DISTRICT HEATING SUBSTATIONS

DESIGN AND INSTALLATION

Svensk Fjärrvärme

Technical regulations | F:101 | April 2008

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ISSN 1401-9264

Item no. 08-04

Preface

These technical regulations for district heating substations (F:101) are sector-wide regulations for the Swedish district heating sector, governing the design, installation, use and maintenance of substations.

If a district heating substation is to operate in the best possible way, the building's space heating and domestic hot water systems must comply with the requirements in these regulations and with those issued by public authorities

These regulations also describe aspects that must be considered when substations need to be replaced. The use then of correct values for the building energy requirements ensures that the new substation will be properly matched to its duties..

These regulations are intended for use by:

- those responsible for contacts between the district heating supplier and the customer;
- those who own, operate and/or administer a building or facility that is heated by district heating;
- those who design, manufacture, purchase, test or install district heating substations..

It is recommended that enquiries should refer to the Swedish District Heating Association's technical regulations when specifying requirements. The procurement criteria described in these regulations must be applied when evaluating tenders.

These regulations have been updated by the Swedish District Heating Association's (Svensk Fjärrvärmes) District Heating Substation Group, whose members are:

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Lars-Göran Nilsson	Lunds Energikoncern AB

The Swedish District Heating Association's Technical Group has ratified these Technical Regulations.

These regulations are valid with effect from April 2008, and replace previously published guidelines and instructions for district heating substations..

Svensk Fjärrvärme
Customer installations

Jan Berglund

Contents

1. Basic rules

These technical regulations, F:101, specify and/or refer to sector requirements, public authority requirements, Swedish and European standards and EU directives.

Local regulations may also apply. Contact the local district heating supplier for information.

Technical, commercial and administrative aspects of district heating supplies are regulated in contracts and in general terms and conditions of contract. These technical regulations, F:101 –"Design and installation of district heating substations", are intended for use as an appendix to such contracts and terms and conditions.

In accordance with the general terms and conditions for the supply of district heating, the property-owner shall provide details of design rating data and proposed connection arrangements to the heat supplier. This applies for both new installations and for conversions. The heat supplier shall confirm that the proposed district heating substation is suitable for use in the supplier's system. The heat supplier will decide the necessary capacity of the heat meter, and will supply the meter.

These sector requirements complement public authority regulations, and are therefore applicable to new installations, conversions, replacement and operation of district heating substations[1]. The sector-specific requirements are intended to ensure the correctness and quality of the installation, its performance and its safety. Correct design, sizing / capacity determination and balancing of space heating and domestic hot water systems are a prerequisite of complying with the sector requirements for cooling of the circulating district heating water.

If alterations are planned to the flow requirements, power rating or any other aspect that affects the function of the substation, the heat supplier shall be notified before the conversion works starts. Such alterations may require changes to the supply contract.

In order to avoid the risk of frost damage to the district heating supply pipes, circulation must always be maintained in them during the winter. It is the responsibility of the property-owner to ensure that the substation and pipes within the property are protected against frost.

Manufacturers of substations must be able to confirm that their equipment complies with the requirements of F:101 and F:103-n. Certification is a confirmation of this ability.

1.1. Efficient use of energy

The EU directive for more efficient use of energy applies also to more efficient end use of heat, in order to reduce emissions of greenhouse gases such as carbon dioxide. Much of Sweden's district heating is produced from fuels that are CO_2-neutral, such as biofuels, that do not affect net emissions of carbon dioxide. However, electricity is used for pumps and fans, and its production contributes to carbon dioxide emissions. In order to reduce the use of electricity, it is important that the district heating substation is optimally designed, and that it is regularly serviced and maintained.

The local district heating supplier can provide details of how the heat is produced, and what its environmental impact is.

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[1] Hereinafter generally referred to simply as 'substations'.

The amount of heat permitted to be used by new buildings and converted/rebuilt buildings is specified by the National Board of Housing, Building and Planning's Building Regulations, Chapter 9. The rules do not consider how the heat that is used in the building is produced. However, the method of production is important from the point of view of efficiency and environmental impact.

1.2. The substation equipment room

The room in which the substation is installed is referred to as the district heating equipment room. It must be available for the heat supplier to inspect it and to read the heat meter.

Determine the space requirement as needed in order to ensure good working conditions, and to enable the equipment to be serviced. The district heating equipment room must always have access to a floor drain.

If a substation has replaced a boiler, the contractor shall ensure that there is controlled ventilation up the old chimney. It may also be necessary to install a radiator in the district heating equipment room.

1.3. Contacts with the heat supplier

1.3.1. First-time connections

Contact the heat supplier to request a heat supply. Discuss the necessary routing of pipes, the proposed type of substation and its position in the building. District heating pipes within the building must be accessible for examination and inspection by the heat supplier. The pipes must be designed and installed in accordance with the heat supplier's technical regulations. See the Swedish District Heating Association's Technical Regulations no. D: 211

Notify requests for district heating supplies in good time, in order to give the supplier a reasonable time to arrange and install connections to the building. The supplier may, in turn, have local regulations that apply: An example of such regulations is given in Appendix 1.

1.3.2. Modifications and replacements

Contact the heat supplier when it is necessary to replace a complete substation or part thereof: changes may have been made in the building, which can affect the demands made upon the proposed replacement equipment. The heat supplier will have operational statistics that can provide valuable information on likely heat requirements: it is hardly ever suitable to select new equipment on the basis of the specifications for the equipment that is to be replaced.

2. Procurement

Refer to F:101 and F:103-n when sending out enquiry documents for substations and their associated installation work. The enquiry should give details of the operating data of the district heating system, in order to ensure that components and ancillary systems are designed and installed in such a way as to meet both the public authority regulations and the requirements of these regulations. When evaluating received tenders, check that they have observed the requirements specified in the enquiry.

If requirements are specified for a certified substation, it is advisable to ask for a copy of the test report for evaluation and to assess the equipment on the basis thereof. Test reports can be downloaded from the Swedish District Heating Association's web site.

The district heating substation and its ancillary systems must:

- comply with technical and quality requirements as given in F:101 and F:103-n
- be assessed with regard to the supplier's / contractor's experience, references and technical knowledge,
- be assessed with regard to the supplier's / contractor's resources and organisation,
- be assessed in respect of the quoted prices and weighted life cycle cost,
- be assessed in respect of its environmental impact, *and*
- be assessed in respect of its compliance with local requirements.

It is therefore not only the price of the product or contract that decides the choice of a suitable product: it is also necessary to consider the extra cost of any necessary additional work for the owner's own organisation.

The section entitled 'Procurement of meters' in Technical Specification F:104 for heat meters provides a more detailed description of the entire procurement process, and can be used as a guide for the procurement of substations and their associated systems.

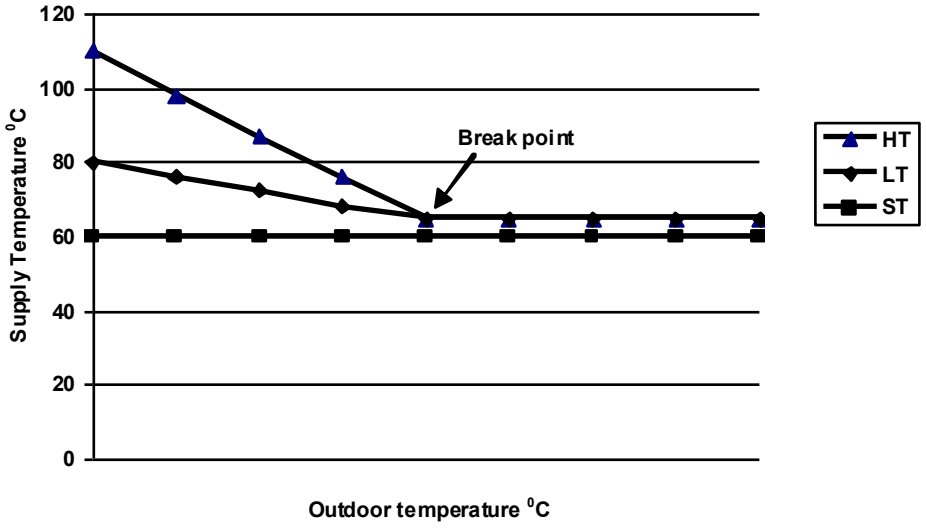
3. Technical data of district heating systems

Traditional high-temperature systems (HT) operate at higher temperatures and pressures than low-temperature systems (LT). Substations that are connected through heat exchangers to HT or LT systems as secondary systems are referred to as secondary-temperature (ST) systems. Table 1 shows rating and design data for the three types of systems.

3.1. Operating temperatures

The temperature curves in the diagram below show the supply temperatures to substations. It is important that the heat supplier clearly specifies which operating temperature characteristics that are employed.

Figure 1



Depending on local conditions, the break point can vary.

3.2. Rating and design data

Swedish district heating systems are generally designed as high-temperature systems with design data of 120 °C and 1,6 MPa. Individual components may have more advanced design data.

Table 1

District heating system	Rating data	Design data
High-temperature system (HT)	100 °C, 1,600 MPa diff. pressure 0,600 – 0,100 MPa	120 °C, 1,600 MPa
Low-temperature system (LT)	80 °C, 1,000 MPa diff. pressure 0,600 – 0,200 MPa	80 °C, 1,000 MPa
Secondary temperature system (ST)*	< 60 °C, 0,600 MPa diff. pressure 0,200 – 0,050 MPa	80 °C, 0,600 MPa

* For substations connected via a secondary connection.

District heating systems are classified by an accredited inspection body in accordance with the Swedish Work Environment Authority's Pressure Vessel Regulations. The maximum operating temperature and pressure limits are defined by the classification of the district heating system, and these values must not be exceeded during normal operation. Differing inspection requirements apply, depending on the applicable temperature limit.

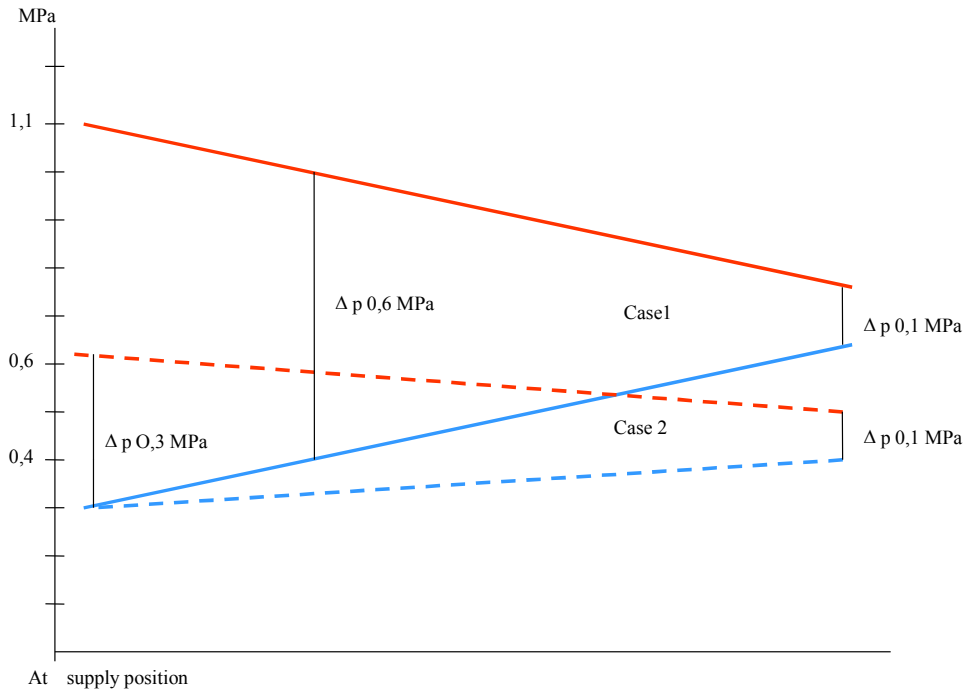
3.3. The importance of return temperature in district heating systems

A district heating system must have good cooling of the water in the substations. Good cooling is, in turn, mainly dependent on the design and adjustment of the building's internal heating systems, as well as on the capacity rating, function and condition of the substation. Good cooling of the return water and good performance of the substation are in the interests of both the customer and the heat supplier.

3.4. Differential pressure

The district heating supplier will provide information on the actual minimum and maximum differential pressures, as measured at the delivery boundary. This data must be used for determining the necessary sizes and capacities of control valves and heat exchangers. Note that the heat supplier must include the pressure drop across the heat meter in the information provided. The pressure drop across the meter can vary, depending on the type of meter.

Figure **2**. An example of **the ranges over which the differential pressure in a district heating system can vary**.



Substations for HT systems normally operate with a differential pressure in the range 0,10 to 0,80 MPa: the commonest range is 0,10 – 0,60 MPa. See the diagram above. The heat supplier can provide further information on differential pressure.

3.5. Water quality

Treatment of the water used in district heating systems is carried out at the production plants, which is where top-up water is also supplied. A dye is often added to the water, in order to assist leak tracing.

The Swedish Thermal Engineering Research Association has produced a guide entitled 'Guide values for water and steam suitable for use in Swedish energy plants' *('Riktvärden för vatten och ånga anpassade till svenska energianläggningar')*, no. 958, published in February 2006. See also F:104.

3.5.1. Classification of various water systems

Table 2

Classification of liquids in the various pipe systems of a district heating substation	
Category 1	Cold water
Category 2	Domestic hot water, water for hygiene purposes
Category 3	Radiator and ventilation heating system water District heating system water

The requirements of the various categories in respect of water qualities are set out in Swedish Standard SS-EN 1717. The standard specifies that water systems must be classified on the basis of their normal use

SS-EN 1717 (Table B1) does not cover the district heating water. However, it does say that the water in heating systems is regarded as Category 3 water, and Item 5.2.3 in the standard, 'Liquids that present some health risk through the presence of several hazardous substances', specifies the requirements for Category 3 water.

District heating water quality is regularly analysed by the heat supplier.

Check valves must be fitted in order to prevent reverse flows between the various water systems. The equipment owner is required to ensure that the valves are working correctly.

The standard specifies that substations must be fitted with Type EB reverse flow protection devices. However, Type EA devices may be fitted, which simplifies checking for correct operation. Chapter 6 (below) gives further details of the requirements applicable to check valves in substations.

4. Design and performance requirements

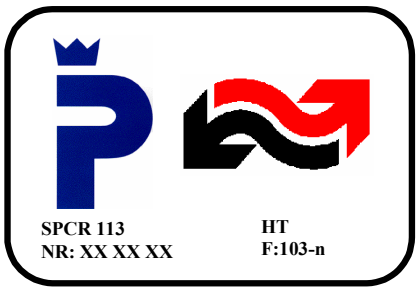
The substation forms part of the district heating system, and must meet the requirements for long-term durability and safety. This means that, regardless of size, substations must be manufactured in accordance with the requirements set out in Table 3 in Section 4.2 (CE-marking).

Pipes, valves and fittings in the substation primary circuit must comply with the requirements for pressurised equipment in the Pressure Equipment Directive: see Annex 1 of the directive. Design validation may be performed by the experimental method of five times the design pressure (5 x 16 bar), or by some alternative calculation-based method. See Table 1 for details of district heating system design pressures.

4.1. Certification

A certified substation must comply with both the customer's and the heat supplier's requirements. A prerequisite for certification is that the substation must be suited to the district heating system, and must provide the customer with good comfort and safe operation. The Swedish District Heating Association has therefore published regulations (F:103-n) for the certification of substations. Substations that fulfil the requirements of F:103-n may be certified, and clearly display the following certification symbol. The certification document is accompanied by a copy of the test report, which sets out the characteristics and features of the substation.

Figure **3.**



An example of the certification symbol

The symbol confirms that the substation has been certified by SP Technical Research Institute of Sweden in accordance with SP's certification rules no. SPCR 113. The accompanying certificate gives details of the manufacturer, the type of unit, the test method and the validity of the certificate.

Information on certified substations is available on the Swedish District Heating Association's web site. This shows the validity period of each certificate, test report details and results and any observations noted during the tests. Each test report has an appendix that lists all the components in/on/of the substation tested..

4.2. CE-marking

According to the Pressure Equipment Directive (PED), 97/23/EC, prefabricated substations must be CE-marked if they are not covered by Article 3 of the directive. Article 3 is equivalent to 8 § in the Swedish Work Environment Authority's Regulations no. AFS 1999:4. A CE-marked substation must therefore have a

declaration of compliance, a copy of which must be delivered by the manufacturer to the heat supplier and to the user of the substation.

Table 3 shows the applicable inspection requirements with which the manufacturer must comply.

Table 3

Heat exchanger		PED / AFS 1999:4				Sw. District Heating Association's requirements		
Prim. volume [l]	Power [kW]	P * V	Cat.	Module	CE-marked	Cat.	Module	CE-marked
< 3.125	< 100	< 50	Art. 3./.8§	Normal practice	No	8§	A	No
> 3.125	> 100	> 50	I	A	Yes	I	A	Yes
> 12.5	> 400	> 200	II	A1,D1,E1	Yes	II	*	Yes
> 62.5	> 2000	> 1000	III	B1+D B1+F B+E B+C1 H	Yes	III	*	Yes
> 187.5	> 6000	> 3000	IV	B+D B+F B+E B+C1 H	Yes	IV	*	Yes

* The manufacturer must indicate against which module the unit has been assessed.

The Volume and Power columns in Table 3 show the requirements for different sizes of heat exchangers.

The columns under the AFS 1999:4 heading are from the Pressure Equipment Directive, and show the procedures required for conformity assessment.

The right-hand columns show the Swedish district heating industry requirements. They are the same as the requirements in the Directive, with the exception that 8 §, Heat Exchangers, must meet the same requirements as Category 1 heat exchangers. This means that units intended for use in detached houses must have a certificate of declaration of compliance. However, under the terms of the Pressure Equipment Directive, they must not be CE-marked. In this respect, the sector requirements are more demanding than those of the Directive, because the unit is intended for use as part of a larger system.

The manufacturer must also show that components, methods of making joints and pipes on the primary side are suitable for use with the static and dynamic loads encountered in the district heating system. Certification in accordance with F:103-n requires the manufacturer to show that the necessary inspections and tests have been performed.

The Pressure Equipment Directive requires the substation to be CE-marked if it belongs to Categories I, II, III or IV. The values in the table apply for HT systems and are based on heat exchanger design data of pressure = 1,6 MPa, temperature = 120 °C and fluid group 2.

4.3. Risk assessment

The manufacturer's declaration of conformity must show that the substation complies with the technical requirements in F:101.

In addition, the plant owner must assess risks affecting operation, care and maintenance of the plant. The Swedish District Heating Association has published a report, no. 2004:2, 'Safety in district heating installations', which is intended to assist this assessment.

5. Design of substations

5.1. Substation design aspects - general

Substations are designed and built for various purposes, such as detached houses, apartment buildings and other buildings. They are manufactured and supplied as prefabricated units, although some can also be assembled at site. Each is a complete unit, containing heat exchangers, control equipment and safety equipment. It must be possible to perform service and maintenance work safely.

Safety and performance of substations are regulated by public authority requirements, directives and sector requirements. It is recommended that certified district heating substations should be used whenever feasible. Such substations will have been certified in accordance with the Swedish District Heating Association's regulations for certification of district heating substations, F:103-n.

The Swedish District Heating Association has produced a computer program, 'FC Kontroll', for assisting inspection and determining the required sizes of substations. The program can be downloaded from the Association's web site.

The safety equipment for the primary side of substations in buildings or other installations heated by district heating is installed in the heat supplier's production plant. The building's or installation's own heating system expansion vessel is intended only to provide a means of accommodating thermal expansion and static pressure of the water.

It must be possible to connect load-control, general operational supervisory, and Communication of measurement value to the substation equipment. The communication protocol must be independent of the make of the substation, freely available and of open type. Use should be made of information from sensors on the control equipment and the heat meter in order to optimise system and operational supervision.

5.2. Heat exchanger performance

Manufacturers of heat exchanger must show the heat exchanger performance data. If requested, they must supply a copy of the test report for each type of heat exchanger. Heat exchangers must be tested in accordance with SS-EN 1148, modified to suit the temperature levels in Swedish district heating systems. See Document F:109, 'Testing Heat Exchangers and Water Heaters' for details of the tests.

Tables 4 and 6 show the temperatures for clean heat exchangers. If the temperature difference between the primary and secondary side return temperatures of the heat exchangers increases from +3 °C to +5 °C, the heat exchangers are no longer efficient.

Heat exchangers for domestic hot water are particularly sensitive to clogging if there is lime in the water. Faults in other equipment, such as a leaking control valve or poor regulation, can cause the heat exchanger to overheat and thus build up lime deposits.

5.3. Domestic hot water systems

The National Board of Housing, Building and Planning's Building Regulations require a substation to be able to supply domestic hot water at a temperature of at least 50 °C at the taps. In order to ensure compliance with this requirement, it is recommended

that, if the water is supplied on demand from a heat exchanger, the temperature of the water from the substation is not less than 55 °C.

Some installations use a hot water storage tank, and in such cases the domestic hot water temperature must be not less than 60 °C. This is also the maximum permissible temperature at the taps under the Board's regulations, in order to avoid a risk of scalding.

See Appendix 5 for details of environmental requirements for domestic hot water in order to counter the risks of Legionnaires' Disease.

Match the control equipment and heat exchanger to each other to ensure good temperature control. If the system incorporates a circulation connection, the temperature in the connection must not be less than 50 °C.

5.3.1. Design temperatures for domestic hot water heat exchangers

Rate the heat exchanger in accordance with the temperatures shown in the following table. These temperatures are for heat exchangers with clean heat transfer surfaces.

Table 4

	District heating water temp., supply	District heating water temp., return	Cold water	Domestic hot water	Temperature at taps
Apartment buildings / other premises	65 °C [1)]	≤22 °C	10 °C	55 °C	50 °C
Detached houses / apartment units	65 °C [1)]	≤22 °C [2)]	10 °C	50 °C	50 °C [3)]
If a hot water storage tank is used	65 °C	≤25 °C	10 °C	60 °C	50 °C

1) 60 °C for ST systems

2) The requirement for ≤22 °C in detached house or individual apartment units comes into force on 1st April 2009, in order to bring it into line with the requirements in the Association's Test Regulations no. F:103-n, Certification of district heating substations'.

3) 55 °C for detached houses with domestic hot water circulation systems

5.3.2. Domestic hot water heat exchangers for apartment buildings: powers and flow rates

Determine the required capacities of heat exchangers for apartment buildings on the basis of the following domestic hot water flows. The diagram is valid for apartment buildings with a normal residential mix.

Figure 4. Design rating capacities per apartment for domestic hot water requirements in apartment buildings

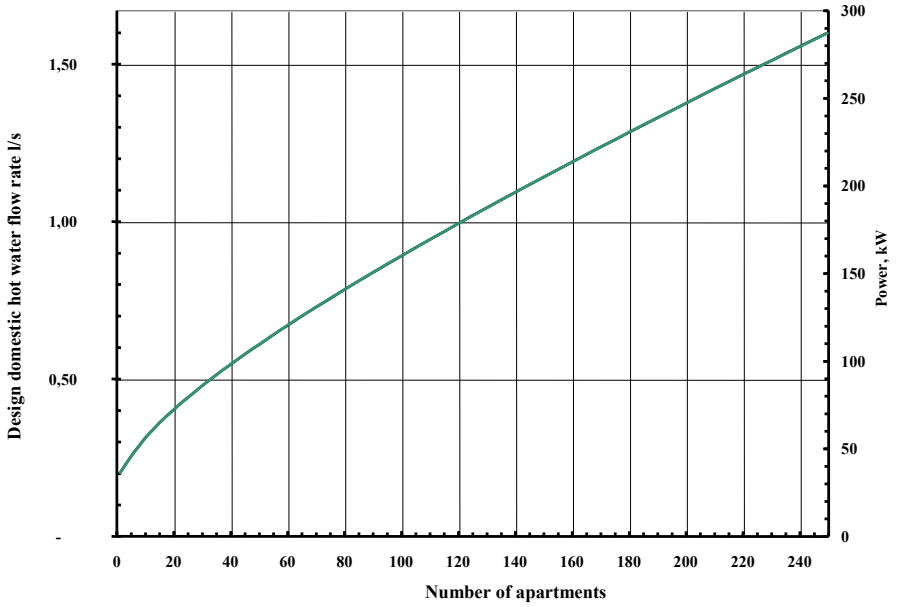


Table 5

No. of apartments	Domestic hot water, l/s	No. of apartments	Domestic hot water, l/s	No. of apartments	Domestic hot water, l/s
1	0,2	80	0,78	170	1,24
5	0,25	90	0,84	180	1,28
10	0,31	100	0,89	190	1,33
20	0,4	110	0,94	200	1,38
30	0,48	120	0,99	210	1,42
40	0,55	130	1,04	220	1,47
50	0,61	140	1,09	230	1,51
60	0,67	150	1,14	240	1,56
70	0,73	160	1,19	250	1,6

Apartment buildings with a high demand for domestic hot water, such as with apartments containing baths or student apartments, may have a domestic hot water demand greater than indicated by the curve or in the table.

The hot water and hot water circulation system pipes have the effect of evening out the temperature of the hot water.

Inability of the system to meet the demand for hot water can occur in the following situations:

- a district heating system supply temperature lower than 65 °C
- a lower differential pressure than the design pressure
- a temperature drop of more than 5 °C between the substation and the taps
- a domestic hot water flow rate exceeding the design flow rate over a longer period of time
- a fault in the control equipment
- the domestic hot water circulation pump has stopped.

5.3.3. Control equipment

Check the settings of the control equipment when the substation is commissioned. The control equipment must be marked to show what software is installed in it.

The Association's certification testing program, F:103-n, describes how the function tests must be performed. The values of the test settings for certified substations are given in the associated test reports.

The following points must be borne in mind when selecting equipment:

- Temperature and pressure variations in the district heating system
- The type of heat exchanger
- The fact that older equipment at draw-off points (taps) often means that flows will be higher.
- The use of a common domestic hot water heat exchanger for groups of detached houses supplied from a single substation.
- The design and setting up of domestic hot water systems and circulation systems.
- Whether the domestic hot water circulation system also heats towel driers, floor heating circuits or radiators. This is not recommended, due to the risk of Legionnaires' Disease.
- Whether the domestic hot water system does not have a circulation connection (detached houses or apartment buildings). If it does not, the equipment should monitor both the cold water flow to the heat exchanger and the temperature of the hot water from it.
- How frequently the domestic hot water is used.

5.3.4. Control valves for domestic hot water

Contact the district heating supplier for details of design capacity determination conditions.

Choice of control valve depends on the differential pressures at the site concerned.

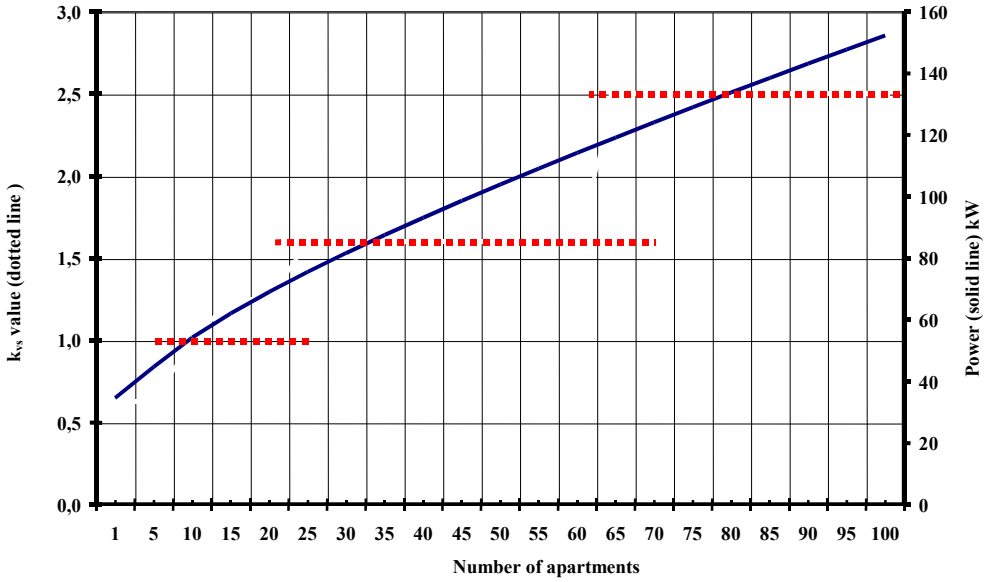
Select control valves so that they properly utilise the available differential pressure, which must be at least 100 kPa across the service connection isolating valves, as shown in Figure 2. This is to allow for the pressure drop across components in the primary circuit.

Control valves may be regulated either thermo-mechanically or electronically. The most difficult regulation case occurs at the highest supply main temperature and highest differential pressure: the valve must be capable of providing good control under these conditions.

In the event of a power failure, the control valve should close.

Check the setting values of the various functions when commissioning the substation.

Figure 5



The diagram shows examples of how control valves with different k_{vs}-values should be matched to heat exchangers. The dotted lines show control valves with k_{vs}-values of 1,0, 1,6 and 2,5. Change to a larger valve where the power curve exceeds the control capacity of a smaller valve. Such a change will be necessary if the domestic hot water circuit in the building supplies heat loads other than purely domestic hot water, or if the taps can deliver higher flow rates than as specified in current standards.

It may also be necessary to log the draw-off rates that actually occur in operation, and then to rebalance the system or, if necessary, to fit a different control valve. The local heat supplier can normally provide assistance in deciding what is required.

The temperature level at the return pipe close to the heat exchanger can vary, but is quickly smoothed out in the building's piping system. This effect is described in the test reports with certified district heating substations.

5.4. Space heating systems

5.4.1. Determining necessary heat exchanger design capacity

Heat exchanger design capacity shall be such as to allow the building's heating requirement to be met at the design outdoor temperature. In some cases, some operating condition other than the minimum outdoor temperature may determine the necessary capacity. Check calculations should be made at the break-point temperature, as shown in Figure 1.

The 'Connection Principles' report, no. 2004:3, describes various ways in which substations may be connected in heating systems. Chapter 8 describes the commonest connection principles.

Select the design and capacity data of the heat exchanger depending on whether the substation is connected to an HT or LT district heating system. If it is connected to an ST system, it is the building's internal requirements that determine the necessary design and capacity ratings.

5.4.2. Capacity determination alternatives for radiator systems

The necessary capacities of radiator systems in buildings already connected to a district heating system can be determined in accordance with Table 6. Other alternatives can be encountered. Note, however, that the primary side return temperature must not be more than 3 °C higher than the secondary side return temperature. Efforts must be made to obtain as low a return temperature as possible on the secondary side.

The primary return temperatures are shown in the table below, and apply at the design outdoor temperature for the location concerned. When the heat requirement is lower, the district heating system temperatures are also lower, tracking the return temperature in the building heating system.

Table 6

HT-/ LT system	District heating system supply temperature	District heating system return temperature	Radiator system supply temperature	Radiator system return temperature
Heating systems in new buildings	100/80 °C	<48 °C <43 °C <33 °C	60 °C 60 °C 70 °C	45 °C 40 °C 30 °C
Ventilation systems in new buildings	100/80 °C	<33 °C	60 °C	30 °C
Heating systems in older buildings (1967 Building Regulations. or earlier)	100/80 °C	<63 °C	80 °C	60 °C
After improvements	100/80 °C	<53 °C	70 °C	50 °C

5.4.3. Control valves for space heating systems

Contact the local district heating supplier for details of design capacity determination conditions.

Select control valves so that they utilise the available differential pressure at the site.

Control valves should have the same body length and nominal diameter (DN) for k_{vs} values from 0,63 to 4,0. The same applies for larger valves, with k_{vs} values from 5,0 to 10,0.

Select control valves so that they utilise the available differential pressure, which must be at least 100 kPa at the delivery boundary, as shown in Figure 2. This is to allow for the pressure drop across components in the primary circuit.

Control valves may be controlled by outdoor temperature-compensated characteristics, i.e. responding to external weather conditions. The most difficult control conditions occur at the highest supply main temperature and differential pressure, and it is under these conditions that good control performance is required. It must also be possible to operate the control equipment by hand. A special valve should be used if thermo-mechanical control is used.

In the event of a power failure, the control valve should not close, but remain in its position.

Check the setting values of the various functions when commissioning the substation.

6. Substation equipment

6.1. Equipment in the equipment room and in/on the substation

Key: K = must be included
R = inclusion recommended
T = supplied by the heat supplier.

Calculate the required power as the rated power of the radiator / ventilation heat exchanger. The amount of equipment required can vary from one district heating system to another.

Table 7

	ST systems	HT systems/LT systems	
	<100 kW	<100 kW	>100 kW
Substation equipment room			
Lighting	K	K	K
Power supply	K	K	K
Meter position	K	K	K
Access to floor drain	K	K	K
Domestic hot water and cold water available	R	R	K
District heating circuit (primary side)			
Main isolating valves	T	T	T
Filter	K	K	K
Pressure gauge [3]		R	R
Pressure sensor connection [3]			K
Temperature display	R	R	R
Radiator / ventilation system heat exchanger	R	K	K
Domestic hot water heat exchanger	K	K	K
Control valve, radiators / ventilation	K	K	K
Control valve, domestic hot water	K	K	K
Instrumentation	R	T	T
Drain valve	R	R	K
Space heating circuit (secondary side)			
Circulation pump [2]	K	K	K
Expansion vessel [2]	K	K	K
Temperature display	R	R	R
Pressure gauge	K	K	K
Safety valve [4]	K	K	K
Filling valve	K	K	K
Check valve in the filling connection [1]	K	K	K
Filter	R	R	R
Domestic hot water system			
Safety valve [4]	K	K	K
Circulation pump	R	R	K
Temperature display [5]	K	K	K
Drain valve	R	R	R
Filter, incoming cold water	R	R	R
Check valve, incoming cold water to heat exchanger [1]	K	K	K
Bypass, isolating valves and check valve [1]		R	R

1 Type EB check valve, in accordance with SS-EN 1717. Type EA is also acceptable.
2 May be fitted outside the substation
3 Not required for units for use in detached houses
4 Overflow pipe must be run to floor drain
5 Not required if there is no circulation connection

Complete substations are delivered with all necessary heat exchangers, control valves and control units. They may also be connected to higher-level supervisory and control systems. In either case, the substation control system must comply with the heat supplier's requirements and meet the heating needs of the building.

The Swedish District Heating Association's certification testing specification F:103-n describes the function requirements for the domestic hot water and space heating control equipment in more detail.

6.1.1. Pipes, valves and fittings etc.

District heating pipes from the service connection isolating valves and within the substation must comply with the same requirements as for other district heating piping, as set out in the Swedish District Heating Association's Technical Regulations for distribution pipes. The Regulations also specify requirements in respect of materials, methods of jointing, connections, sealing materials and valves and fittings. It must be possible to check, and further tighten if necessary, connections that incorporate gaskets as the seal.

Control valves, actuators and other piping fittings must be suitable for use with the static and dynamic loads that can occur in the primary system. See Chapter 3. Valves must be clearly marked with identification of their type, design and capacity. Noise, such as from cavitation, must be minimised. See requirements in respect of noise levels in the National Board of Housing, Building and Planning's regulations concerning noise protection.

Valves, fittings etc. that may need to be replaced must have flanged joints or connectors fitted with gasket seals.

Threaded connections larger than G1” should not be used. All threaded components must have a marked position to which an opposing force may be applied to prevent the component from turning when the thread is being tightened.

The quality of seals, gaskets and sealing surfaces etc. in joints must be suitable for use in HT systems. Materials must meet the requirements of applicable parts of EN 681-1, Table 3, 'Material requirements for pipe joint seals used in hot water pipes with a continuous water temperature of up to 110 °C': see Appendix 6. Seals etc. must be centred in relation to the sealing surface after tightening the joint. Sealing surfaces must be rated for the system design pressure.

6.1.2. Insulation

Thermal insulation should be provided on the primary side in accordance with the Swedish HVAC AMA codes, Table RB/1, Series 43, or equivalent.

6.1.3. Service connection isolating valves

The service connection isolating valves are supplied by, and are the property of, the heat supplier, and must be connected to the district heating system by means of welding or brazing. Take care when making any welded or brazed joints in the vicinity of the service valves, in order to prevent damage to the seals in the valves.

Service connection isolating valves must be easily accessible, and clearly marked, so that they can be quickly found in an emergency situation.

Service connection isolating valves having a manual operating lever must be installed in such a position that the valve will not be accidentally opened if a person or object

falls against it. Where possible, valves should be opened by moving the lever upwards.

6.1.4. Potential equalisation

Electric fields and stray currents are an electrical problem, and must be solved using methods as described in the Heavy Current Regulations and the Swedish Electrotechnical Commission's Guide No. 413, 'Potential Equalisation in Buildings'. If the building already incorporates potential equalisation bonding, the district heating pipes must be bonded to the system.

6.1.5. Filters

The filter mesh size must be 0.6 mm. It must be possible to clean the filter without having to dismantle the filter casing. The filter must be positioned so that there is no risk of water damaging electronic equipment when the filter is being cleaned.

6.1.6. Pressure sensors

Pressure sensors read the static pressure and the differential pressure in the substation, and must display between zero and the lowest design pressure. They may be either analogue or electronic: if they are of analogue type, the isolating valve in the connection to the sensor must be open only when reading..

Electronic sensors must meet the relevant requirements applicable to the district heating system (see Chapter 3). The signal from the sensors is combined with other measurement equipment, such that the integrator may be the instrument that provides local indication and transfers static pressure in the supply and return connections, as well as transferring the differential pressure signal to the overall control system.

6.1.7. Temperature display

Temperature may be displayed directly by means of thermometers or by means of sensors connected to control and/or supervisory equipment. Measurement ranges must cover at least the maximum temperature variation.

Pockets for temperature sensors must not be covered by insulation. It must be possible to see whether a sensor is fitted in a pocket

6.1.8. Space heating and ventilation heat exchangers

The materials in heat exchangers must withstand the liquids in both sides of the system. Advice must be obtained from the manufacturer before carrying out chemical cleaning.

6.1.9. Heating and ventilation control system

The system consists of control valve, valve actuator, sensors and controller. The controller must provide a menu function for selecting the required software. It must be possible manually to control the valve.

Note and record the values after adjusting/setting the control parameters in the regulator. Position sensors as close to the heat exchanger as possible.

6.1.10. Domestic hot water heat exchanger

The material on the district heating side of this heat exchanger must withstand the treated water in the district heating system. On the secondary side, it must withstand oxygenated water. Advice must be obtained from the manufacturer before carrying out

chemical cleaning. It must be possible to test the density of the heat exchanger after it has been installed.

6.1.11. Domestic hot water control system

The system consists of control valve, valve actuator, sensors and a controller, although thermo-mechanical valves may also be used in detached house substations. The equipment must be capable of meeting the temperature performance requirements for domestic hot water as specified by the National Board of Housing, Building and Planning.

It must be possible to check, by means of the menu function in the controller, which control software program is being used. Note and record the control setting values after adjusting/setting them in the regulator: appropriate settings are noted in the test certificates supplied with certified substations. Position sensors as close to the heat exchanger as possible in order to ensure best performance of the regulator.

6.1.12. Heat meter

The heat meter will be supplied by, and is the property of, the heat supplier. Its design and function comply with SFS 1994:99, the Ordinance Concerning Electricity, Water and Heat Meters. The heat supplier must be able to connect the metering equipment to a communication system for remote meter reading.

6.1.13. Meter position

The meter position must be arranged as shown in Figure 6. It incorporates a filter and temperature sensor in the supply connection, and a flow sensor and temperature sensor in the return connection. In addition, space for an integrating meter and power supply must be provided. The temperature reading from the integrator is normally used to check the district heating water supply and return temperatures

The vent connections may be omitted if the system is vented in some other way.

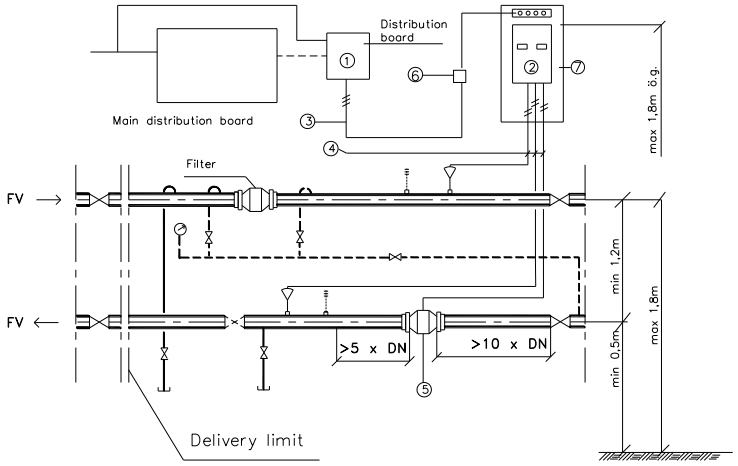
If the meter position is not in the substation equipment room, shut-off valves must be fitted on each side of flow sensors. There must not be any connections, valves or changes in pipe size in the straight pipe length upstream of flow sensors.

Flow sensors, temperature sensors and integrators must be installed so that they are easy to read and to replace.

Differential pressure measurement can be arranged by fitting a pressure gauge to a prepared measurement point. The valves should be suitable for fitting of pressure gauges for check purposes. Pressure may also be measured by differential pressure sensors, communicating with the existing communication system and fitted in the prepared measured points.

A more detailed description of heat meters is given in the Swedish District Heating Association's Technical Regulations no. F:104.

Figure 6



Schematic diagram of the meter position connections and arrangements

Key:

1 Electrical distribution board, with fuses. Can be sealed with lead seal.
2 Integrator
3 Supply from distribution board. Cable size at least 1,5 mm²
4 Connections between the parts of the meter. Cable/wire size at least 0,75 mm². Use at least 1,5 mm² conductors if the distance exceeds 7,5 m.
5 Flow sensor. DN = sensor connection size.
6 Isolator, with lock-out facility and/or lead seal. Must be fitted if the meter position and the fuse (1) are not in the same room.
7 Meter board.

Figure 6 shows schematic details of required meter positions, pipe runs, maximum distances between components etc. The integrator must be mounted within 2 m cable length from the flow sensor.

Certain types of flow sensors are insensitive to the length of straight runs of pipe before and after the sensor. In such cases, it is permissible to follow the supplier's recommendations concerning the length of straight runs. However, in order to be able to change, if necessary, to some other type of flow sensor in the future, it is recommended that straight runs of pipe should be provided on each side of the sensor position, of lengths 10 x DN upstream of the sensor and 5 x DN downstream of it. In addition, it is desirable that the sensor can be rotated around its own axis in order to avoid air pockets. The meter supplier should be able to verify that the meter can perform within the permitted error limits even without straight stretches of pipe. Manufacturers of flow sensors complying with EN 1434:2007 must state the necessary lengths of straight pipe runs in the information material supplied with the meter. Type testing includes tests to verify this information.

6.1.14. Vent valve

This valve, together with its discharge connection, must be fitted to the highest point of the district heating pipes for manual venting of air in the system. The discharge pipe must be fitted with an end plug.

6.1.15. Drain valve

The drain valve, together with its discharge connection, must be fitted to the lowest point of the pipes. The drain pipe must be fitted with an end plug.

6.2. Equipment for the radiator and ventilation circuit

6.2.1. Circulation pump

The pump must be suitable for use with the pressure class for which the radiator and ventilation system is designed, and must also be capable of generating a suitable head and flow rate. Speed control of the pump is recommended.

6.2.2. Expansion vessel

The expansion vessel in non-directly heated secondary heating systems must be able to accommodate normal volume variations, and must be suitable for use with the pressure class of the radiator and ventilation system. Safety equipment for the primary side of the system is installed in the heat supplier's plant.

6.2.3. Temperature display

Temperature may be displayed directly by means of thermometers, or by means of sensors connected to supervisory equipment or to the control unit. Measurement ranges must cover at least the maximum temperature variation. For safety reasons, pockets for temperature sensors having threaded connections must not be covered by insulation.

6.2.4. Pressure gauge

The pressure gauge is intended for manual reading of the pressure in the radiator/ventilation circuits. It must be graduated between zero and not less than the design pressure, and must also be marked to show the pressure at which the system safety valve operates.

6.2.5. Safety valve

The safety valve can most suitably be fitted to the incoming connection to the heat exchanger. No shut-off valves are allowed between the safety valve and the heat exchanger. A safety valve is not required for open expansion systems.

6.2.6. Filling valve and check valve

This valve is used for filling the radiator and ventilation system with hot water to obtain the correct working pressure. The equipment consists of a shut-off valve and check valve. Filling is performed manually and under supervision. This connection is closed during normal operation of the system.

6.2.7. Filter

The filter mesh size must not exceed 0,6 mm. It must be possible to clean the filter without having to dismantle or remove the filter casing.

6.3. Equipment for the domestic hot water circuit

6.3.1. Safety valve and check valve

Fit the safety valve in the cold water connection to the domestic hot water heat exchanger. No shut-off valves are allowed between the safety valve and the heat exchanger. The check valve must be fitted on the cold side.

6.3.2. Domestic hot water circulation pump

Pump capacity must be such that good performance is obtained throughout the domestic hot water circulation system.

6.3.3. Emergency connection

The emergency connection is a pipe that is intended, in the event of an emergency or repairs to the system, to keep the domestic hot water system pressurised. The connection is normally closed, and is fitted with a shut-off valve and check valve.

6.3.4. Temperature display

Temperature may be displayed directly by means of thermometers, or by means of sensors connected to control and supervisory equipment. The thermometer must have a measurement range covering at least the maximum temperature variation.

6.3.5. Drain valve

This valve must fitted at the lowest point of the pipework, and must be fitted with a plug. This is a safety requirement.

7. Quality assurance

7.1. Installation

7.1.1. Initial design

Contact the heat supplier for information on connection to the district heating system and on choice of suitable substations. The necessary power requirement for the substation should be discussed with the supplier. Obtain energy statistics for the building when converting an existing substation or building. See also Chapter 1, 'Basic rules'.

The Swedish District Heating Association recommends that means of reducing the return temperature from secondary systems should be investigated. One such means can be that of including a low-flow system for the radiator circuit. See also the basic requirements in Chapter 1.

Certification and CE marking of substations confirm the function, quality and performance of the units as a whole and of the components in them. CE-marked substations must always be accompanied by a printed declaration of conformity.

7.1.2. Selection and installation of piping

The Association's technical regulations for district heating piping must be complied with in connection with the selection and installation of piping materials and fittings.

7.1.3. Selection of components and pipe parts

Components, piping parts and joint/sealing materials must be made of approved materials, and be of at least the pressure rating as required by the system concerned. Piping and components must be capable of withstanding the dynamic pressure variations that can occur in district heating systems. Suitable materials are steel, steel castings and dezincification-resistant brass.

All components must be installed in such a manner that they can be easily serviced and/or replaced.

7.1.4. Selection of heat exchangers

Manufacturers of heat exchangers and water heaters must be able to prove that the equipment fulfils the requirements of Swedish Standard SS-EN 1148. The Swedish District Heating Association's Technical Regulations no. F:109 describe the test procedure.

Inspection also includes checking to ensure that the performance of the manufactured products is in accordance with the results of the manufacturer's computer design/rating program(s).

7.1.5. Welding and brazing

Welding and brazing on HT systems must comply with the workmanship and inspection requirements in the Swedish District Heating Association's instructions for district heating pipes.

There are no regulatory requirements for the testing of welders or brazers of pipes or joints for LT or ST systems, or for welders to be licensed. Nevertheless, it is recommended that, in order to assure quality, corresponding requirements are applied in respect of welding and brazing work carried out on such systems.

Equipment installed in the substation or plant may include materials that can be damaged by high temperatures, and allowance must be made for this when deciding on the type of welding method to be used.

7.1.6. Inspection and testing at site

On conclusion of the work, its quality must be inspected by leak testing and pressure testing of the system in accordance with the Swedish HVAC AMA codes. If welding work has required the use of licensed welders, sample welded joints must be radiographically tested. Records of the leak and pressure test results must be kept by the piping contractor in accordance with the requirements of the AMA codes. The heat supplier can also require welded and brazed or soldered joints to be inspected.

7.1.7. Inspection and testing

The Swedish Work Environment Authority's regulations specify the inspections that must be performed, and who may perform them.

The heat supplier will always inspect the substation and the installation to ensure that they fulfil the requirements in these regulations. The records of results of leak and pressure testing that have been carried out must be submitted to the inspector(s).

Appendix 4 is a Model Form of Final Inspection that can be used.

7.1.8. Operating and care instructions

Written operating and care instructions must be available before the substation can be started up. These instructions should contain:

- Data sheets, brochures etc. describing the equipment, apparatus and components.
- A description of the method of working of the equipment, complemented as necessary by drawings, flow diagrams and operating instructions.
- A list of components that require periodic inspection/attention.
- A description of procedures for inspection and maintenance regarded as necessary for reliable, uninterrupted operation.
- Addresses and telephone numbers for arranging service and corrective maintenance.

7.2. Commissioning

7.2.1. System balancing

Balance the space heating and domestic hot water systems, including any circulation system that may be included, in order to ensure a properly operating system. Record the results.

Balancing involves:

- Checking and, if necessary, adjusting the control parameters

  Appropriate setting values for the domestic hot water system are given in the test record form supplied with certified substations.

- Balancing the building's heating system so that the required temperature drop in the system is obtained

- Adjusting the domestic hot water circulation system flow rate and thermostatic valves to give the required water temperature at taps and in the circulation connection.

7.2.2. Function checking

When installation is concluded, and the system has been properly set up and balanced, a function inspection should be carried out, with measurement of temperatures, in order to confirm that the promised performance has been achieved.

Appendix 2 describes the necessary function checks.

7.2.3. Regular surveillance inspection of a district heating system installation

A surveillance inspection programme, in accordance with the requirements of the Swedish Work Environment Authority, must be applied for inspection of the substation and its associated primary connections. This inspection programme must be based on the results of the risk assessment carried out by the installation owner/user for the installation. It is therefore in the interests of the installation owner/user to inspect, at least once a year, the substation in accordance with the inspection programme. The results of inspections should be documented, together with details of any defects found and work carried out.

The heat supplier can provide advice on suitable procedures. The Swedish District Heating Association has also produced a report, 'Safety in District Heating Installations', no. 2004:2.

7.3. Operation and maintenance of the substation

It is important to prepare and keep operation and maintenance reports in order to ensure correct operation of the substation and of the building's heating systems. The Association's report no. 2004:1, entitled 'Your District Heating Substation', gives advice on this.

7.3.1. Checking for leaks

A common method of finding leaks in district heating systems is to use a dye as a tracer. The dye is injected into the district heating water by the heat supplier, after having received permission to do so from the local authority environmental department and having notified the public. The method is described in the Swedish Thermal Engineering Research Association's report no. 343, 'Dyes for leak tracing in district heating systems'.

Contact the manufacturer of the heat exchanger for advice on suitable cleaning agents and working methods before cleaning heat exchangers and associated systems. The heat supplier should also be informed of planned cleaning.

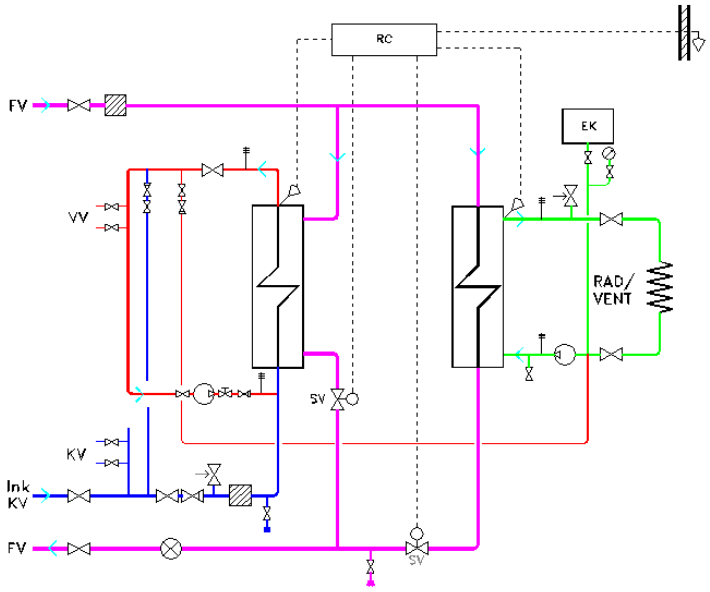
8. Connection principles

Various connection arrangements are possible, depending on the building's heat requirements and the design of its heating system.

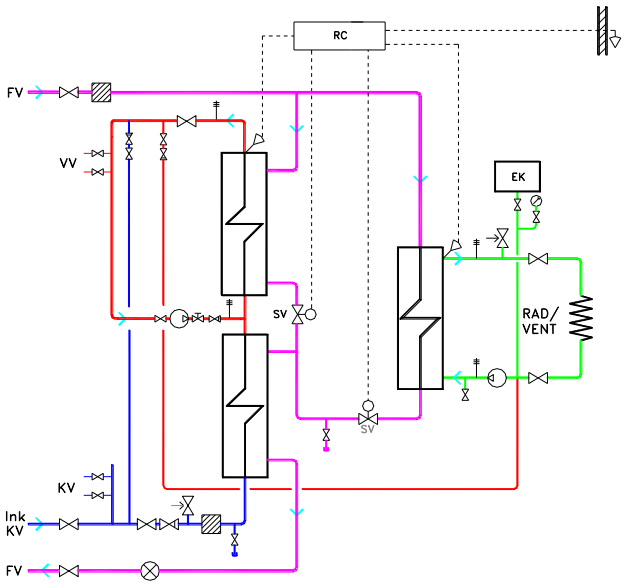
The Swedish District Heating Association has published a report, no. 2004:3, entitled 'Substations - Connection Principles', which describes different arrangements and their characteristics.

The two commonest principles are shown in the diagrams below:

Parallel connection



Two-stage connection



9. Appendices

1. Examples of local regulations
2. Checking substation functions
3. Information on determining substation capacity
4. Model form of final inspection requirements
5. Environmental requirements for domestic hot water, with particular attention to avoiding risks of Legionnaires' Disease
6. Requirements for seals

Appendix 1

Examples of local regulations

HT system design temperature
Under certain conditions, the supply temperature may exceed the ……..^{o}C operating temperature. Installations must therefore be designed so that they can withstand a maximum temperature of 120 °C and pressure of 1.6 MPa.

Classification of district heating systems
This district heating system is classified for a maximum temperature of ……. and pressure of …….
Diagram of the district heating system supply temperature as a function of outdoor temperature in accordance with the classification.

Documents for submission to the heat supplier

- a site plan
- layout drawing for the district heating connections to the equipment room
- plan of the equipment room, the substation and the position of the heat meter
- schematic diagram of the substation and the building's heating system
- parts and labour description for installation of the substation
- for installations less than 100 kW in size, only the schematic diagram and parts/materials specification are required
- capacity/rating-determining material: see Appendix 3.

Information from the heat supplier

- type of system: LT/HT
- classification temperature of the system
- delivery boundaries
- differential pressure at the supply point
- suggestion for suitable connection arrangement
- date/time for supply of district heating
- operating data from existing installation (for conversion of an existing unit)
- valuation of reduced return temperature from the substation.

The heat supplier will supply the following equipment, as needed:

All equipment to be installed by the customer's pipework contractor:

- filter, primary side
- pressure gauge

- spacer section for flow sensor
- instrumentation pockets for temperature sensors.

Procedures during/after installation

Installation drawings that have been examined by the heat supplier shall, on request, be available for the heat supplier's inspector at the installation site.

When installation work has started, it is recommended that a representative of the heat supplier is present to check the erection work.

Before the installation is started up, the district heating circuit must be tested in the presence of the heat supplier's representative.

On completion of installation, the customer or his representative shall notify the heat supplier of readiness for final inspection.

The heat supplier's representative shall be present when the installation is commissioned.

Appendix 2

Function checking of the substation

Installation no.:

Date:	Issue by:
Customer / Company:	Routine visit / Notified fault:

DISTRICT HEATING

Meter readings:

1 Volume m^3
2 Energy MWh

Pressures:

3 Supply, before filter kPa
4 Supply, after filter kPa
5 Pressure, return kPa

Temperature in district heating supply mains

6 Temperature supply	°C
7 Temperature return	°C
8 Temperature after radiator heat exchanger	°C

Other meter readings:

13 Cold water m^3
14 Domestic hot water m^3

THE BUILDING'S HEATING SYSTEM

Radiators		Ventilation system	
9 Temperature supply	°C		°C
10 Temperature return	°C		°C
11 Domestic hot water supply			°C
12 Domestic hot water circulation return			°C

Miscellaneous

15 Outdoor temperature at time of visit: °C

Item	System / component	Item	Fault description / Notes: Status: 1=Acute 2=Should be dealt with 3=Information 4=Dealt with by inspector	Item	Estimated cost for correction
1	District heating circuit				
1.1	Main isolating valves				
1.2	Filter				
1.3	Pressure gauge				
1.4	Thermometer				
1.5	Flow sensor				
1.6	Meter integrator				
1.7	Temperature sensors				
1.8	Miscellaneous				
2	Space heating circuit				
2.1	Heat exchanger				
2.2	Filter				
2.3	Sensor				
2.4	Control unit				
2.5	Control valve				
2.6	Thermometer				
2.7	Pumps				
2.8	Exp. vessel / safety valve				
2.9	Valves				
2.10	Filling and check valves				
2.11	Miscellaneous				
3	Domestic hot water system				
3.1	Heat exchanger				
3.2	Filter				
3.3	Control unit				
3.4	Control valve				
3.5	Sensor				
3.6	Thermometer				
3.7	Circulation pump				
3.8	Valves				
3.9	Check valves				
3.10	Miscellaneous				
4	Miscellaneous				

Appendix 3

Rating and capacity data

Enter the rating and capacity data on the unit's flow diagram

Heated floor area .....m^2 Address.....…
No. of apartments ....…
Flow (vv).....l/s
Transmission..... kW at design outdoor temperature ..... °C
Transmission..... kW at outdoor temperature °C break point
Ventilation..... kW at design outdoor temperature..... °C

Heat recovery

Heat pumps .....…….. kW from waste heat source....…….....….
Other type .....…….. kW from heat source .....…….....….

Heat exchangers Make	**Domestic hot water**	**Radiators**	**Floor heating**	**Ventilation**	**Other**
Type / no. of plates					
District heating system					
Design flow rate, m^3/h					
Pressure drop, kPa					
Design temperature, °C					
Building's system					
Design flow, m^3/h					
Pressure drop, kPa					
Design temperature, °C					

Control valves / Valve actuators Make	**Domestic hot water**		**Radiators**	**Floor heating**	**Ventilation**	
Type of control unit / program version						
Type of control valve						
Flow, m^3/h						
Pressure drop, kPa						
Valve calculations, DN/k_{vs}-value						
Installed valve, DN/k_{vs}-value						
Actuator, run times, open to closed, closed to open						

Appendix 4

Model form for final inspection

Inspection results for district heating service

Customer:
Address:
Property name:
Telephone no.

Date of connection: _____
Date of inspection: _____

Primary pipes:	Main isolation valves:	☐	OK	☐	Note:	
	Seals to walls:	☐	OK	☐	Note:	
	Supports:	☐	OK	☐	Note:	
	Penetrations:	☐	OK	☐	Note:	
	Pipe runs:	☐	OK	☐	Note:	
	Insulation:	☐	OK	☐	Note:	
	Vent connections:	☐	OK	☐	Note:	
	Floor drain:	☐	Yes	☐	Absent	☐ Note.
Other space heating and domestic hot water pipes:	Radiator circuit	☐	OK	☐	Note:	
	Domestic hot water circuit	☐	OK	☐	Note:	
	Insulation	☐	OK	☐	Note:	
Heat exchanger installations:	Pipe runs	☐	OK	☐	Note:	
	Cubicle	☐	OK	☐	Note:	
Control equipment:	Space heating	☐	OK	☐	Note:	
	Domestic hot water	☐	OK	☐	Note:	
	Balancing	☐	OK	☐	Note:	
Electrical installation:	220 Volt	☐	OK	☐	Note:	
	Outdoor temperature sensor	☐	OK	☐	Note:	
	Indoor temperature sensor	☐	Yes	☐	Absent	☐ Note:
	Signal cable	☐	Yes	☐	Absent	☐ Note:
Heat metering:	Meter					
	Meter position					MWh
	Seals	☐	OK	☐	Note:	

Miscellaneous:
Faults and shortcomings noted above are not sufficiently serious to interfere with proper function of the installation. The inspected parts of the installation are hereby declared approved.

The warranty period is two years, starting from:

Appendix 5

Environmental requirements for domestic hot water, with particular attention to avoiding risks of Legionnaires' Disease

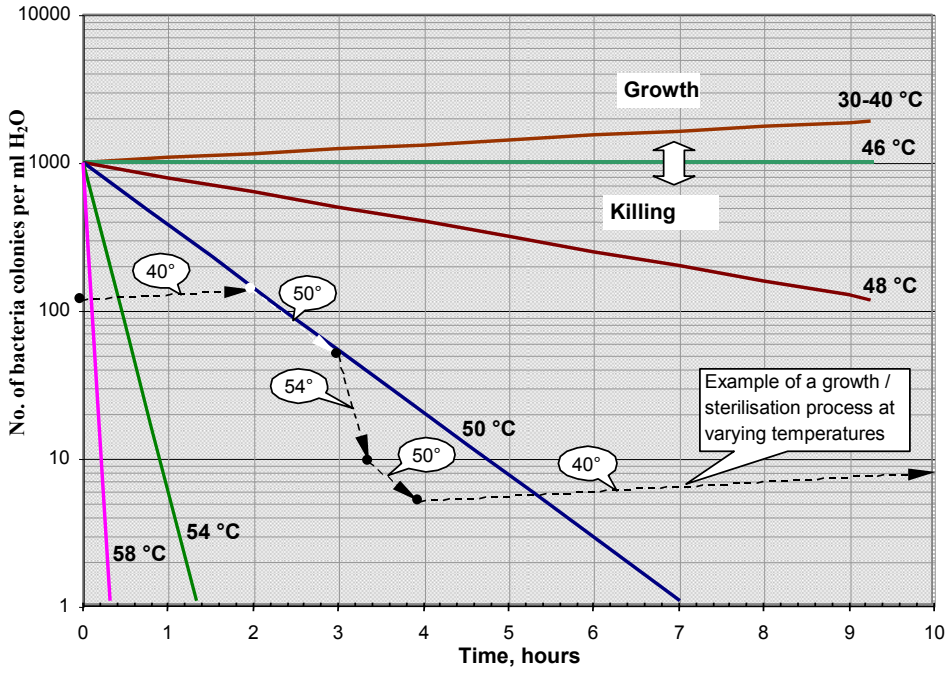
Domestic hot water systems must be designed to supply domestic hot water of good quality.

Towel dryers and floor heating coils connected to domestic hot water systems are a source of risk. If they are turned off, colonies of Legionnaires' Disease bacteria can become established in them, infecting the entire system when these parts are again turned on. For this reason, towel dryers and floor heating coils should be on a separate circuit from the domestic hot water system, which should not be used for any purposes other than the supply of sanitary water.

The Swedish District Heating Association recommends that any storage of water below the domestic hot water design temperature should be avoided, in order to achieve the best possible environmental requirements applicable to the water.

A temperature of 60 °C must be reached and maintained in hot water storage or buffer tanks for a sufficient time to ensure that any Legionnaires' Disease bacteria are eliminated before the water is distributed to taps.

The bacteria will not be eliminated by secondary heating of water from, say, 40 °C up to 55 °C in a heat exchanger supplied with primary water from a district heating supply. Such secondary heating raises the temperature very quickly, without sufficient time to kill all Legionnaires' Disease bacteria. Such an arrangement is unsuitable, and does not meet the National Board of Housing, Building and Planning's requirements in respect of health and environmental conditions as described in the Building Regulations.



The diagram is reproduced from Report no. FoU 2002:75

It can be seen from the above diagram how dangerous it is temporarily to reduce the water temperature in a domestic hot water circuit. Over a ten-hour period, the water temperature has been at 50-54 °C for only two hours, and as low as 40 °C for the remaining eight hours. Such conditions are extreme in anything other than a very badly set up domestic hot water riser.

Nevertheless, despite the unfavourable temperature conditions, any bacteria colonies will have been more than decimated. From this point of view, it can be seen that temporary temperature drops to 40-45 °C, resulting from very high draw-off rates, have no practical significance if they do not last for more than 15-20 minutes, and do not occur more than once a day.

Appendix 6

Seals must meet the requirements of applicable parts of EN 681-1, Table 3, 'Material requirements for pipe joint seals used in hot water pipes with a continuous water temperature of up to 110 °C'. The table below shows a summary of the required tests and properties.

Property	**Test method**	**Requirements for different hardness classes**				
		50	**60**	**70**	**80**	**90**
Hardness	ISO 48	±5	±5	±5	±5	±5
Max. compression set, %:	ISO 815					
72 hours at 23°C		15	15	15	15	15
24 hours at 125°C		20	20	20	20	20
Ageing, 7 days at 125°C:	ISO 188					
Max. hardness change, IRHD	ISO 48	+8/-5	+8/-5	+8/-5	+8/-5	+8/-5
Max. failure strength, %	ISO 37	-20	-20	-20	-20	-20
Max. change in rupture strain, %	ISO 37	+10/-30	+10/-30	+10/-30	+10/-40	+10/-40
Relaxation in compression, maximum, %:	ISO 3384					
7 days at 23°C		15	15	15	18	18
7 days at 125°C		30	30	30	30	30
Volume change in water, 7 days at 95°C	ISO 1817	+8/-1	+8/-1	+8/-1	+8/-1	+8/-1
Relaxation in water, 70 days at 110 °C , maximum, %	EN 681-1, Annex B	30	30	30	30	30

Technical regulations

District heating substations **F:101**
Design and installation

District cooling substations **F:102**
Design and installation

Certification of district heating substations **F:103-n**
Test and inspection programme

Heat meters **F:104**
Technical requirements and advice on meter installations

Testing heat exchangers and water heaters **F:109**

Heat meters **F:111**
Dynamic function testing of heat meters for detached houses

Reports

Your district heating substation **2004:1**
A handbook for caretakers

Safety of district heating installations **2004:2**
Rules and advice for risk assessment

District heating substations **2004:3**
Connection principles

Publications

Publications can be ordered from the District Heating Association's Publishing Service on telephone +46 26-24 90 00 or fax +46 26-24 90 10. A current list of publications is also available on the Association's web site.

Fjärrvärme och fjärrkyla skapar effektiva och miljöanpassade energilösningar som tar tillvara resurser som annars går förlorade, och ger kunden enkel, trygg och bekväm värme och kyla.

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