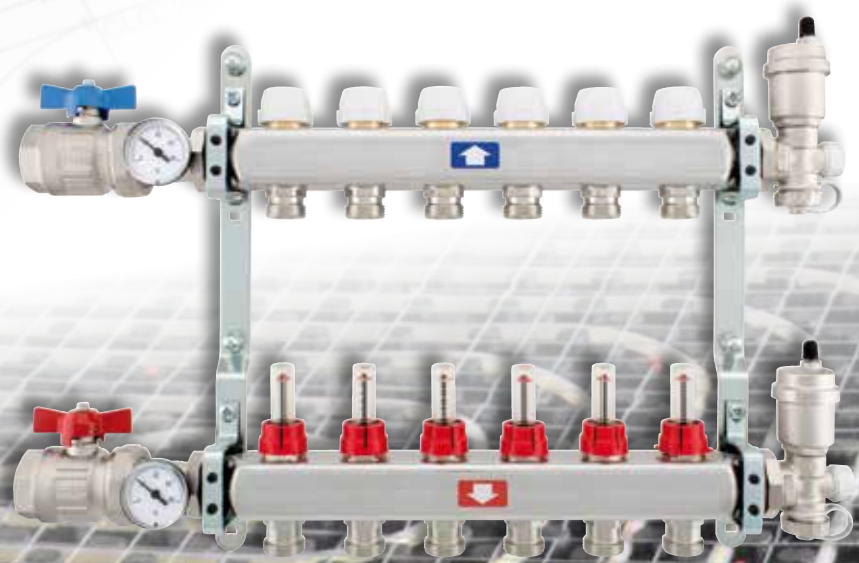




SIZING **RADIANT FLOOR** **SYSTEMS**



THE REGULATION

The design and installation of radiant floor systems is governed by European standard:

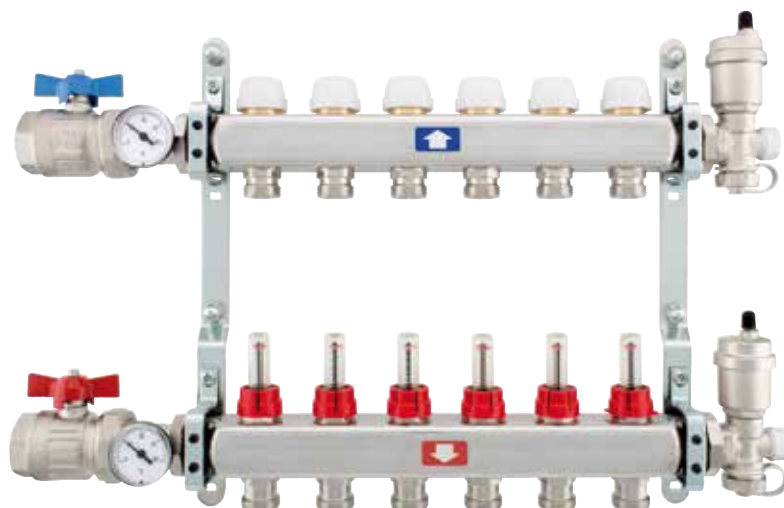
UNI EN 1264: water based surface embedded heating and cooling systems

As for all regulations, it is advisable to check it regularly for applicability and updates.

For the purposes of this document, we consider only the technical aspects of the distribution manifold and the variables it influences and control.

We refer only briefly to the other components, in order to illustrate the function of the manifold in the context of the entire radiant system installation.

This is because Itap intends to promote its own stainless steel manifold, and also because Itap does not offer the other accessories and components required to build a complete radiant system (for instance, insulating panels, boundary strip, plastic or other pipes, etc.).

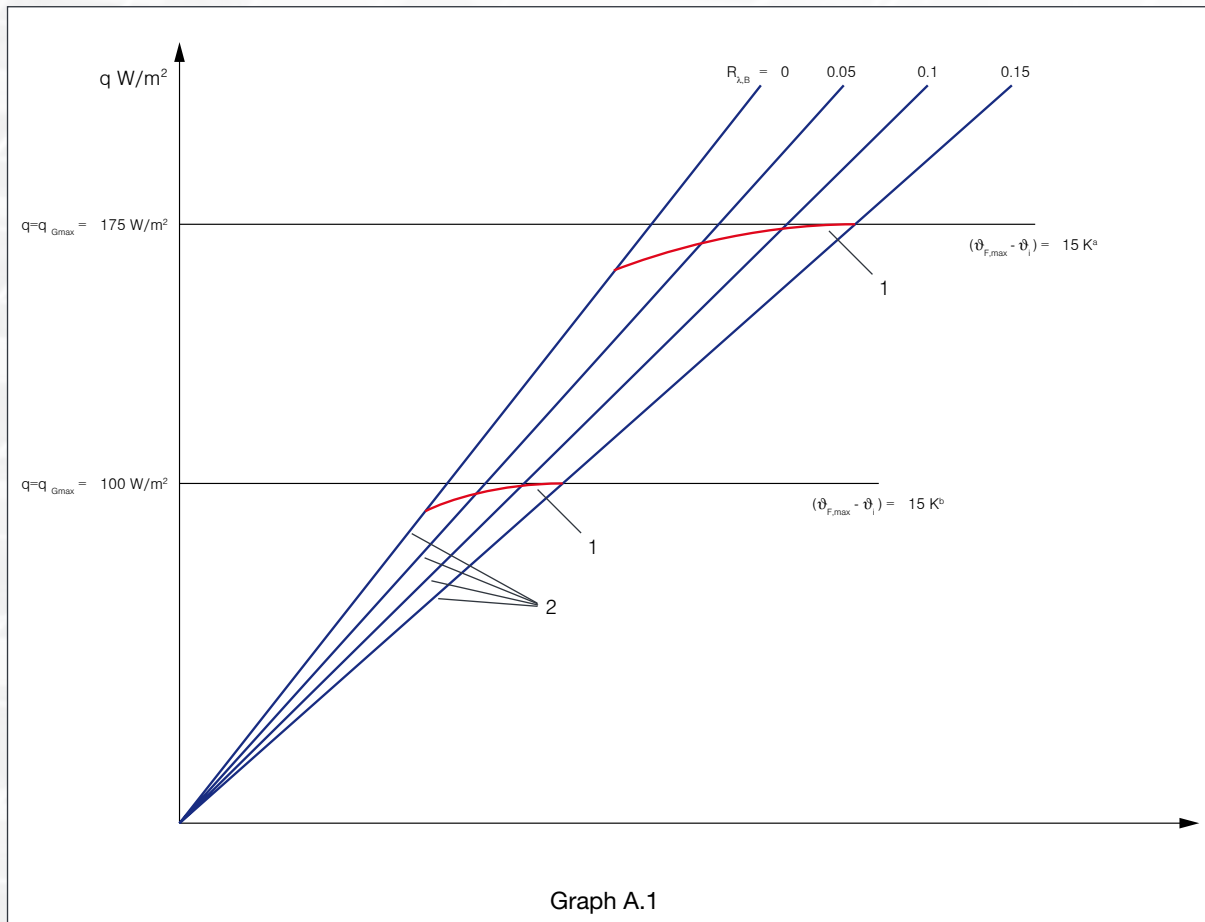




DELIVERY TEMPERATURE CALCULATION

When designing a floor heating system, **only one delivery temperature is specified**, which is constant for each circuit.

The first aspect we consider is the **surface temperature of the floor**.



Graph A.1 shows the characteristic curves (2 – blue) of the system, in relation to four different values for the thermal resistance of the floor.

The thermal resistance values, denominated $R_{\lambda, B}$, are typically taken from the following values, which are considered to cover all typical installations: 0 ; 0.05 ; 0.10 ; 0.15 [$m^2 K/W$].

The characteristic curves are drawn from the following equation, which enables us to calculate **the difference $[\Delta\vartheta_H]$ between the temperature of the vector fluid and that of the room:**

$$\Delta\vartheta_H = \frac{\vartheta_V - \vartheta_r}{\ln \frac{\vartheta_V - \vartheta_i}{\vartheta_r - \vartheta_i}}$$



Delivery temperature calculation

where:

ϑ_v = radiant system water delivery temperature [°C]

ϑ_r = radiant system water return temperature [°C]

ϑ_i = temperature in the room [°C]

These curves express the relation between the heat released by the panel [q] and variation in the temperatures [$\Delta\vartheta_H$].

The graph shows two limit curves (1 – red), used to identify the maximum heat [$q_{G, max}$] which can be released by the panel:

- For occupied surfaces, the maximum value is 100 W/m²
- For marginal surfaces¹, the maximum value is 175 W/m²

From the above, we can derive the limit temperatures of the surface [$\vartheta_{f, max}$] inside a building:

- 29°C in occupied areas
- 35°C in marginal areas

The regulation also specifies that the maximum temperature for bathroom floors may not exceed 33°C (which corresponds to a value of [$q_{G, max}$] of 150 W/m²).

NOTE: we recommend, for radiant systems in residential applications, to size the system using a resistance value [$R_{\lambda, B}$] of 0.10 [m² K/W]. Higher values may be used, when required due to the use of special flooring materials.

The curves given in graph A.1 apply for a temperature differential [σ] with the following limit:

$$0 \text{ K} < \sigma \leq 5 \text{ K}$$

The value [σ] is the difference between the system's delivery and return temperatures.

¹ Marginal areas are the areas within 1 m of the perimeter walls of the room

Delivery temperature calculation



The value $[\sigma]$ is the difference between the system's delivery and return temperatures. The first parameter we calculate is the delivery temperature $[\vartheta_{v, des}]$

$$\vartheta_{v, des} = \Delta\vartheta_H + \sigma/2 + \vartheta_i$$

Where:

$\Delta\vartheta_H$ = the difference between the temperature of the vector fluid and the temperature of the room $[\text{°C}]$

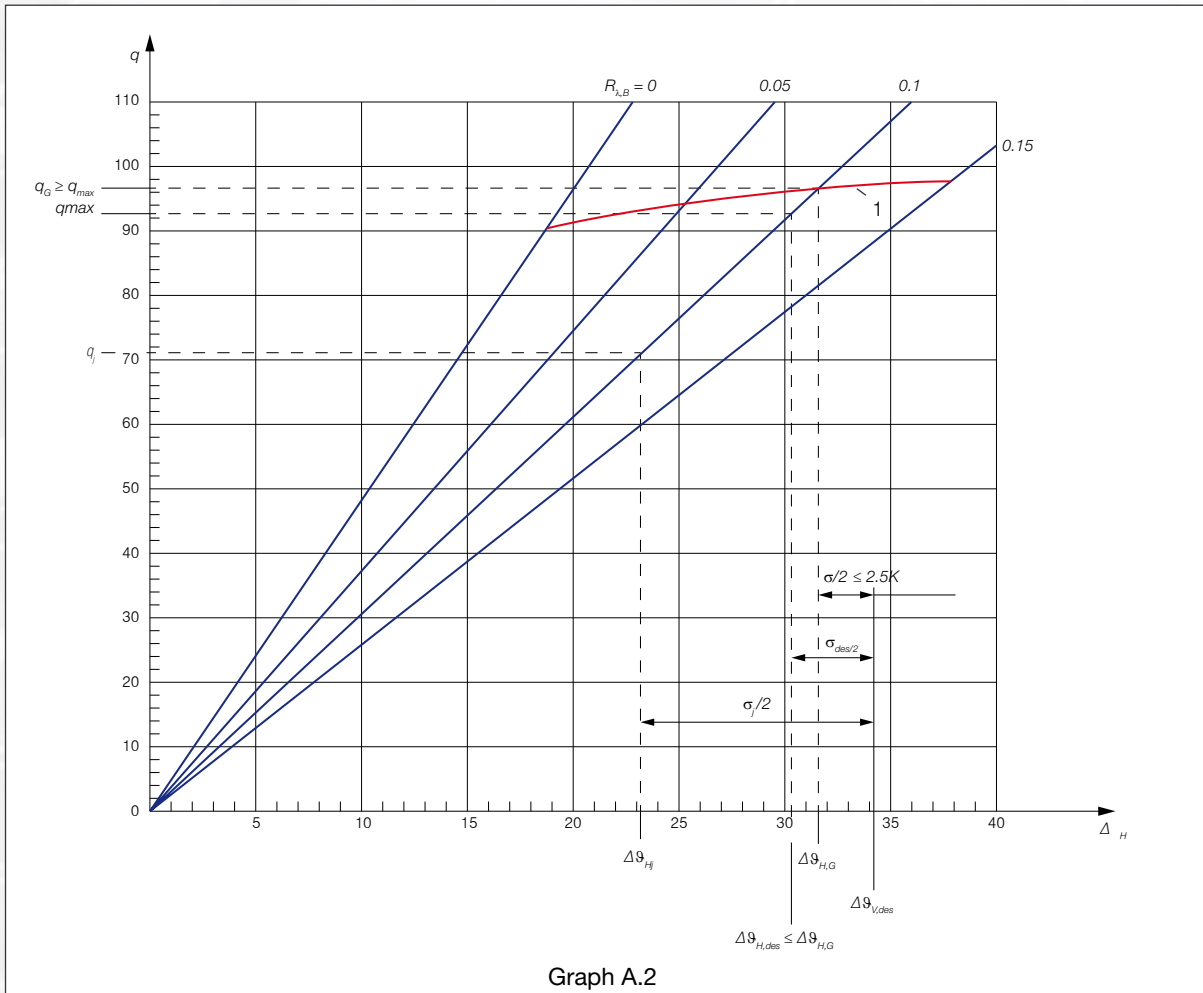
σ = differential between the delivery and return temperatures $[\text{K}]$

ϑ_i = temperature of the room $[\text{°C}]$

To apply this formula, we select the worst case room, i.e. the one with the greatest thermal power demand (not including the bathrooms). The thermal differential $[\sigma]$ is set to be no greater than 5 K: if necessary, the panel in a room can be powered with more than one radiant circuit.

Given the above conditions, the maximum thermal load $[q_{max}]$ must not exceed $[q_G]$

$$[q_{max}] \leq [q_G]$$





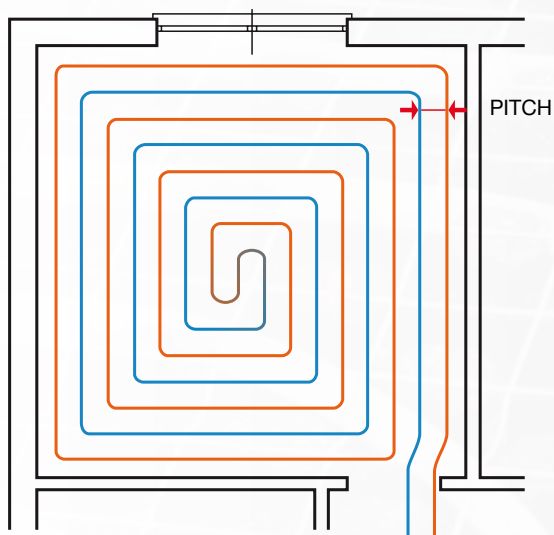
Delivery temperature calculation

Graph A.2 shows how to determine the delivery temperature $[\vartheta_{v, des}]$ for a known load $[q_{max}]$.

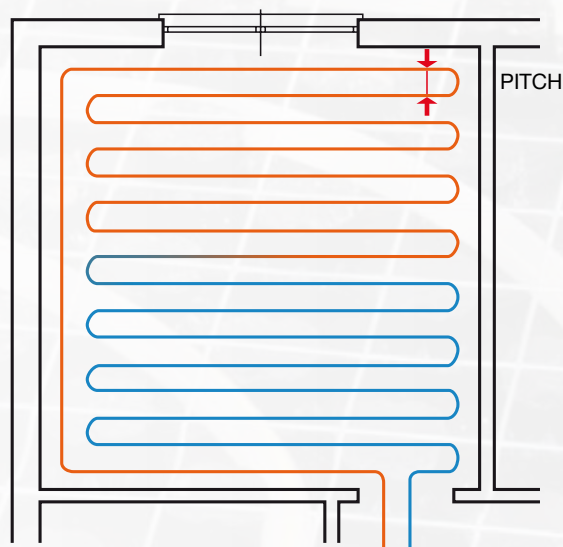
It is advisable always to use the smallest value of the pitch (gap between adjacent pipes in the radiant panel).

The pipes may be installed at constant or variable pitch, and in a serpentine or spiral configuration.

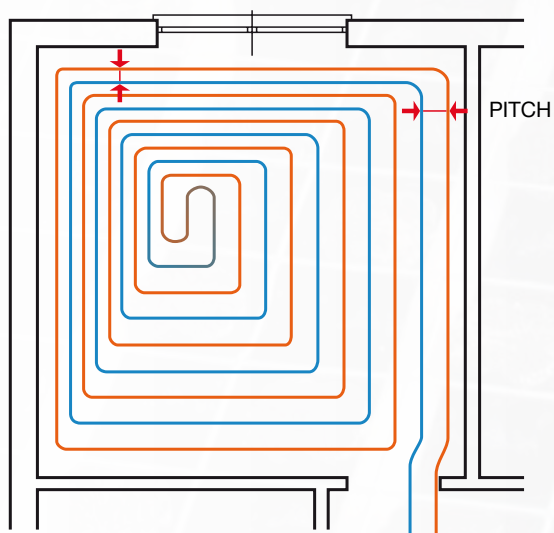
The spiral configuration is usually preferable, since it provides more uniform heating and is quicker to install.



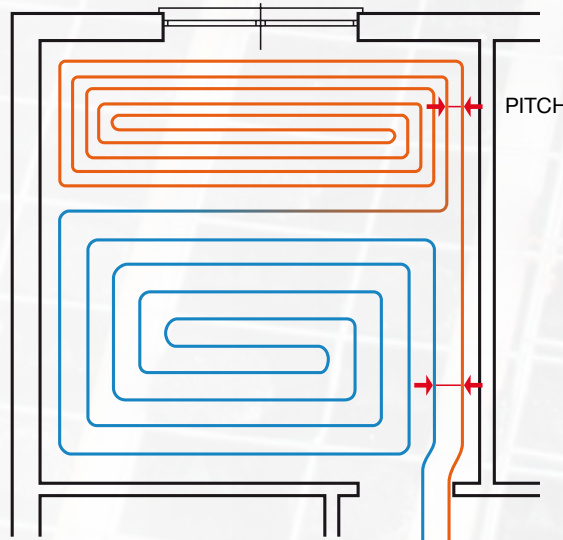
Spiral panel - constant pitch



Serpentine panel - constant pitch



Spiral panel - variable pitch



Serpentine panel - variable pitch

Delivery temperature calculation



Variable pitch installations are suited to rooms with a high level of heat loss (for instance, two outer walls, balcony doors, etc.): in this case, using a smaller pitch can compensate for the thermal dispersion.

Note also that, for serpentine installations, the delivery should always be conveyed towards the outer walls.

UNI EN 1264 provides that the distance between the pipes and the structures delimiting the room must be at least:

- 5 cm for vertical structures
- 20 cm for flue pipes, chimneys and lifts

The thermal differential $[\sigma]$ is calculated with the two following equations:

Case 1) with $\sigma/\Delta\vartheta_H \leq 0.5$

$$\sigma = \vartheta_{v, des} - \vartheta_i - \Delta\vartheta_H$$

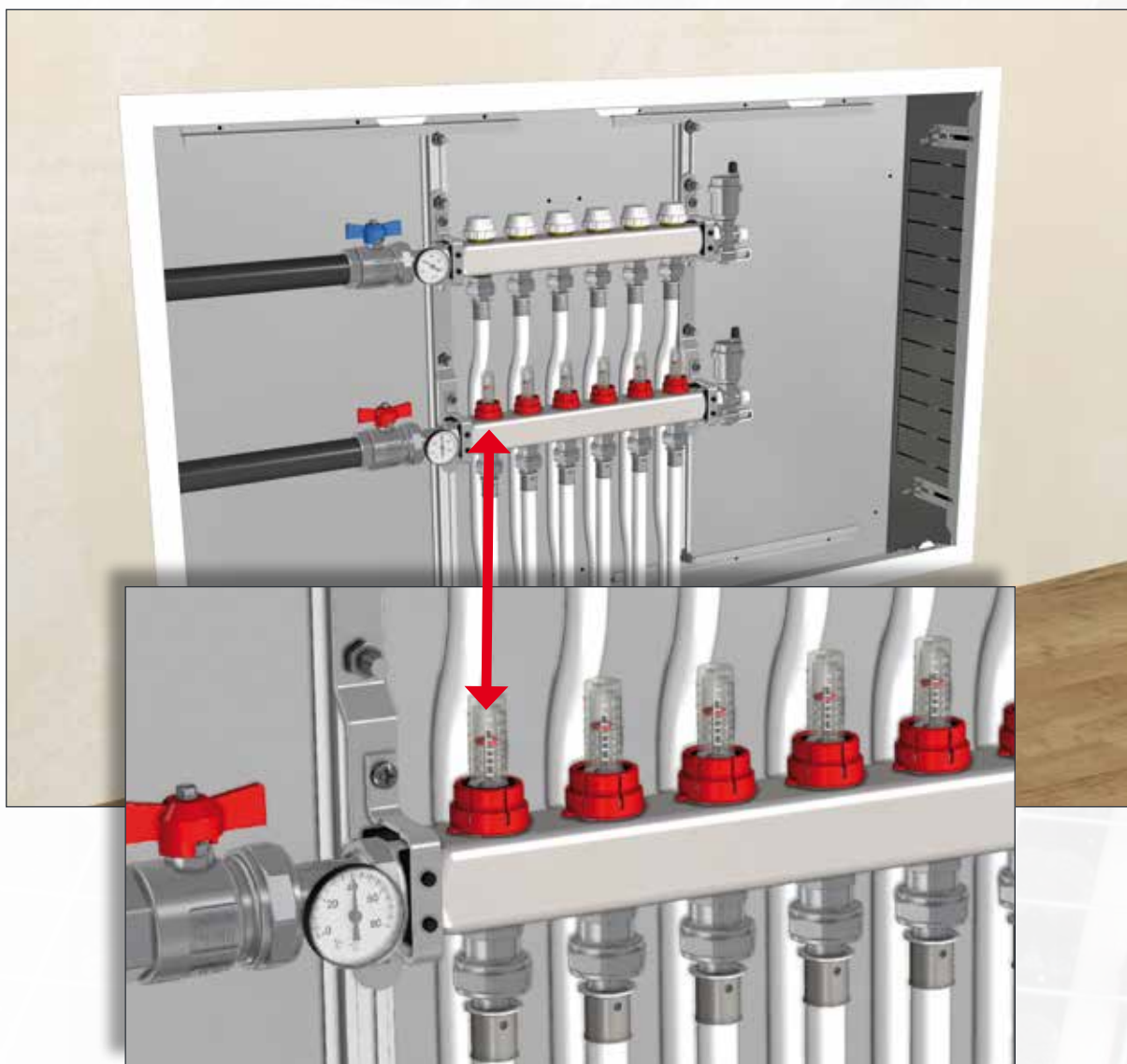
Case 2) with $\sigma/\Delta\vartheta_H > 0.5$

$$\sigma = 3 * \Delta\vartheta_H * \left[\sqrt{1 + \frac{4 * (\vartheta_{v, des} - \vartheta_i - \Delta\vartheta_H)}{(3 * \Delta\vartheta_H)}} - 1 \right]$$



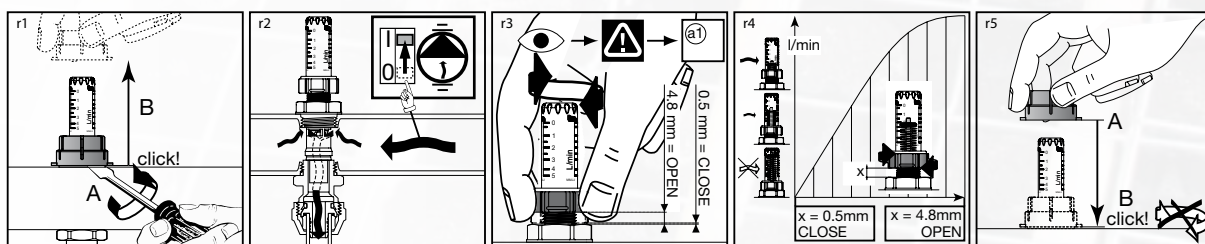
DELIVERY FLOW CALCULATION

In floor heating systems, every circuit has a specific flow value. The flow can be regulated with flow meters at the intake of each delivery circuit:



Thanks to its graduated transparent plastic section, the technician can quickly set the project value by reading the flow rate directly in [l/min].

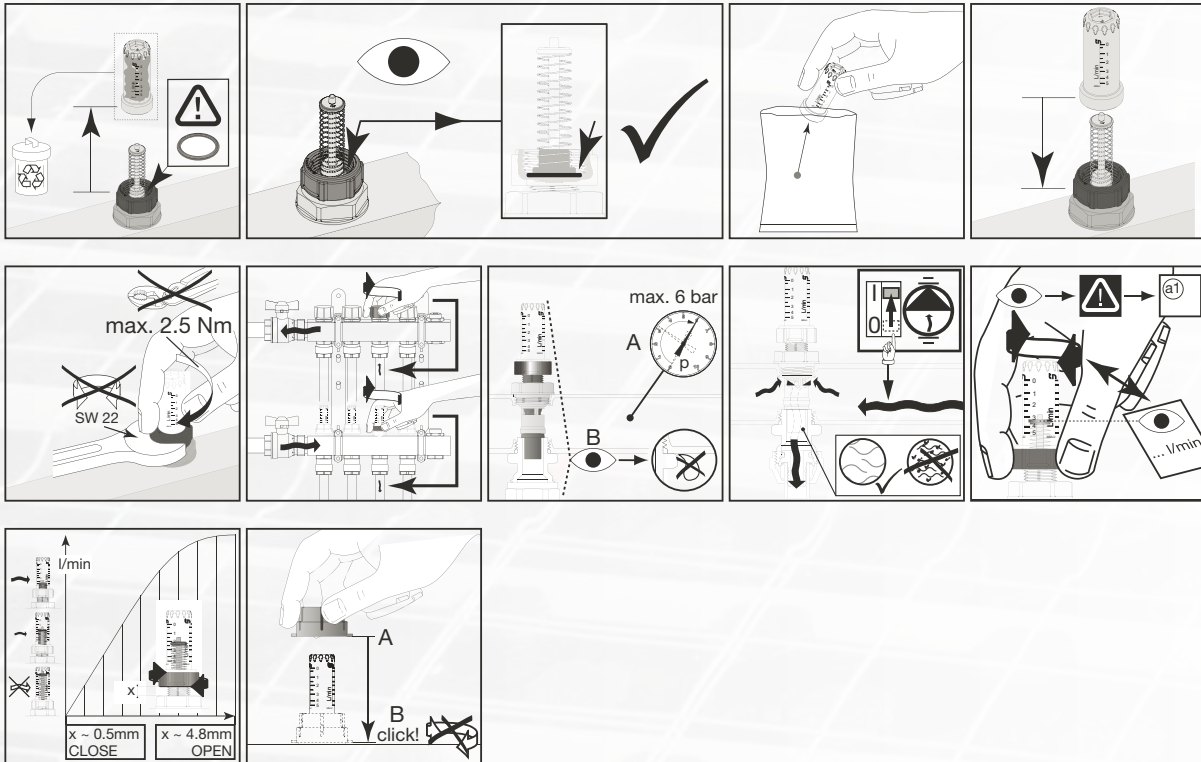
We explain the flow meter adjustment procedure below:





If the transparent plastic part of the flow meter is opaque due to impurities in the circuit, the part itself can be cleaned or replaced without have to drain the entire circuit.

The maintenance procedure is as follows:



The flow rate [m_H] is given by the following formula:

$$mH = \frac{A_f * q}{\sigma * C_w} * \left(1 + \frac{Ro}{Ru} + \frac{\vartheta_i - \vartheta_u}{q * Ru} \right)$$

Where:

A_f = surface area of the room [m^2]

C_w = specific thermal capacity of the water (4,190 J/Kg K)

Ro = resistance of the floor to the transmission of heat upwards [$(m^2 K)/W$]

Ru = resistance of the floor to the transmission of heat downwards [$(m^2 K)/W$]

ϑ_i = temperature of the room per EN 1264-2 [$^{\circ}C$]

ϑ_u = temperature of the room below the room being heated [$^{\circ}C$]



Delivery flow calculation

The following formulas are used to calculate [Ro] and [Ru] respectively:

$$R_o = \frac{1}{\alpha} + R_{\lambda,B} + \frac{Su}{\lambda u}$$

$$R_u = R_{\lambda,ins} + R_{\lambda,ceiling} + R_{\lambda,plaster} + R_{\alpha,ceiling}$$

Where:

$$\frac{1}{\alpha} = 0.0093 \text{ (m}^2 \text{ K) / W}$$

$R_{\alpha, ceiling}$ = resistance to the transmission of heat of the ceiling slab beneath the room being heated. This usually has a value of 0.17 (m² K)/W

$R_{\lambda,B}$ = thermal resistance of the floor [(m² K)/W]

Su = thickness of the substrate supporting the pipe [m]

λu = thermal conductivity of the substrate supporting the pipe [W/(m K)]

$R_{\lambda, ins}$ = thermal resistance of the thermal insulation [(m² K)/W]

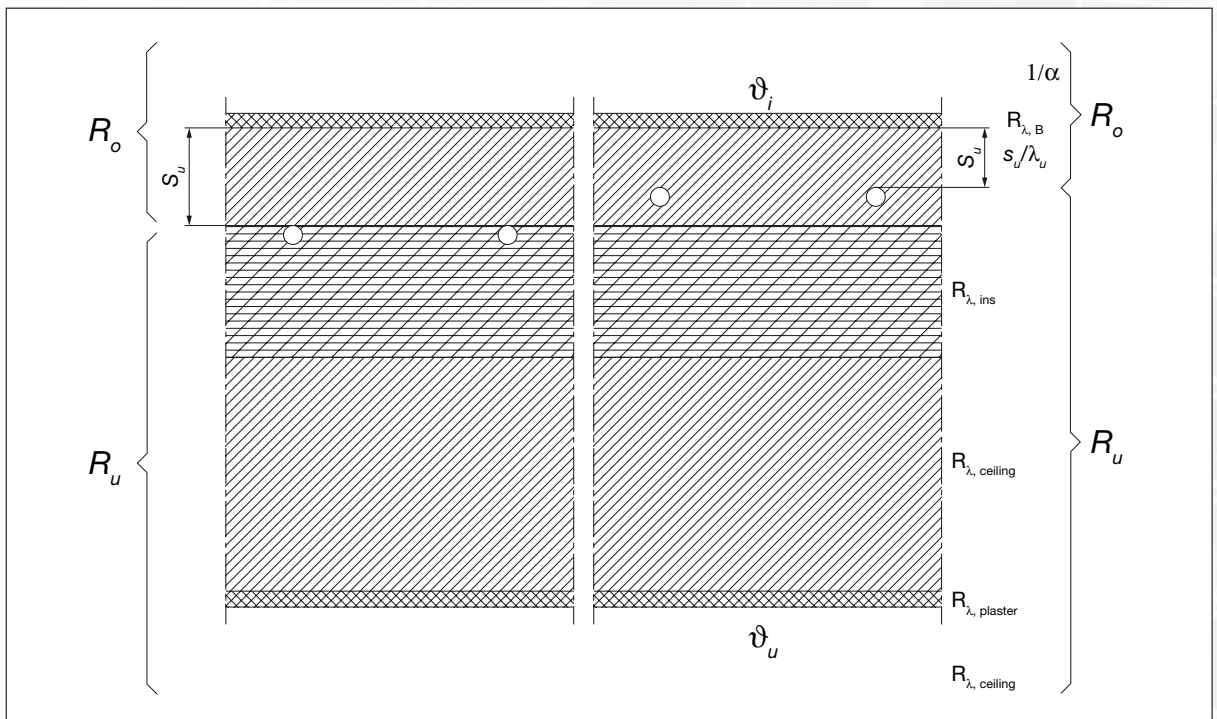
$R_{\lambda, ceiling}$ = thermal resistance of the ceiling slab [(m² K)/W]

$R_{\lambda, plaster}$ = thermal resistance of the layer of plaster [(m² K)/W]

The following image shows two example installations of a floor heating system:

- Left: pipe inside the insulation layer
- Right: pipe above the insulation layer

We also show the characteristic values for the data required to calculate the above formulae, as an aid to comprehension.



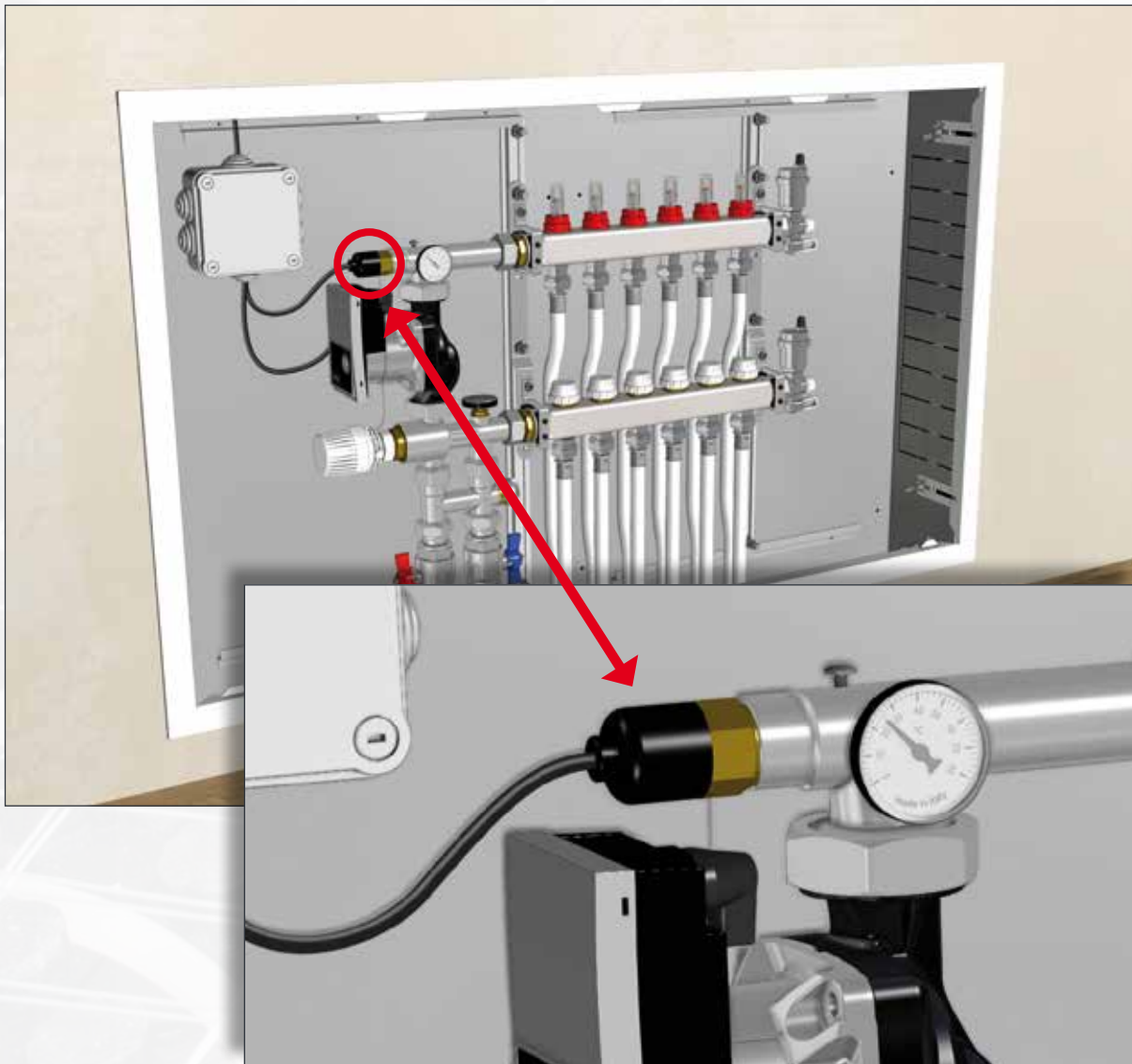
Testing and first startup of radiant floor systems



A very important aspect is the use of UNI EN 1264 compliant components and accessories.

The first requisite, when using a mixer system to lower and adjust the temperature of the vector fluid, relates to the installation of a safety device able to **restrict the delivery temperature to 55°C.**

If an Itap fixed point mixer kit is used, a safety thermostat is included which shuts off electrical power to the secondary circuit pump when the 55°C limit is exceeded.





Testing and first startup of radiant floor systems



Once a regulatory system has been installed, a **seal test** must be run with water or compressed air.

Before the floor is poured, a 4 - 6 bar seal test must be run.

If the test risks forming ice in the pipes, precautions must be taken, such as the use of antifreeze.

Note that the test must be maintained and monitored throughout the pouring of the floor.

The circuit must be flushed at least 3 times and all antifreeze removed before the heating system can be used in normal service.

If the seal test is passed, the system can be started up for the first time.

The first startup must be done at least 21 days after the floor has been poured. This time can be significantly reduced by using appropriate additives, but the first startup should not be done before 7 days.

The startup must be run at a delivery temperature of 20°C to 25°C, for at least 3 days.

You can then increase the delivery temperature to the maximum project temperature, and hold it for at least 4 days.

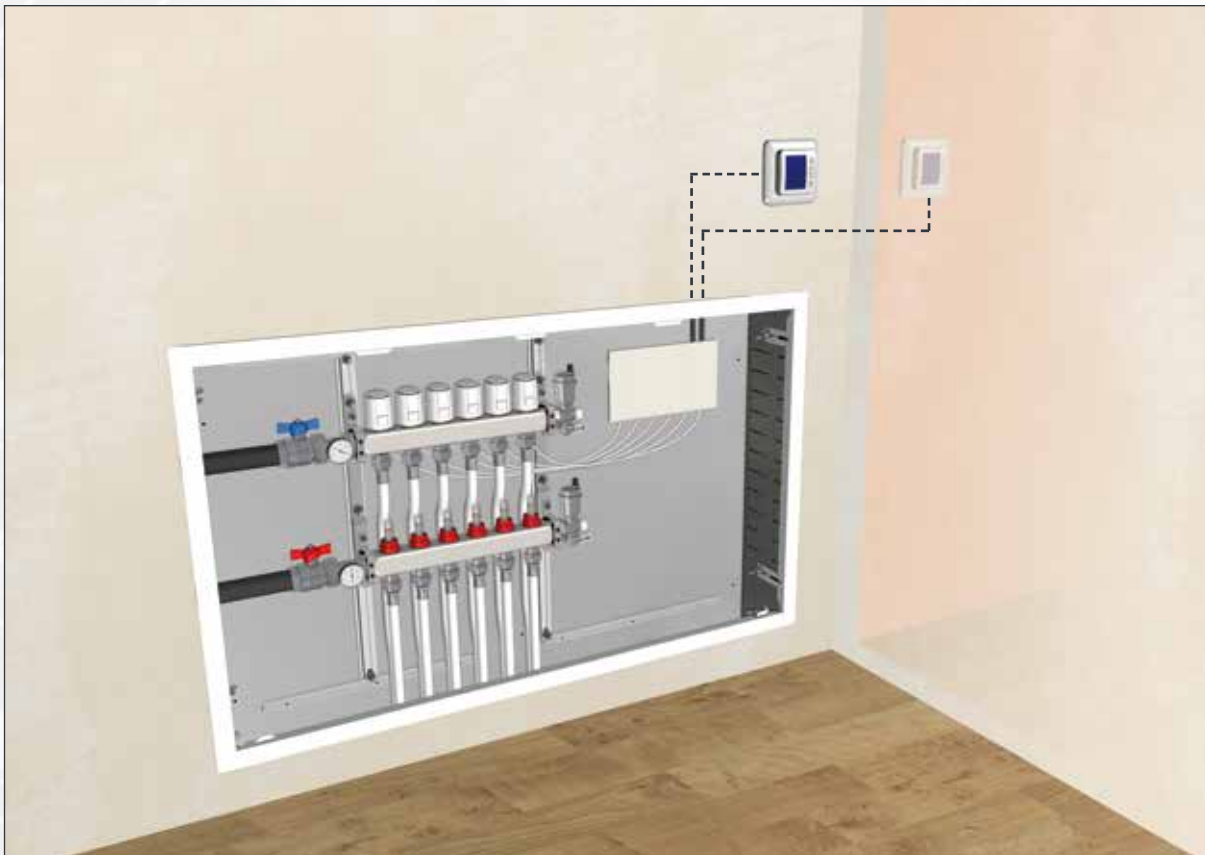
The first startup, like the seal test, must be logged and filed.



VARIABLE FLOW SYSTEMS AND USING A DIFFERENTIAL BY-PASS

It is worth discussing the increasing popularity of variable flow systems.

In such systems, **the individual services are regulated by control valves** which respond to the temperature in the room. In other words, as regards floor heating, each circuit can be controlled by an electro-thermal controlled connected to a temperature sensor (or room thermostat) in the room.



When the sensor's setpoint temperature is reached, the electro-thermal actuator closes. This changes the flow in the circuit and thus increases the differential pressure. This incurs a number of problems, including:

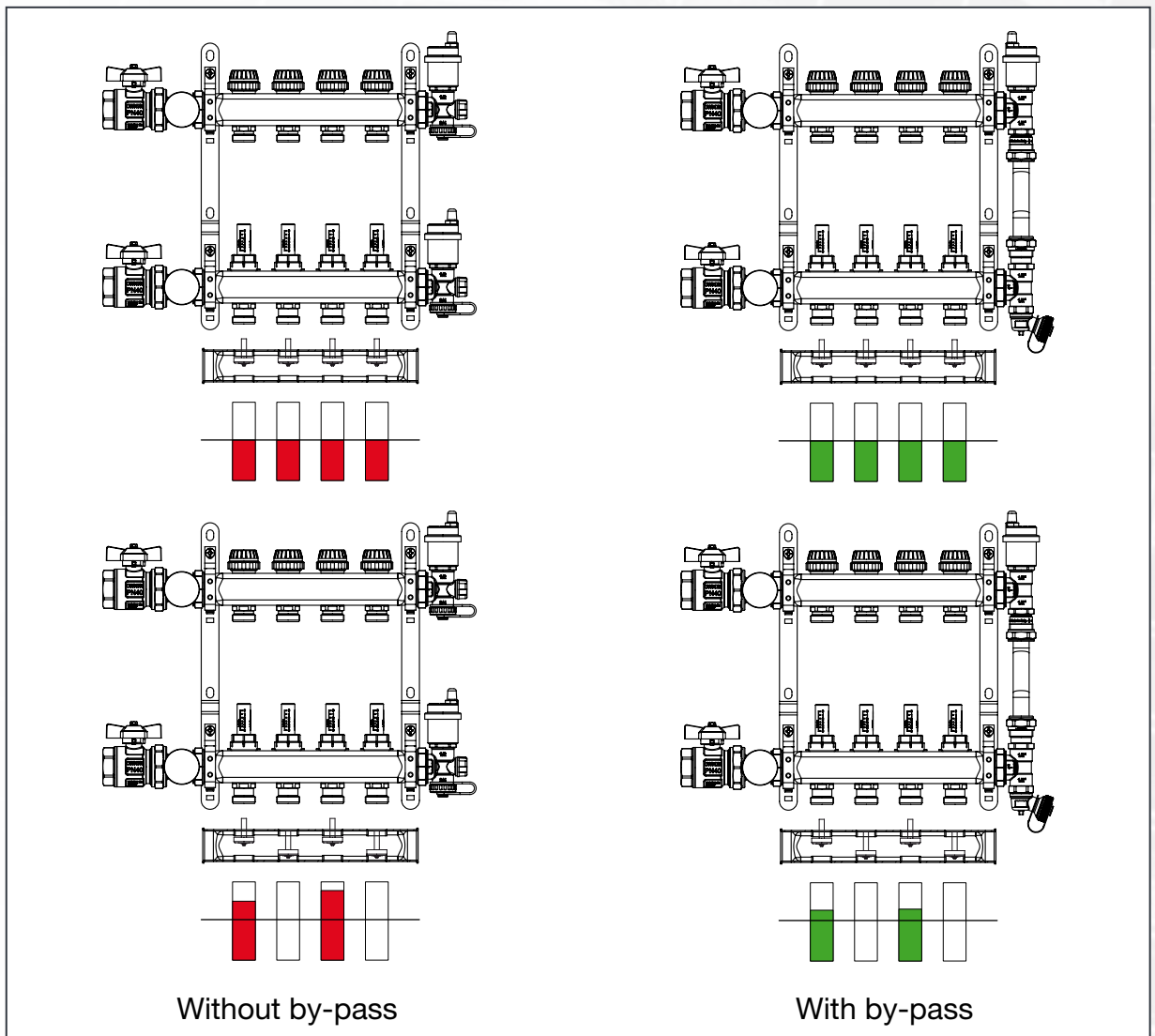
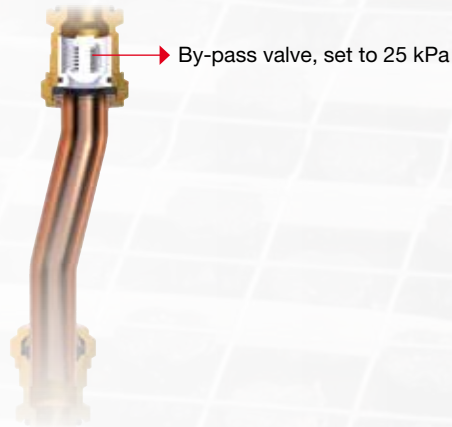
- noise
- excessive wear of internal components
- imbalance of the individual circuits. This latter aspect is quite critical, since it generates an increase of flow towards the open circuits.

To minimise the effect of imbalance in the system, we recommend installing our



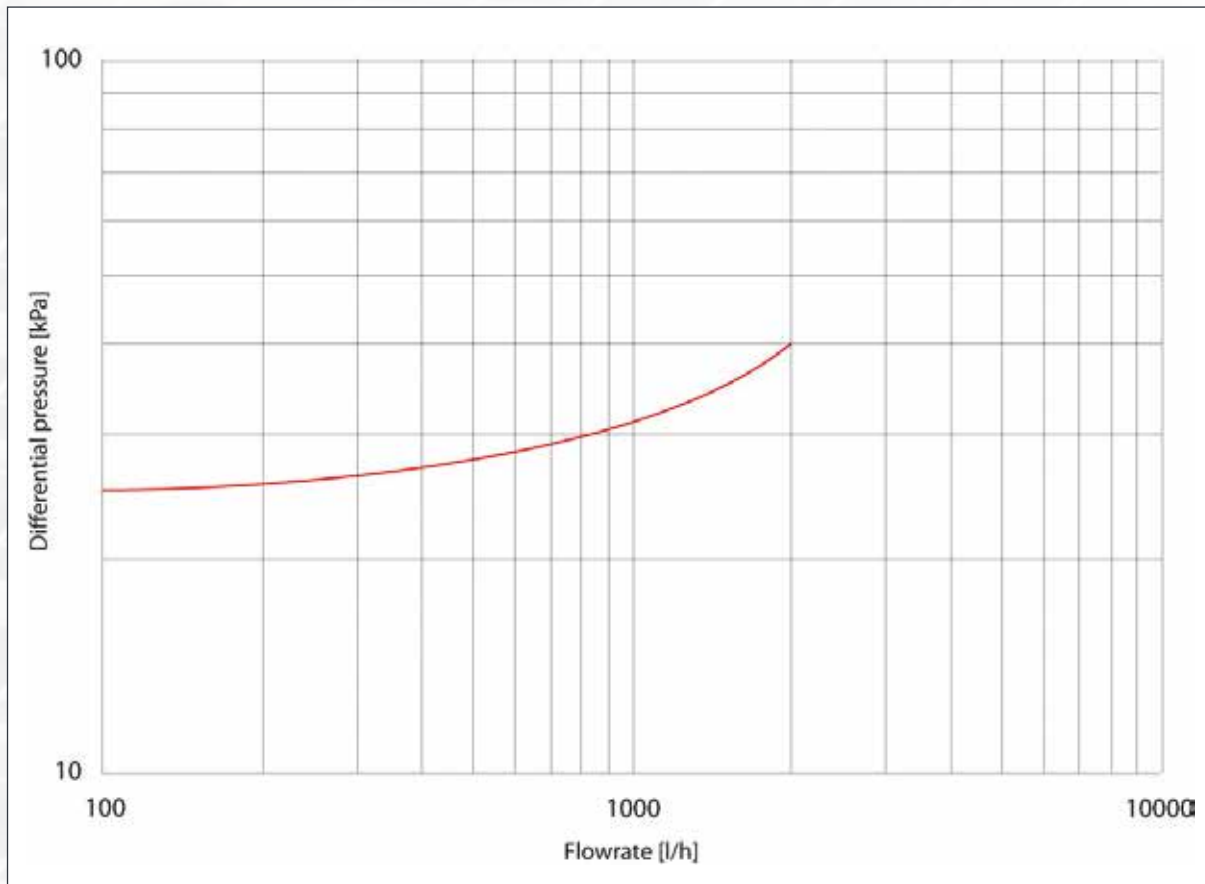
differential by-pass.

With its internal check valve, set to 25 kPa, it ensures that there is always a connection between the delivery and return, so that excess pressure is discharged and the flow in each circuit is kept constant.





The following graph shows the flow rate of the differential by-pass valve as a function of the pressure differential between the delivery and return:



Let's consider a practical example of the benefits of using the by-pass.

Using the previous graph and assuming a differential pressure of 30 kPa, we derive a flow rate of around 15 [l/min].

If we take a moderate value, realistic for medium sized residential installations, of the flow per circuit of 3 [l/min], the differential by-pass is able to balance the excess pressure up to a maximum of 5 completely closed circuits.

Beyond this value, there will be an imbalance in the open circuits, although it will be lower than that experienced with an installation without differential by-pass.



Bibliography:

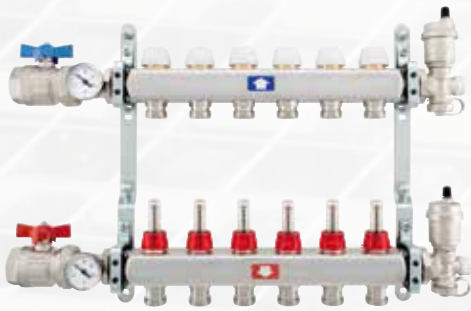
EN 1264-1: water based surface embedded heating and cooling systems – Part 1: Definitions and symbols

EN 1264-2: water based surface embedded heating and cooling systems – Part 2: Floor heating: Prove methods for the determination of the thermal output of floor heating systems using calculation and test methods

EN 1264-3: water based surface embedded heating and cooling systems – Part 3: Dimensioning

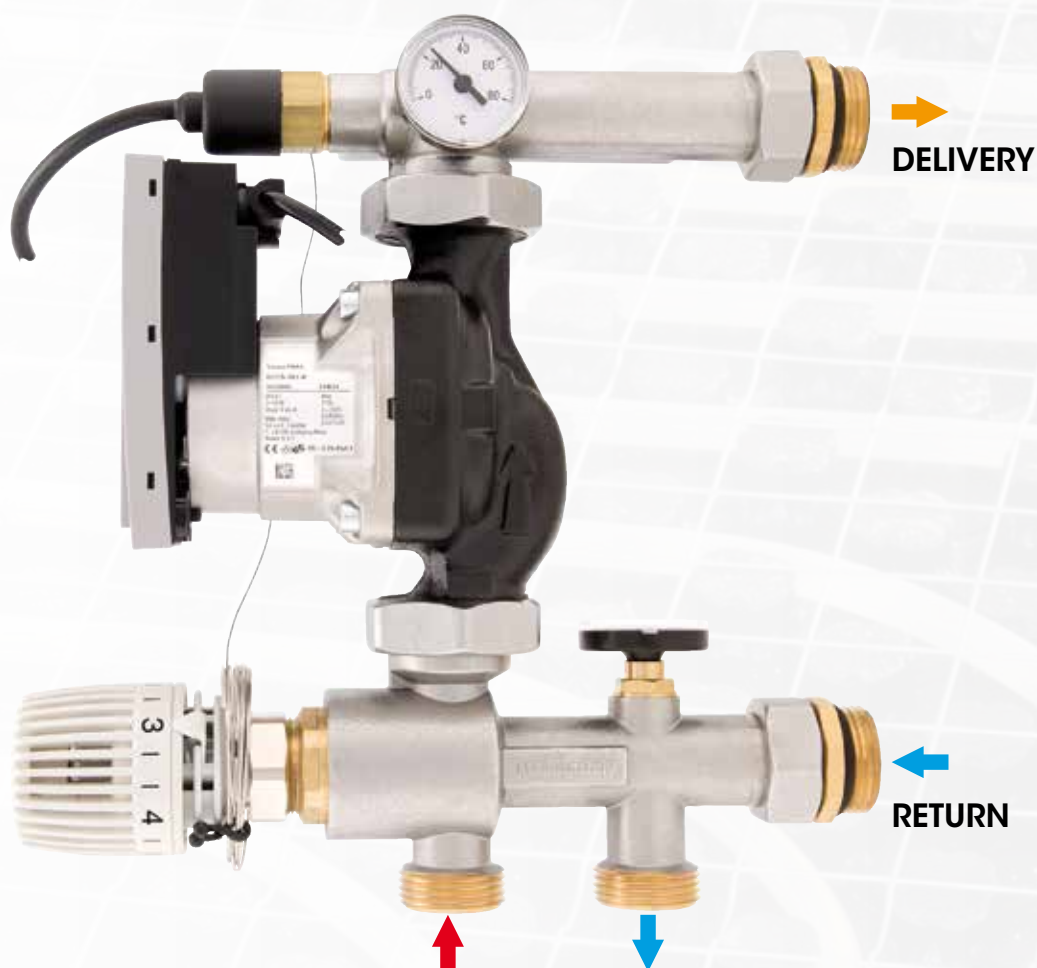
EN 1264-4: water based surface embedded heating and cooling systems – Part 3: Installation

The ITAP range of stainless steel manifolds





Mixing



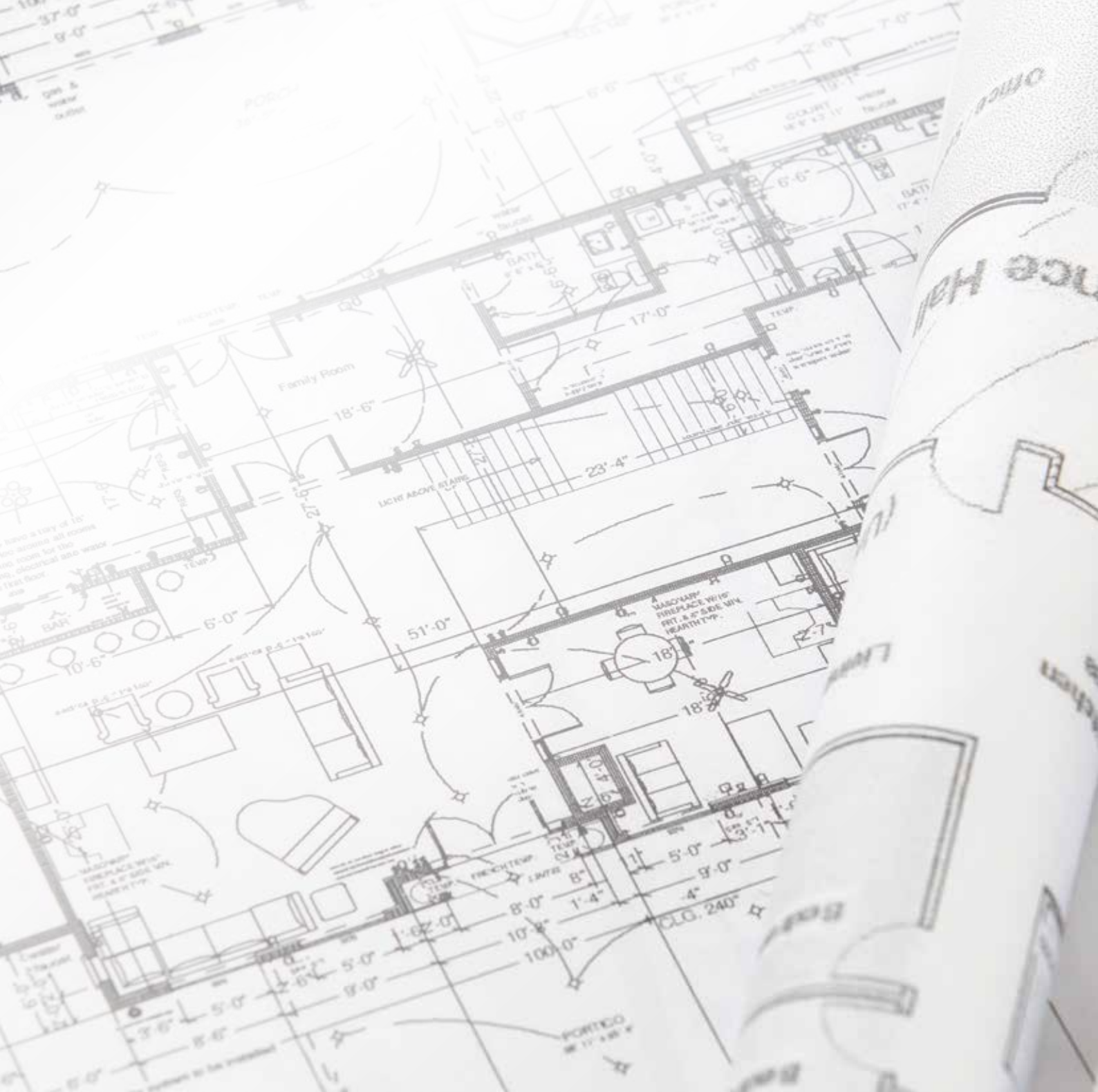
Available with low power draw pump (9490100200CPF) or without low power draw pump (9490100200SPF).

Comprised of:

- 3-way mixing valve
- Thermostatic head with contact sensor
- Safety thermostat set to 55°C
- Thermometer (0°-80°C scale) on delivery and return
- Low power draw pump (optional)

Technical specifications:

- Vector fluid: water, glycolate solutions max. 30%
- Temperature setting: 20°C – 55°C
- Maximum operating pressure: 6 bar
- Valve body and fittings: nickel-coated brass
- Available size: 1"
- ISO 228 threaded fittings (equivalent to DIN EN ISO 228 and BS EN ISO 228)



via Ruca 19/21 - 25065 Lumezzane - Brescia - ITALY
Tel +39 030 89270 - Fax +39 030 8921990
info@itap.it - www.itap.it