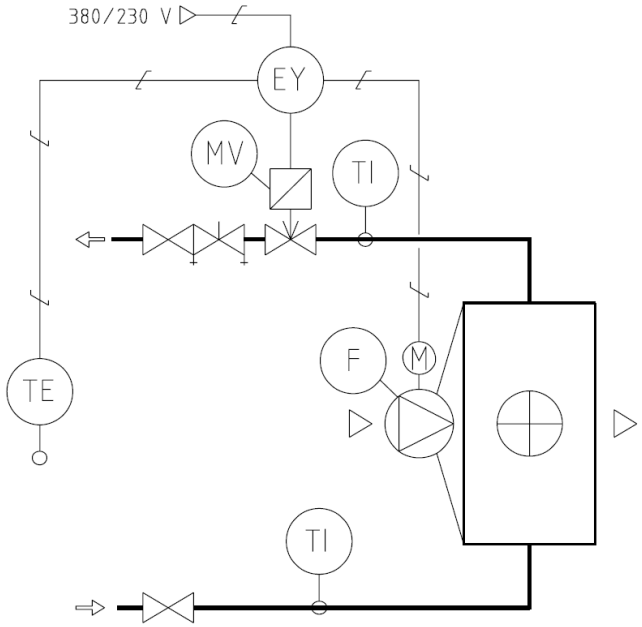
EXAMPLE CONNECTION 8
Shunt connection



OPERATING DESCRIPTION:

Temperature sensor TE in the room switches on and off the fan F by means of the relay EY. When the fan starts the solenoid valve MV opens. When the fan stops the solenoid valve closes.

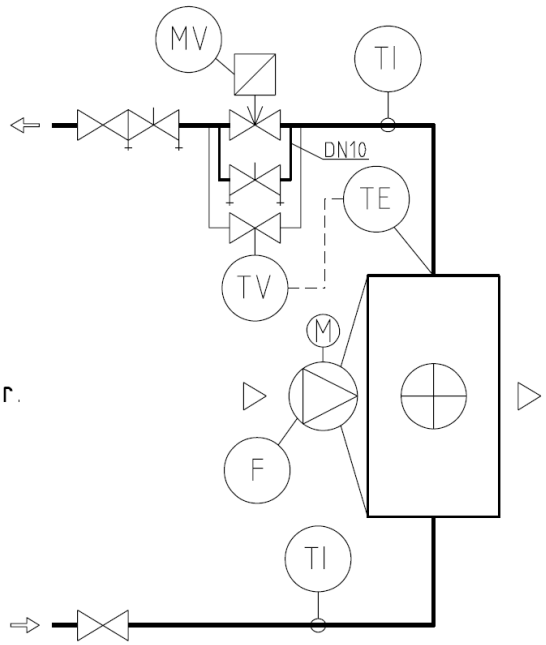
In order to secure the cooling of district heating water, all the air circulating heaters connected to same network shall be switched on simultaneously or the pump has to be controlled by means of pressure difference control.



In spaces, where there is a danger of the radiator to freeze, the solenoid valve can be bypassed with a pipe with a double regulating valve DN10 (or with a thermostatic valve).

In a heating network where all the heat emitters are air circulating heaters, a bypass pipe is installed e.g. in the furthermost air circulating heater in order to secure the water flow in the heat exchanger.

The preset control values for the double regulating valves shall be stated in the plan. The water flow in the bypass pipe has to be adjusted as small as possible.



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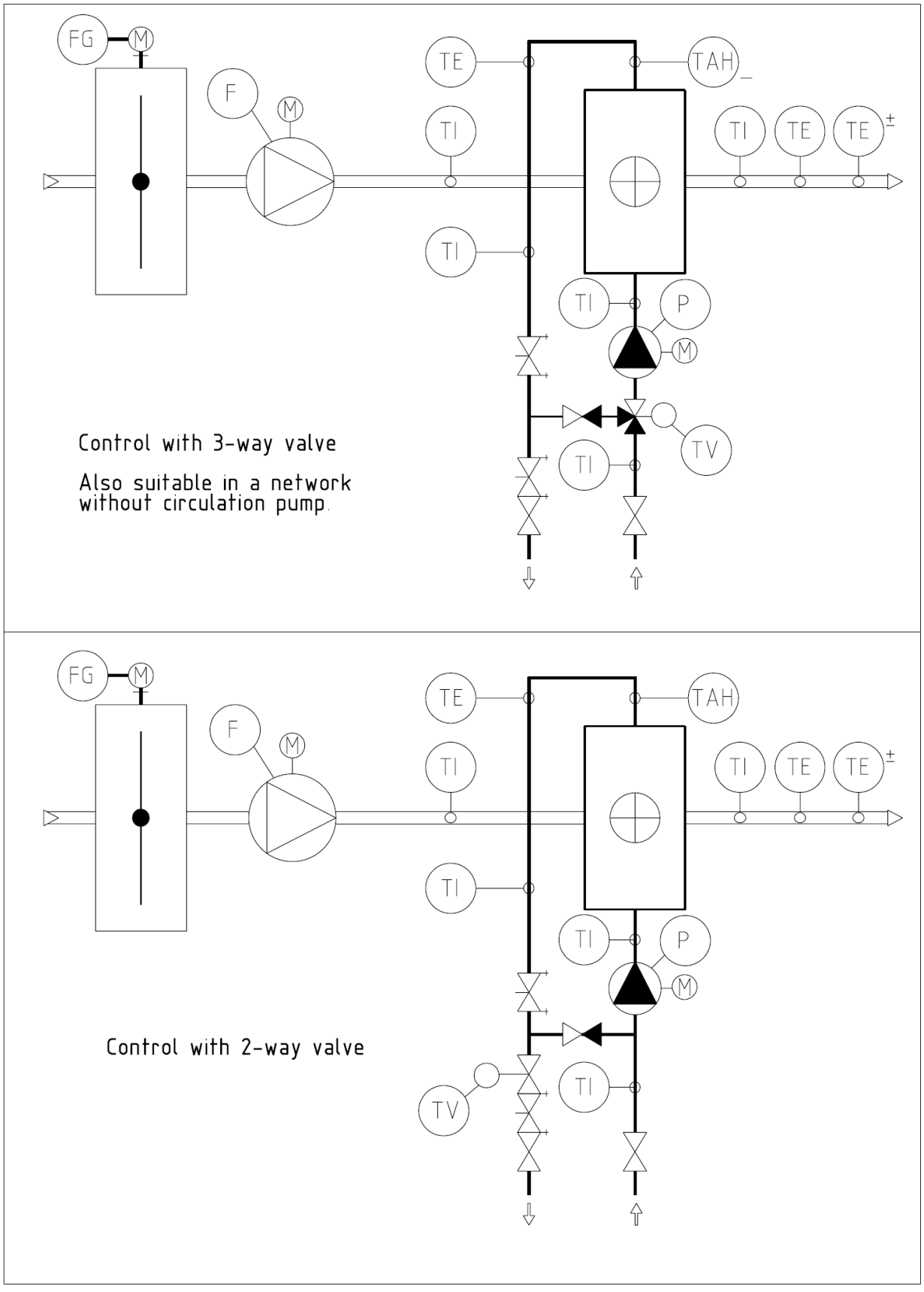
EXAMPLE CONNECTION 10
Pipe connections of ventilation device



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