Instructions for designing heating systems.

In order to obtain the required effect, a lower consumption, a smaller quantity of impurities and improved comfort, heat and domestic hot water installations in new and existing buildings have to be installed in a way that fits into the total pattern.

The solutions stated below are those which appear to be the most suitable for this purpose for the years to come.

Comfort.

The purpose when building houses and to supply them with heating and domestic hot water is to create better conditions for the residents.

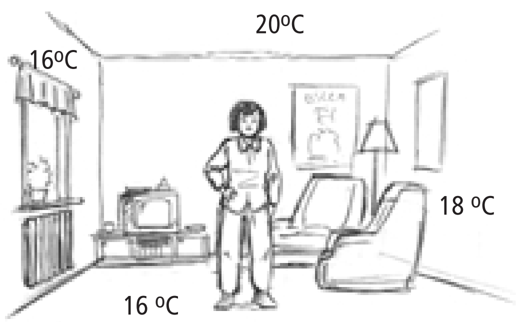
Comfort here is a question of creating conditions so that an apartment will be comfortable to live in.

1. Room temperature.

Metering the room temperature with a thermometer is not a very good measure of comfort, but it is the simplest method of measuring we have.

Heating systems are usually designed for a room temperature of 18-20 °C, and that is for most cases sufficient. Elderly or sick persons may need a higher temperature to experience the same comfort as younger and healthy ones.

The temperature difference vertically in a room should not be too great either. It is not nice if the feet are cold, while it is too warm in the area round the head.

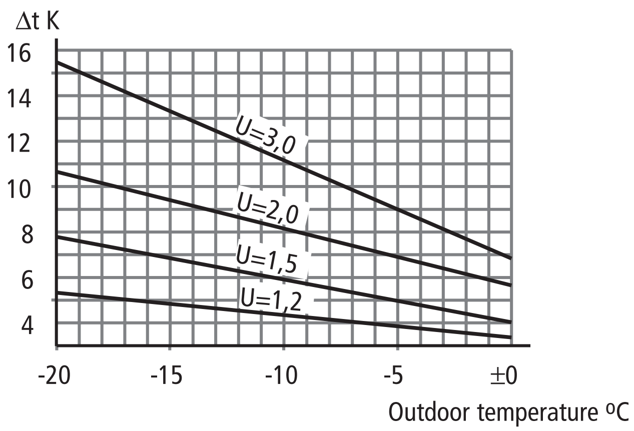


Measured air temperature is not a measure of comfort.

Fig. 6:1

2. Temperatures on the surfaces of the room.

The heat transfers from warm to cold surfaces.
A person sitting close to a cold window emits heat to the window, and after a while he/she will experience unpleasedt conditions. All surfaces with a lower temperature than the skin receives radiant heat from the person. How much is depends on the difference in temperature.



Difference in temperature between room, 20°C, and window of different window constructions. Window temperatures below +12°C can cause radiant cooling. Window with sealed double glazing give a U = 3.0.

Fig. 6:2

A room with many cold surfaces (a corner room with a roof) provides a lower level of comfort than a room with few cold surfaces (a room with only one exterior wall), due to the radiant heat.

To increase the comfort, the temperature of the cold surfaces must be raised, which can be done in two ways; either by raising the room temperature or improving the insulation.

A better level of insulation with regard to windows means having sealed double glazed units.

Roofs should be better insulated, and a heat transmission coefficient of 0,3 W/m^2K, about 100 mm mineral wool, is a minimum requirement. Gable walls should be insulated in the same way as roofs.

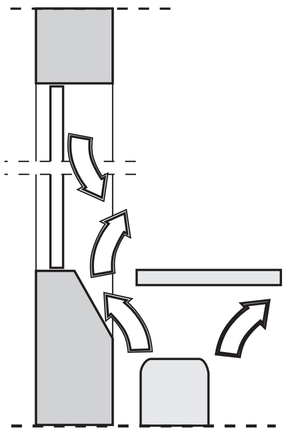
3. Downdraught

Downdraught is a reverse convection. Air coming into contact with a surface that holds a lower temperature, cools down, becomes heavier and descends.

Downdraught occurs mostly in the window areas, as the window has the lowest temperature in a room, but all the surfaces with a lower temperature than the room air causes downdraught. How much will depend on the difference in temperature.

The cold air descends to the floor where it stays. Radiators below the windows can remove the downdraught providing they cover the whole width of the window.

Heat emission through radiation to a cold surface, cold radiation, is often mistaken for down draught. The same measures apply on both down draught as well as cold radiation. To counter balance this, raise the temperature of the cold surfaces!

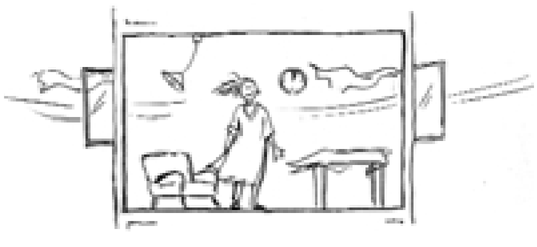


The down draught from the window can be prevented by the heat from the radiator if the window bay and the windowledge are designed properly.
Fig. 6:3

4. Ventilation.

Ventilation removes impurities, such as small particles, odour and moisture, from the rooms. Odour and moisture are secreted from the human body, but they are also produced by cooking. The introduction of showers in the apartments increases the moisture production greatly, and a brief and effective ventilation is required.

An easy way to ventilate is to simply open a window. If this is done briefly with a fully open window or even with cross draught, it is both efficient and cheap. If no extra measures are taken to insulate round the windows, these leaks are sufficient during the winter months, together with an efficient airing, to remove the odour and moisture.



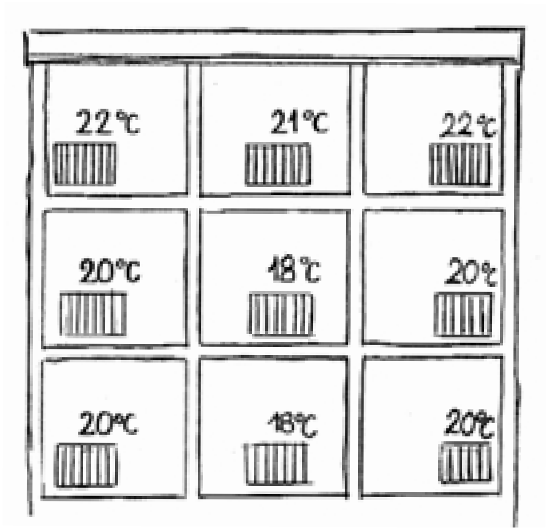
A brief cross draught is cheap and efficient.
Fig. 6:4

5. Wind influences.

The air changes in the building increases when it is windy, and if one wants to preserve the room temperature at the set level, a higher flow temperature to the radiators is required.

6. Distribution of the heat.

In principle, the room temperature should be the same in all the rooms of a building. If roof and gable walls are not insulated, it should be possible to keep a somewhat higher temperature in rooms with roof and/or gable walls.



The room temperature must be somewhat higher in rooms with more cold surfaces to keep the same comfort.
Fig. 6:5

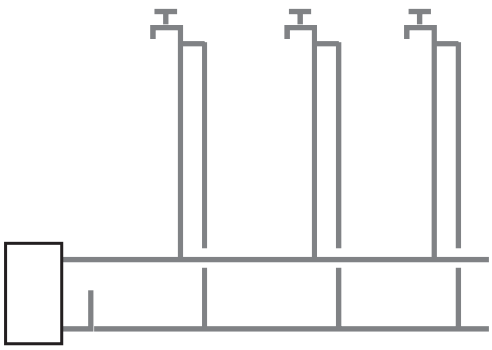
7. Domestic hot water.

Each apartment should have access to domestic hot water in the kitchen and in the bathroom. The bathroom should be equipped with a floor drain and a shower.

When a combined heating and power plant is in operation and is using the apartment, heating systems for cooling, the costs for a shower are small, but the value of hygiene and comfort is substantial.

8. Hot water circulation.

When the water in a riser for domestic hot water stands without tapping for a long time it will take room temperature. The first person wanting hot water will therefore run away a large amount of water before hot water reaches the tap. If a small circulation pipe is laid parallel to the riser and connected with the riser at the top, a gravity circulation is obtained so that hot water always is available.



A gravity circulating system makes water of the right temperature available throughout the whole system.
Fig. 6:06

Conditions.

1. Heat requirement.

The heat losses in a building consist of:

- transmission
- ventilation
- domestic water

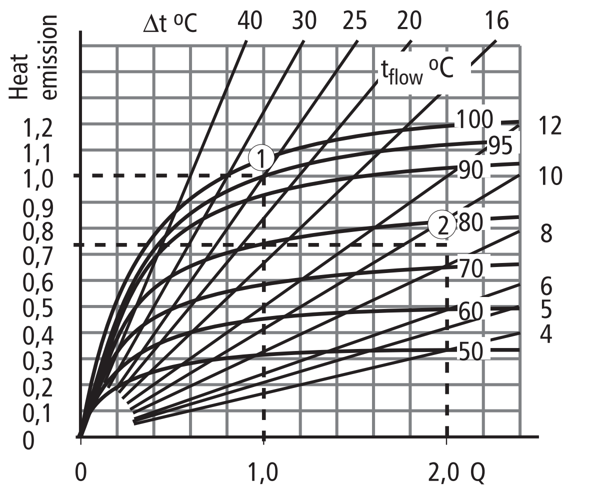
2. Calculation of the transmission losses.

The transmission losses are losses through walls, floors, ceilings/roofs, windows and doors, arising due to the outdoor and indoor temperature differences.

The size of these losses should be calculated at the outdoor design temperature for the specific geographical area, for example −10°C, and a room temperature of 18-20°C.

The calculated transmission loss will always be considerably higher than the real value.

When starting up the system the real losses are to serve as a basis for the adjustments made.



	t_{flow}	t_{return}	Δt	Q	Required heat
1. Calculated	95	70	25	1	1,0
2. Measured	75	66	9	2	0,74

The calculated heat requirement is never equal to the actual requirement.
Fig.6:7

3. Ventilation.

It is rather easy in buildings with mechanical supply and exhaust air, to calculate the heat requirement for the ventilating air. The size of the air flow and the specific heat content of the air are known as well as the required temperature rise. These factors are multiplied and the heat requirement for ventilation is determined.

A fan exhausting air from an apartment, a kitchen fan for instance, takes in air through leaks in the building, and that air is warmed up by the radiators in the rooms.

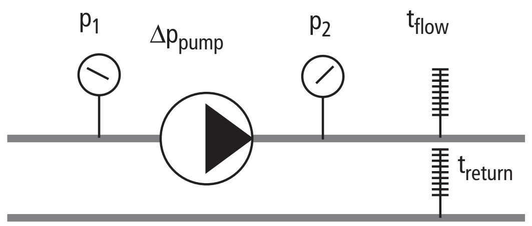
It is difficult to determine the size of the air flow at self draught or at airing through leaks. A lowest standard value is 0,5 air change per hour. However, the cold incoming air is to be warmed up by the radiators.

Large forces arise in high-rise buildings due to differences in temperature between the air outside and the air inside the building, so called self draught forces. The stair-well in a high-rise building becomes a ventilating duct, removing large amount of heat from the building, especially if the outer door on the ground floor is open. Keep the outer door closed and put another door a few meters inside the outer door, a so called airlock !

4. Incidental heat gain.

Incidental heat gain from other heat sources than the heating system have to be used to reduce the heat consumption. The incidental heat gain will give over-temperatures if the heat supply from the heating system is not reduced correspondingly. Thermostatic valves are well suited to use the incidental heat gains with a preserved room temperature.

The amount of the incidental heat gain will largely depend on the activity of the residents, and the amount of the incidental heat gain as part of the heat requirement of a room becomes larger the better the room is insulated.



Find Δp_{pump}; p_2 - p_1;
Find the flow from the flow chart of the pump and
Δt for the circuit = t_{flow} - t_{return} ^oC.
Heat consumption = Δt x flow;
Fig. 6:8

Heat requirement for domestic hot water	
Cold water:	+8 ^oC
Hot water:	65 ^oC
Flow:	1 l/s

$P = 1 \times 3.600 \times 57 \times 0.86 = 176.472$ W;
P = 176 kW;

5. The wind influence on the heat requirements.

The air change increases in the buildings in windy conditions. The harder the wind, the larger the air changes. An increase in volume of cold air supplied to the room has to be warmed up to room temperature. Otherwise the room temperature will decrease.

It is not usually windy at the same time as we have design outdoor temperatures. Thus the radiator size needs no compensation for the wind influence, unless the experience/statistics from the area is/are showing something else. The flow temperature, however, must be raised in windy conditions. As an alternative, a slightly too high flow temperature is used and the thermostatic valves will keep the room temperature at the right level. Then the heat is there even in windy conditions.

6. Heat requirement per room.

The total heat requirement per room is equal to the sum of the transmission and the ventilating requirement. The size of the radiators and the required flow are determined according to this value, at maximum load.

7. Control of the actual heat requirement.

The actual heat requirement for a building cannot be obtained until the building is built and the system is in operation. The simplest way is to meter the current flow and the flow and return temperatures. A multiplication of the temperature difference and the flow gives the heat amount.

8. Domestic hot water.

The heat requirement for heating domestic water is rather easy to calculate, the flow multiplied by the temperature raise, but the size of the accumulated flow is difficult to determine.

The pipes for domestic hot water have to be made of copper or of heat resistant plastics.

Heating systems.

The heating system should be constructed and operated in a way that the stated requirements can be reached with regard to environment, comfort, operating economy and a low return temperature.

Before a system or part of it is taken into operation it have to be pressure tested. The system in question is filled with treated water and all the air is let out. After that, the pressure is increased with a pump, up to at least 1,3 times the maximum working pressure. The pressure should be kept constant for at least 60 minutes, without dropping. Joints, connections and equipment should be checked visually during the pressure testing to make sure that there is no leakage. The supervisor in charge should keep records, of the pressure tests. The records should contain information on time, place, scope, current pressures at the beginning and the end of the test, and also possible leakages attended to. The records are then to be signed by the supervisor in charge.

1. Heat exchangers.

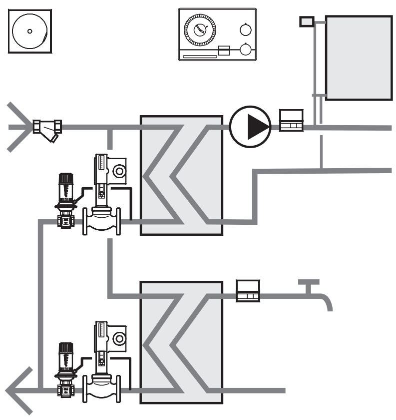
Each building ought to be equipped with its own sub-station. It is appropriate in long buildings to have several sub-stations. The same applies to high-rise buildings, of more than 18 floors. These are however divided vertically.

Sub-station.

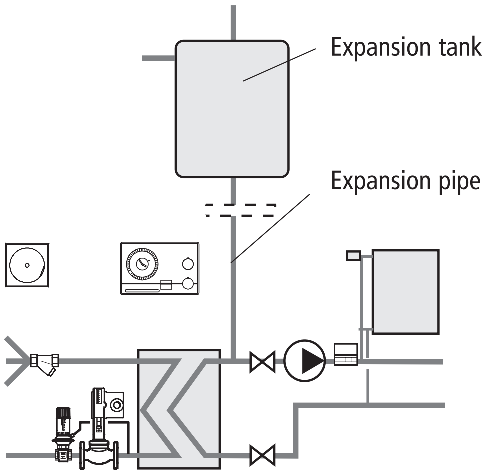
In the sub-station, the high temperatures in the primary system are converted to the level required by the system in the building. The systems are completely separated from each other, a fact which requires an expansion system and a circulation pump to make the secondary system work.

Circuit diagram.

If there is only one heat exchanger in the sub-station, there are no problems in connecting it, but a parallel connection of the exchangers is recommended when it is a case of several exchangers. Then each system will have its own control equipment and expansion vessel, as well as circulation pump.



Two parallel connected heat exchangers.
Fig. 6:9



Pump in the flow pipe and no shut-off valve between the heat exchanger and the expansion tank.
Fig. 6:10

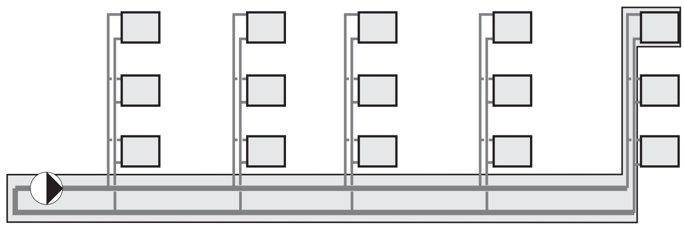
2. Expansion system.

Expansion system.
An open expansion system, with the circulation pump installed in the flow pipe, is a simple and practical solution.

There has to be room around the vessel for inspection and repair work.

The connection of the expansion pipe to the heat exchanger must not be equipped with a shut-off device.

Corrosion protection of expansion vessels.
The expansion vessel and the upper part of the expansion pipe should be made of rust-proof material.



The design circuit is the pipes from the heat exchanger to the radiator located farthest away. The resistance in this circuit is equal to the pump head.
Fig. 6:11

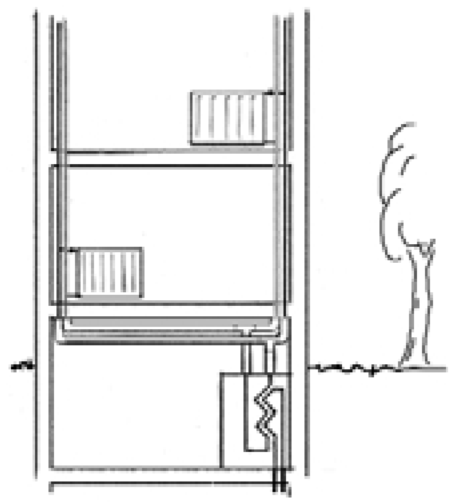
3. Circulation pump.

Circulation pumps should be installed in the flow, which will guarantee that there is water in all the radiators when the pump is in operation. The pumps should be reliable and equipped with a tight sealing shaft that requires no maintenance. It is advisable to place a unit for sludge separation after the pump, a filter for instance. The filter unit is constructed with shut-off devices so that it can easily be emptied of sludge.

The flow is determined from the calculated heat requirements and the temperature drop. The pressure increase over the pumps is obtained from the pipe calculation. There is no reason for making any increases in these values. The pumps are already oversize with the increases made when calculating the heat requirements for the building. A too high differential pressure can cause flow noise in valves and radiators.

4. Horizontal distribution pipe.

Definitions.
The horizontal distribution pipes distributes the water from the sub-station to other buildings and/or risers.



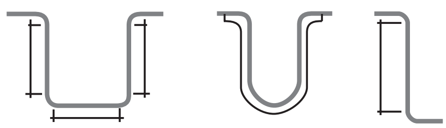
Horizontal distribution pipes.
Fig. 6:12

Pipe material.
Standard pipes joined together by welding are used for the larger units. The connection of valves and devices is made with flanges.

Smaller pipe installations are of threaded steel pipe and the sizes are adapted to standardized pipe threads.

Piping.
The distribution pipes can be laid as pre-insulated pipes, in the ground, under a building or hung from the roof in the basement of the building, depending on how the building is constructed.

Compensation of the linear expansion due to variations in temperature.
The linear expansion for steel pipes is 0,12 mm per meter of pipe and a temperature change of 10°C. The temperature change 10-95°C gives 85 °C, i.e. 8,5×0,12 mm =1,02 mm/m. Measures must be taken with regard to long pipework seetions.

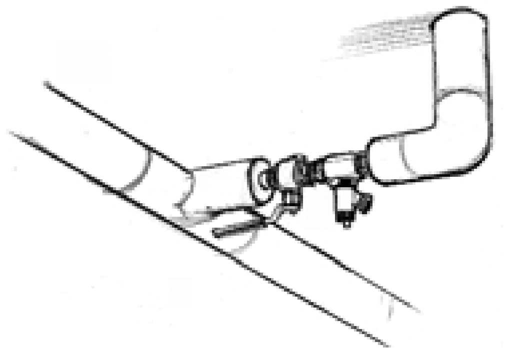


Length of expansion loops.
Fig. 6:13

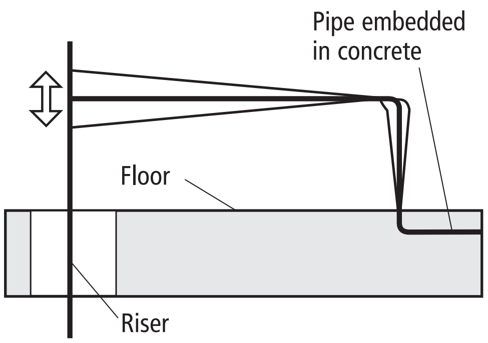
The linear expansion is absorbed up by expansion loops on the pipework or by shifting the pipe course sideways to create an expansion loop. It is important that the pipes can move towards the device picking up the expansion and that the branches are of such length, up to a passage through a wall or a vault, that they can pick up the expansion without failing.

Insulation.
The distribution pipes are insulated in such a way that the heat losses to the consumers are as small as possible. When the piping is visible, the insulation is provided with a protective surface layer.

It is important for the functioning of the system that the flow temperature is the same for each connected riser.



Riser with shut-off and draining valves.
Fig. 6:14



The expansion of the riser must be taken into consideration when the branch is installed.
Fig. 6:15

5. Risers.

Definition.

Risers are the vertical pipes emanating from the horizontal distribution pipes up through the building.

Each riser is equipped with shut-off and draining valves and possibly a differential pressure valve.

Pipe material.

Standard pipes joined together through welding are used for the larger installations.

The connection of valves and devices are made with flanges.

Smaller pipe dimensions are made of threaded steel pipes and the sizes are adapted to standardized pipe threads.

Piping.

The risers are placed in central shafts with branches on each floor. The branches are equipped with shut-off valves.

Compensation of the linear expansion due to variations in temperature.

The linear expansion for steel pipes is 0,12 mm per meter pipe and a temperature change of 10°C, i.e. approximately 1 mm/m in heating systems. Measures should be taken when the piping is 15 m long or more.

The linear expansion is absorbed by expansion loops on the piping or by shifting the pipe course sideways to create an expansion loop. The pipes should be fixed so that they can move towards the device absorbing the expansion.

The branches on each floor should be of a sufficient length or have a flexible insulation to be able to absorb the expansion. They must not be locked.

Insulation.

The risers are insulated in a way that the heat losses to the consumers are as small as possible. When the piping is visible, the insulation is provided with a protective surface layer.

It is important for the functioning of the system that the flow temperature is the same at the branches on each floor.

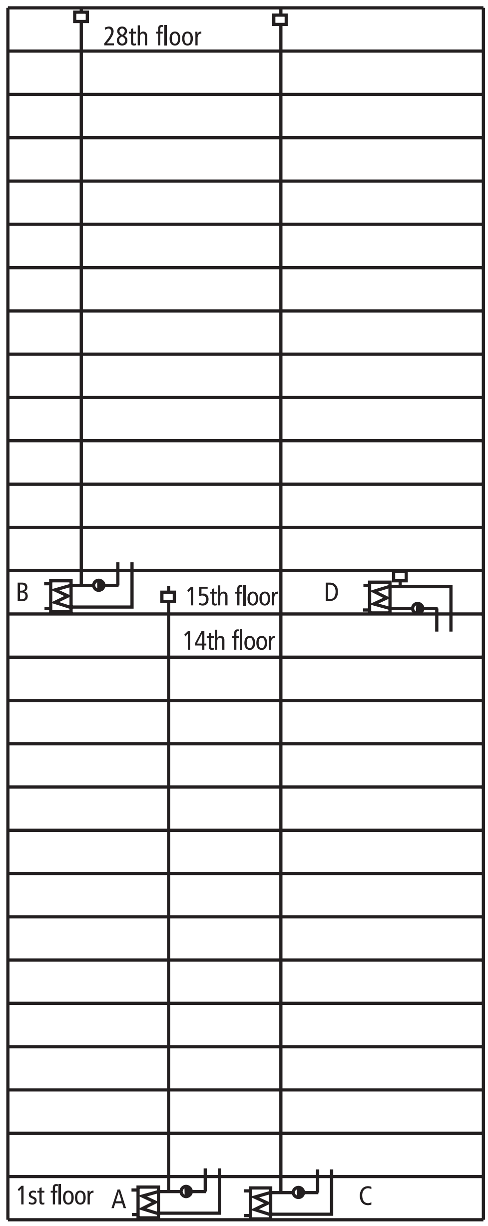
6. High-rise buildings.

The equipment included in a heating system, radiators, pumps, valves etc., are designed to the highest working pressure, usually 600 kPa (6 bar). Each meter vertically corresponds to about 10 kPa. With an apartment height of three meters and an open expansion vessel placed at the roof on the top floor, it is possible to accommodate 19 floors ((600-30)/30=19 floors), but then there are no margins. A maximum of 18 floors would be more realistic.

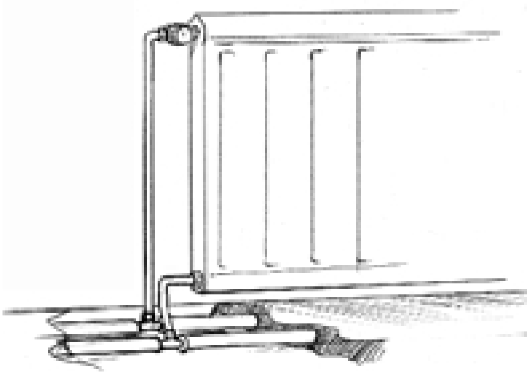
In buildings with more than 18 floors, the heat installation ought to be vertically divided. A building with 28 floors receives two heating systems, managing 14 floors each. There are two options for the upper floors. The heat exchanger can either be placed in the sub-station on the ground floor (A), or a separate sub-station is set up on the 15th floor (B). The sub-station on the 15th floor might also serve the 14 first floors, but in that case with a separate heat exchanger. (D)

If the sub-station of both the heating systems is placed on the ground floor (A, C), the equipment installed for the highest located heating system (C) have to manage the higher static pressure occurring, more than 600 kPa.

If the sub-station is placed on a floor halfway up the building, it will provide a correspondingly higher static pressure for the primary system, (steam pressure at 120°C 100 kPa, height to the sub-station placed on the 18th floor 300 kPa, plus the possible difference in level between the floor in the production unit and the floor on the 1st floor of the connected building, sum = at least 400 kPa). The material on the primary side usually manages these pressures if the boilers are separated with heat exchangers.



Sub-station in high-rise buildings.
A or D for the lower part of the building
B or C for the upper part of the building



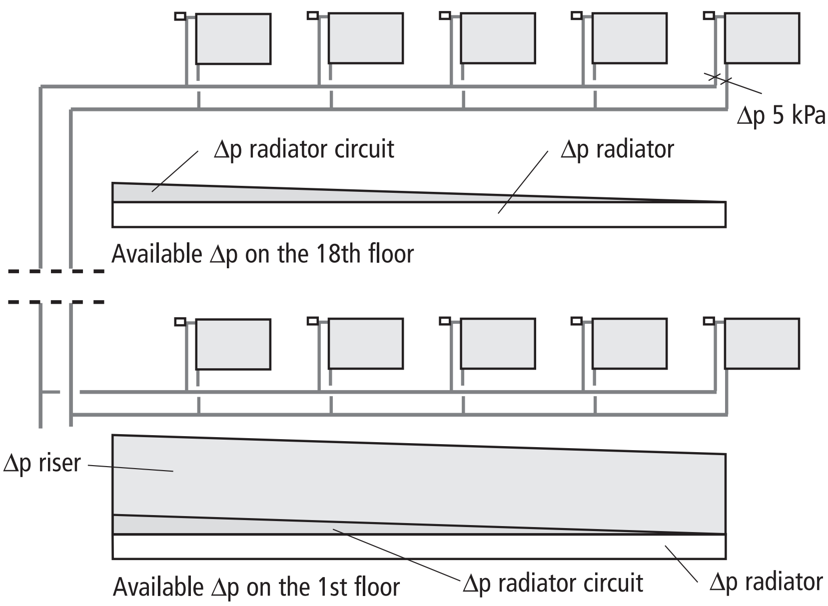
Insulated pipes for the radiator circuit embedded into the floor.
Fig. 6:17

7. Radiator circuit, two-pipe horizontal.

The horizontal two-pipe system emanates from a centrally placed riser with branches on each floor. A differential pressure control, keeping the differential pressure constant at 10 kPa, is installed on the branch on each floor. Then, branches are made for one radiator circuit to each apartment. Each branch is equipped with shut-off valves and flow meters. The radiator circuit is either laid as a two-pipe system with a parallel flow and return pipe, or as a Tichelmann-coil with the pipes insulated in the screed. With regard to existing buildings, the pipes are laid uninsulated on a wall.

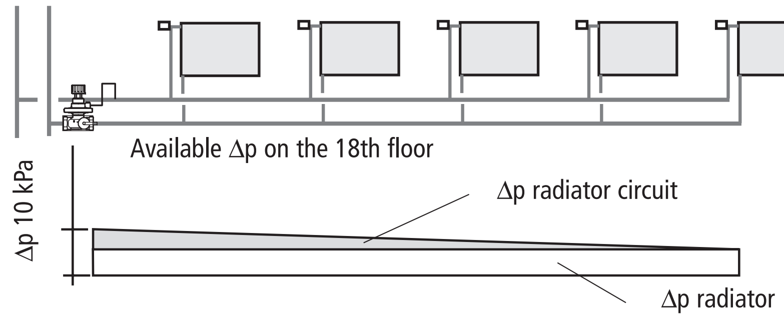
Adjustment.

The thermostatic valves in a two-pipe system provide a varying flow and a varying differential pressure. A pre-set adjustment will only function at a maximum flow, when the flow decreases, the resistance over the adjustment changes by the square of the flow change.



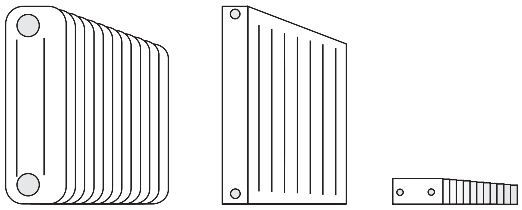
Available differential pressure in the riser without differential pressure control.
Fig. 6:18

A simple and safe method for the balancing of two-pipe systems with a varying flow is based upon differential pressure controls at the bottom of each riser or for each radiator circuit/floor. The differential pressure control keeps the differential pressure constant independent of the changes in flow. Maximum differential pressure across the thermostatic valves is 25 kPa to prevent excessive noise.



Differential pressure control gives the same available pressure on each floor.
Fig.6:19

It is sufficient with an approximate adjustment based upon heat requirement for each radiator. The adjustment will only take effect if and when the available heat volume is not enough to keep the temperature set on the thermostatic valve, i.e. at a long decrease in the flow temperature or at disturbances in the heat supply.



Section radiator. Panel radiator Convector

Fig. 6:20

8. Radiators – convectors.

There are three types:

• radiators

• convectors

• convection radiators, convector with a front plate giving radiated heat.

Radiators emit heat through radiation but not through convection, or air movement, until higher temperatures are reached – above 40ºC surface temperature at 20ºC room temperature.

Convectors emit heat through convection.

Convection radiators emit a smaller part of heat through radiation.

Approximate distribution among radiation and convection for different heaters.:

	Radiation %	Convection %
Section radiators	15	85
Panel radiators, single	32	68
Convectors	–	100
Convection radiators	10	90

As systems they are pretty much equal but they should not be mixed in the same system, and from now on they will all be treated as radiators.

Radiator size.

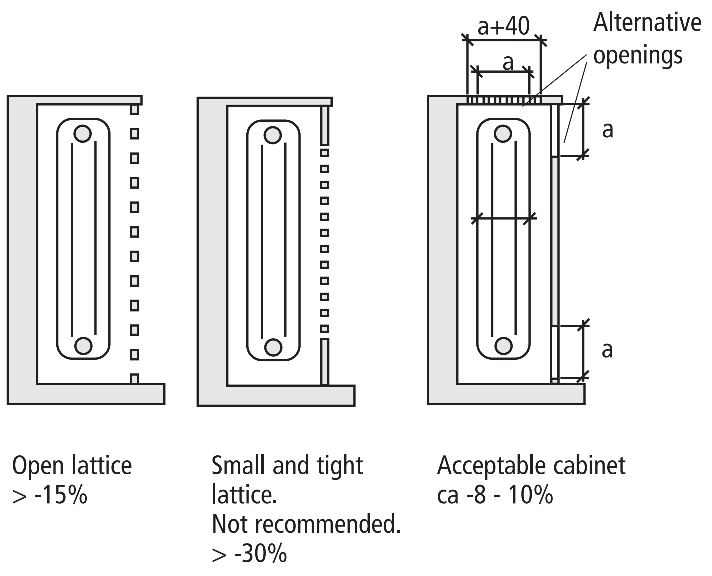
The radiators are sized for a nominal heat requirement, and the flow will vary when the thermostatic valves adjust the heat supply to the current requirement. The best effect is reached if the connection with the flow is made to the upper tap-in, and the return to the lower tap-in on the same side of the radiator.

Mounting.

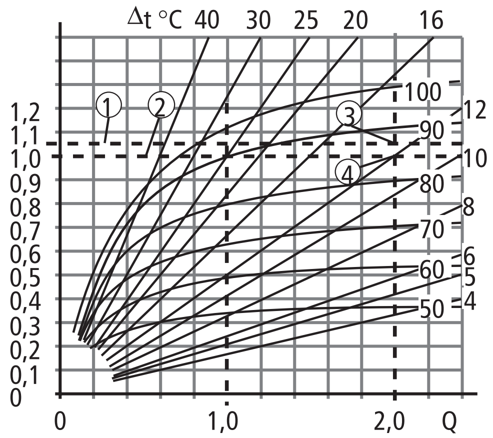
In order to prevent downdraught, the warm air from the radiators must be able to rise and meet the cold glass in the windows. Window ledges, if any, should be constructed so there is a gap along the whole window. The gap should be at least 30 mm wide, as close as possible to the window.

The covering of radiators reduces the heat emission by obstructing the heat emission from the radiator to the room. The most common type of covering, which has only a grille in front of part of the radiator, reduces the heat emission disastrously. A better solution, if the radiator is to be concealed, is to make the front tight but with a 10 cm high opening at the floor. The width of the opening should be equal to the width of the radiator. An opening is made in the horizontal protection plate of the cover of the same length as the radiator. The depth of the opening should be 15-20 cm and it should be as close as possible to the window.

This function will be even better if plates are placed closely, at both ends of the radiator so that a vertical passage is formed. The reason why many residents are using radiator screens is that the high surface temperature causes a strong radiant heat which is experienced as unpleasant, when you are close to the radiator. The flow temperature should therefore not be higher than that which is necessary to manintain the desired room temperature.



Covering a radiator reduces the heat emission.
Fig. 6:21



① first radiator in circuit, t_{flow} 95°C, Q = 1,0

② last radiator in circuit, t_{flow} 90°C, Q = 1,0

If Q = 2,0 the temperature drop across radiator will be 50% lower. The flow temperature can be reduced while the heat emission remain the same.

③ first radiator in circuit, t_{flow} 87,5°C, Q = 1,0

④ last radiator in circuit, t_{flow} 85°C, Q = 1,0

Operating conditions.

1. Temperature levels.

A flow temperature of 95°C and a temperature drop of 20-25°C have been referred to as the calculated values. If the radiators are sized correctly, a flow temperature of 95°C is required for the last radiator. The temperature drop from the sub-station to the last radiator is about 5°C in larger systems. Consequently the outgoing temperature from the sub-station should be 100°C and that is not possible.

90°C is the highest temperature at which a radiator system can be operated under these circumstances, which means an outgoing temperature of about 95°C from the sub-station. The adjoining heat emission curve for radiators is therefore made for a flow temperature of 90°C.

A lower flow temperature or a smaller temperature drop requires larger radiators. The lower flow temperature should be used if it turns out that a lower flow temperature can be used without influencing the desired room temperature, (the heat authority of the thermostatic valves or a low return temperature). A lower flow temperature provides improved comfort by reducing the difference in surface temperature between different surfaces in the rooms.

A two-pipe radiator system requires that the flow temperature to all the radiators is pretty much the same if the system is going to function well. By metering the temperature drop across a radiator and then reading the room and the outdoor temperatures, it is possible to get an idea of how large the system in question is, compared to the actual requirement. The flow temperature is set at a level providing good heat authority for the last thermostatic valve of the design circuit. The calculated temperature drop across radiator or radiator circuit should be strived for.

2. Return temperature.

The return temperature from the radiators should be at least as low as the required primary return temperature. 70°C is the calculated value, but a lower temperature is preferable and should be strived for.

A two-pipe system is the only solution that can guarantee a low return temperature at the right conditions.

3. Temperature drops in the pipe system.

Excessively large pipes result in low water rates and large heat losses. Large heat losses in pipes with a small area result in a large temperature drops, and it is important for a good functioning that the flow temperature is the same to all the radiators.

Good insulation and the highest rates applies for a good functioning.

The stated maximum water rates should be strived for. See graph in chapter 8.

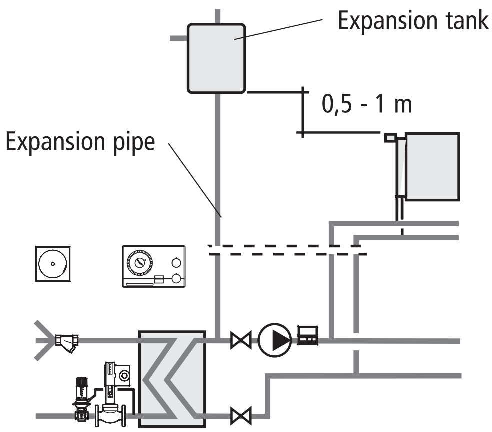
4. Static pressure.

At temperatures below 100ºC, the static pressure is equal to the height converted into kPa from the pressure gauge in the sub-station to the highest point of the system. The pumps should be installed in the flow.

The static pressure is to ensure that all the parts of the system are filled with water, whether the circulation pump is in operation or not.

5. Expansion vessels.

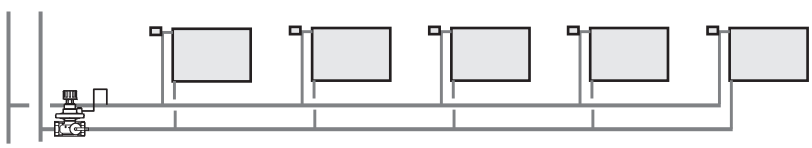
The expansion vessel should be placed on the roof on the top floor. The bottom of the vessel should be at the level for the static pressure, 0,5-1 meter above the highest point of the system. The space is warm, thus there is no risk of freezing, and it can be equipped with a floor drain so that a possible overflow does not cause any water damage.



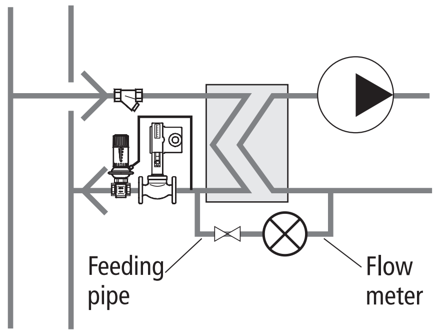
The lower edge of the expansion tank should be placed above the highest point of the system.
Fig. 6:23

6. Available differential pressure.

The available differential pressure must not be so high that it causes disturbing noise. With regard to thermostatic valves, 25 kPa is applied today, as a maximum for the highest quality thermostatic valves. Differential pressure controls with a set constant differential pressure of 10 kPa guarantees quiet and well-controlled thermostatic valves.



The differential pressure controls give the same available differential pressure to each radiator circuit.
Fig. 6:24



The secondary system can be filled up with treated water from the district heating system but controlled. The amount of water fed into system is to be measured and leakages are not acceptable.
Fig. 6:25

7. Water quality.

The requirements of the water used for filling the primary system also applies to the secondary system.

The system must never be emptied of water, not even during longer breaks in operation. As regards possible repairs, only the parts of the system directly affected should be emptied.

Leakages should be attended to immediately.

Water for filling the system is taken from the primary system. The refilling pipe should be equipped with a flow meter so you can register the quantity of the refill in order to control the losses.

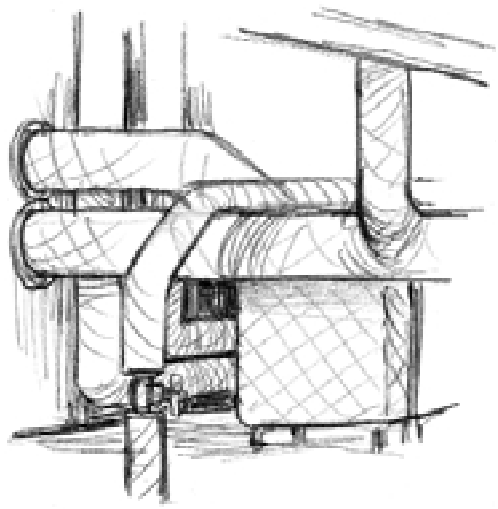
8. Heat losses in the sub-station.

There are many surfaces with high temperatures emitting a lot of heat in the production units.

All warm surfaces should be well insulated in order to increase the efficiency of the plant.

A high room temperature, which is a result of a bad insulation or none, is shortening the life of the equipment required in a modern plant of this type, not to mention the electronic controls. Furthermore, people have to be able to work efficiently within the plant.

Ventilation assisted by of a thermostatically controlled fan reduces the over-temperatures which arise.



Good insulation increases the efficency and lower the temperature in the sub-station.
Fig. 6:26

Control.

It is in the apartments that the actual consumption occurs. Hot water emits heat to a room and comfort is created with the right heat supply.

Comfort requires a control of the heat supply, that is, it must not be too warm or too cold.

Comfortable environment and living conditions require efficient systems with control over heat supply and heat emission.

1. Control and supervision.

The regular supervision of pressures and temperatures in sub-stations is necessary for an economic and environmentally sound operation of the local district heating system and in due course the combined heating and power plants.

Information data on temperatures, water level or pressures in expansion vessels, the position of the cone in the control valve, current primary flow etc., is transferred to the computer in the local production plant, and alarms for excessive temperatures, a low water level etc. can be recorded.

A computerized control and supervision makes it possible to optimize the operation and also increases the operating safety.

Control and supervision will be efficient when computerized.
Fig. 6:27

Control valves.

Two-way valves should be used on the primary side, which means that no more water than required is circulating in the system and that a large temperature drop can be maintained.

Each heat exchanger should have its own control valve, which should be sized according to the current flow and the lowest available differential pressure. Avoid too large valves!

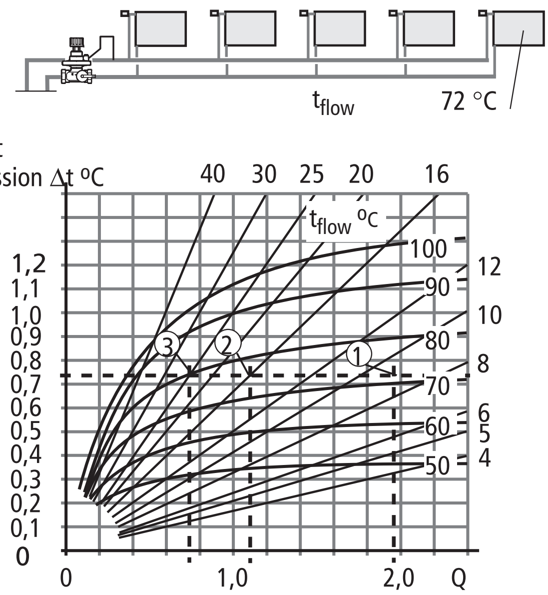
The valve capacity is stated with a k_v-value. The flow through the valve in m^3/h, Q, at a differential pressure across the valve, Δpv, on 1 bar (100 kPa). The k_{vs}-value states the flow at a fully open valve.

2. Control of flow and return temperature.

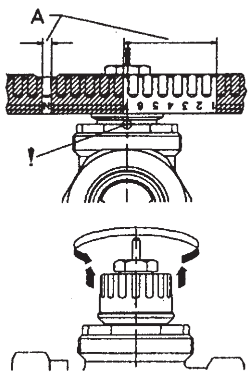
The flow temperature should be adjusted according to the outdoor temperature with a weather compensator which can be connected to a computerized control and supervision system.

The flow temperature should be set so that the worst located thermostatic valve will have good heat authority. Measure the flow and return temperature across the radiator! A too high return temperature is obviated by gradually increasing the flow temperature.

Measure the flow temperature to and the temperature drop across the last radiator in the design circuit.
A small increase in flow temperature has a big influence on the temperature drop as well as on the flow.



① : t_{flow} 72°C, Δt 9°C, heat requirement 0,73.
② : Δt 16°C, requires t_{flow} 75°C.
③ : Δt 25°C, requires t_{flow} 80°C.
Fig. 6:28



	k_v							
	1	2	3	4	5	6	7	N
RTD-N 15	0,04	0,08	0,12	0,20	0,27	0,36	0,45	0,60
RTD-N 20	0,10	0,15	0,17	0,25	0,32	0,41	0,62	0,83
RTD-N 25	0,10	0,15	0,17	0,25	0,32	0,41	0,62	0,83

Pre-set values for thermostatic valves.
Fig. 6:29

3. Control of the room temperature.

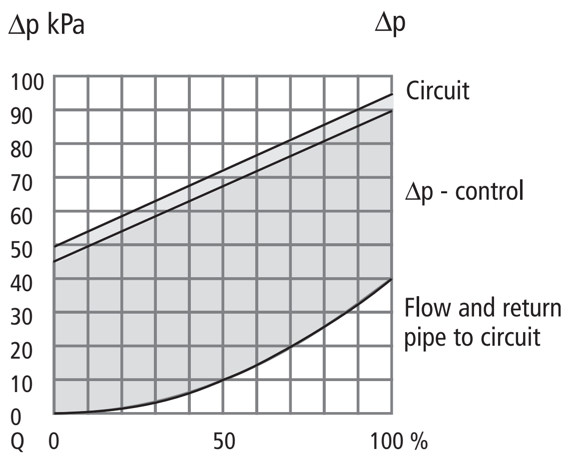
The room temperature is controlled by having thermostatic valves on each radiator. Even the last thermostatic valve is to have good heat authority. A rough adjustment of the required flow is made on each thermostatic valve.

The thermostats can be limited to a maximum temperature of 18-22°C. The temperatures should be higher where elderly or sick persons live.

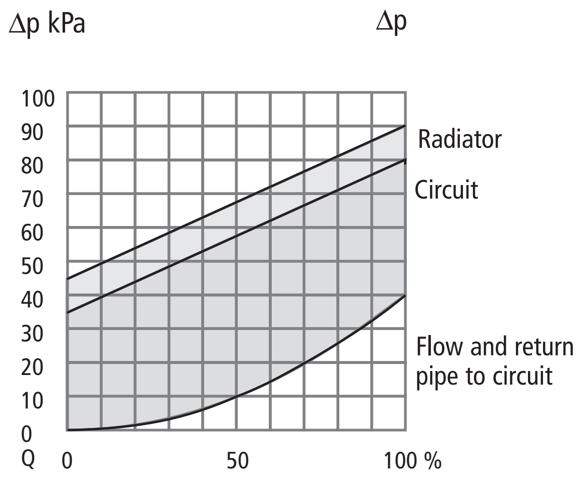
A thermostatic valve with a built-in thermostat should in most cases be used. When the valve cannot sense the actual room temperature, it is replaced by a separate capillary connected sensor, placed at a suitable point, in the room.

4. Pressure control of pumps.

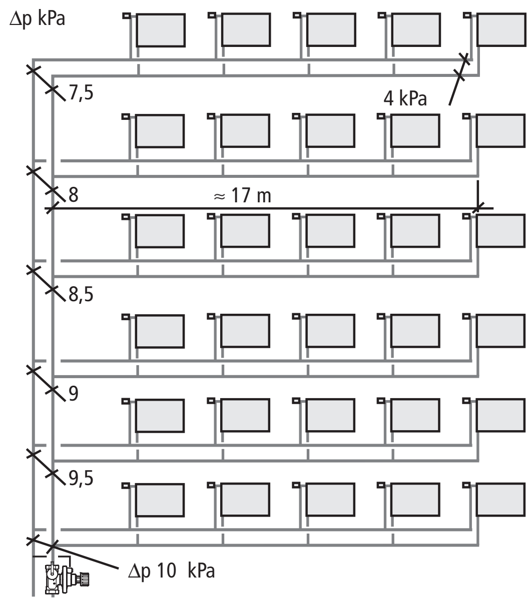
All the circulation pumps in systems with varying flow should be equipped with pressure control. A constant differential pressure at the last branch/valve provides the largest saving. Using pressure control doesn't mean that differential pressure control valve should be excluded.



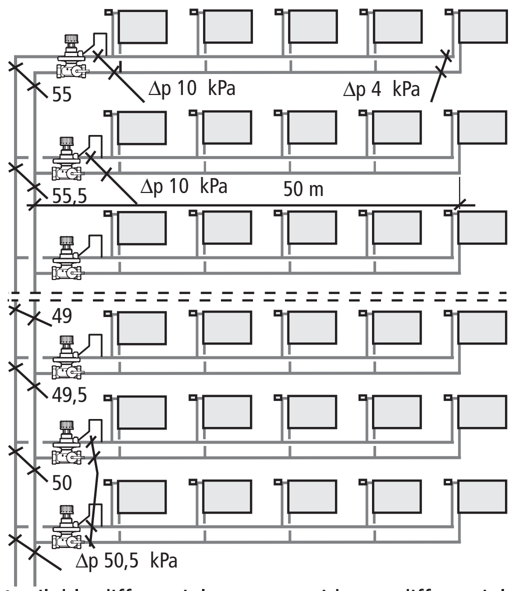
Available differential pressure for a circuit close to the sub-station but with Δp control for the circuit. The pump has proportional pressure control.
Fig. 6:30



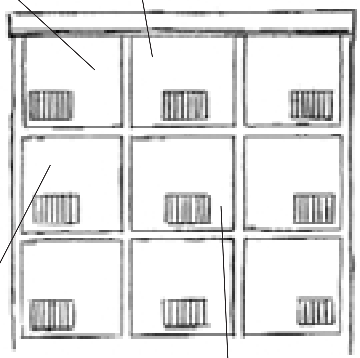
Available differential pressure for a circuit close to the sub-station. The pump has proportional pressure control.
Fig. 6:31



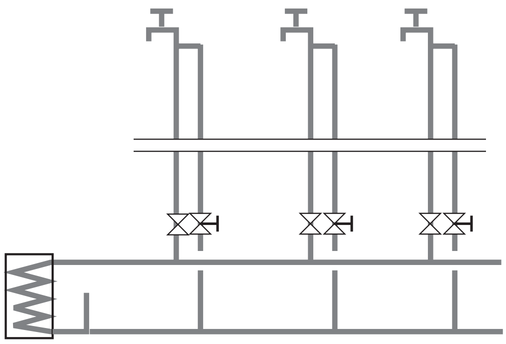
Available differential pressure with the differential pressure control in the riser, up to six floors.
Fig. 6:32



Available differential pressure with one differential pressure control for each radiator circuit in high-raise buildings.
Fig. 6:33



The heat comsumption, for apartments of the same size, will vary depending on how many outer wall and roof surfaces there are. A correction factor can be calculated based on the heat requirement per apartment or per square meter.
Fig. 6:34



Principles for domestic hot water in installation with circulation pipe, shut-off and adjustment valves.
Fig. 6:35

5. Control of the available differential pressure.

In buildings of maximum 6 floors, each riser is equipped with a differential pressure control providing 10 kPa.

When the building has more than 6 floors, a differential pressure control, providing 10 kPa, should be installed on each floor.

6. Flow metering per apartment.

Heat.

Each apartment is equipped with a flow meter for the distribution of the heating costs. The flow meter should be accessible for reading from the stair-well, and possibly connected with the control and supervision system of the building.

With regard to gable apartments and apartments with a roof, a compensating factor is calculated on the basis of heat requirement calculations made for a similar apartment in the centre of the building.

Domestic water system.

Domestic hot water is produced in a heat exchanger of the percolation type in the sub-station.

A distribution pipe is laid in the ground floor of the building, from which risers are drawn up centrally through the building. Each riser is equipped with shut-off and draining valves.

The branches on each floor are equipped with shut-off valves.

Distribution pipes and risers should be made of a non-corrosive material and well insulated.

A gravity pipe for the of hot water should be laid parallel to the tap water pipe.

The circulation pipe should be laid uninsulated in the riser, and at the connection with the horizontal circulation pipe be equipped with an adjustment valve.

Flow meters for domestic hot water should be installed in the stair-well, one for each apartment.

7. Control of domestic hot water.

The outgoing temperature from the heat exchanger should be kept constant. A control valve on the primary side, regulated by an electronic control, which is either built-in to the weather compensator or placed separately, keeps the outgoing temperature constant. Self-acting controls can also be used.

The maximum temperature at the tap is 65ºC and the minimum is 60ºC.

The return temperature from the heat exchanger for domestic water should be below 60ºC, by a comfortable margin.

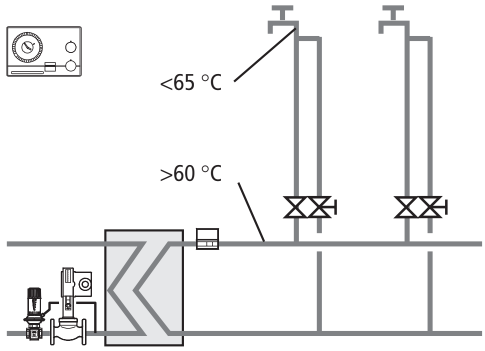
8. Control of domestic water in an apartment.

The taps for personal hygiene, shower and wash-basin should be designed so that hot and cold water can be mixed to a suitable temperature.

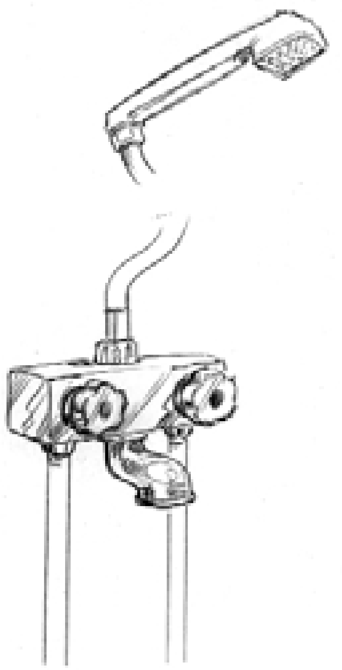
Max flow in the shower, 0,2 l/s.

Max flow in the wash-basin, 0,1 l/s.

Max flow in the kitchen, 0,2 l/s



Control of flow temperature for domestic hot water. Maximum and minimum temperatures are important.
FIG. 6:36



Shower with mixer.
FIG. 6:37