

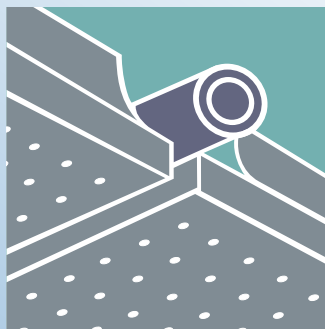


ALUMINIUM RADIANT FALSE CEILINGS

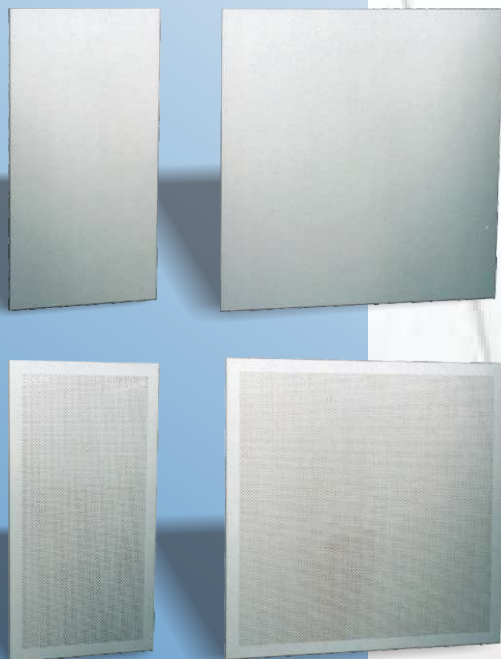
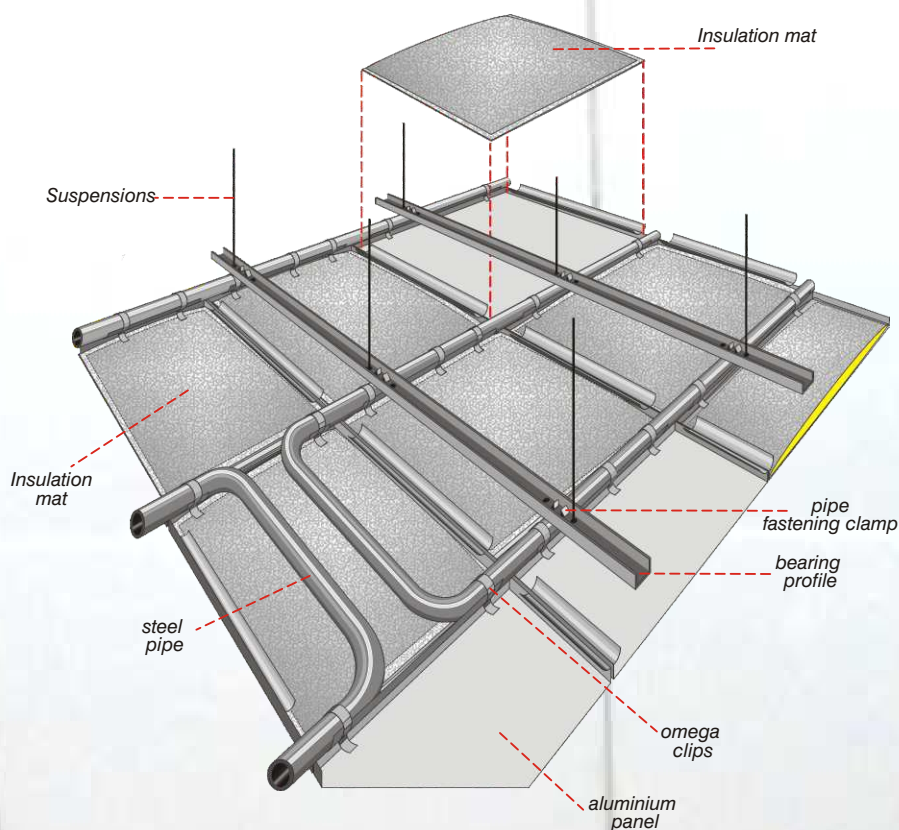


ECOCLIMA

ECOPAN



ECOPAN Aluminium false ceilings



Models

ECOPAN Aluminium false ceilings are composed of pre-painted aluminium panels, 0,78 mm thick, coloured in matt white RAL 9010. Standard sizes are 600x600 mm, 300x600 mm and 200x2.500 mm, each available in perforated or non-perforated version.

It is possible to realize two types of false ceilings: either with or without primary air run above them.

Radiant false ceilings without air

When installing false ceilings for heating, it is necessary to consider that a high average temperature of the ceiling may influence people's comfort. It is therefore necessary to respect some values indicating, as a function of the height of the ceiling, the maximum thermal output that must never be exceeded (for example, a radiant ceiling installed 3 metres high can emit maximum 200 W/m²).

In case of heating operation, hot water in serpentine pipelines can reach an average temperature of about 50°C. In case of cooling, on the contrary, water temperature can never be under 18÷19°C because it is depending on the dew point of the air in the room.

Radiant false ceilings with air

It is possible to run primary air in the plenum between ceiling and false ceiling. In this way the output of the false ceiling increases considerably. If used for heating, the false ceiling can emit more than 300 W/m² and is therefore in the condition to satisfy any requirement. If used for conditioning, air run in these conditions the dew point of the air decreases to 12,5°C and this means that, with water temperature 13°C÷16°C, the risk of condensation is avoided.

The spread between room temperature and average temperature of





circulating water is high enough to allow a strong cooling emission, which may reach $80 \div 100 \text{ W/m}^2$.

This combined conditioning system with air and radiant ceiling needs a lower total cooling output than traditional systems with air only. This is a radiant system, therefore the operating temperature is to be considered, with an air temperature that can be maintained some degrees higher, providing the same comfort.

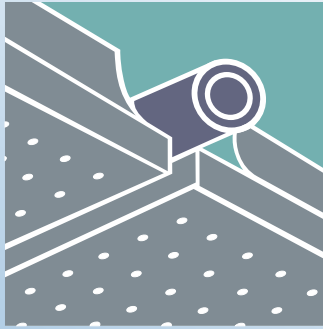
The false ceiling reduces part of the load, therefore the required quantity of air is quite smaller than in a total air system. This produces a reduction of duct size, due also to the fact that the air expands in the plenum above the false ceiling, allowing to keep a rather high speed in the main ducts. The distribution of air in the room does not disturb people because it is carried out through 1,5 mm wide slits between panels, producing an inductive rainfall effect on the whole surface of the ceiling (up to 20 vol/h can be run into the room without any inconvenience to users).

This technology is easy to design and realize, does not require any masonry and the installation times are quite limited, both in new and existing buildings. Furthermore, the possibility of absorbing noise makes this system quite suitable for the conditioning of big crowded areas.

The main advantages provided by this system are the following:

- an air expansion plenum is created between ceiling and false ceiling, useful also as an accessible service area
- it is suitable for many architectural needs
- it can be used for noise absorption
- it does not take up any space on the floor and does not obstruct any movement
- it allows the use of many lighting solutions
- thermal inertia is low
- air is homogeneously distributed
- there is no thermal gradient
- there is no noise
- it does not need any maintenance
- it is the perfect solution where strong air exchanges are required
- being a combined radiation-air system, it allows a significant energy saving.





Technical data for the calculation of ECOCLIMA radiant ceilings without primary air.

Being independent from the wall structure and completely metallic, the radiant false ceiling can theoretically be supplied with high temperature fluids, as it already happens for industrial systems with ceiling radiant panels. This happens only in theory because practically, in particular in residential buildings, it is necessary to consider that when installation height is reduced, a false ceiling with a high average temperature (depending on fluid temperature, pipe spacing and thickness of metal sheet) may cause problems to the users' comfort. The values in the following table (table n. 1) must therefore be respected. This table indicates, as a function of the installation height, the maximum thermal output that should never be exceeded.

Relation between installation height and maximum heat quantity W/m^2 , not to be exceeded to avoid physiological inconvenience to people



height of false ceiling H (m)	transmitted heat Q_o (w/m ²)	average ceiling t_m (°C)
2,2	95-135	31-33,5
2,4	105-155	32,5-35
2,5	125-175	34-37
2,6	140-190	36-39
2,8	165-210	38-41
3,0	190-235	41-43
3,2	210-250	43-45
3,5	245-290	46,5-48
3,8	320-350	52,5-54
4,0	385-420	57,5-59
5,0	500-535	67-68,5

Table n° 1

Table n. 2 indicates, for the different values of pipe spacing (mm 200, 300, 400, 600) and for different average temperatures of heating fluid, the thermal output in W/m^2 for a room temperature $T_{room} = 20^\circ C$, local temperature at upper floor $T_{sup} = 20^\circ C$ and aluminium thickness 0,8 mm

HEATING THERMAL OUTPUT FOR ECOCLIMA RADIANT CEILINGS (W/m^2)
Pre-painted aluminium, thickness 0,8 mm

average water temperature °C	ceiling 600x600 pipe spacing mm 600	ceiling 300x600 pipe spacing mm 300	board ceiling spacing mm 200		
			pipe spacing mm		
			mm 600	mm 400	mm 200
40	62	110	62	93	137
45	79	140	79	116	169
50	95	169	95	140	200
55	113	200	113	166	233
60	128	233	128	192	267
65	148	264	148	215	302
70	163	296	163	242	337
75	180	331	180	267	372
80	198	363	198	290	409
85	219	401	219	320	445
90	235	433	235	343	483

Table n° 2



Please Note: Thermal outputs for temperatures different from 20°C are obtained as follows.

E.g.: Room temperature 15°C and average water temperature = 70°C.

To obtain the output, check the average water temperature 70°C + (20-15) = 75°C.

For temperatures of the room at upper floor different from 20°C, the following correction coefficients shall be applied:

- for $T_{sup} = 0^{\circ}C$ $K = 0,97$
- for $T_{sup} = -10^{\circ}C$ $K = 0,94$
- for $T_{sup} = -20^{\circ}C$ $K = 0,92$

For cooling operation, these metal false ceilings can be supplied with cold water, whose temperature, depending on the air dew point in room, must be higher or equivalent to 18°C.

Table n. 3 shows cooling outputs in W/m^2 for three temperatures of supply water (18°, 19° and 20°C), for pipe spacing = 200, 300, 400 and 600 mm, $T_{room} = 26^{\circ}C$, $T_{sup} = 26^{\circ}C$.

COOLING OUTPUT FOR ECOCLIMA RADIANT CEILINGS (W/m^2)
Pre-painted aluminium, thickness 0,8 mm

average water temperature °C	ceiling 300x600 pipe spacing mm 300	ceiling 600x600 pipe spacing mm 600	board ceiling width mm 200		
			pipe spacing mm		
			mm 600	mm 400	mm 200
18	26	47	26	39	56
19	22	41	22	34	49
20	19	34	19	31	43

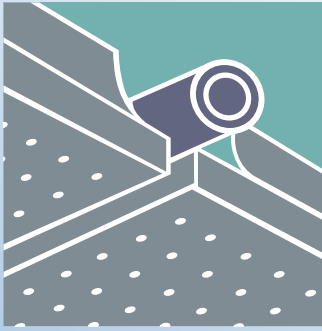
Table n° 3

Please Note: When establishing the average temperature of circulating water in the $\varnothing 1/2"$ pipes of the radiant ceiling, it is necessary to make sure that the same temperature is not below the air dew point.

In order to grant the turbulent state in pipes $\varnothing 1/2"$ and therefore the required cooling output, the water flow in each pipe must not be under 250 l/h, corresponding to a speed of 0,26 m/s

For a temperature of upper room (external) = 32°C, the correction coefficient of $K = 0,94$ must be applied to the indicated outputs.





Technical data for the calculation of ECOCLIMA radiant ceilings with primary air run in the plenum between ceiling and false ceiling.

In this case the inlet of primary air at 16°C is to be foreseen, coming down in the room through the 1,5 mm slits in the false ceiling.

The table n. 4 shows the heating output in W/m² for metal radiant ceilings "ECOCLIMA" with pipe spacing 300 mm and room temperature = 20°C.

HEATING THERMAL OUTPUT FOR "ECOCLIMA" RADIANT CEILINGS (W/m²)
Pre-painted aluminium, thickness 0,8 mm

average water temperature	1 vol/h	2 vol/h	3 vol/h	4 vol/h	5 vol/h	6 vol/h
70	273	302	337	360	372	384
60	215	233	244	279	291	302
50	163	169	180	203	221	227
40	110	116	122	140	151	163
30	58	64	70	81	93	99

Table n° 4

It is now important to consider the cooling performance of "ECOCLIMA" aluminium radiant ceiling with primary air, where air is distributed through the 1,5 mm slits.

As noticed when examining cooling radiant ceiling without air run above it, performance is limited because depending on dew point of air in the room. With "ECOCLIMA" system with primary air, on the contrary, the pipe coil with cold water is surrounded by conditioned air, run in the plenum at 16°C and R.H. 80%. In such conditions the air dew point is 12,5°C and there is therefore no risk of condense water when supplying serpentine pipelines with water at 13°C.

The Δt between room temperature and average water temperature is high enough to allow a strong cooling emission from the radiant ceiling and consequently the reduction of the volume of air to be treated.

COOLING OUTPUT FOR "ECOCLIMA" RADIANT CEILINGS (W/m²)
Pre-painted aluminium, thickness 0,8 mm

vol/h	quantity of air run m ³ /h m ² floor	ceiling 600x600 pipe spacing mm 600	ceiling 300x600 pipe spacing mm 300	board ceiling spacing mm 200		
				pipe spacing		
				mm 600	mm 400	mm 200
1	3	41	70	41	58	79
1,5	4,5	42	75	42	60	81
2	6	43	77	43	62	85
2,5	7,5	45	79	45	64	87
3	9	47	82	47	66	89
3,5	10,5	48	84	48	67	93
4	12	50	85	50	70	96
4,5	13,5	53	87	53	73	99
5	15	54	91	54	75	101
5,5	16,5	56	94	56	77	103
6	18	57	96	57	78	105
6,5	19,5	59	99	59	80	108
7	21	62	100	62	81	110
7,5	22,5	63	102	63	85	112
8	24	64	105	64	87	114

Table n° 5



Table n.5 shows the different cooling outputs according to the vol/h of air run through the ceiling and to the spacing of pipes $\varnothing 1/2''$, which compose the serpentine pipelines. The following data are considered:

- T room = +26°C U.R. 50%
- T supply cold water = +13°C
- T return cold water = +16°C
- state of air run in the plenum: = +16°C U.R. 80%
- room height = 3 m

This mixed cooling system requires a lower total cooling output in comparison to a traditional system with air only.

It is well known, and demonstrated by all essays about thermal technique, that the reference unit of radiant systems is operating temperature. Practically, if during winter the air temperature can be 2°C lower than that which is normally set for traditional systems, during summer cooling up to 28°C is enough, while normally 26°C are required. Furthermore, as indicated by the "GUIDE AND DATA BOOK '54" published by ASHRAE, using a metal radiant ceiling, it is possible not to consider in the calculation of summer heating loads the following percentages:

- 100% of the heat penetrating through the ceiling or the roof
- 13% of the solar radiation on the windows
- 25% of perceptible (dry) heat emitted by people in the room
- 16-20% of the heat of lamps inside the false ceiling, provided that there is a direct metal contact between box and heating pipe.

The above mentioned percentages, which can be deducted from the general estimate of summer heating loads, must on the contrary be considered, for an appropriate thermal balance, when calculating cooling water flow.

The following example can clarify the concept:

Example

Room temperature = 28°C

Total summer heating loads:	5.200 W
Perceptible heat absorbed by radiant ceiling, according to the above indicated percentages:	900 W
Residual cooling load:	4.300 W

Considered room surface = 50 m²

Useful radiant surface: 50x0,85 = 42,5 m²

Considering that air at 16°C in quantity of 2 vol/h is run in the plenum, the cooling output of air is:

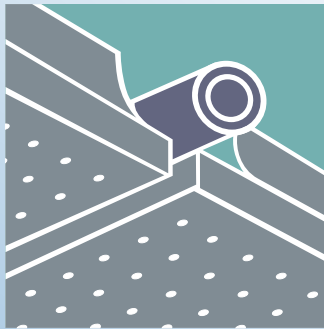
$$2 \text{ vol/h} \times (50 \times 3) \times (28 - 16) \times 0,34 = 1.224 \text{ W}$$

The false ceiling covers: 4.300 - 1.224 = 3.076 W

The surface available to be used is 42,5 m² and the cooling output required to the radiant ceiling is 3.076 : 42,5 = 72,4 W/m².

As results from the table n. 5, the installation of a false ceiling in the size mm 300x600, with 2 vol/h of air run in the plenum, grants a satisfying output of 77 W/m².





If considering the possibility of conditioning the same room with a standard system with air only, the situation is the following.

Room temperature = +26°C

$$\text{Total cooling load: } \frac{5.200}{26} \times 28 = 5.600 \text{ W}$$

Temperature of run air: +15°C

$$\Delta t = 26 - 15 = 11^\circ\text{C}$$

$$K = 0,34 \text{ aria} \quad \Delta t \times K = 11 \times 0,34 = 3,74 \text{ Wh/m}^3$$

$$\text{Quantity of chilled air to be run} = 5.600 : 3,74 = 1.497 \text{ m}^3/\text{h}$$

The volume of the room is 150 m³, therefore about 10 vol/h are needed.

The example shows the following:

- in case of mixed air + radiant panels conditioning system, the quantities of circulating air are reduced and it is therefore possible to use only clean primary air, discharging all fug and improving the room conditions
- reduced quantities of air allow containing the sizes of ducts, which often cause problems to designers, architects and installers, due to their dimensions. Considering then that air flows and expands in the plenum, it is possible to keep a high speed in the main ducts, reducing their size even more. Air distribution does not create any inconvenience to people because it flows in rooms through 1,5 mm slits existing in the aluminium false ceiling, producing a lamellar flow, that ensure an outlet speed of 3 m/s with an overpressure in the plenum of about 0,5 mm only. This is optimal to provide an inductive effect without any movement of dust, germs and various suspended particles in rooms. This solution allows a rainfall distribution of air to any point in the room.



The following table shows the relation between overpressure in the plenum, air speed in slits and single airflow in 1,5 mm slits.

Overpressure mm H ₂ O	Speed in slits m/s	AIR FLOW IN SLITS		
		ceiling 600x600 slits mm 1,5x600	ceiling 300x600 slits mm 1,5x300	board ceiling spacing 200 - independent from pipe spacing m ³ /h per m slit
0,5	3,1	10	5	16,6
1,0	6,0	18	9	29,0
1,5	7,7	25	12,5	41,0
2,0	8,6	28	14	47,0
2,5	9,8	32	16	53,0
3,0	11,7	38	19	63
3,5	12,3	40	20	66
4,0	13,2	43	21,5	71
4,5	14,1	46	23	76
5,0	14,8	48	24	79
5,5	16	52	26	86
6,0	16,9	55	27,5	91
6,5	17,9	58	29	96
7,0	18,5	60	30	100

Table n° 6



In special cases, these systems have reached an air distribution through the false ceilings up to 20 vol/h, without inconvenience to users.

To understand the actual extreme convenience of these systems, let us consider an office building having volume 3.000 m², where rooms are 3 m high.

A mixed radiant panels and air system would need: 2 vol/h x 3.000 x 3 = 18.000 m³/h of circulating air.

A full air system would need instead: 10 vol/h x 3.000 x 3 = 90.000 m³/h.

When using "ECOCLIMA" radiant false ceilings for conditioning, no insulation mat is required, except in case of perforated panels for noise absorption. In this last case, a glass wool foil is supplied, cut and sized according to panels or boards.

In special rooms, where air inlets higher than 20 vol/h are required (kitchens, refectories, etc.), it is possible to install perforated aluminium panels, size 600x600 with 3 mm wide holes (4050 holes per panel). The following graphic shows the relation between flow of each single panel, speed of air outlet and corresponding pressure drop.

Resistance of air to passage through the 4.050 holes Ø 3 mm (app. 286,13 cm²) of a 600x600 mm panel without insulation

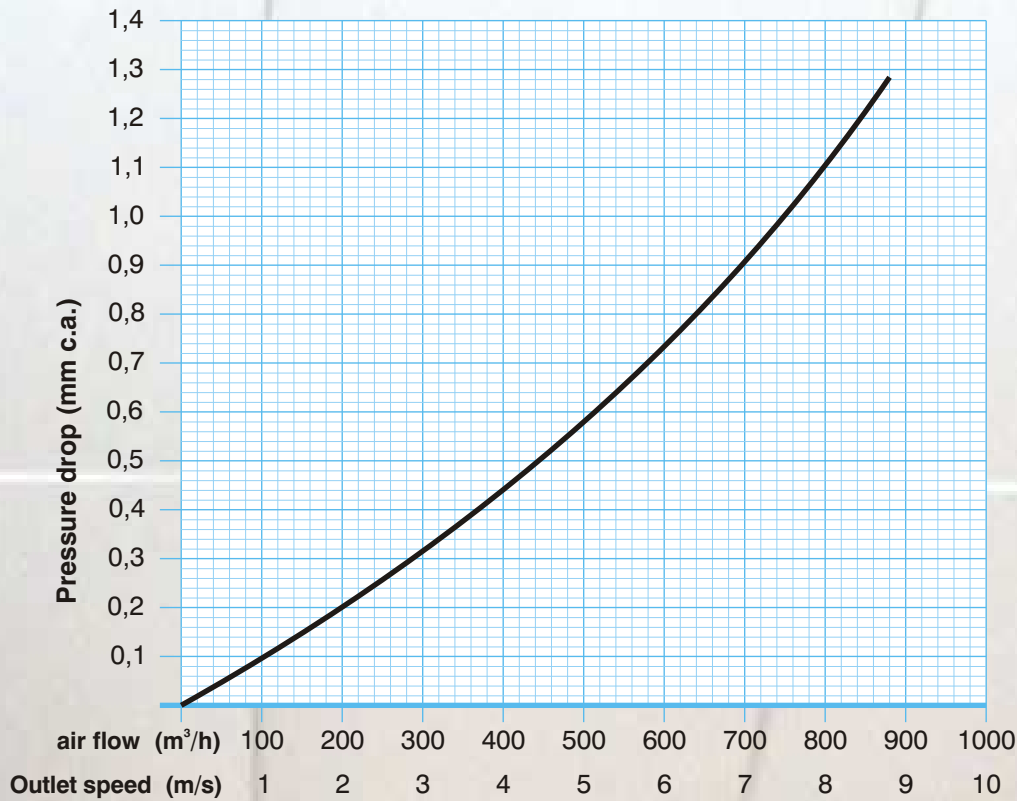
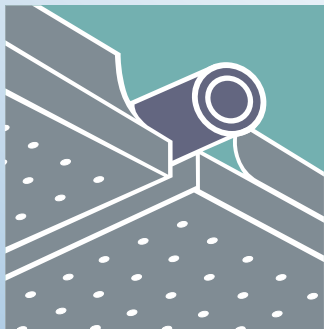


Fig. N° 7





General indications to design a radiant ceiling system

Calculation of summer and winter heating loads.

The basic calculation is carried out considering the current norms in each single country, but keeping in mind that with radiant systems a project temperature of internal air 2°C lower for heating and 2°C higher for conditioning can be considered, in comparison to traditional systems. No increase due to thermal gradient for rooms higher than 3 m must be calculated and no increase for intermittent use, because thermal inertia is quite reduced.

Choosing the size of the false ceiling and the spacing of serpentine pipelines.

According to the thermal emissions indicated in the tables, the size of the false ceiling and the pipe spacing is chosen. Normally a serpentine pipeline covers about 20 ÷ 25 m² of false ceiling; for example, a 100 m² room has 4 serpentine pipelines. This means that from the main piping network, running normally in narrow corridors, a branch line runs to the room and from this one 4 sections spread out to supply the 4 serpentine pipelines.

Panels develop horizontally, therefore the removal of possible air bubbles is of basic importance. The presence of those bubbles is revealed by continuous ticking noises, disappearing after drain. It is very important that the suitable water speed inside pipes is granted.

Distribution types.

When installing large and important systems, it is always recommended to start with collectors in the heating central unit having their own automatic modulating regulation for each side. This is particularly useful during in-between seasons when one side of the building needs heating and another needs cooling.

Horizontal distribution to levels should be carried out in order to balance the pressure drops in the various pipe sections.

To easily remove air from the circuits, when possible, the "source" supply can be foreseen, namely water supply network is separated from the rising column and goes up to the serpentine pipelines, pushing any possible air bubble towards the return network, that flows up to the return column, on top of which a vent keg with drain tap is installed (the use of automatic kegs is not recommended).

If this "source" supply is not possible, it will be necessary to choose the "rainfall" solution, with supply and return distribution networks above serpentine pipelines. These pipelines must be installed with appropriate "ascending" slope towards the rising columns with vent kegs mounted on the top.

Automatic regulation of room temperature.

In addition to the automatic regulation of the central unit, already described, each room or group of similar rooms can be equipped with a 2 or 3-way motorized valve

Current digital regulation systems are reliable and ensure optimal comfort conditions.

An accurate calculation of dispersions and summer heating loads, considering spacing of serpentine pipelines and adjustment of water and air flow in each single room, allows to limit the regulation to central



unit circuits only

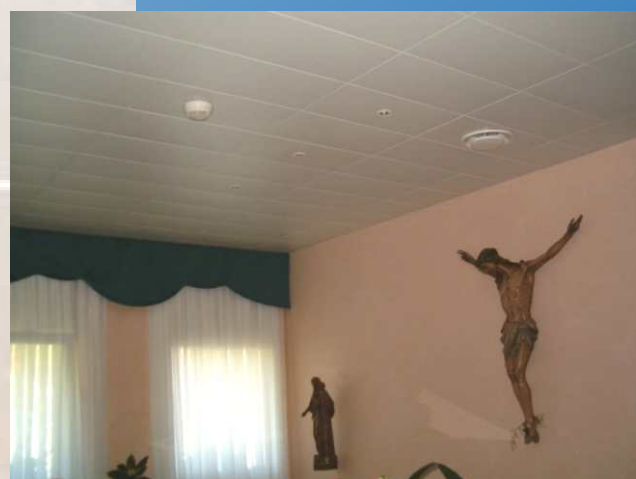
Description for technical specifications

M²..... aluminium radiant false ceiling, size mm (300x600), (600x600), (200x2500):

- main structure, heating or cooling, composed of serpentine pipelines made of polished black steel pipes Ø1/2" taken from hot laminated band, pickled, externally bordered, tested, degreased, phosphate-treated and kiln painted with water epoxy paint (10-15 µm), hanging to the ceiling by means of proper zinc-coated U-shaped profiles, sized U 40x20 mm, thickness 1,5 mm, with adjustable height and perpendicular to the above mentioned pipes. All installation fittings must be properly protected against rust
- aluminium non-perforated (perforated) pre-painted panel, alloy 3003 H 44, thickness 0,78 mm, one face in standard colour 1131, gloss 10%, paint thickness 18±2 microns and protection film, other face with Primer 08L
- aluminium U-profiled perimeter frame, thickness 0,6 mm.

Conclusion

All subjects described in this report show that this installation technology is easy to design and install. No masonry works are required and building times are contained. This is very important when installing the system in existing and occupied buildings (e.g. old hospitals, hospices, etc) where inconvenience can be reduced to the minimum level because it is possible to proceed room by room. In case of new buildings, the system allows the monetization of the building in short times, because this gathers up many tasks to a single supplier, avoiding any problem in coordinating builders, electricians and installers. The relevant noise absorbing performance makes ECOPAN false ceilings particularly suitable also for large and crowded environments.



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