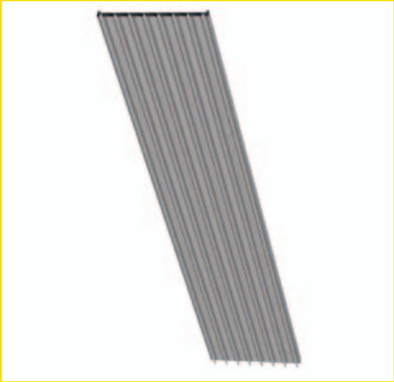
PANELS COMPLYING WITH EUROPEAN NORM 14037

WATERSTRIP



FRACCARO
RADIANT SOLUTIONS

Update on 11/2012

WATERSTRIP
HOT WATER
RADIANT PANELS

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FRACCARO RADIANT SOLUTIONS

Model number: WP2 060-090-120
WP3 030-040-060-090-120

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EN 14037-1 Ceiling mounted radiant panels

RADIANT SOLUTIONS

1.0 “WATERSTRIP” HOT WATER RADIANT PANELS

1.1 OPERATING PRINCIPLE

WATERSTRIP (hot water radiant panels) are suitable for heating large industrial and civil buildings by infrared rays. They are the best solution where low-noise operation, no air flow, and no dust circulation are required. WATERSTRIP are also suitable to heat rooms housing inflammable mixtures.
No air flow and low stratification ensure low running costs.
The power emission and the production quality are certified according to the European norm EN14037. Furthermore, the “WP” series is the result of a new patented production technology which assures the highest quality of the finished product.
In summertime, the same installation can work as a cooling plant. This is possible by using cold water as working fluid.

1.2 CONSTRUCTIVE FEATURES

WATERSTRIP consist of a set of pipes secured to an insulated shield placed on the top side. Even after several years of operation, the accurate assembly ensures a perfect contact between pipes and shield, enabling peak thermal emission values.
Side stripes can be added to reduce air circulation. A joint-cover is fitted on the welds connecting the sections. Strengthening cross-pieces are fitted on the top side, and are also used for anchoring. Fibreglass panels with aluminium foil at the top are fitted to eliminate upward radiation. The manifolds are square-sectioned, not welded to the thermal panels and can be used both with hot and cold water. The standard colour is white RAL9010. Other colours can be provided upon specific request.
WATERSTRIP panels can also work with steam: in this case special manifolds should be applied.

Key:
1 = Metal sheet panel
2 = Ø 22 mm tubes
3 = Cross-piece strengthening
4 = Top insulating panel
5 = Lateral anti-convective stripes
6 = Square manifold
7 = Joint cover

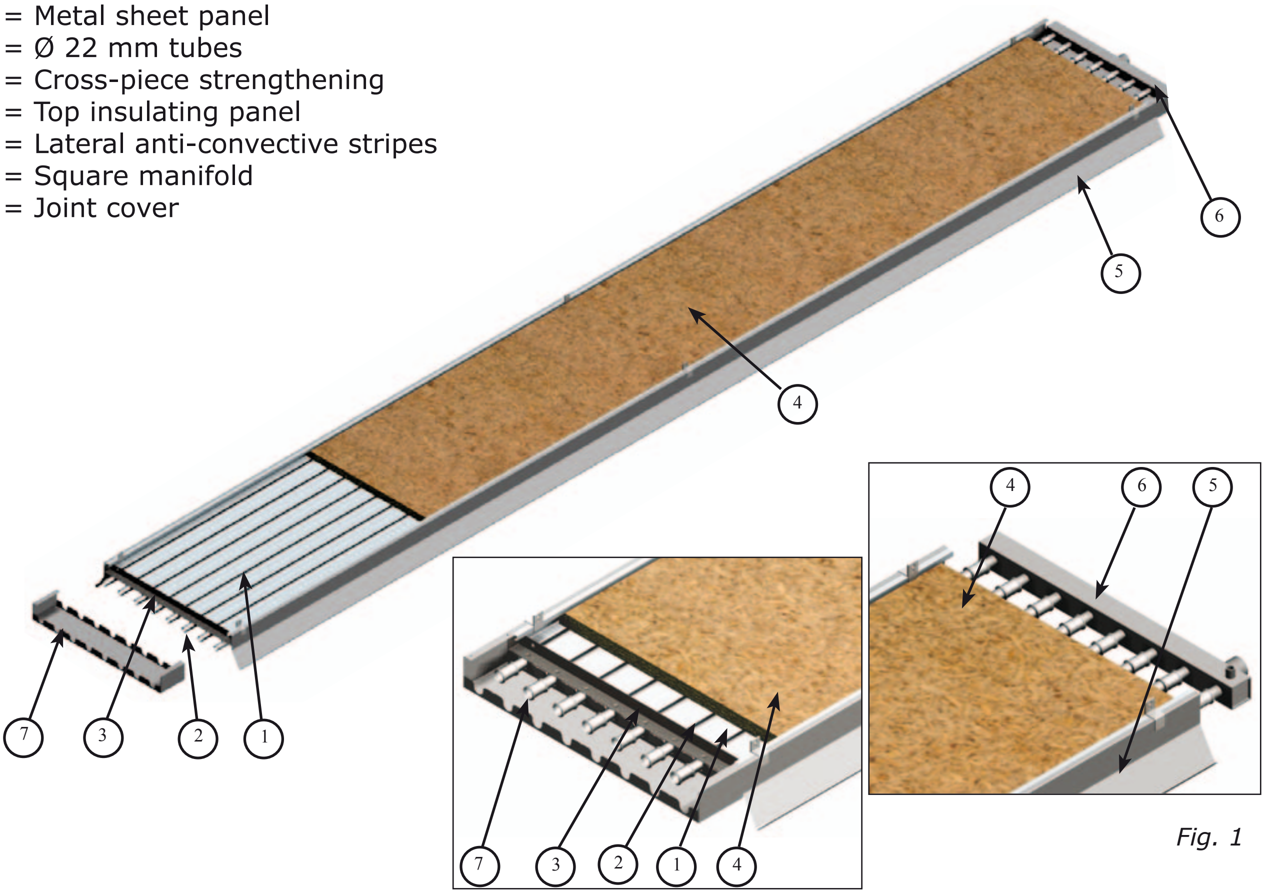


Fig. 1

1.3 WP SERIES

The “WP” series comply with the usual reliability and flexibility of Fraccaro’s products. Their main features are:

- Ø22 mm galvanised steel tube: the nominal diameter is in compliance with the international pressfitting standards;
- Radiant panel with double protection: the steel sheet is galvanised and pre-painted;
- Self-supporting panel;
- High flexibility for the installation: possibility to hook the chains to the cross-piece strengthenings (each 1,5 meters); no binds by using the sliding hooks;
- New asymmetrical manifolds which improve the balancing of water flow and allow the homogeneous distribution of the temperature into the panels.

1.4 MODELS AND SIZES
“WP” SERIES

WATERSTRIP "WP" series		WP2-060	WP2-090	WP2-120	WP3-030	WP3-040	WP3-060	WP3-090	WP3-120
Number of tubes		4	6	8	3	4	6	9	12
External tube diameter	[mm]	22			22				
Distance between tube centres	[mm]	150			100				
Water capacity	[L/m]	1,13	1,70	2,27	0,9	1,13	1,70	2,55	3,40
Panel weight without water 4 m	[Kg/pcs]	29,15	42,46	55,76	20,38	25,78	36,56	53,02	69,48
Panel weight without water 6 m	[Kg/pcs]	44,28	64,53	84,76	30,92	39,11	55,46	80,43	105,42
Panel weight with water 4 m	[Kg/pcs]	33,98	49,70	65,41	24,00	30,61	43,80	63,88	83,96
Panel weight with water 6 m	[Kg/pcs]	51,52	75,39	99,24	36,35	46,35	66,32	96,72	127,14

Tab. 1

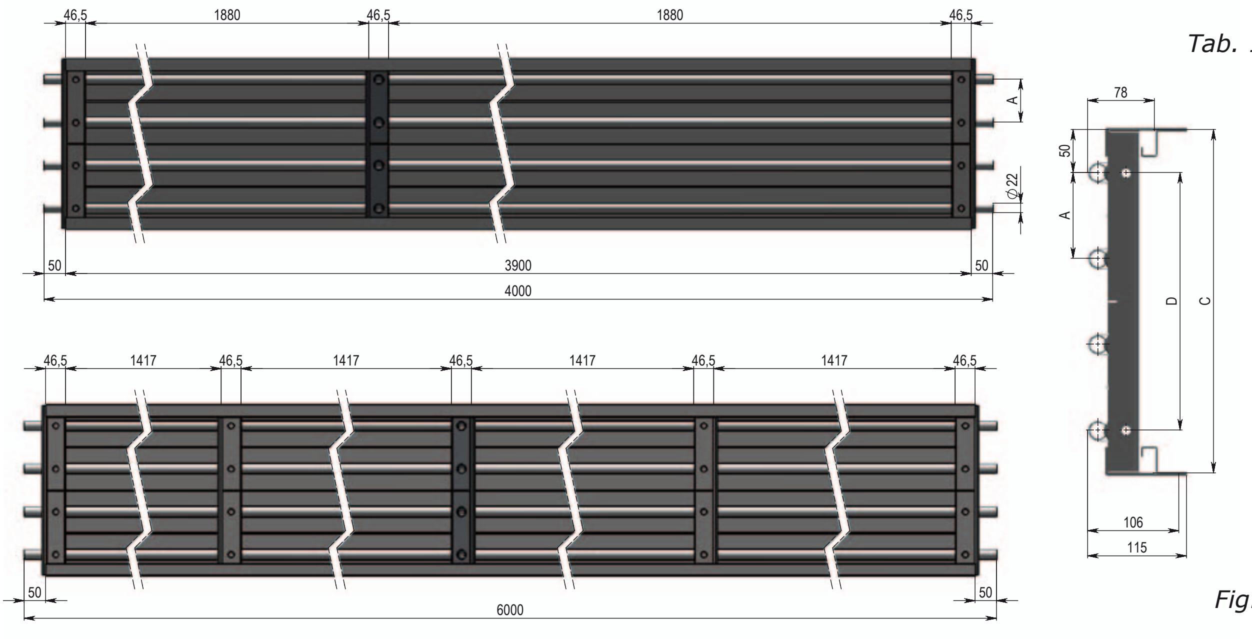


Fig. 2

Dimensions [mm]		WP2-060	WP2-090	WP2-120	WP3-030	WP3-040	WP3-060	WP3-090	WP3-120
Distance between centres of tubes	[A]	150			100				
Panel width	[B]	550	850	1150	300	400	600	900	1200
Distance between sliding hooks	[C]								
Distance between holes	[D]	450	750	750-1050	200	300	500	800	400-1100

Tab. 2

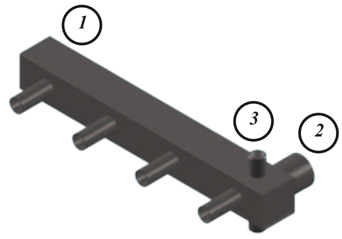
Manifold

WATERSTRIP manifold dimensions		"WP" series
Square section manifold	[mm]	50x50
Tube external diamenter	[mm]	22
Inlet connection (external thread)	[inches]	1" 1/4
Bleed (internal thread)	[inches]	3/8"

Tab. 3

"WP" series manifold

Fig. 3



Key:
1. Square section manifold
2. 1"1/4 inlet connection
3. 3/8" bleed

Manifold-hot water panel connection

The connections among hot water panels WATERSTRIP or between the hot water panel and the manifold are made by means of pressfitting couplings.
Using the pressfitting coupling, a perfect tight is guaranteed. The development of this kind of connection has been specifically based on the dimensions of the hot water panels pipes, which strictly respect the dimensional characteristics of the major pressfitting manufacturers. The standard panel is suitable for a maximum temperature of 120°C (either water or steam), with operating pressures up to 4 bars. On request, a special panel with operating pressures up to 16 bar and temperatures up to 180°C is available. Pressfittings joints can be used with operating pressures up to 16 bar with temperatures up to 95°C, or 4,5 absolute bar with temperatures up to 148°C. For special applications tube joints can be made by means of welding.

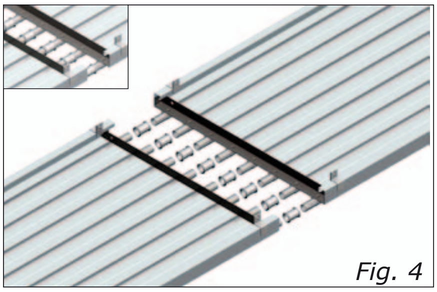


Fig. 4

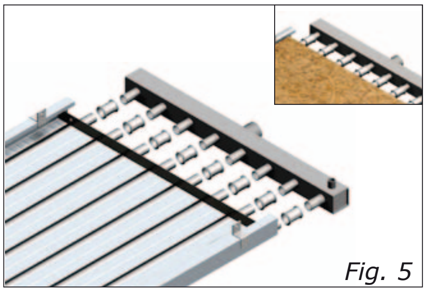
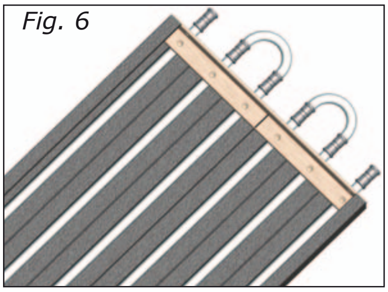


Fig. 5

Fig. 6


Installation of hot water panels

The coupling of WATERSTRIP panels to the supporting structure of the building can be realized in two different ways. They are shown in the following pictures:

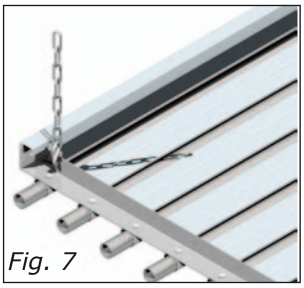


Fig. 7

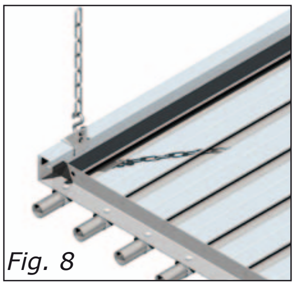


Fig. 8

The coupling can be made by using the two holes placed at the end of the strengthening (see position and distance between pipe centres in the dimensions of the hot water panels section). Coupling can be done by means of hooks inserted in the mentioned holes and chains anchored to the supporting structure, either by anchors (for concrete structures) or by steel strengthening.
Otherwise, when it is not possible to use the strengthening as a connection point, sliding-hooks can be used (provided by FRACCARO on request). This kind of coupling enables fastening the hot water panels everywhere the coupling to the cover is present.

Protective steel sheet for gymasium

For the installation of water panels in gymnasium or sport centres, it is possible to provide protective steel sheet installed on the top of the panel, so to avoid that any ball might remain stuck on it.

Fig. 9

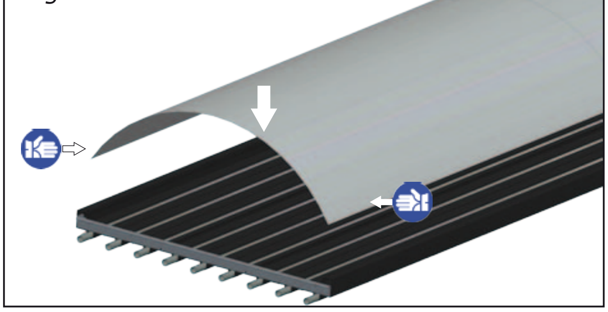
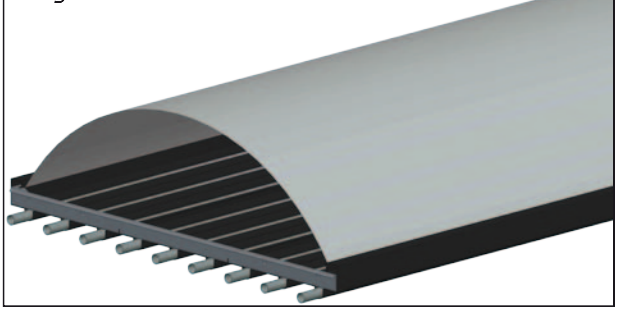


Fig. 10



Lateral stripes

Hot water panels heat mainly by radiation and partially by convection. In specific cases such as very high rooms or in presence of significant air movement, the percentage of energy transferred by convection can be higher, causing a negative outcome from the economical point of view.
In that case it is useful to mount optional lateral stripes. They act as barriers against air movements and reduce the convective effect.

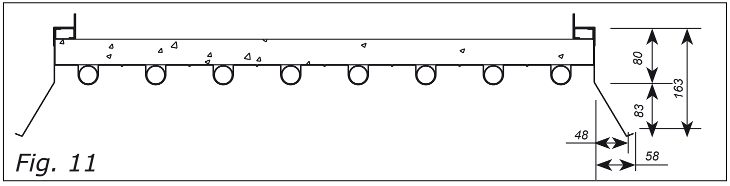
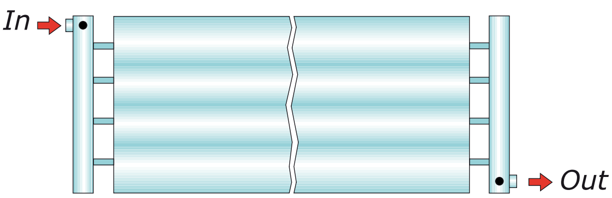


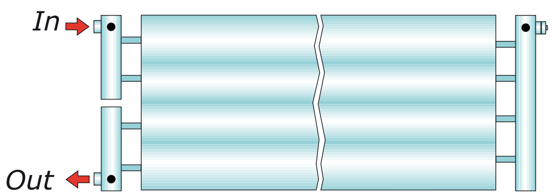
Fig. 11

Manifolds connection

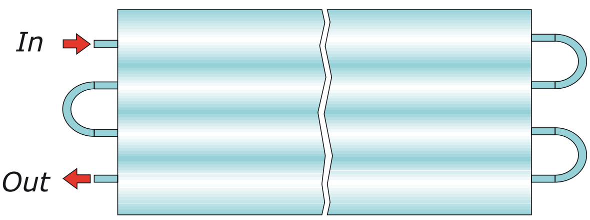
Circuit TYPE B



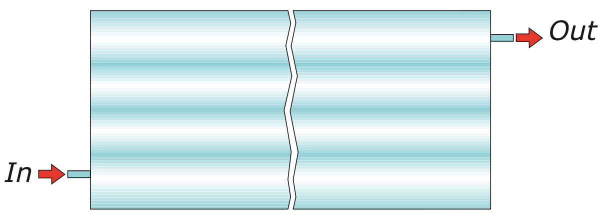
Circuit TYPE D **(NO WP3 - 030)**



Circuit TYPE C



Circuit TYPE C



Only for
WP3 - 030 WP3 - 090

Fig. 12

2.0 WATERSTRIP INSTALLATION DESIGN

2.1 THERMAL POWER

"WP" series – thermal emissions of the panels per linear meter

	Mod. WP2 (150 mm)			Mod. WP3 (100 mm)				
	WP2-060	WP2-090	WP2-120	WP3-030	WP3-040	WP3-060	WP3-090	WP3-120
ΔTm [°K]	W/m	W/m	W/m	W/m	W/m	W/m	W/m	W/m
30	144	202	272	93	123	172	246	317
32	156	218	293	100	133	186	266	343
34	167	235	315	108	143	200	285	368
36	179	251	336	115	153	214	306	394
38	190	267	358	123	163	228	326	420
40	202	284	380	130	173	242	346	446
42	214	301	402	138	184	257	367	472
44	226	318	424	146	194	271	388	499
46	238	335	447	154	204	286	409	526
48	250	352	470	162	215	301	430	553
50	262	369	492	170	226	316	451	581
52	275	387	515	178	236	331	473	608
54	287	404	539	186	247	346	495	636
56	300	422	562	194	258	361	516	664
58	312	440	585	202	269	377	538	692
60	325	458	609	211	280	392	561	720
62	337	476	632	219	291	408	583	749
64	350	494	656	227	302	423	605	777
66	363	512	680	236	313	439	628	806
68	376	531	704	244	325	455	650	835
70	389	549	728	253	336	471	673	864
72	402	567	752	261	348	487	696	894
74	415	586	777	270	359	503	719	923
76	428	605	801	279	370	519	742	953
78	441	624	826	287	382	536	766	982
80	454	642	850	296	394	552	789	1012
82	468	661	875	305	405	568	812	1042
84	481	680	900	314	417	585	836	1072
86	494	699	925	323	429	602	860	1102
88	508	719	950	331	441	618	884	1133
90	521	738	975	340	453	635	907	1163
92	535	757	1000	349	465	652	931	1194
94	549	777	1026	358	477	669	956	1225
96	562	796	1051	367	489	686	980	1256
98	576	816	1077	377	501	703	1004	1286
100	590	835	1102	386	513	720	1028	1318
102	604	855	1128	395	525	737	1053	1349
104	617	875	1154	404	537	754	1078	1380
106	631	895	1179	413	549	771	1102	1412
108	645	915	1205	422	562	789	1127	1443
110	659	935	1231	432	574	806	1152	1475
112	673	955	1257	441	586	823	1177	1507
114	687	975	1284	450	599	841	1202	1538
116	701	995	1310	460	611	859	1227	1570
118	716	1015	1336	469	624	876	1252	1602
120	730	1035	1362	479	636	894	1277	1635

Tab. 4

“WP” series – thermal emission for a couple of collectors

	Mod. WP2 (150 mm)			Mod. WP3 (100 mm)				
	WP2-060	WP2-090	WP2-120	WP3-030	WP3-040	WP3-060	WP3-090	WP3-120
ΔTm [°K]	W	W	W	W	W	W	W	W
30	97	146	183	40	64	95	153	198
32	105	158	198	44	69	103	165	214
34	113	170	213	47	74	111	177	231
36	122	182	228	50	80	119	190	248
38	130	195	244	54	85	127	203	265
40	139	207	260	57	91	135	215	282
42	147	220	276	60	96	144	228	299
44	156	233	292	64	102	152	241	317
46	165	246	308	67	107	160	254	335
48	174	259	325	71	113	169	268	353
50	183	272	342	74	119	178	281	371
52	192	286	358	78	125	186	294	389
54	202	299	375	81	131	195	308	408
56	211	313	392	85	136	204	321	427
58	220	327	410	89	142	213	335	445
60	230	341	427	92	148	222	349	464
62	239	355	444	96	154	231	363	484
64	249	369	462	100	161	240	377	503
66	259	383	480	103	167	249	391	522
68	268	397	498	107	173	258	405	542
70	278	412	516	111	179	268	419	561
72	288	426	534	115	185	277	433	581
74	298	441	552	119	192	287	448	601
76	308	455	570	122	198	296	462	621
78	318	470	589	126	204	306	477	642
80	329	485	607	130	211	315	491	662
82	339	500	626	134	217	325	506	682
84	349	515	645	138	224	334	521	703
86	360	530	663	142	230	344	535	723
88	370	545	682	146	237	354	550	744
90	380	560	701	150	243	364	565	765
92	391	576	721	154	250	374	580	786
94	402	591	740	158	256	384	595	807
96	412	606	759	162	263	394	610	828
98	423	622	779	166	270	404	626	850
100	434	638	798	170	277	414	641	871
102	445	653	818	174	283	424	656	893
104	455	669	837	178	290	434	671	914
106	466	685	857	182	297	444	687	936
108	477	701	877	186	304	455	702	958
110	488	717	897	190	311	465	718	980
112	499	733	917	194	318	475	733	1002
114	511	749	937	198	324	486	749	1024
116	522	765	957	202	331	496	765	1046
118	533	781	977	206	338	506	780	1068
120	544	797	998	211	345	517	796	1091

Tab. 5

How to calculate the thermal emission

Following the norm EN 14037, the thermal emission should be calculated by this formula: $Q=K(\Delta t_m)^n$ [W/m]. The same formula should be used to calculate the thermal power of each collector.

The parameter Δt_m is the difference between the mean temperature of the hot fluid and the ambient temperature (example: hot water, input temperature: t_i=80°C; output temperature: t_o=70°C, mean temperature: $t_m=(t_i+t_o)/2$=75°C; ambient temperature: t_a=19°C; then: $\Delta t_m=(t_m-t_a)$=56°C. Values in the following table are calculated by considering Δt_m=56°C:

Model	Thermal power [W/m]	Model	Thermal power [W/m]
		WP3-030	194
		WP3-040	258
WP2-060	300	WP3-060	361
WP2-090	422	WP3-090	516
WP2-120	562	WP3-120	664

Tab. 6

The resulting thermal power is available in the previous tables: the values of k and n are indicated herebelow:

PANELS	Mod. WP2 (150 mm)			Mod. WP3 (100 mm)				
	WP2-060	**WP2-090**	**WP2-120**	**WP3-040**	**WP3-040**	**WP3-060**	**WP3-090**	**WP3-120**
k	2,717	3,696	5,220	1,652	2,196	3,014	4,325	5,691
n	1,168	1,177	1,162	1,184	1,184	1,189	1,188	1,182
MANIFOLDS	**Mod. WP2 (150 mm)**			**Mod. WP3 (100 mm)**				
	WP2-060	**WP2-090**	**WP2-120**	**WP3-040**	**WP3-040**	**WP3-060**	**WP3-090**	**WP3-120**
k	1,409	2,242	2,841	0,709	1,013	1,501	2,670	2,997
n	1,244	1,227	1,224	1,190	1,218	1,220	1,190	1,232

Tab. 7

Percentages of radiant and convective heating

In the table below are reported the percentages of radiant and convective emissions according to the mounting angle of the WATERSTRIP.

Panel mounting angle	WP2-060		WP2-090		WP2-120	
	Radiant emission [%]	Convective emission [%]	Radiant emission [%]	Convective emission [%]	Radiant emission [%]	Convective emission [%]
0°	65%	35%	60%	40%	71%	29%
15°	60%	40%	55%	45%	66%	34%
30°	55%	45%	50%	50%	61%	39%
45°	50%	50%	45%	55%	56%	44%
60°	45%	55%	40%	60%	51%	49%
90°	35%	65%	20%	80%	41%	59%

Panel mounting angle	WP3-030		WP3-040		WP3-060		WP3-090		WP3-120	
	Radiant emission [%]	Convective emission [%]	Radiant emission [%]	Convective emission [%]	Radiant emission [%]	Convective emission [%]	Radiant emission [%]	Convective emission [%]	Radiant emission [%]	Convective emission [%]
0°	45%	55%	55%	45%	66%	34%	70%	30%	72%	28%
15°	40%	60%	50%	50%	61%	39%	65%	35%	67%	33%
30°	35%	65%	45%	55%	56%	44%	60%	40%	62%	38%
45°	30%	70%	40%	60%	51%	49%	55%	45%	57%	43%
60°	25%	75%	35%	65%	46%	54%	50%	50%	52%	48%
90°	15%	85%	25%	75%	36%	64%	40%	60%	42%	58%

Tab. 8

2.2 WATER FLOW RATE AND FLOW RESISTANCE

On the following tables we indicate the flow resistance of every WATERSTRIP model. To consider the collectors influence, 5% of total line flow resistance should be added. It is very important not to exceed the maximum flow rates. A high water speed may cause noise and vibrations, a low speed may reduce the thermal power of the panels.

	Circuit type B						Circuit type C						Circuit type D				
Model	WP3-030	WP2-060 WP3-040	WP2-090 WP3-060	WP2-120	WP3-090	WP3-120	WP3-030	WP2-060 WP3-040	WP2-090 WP3-060	WP2-120	WP3-090	WP3-120	WP2-060 WP3-040	WP2-090 WP3-060	WP2-120	WP3-090	WP3-120
n° tubes	3	4	6	8	9	12	3	4	6	8	9	12	4	6	8	9	12
Water flow [l/h]	Flow resistance [mm H_2O/m]																
65							1,86	2,49	3,73	4,97	5,59	7,46					
90							3,31	4,41	6,61	8,82	9,92	13,22					
110							4,71	6,28	9,41	12,55	14,12	18,83					
140							7,19	9,59	14,39	19,19	21,58	28,78					
170							10,13	13,5	20,25	27	30,38	40,5					
200	0,65						13,48	17,97	26,96	35,94	40,44	53,91	2,66	1,30	0,78	0,65	
225	0,80						16,58	22,11	33,17	44,22	49,75	66,33	3,26	1,60	0,96	0,81	
250	0,96	0,58					19,96	26,62	39,92	53,23	59,89	79,85	3,92	1,92	1,16	0,97	0,56
275	1,14	0,69					23,61	31,48	47,22	62,95	70,82	94,43	4,64	2,28	1,38	1,15	0,68
300	1,33	0,80					27,51	36,69	55,03	73,37	82,54	110,06	5,42	2,66	1,60	1,34	0,78
350	1,74	1,05					36,09	48,12	72,18	96,24	108,27	144,36	7,10	3,48	2,10	1,76	1,02
400	2,20	1,33	0,65				45,65	60,87	91,30	121,74	136,95	182,61	8,98	4,38	2,65	2,23	1,30
450	2,71	1,63	0,80				56,17	74,89	112,33	149,78	168,50	224,67	11,06	5,42	3,26	2,73	1,60
500	3,26	1,96	0,96	0,58			67,61	90,15	135,22	180,30	202,83	270,44	13,30	6,52	3,93	3,29	1,92
550	3,85	2,32	1,14	0,69			79,96	106,61	159,92	213,22	239,88	319,84	15,74	7,70	4,64	3,89	2,28
600	4,49	2,71	1,33	0,80	0,65		93,19	124,25	186,38	248,51	279,57	372,76	18,34	8,98	5,42	4,54	2,65
650	5,17	3,12	1,53	0,92	0,75		107,29	143,05	214,58	286,10	321,87	429,16	21,12	10,34	6,24	5,22	3,06
700	5,89	3,55	1,74	1,05	0,85		122,24	162,98	244,47	325,96	366,71	488,95	24,06	11,78	7,10	5,95	3,48
750	6,65	4,01	1,96	1,18	0,96	0,58	138,02	184,02	276,04	368,05	414,05	552,07	27,16	13,30	8,02	9,72	3,93
800	7,45	4,49	2,19	1,33	1,08	0,65	154,62	206,16	309,24	412,32	463,86	618,48	30,44	14,90	8,99	7,52	4,38
900	9,17	5,53	2,71	1,63	1,33	0,80	190,24	253,65	380,47	507,30	570,71	760,95	37,44	18,34	11,06	9,26	5,42
1000	11,04	6,65	3,26	1,96	1,60	0,96	229,00	305,33	457,99	610,66	686,99	915,99	45,08	22,08	13,31	11,14	6,52
1100	13,06	7,87	3,85	2,32	1,89	1,14	270,82	361,09	541,64	722,19	812,46	1083,28	53,30	26,12	15,74	13,18	7,70
1200	15,22	9,17	4,49	2,71	2,20	1,33	315,64	420,85	631,27	841,70	946,91	1262,55	62,12	30,44	18,34	15,36	8,98
1400	19,96	12,03	5,89	3,55	2,89	1,74	414,01	552,02	828,03	1104,04	1242,04	1656,05	81,50	39,92	24,06	20,15	11,78
1600	25,25	15,22	7,45	4,49	3,65	2,19	523,70	698,26	1047,39	1396,53	1571,09	2094,79	103,08	50,50	30,43	25,49	14,90
1800	31,06	18,72	9,17	5,53	4,49	2,71	644,33	859,11	1288,66	1718,21	1932,99	2577,32	126,82	62,12	37,44	31,36	18,34
2000	37,39	22,54	11,04	6,65	5,41	3,26	775,61	1034,14	1551,21	2068,28	2326,82	3102,43	152,66	74,78	45,07	37,76	22,08
2200	44,22	26,65	13,06	7,87	6,40	3,85							180,54	88,44	53,31	44,65	26,12
2400	51,54	31,06	15,22	9,17	7,45	4,49							210,42	103,08	62,13	52,03	30,44
2600	59,34	35,76	17,52	10,56	8,58	5,17							242,26	118,68	71,53	59,91	35,04
2800	67,60	40,75	19,96	12,03	9,78	5,89							276,00	135,20	81,49	68,26	39,92
3000	76,33	46,01	22,54	13,58	11,04	6,65							311,64	152,66	92,01	77,07	45,08
3200	85,51	51,54	25,25	15,22	13,37	7,45							349,14	171,02	103,08	86,34	50,50
3400	95,14	57,30	28,09	16,93	13,76	8,29							388,44	190,29	114,60	96,06	56,18
3600	105,21	63,41	31,06	18,72	15,22	9,17							429,55	210,43	126,82	106,23	62,13
3800	115,72	69,74	34,17	20,59	16,74	10,09							472,44	231,43	139,49	116,83	68,33
4000	126,65	76,33	37,39	22,54	18,32	11,04							517,07	253,30	152,66	127,87	74,79
4200	138	83,18	40,75	24,56	19,96	12,03								276,01	166,35	139,34	81,49
4400	149,72	90,27	44,22	26,65	21,66	13,06								299,56	180,55	151,23	88,44
4600	161,97	97,62	47,82	28,82	23,43	14,12								323,94	195,24	163,53	95,64
4800	174,57	105,21	51,54	31,06	25,25	15,22								349,13	210,42	176,25	103,08
5000	187,57	113,05	55,38	33,38	27,13	16,35								375,14	226,10	189,38	110,76
Max. flow	6000	8000	12000	16000	18000	24000	2000	2000	2000	2000	2000	2000	4000	6000	8000	8000	12000
Min. flow	200	260	400	540	620	820	65	65	65	65	65	65	130	200	270	310	410

Tab. 9

2.3 INSTALLATION: HEIGHT AND CENTER-TO-CENTER DISTANCE

The thermal rate at floor level changes depending on the variation of the installation height of the panels. This is an important principle to consider during the installation design process. Correction factors are reported in the table below.

Installation height [m]	6	6,5	7	7,5	8	8,5	9	10	11	12
Correction factor	1	0,98	0,97	0,96	0,94	0,92	0,9	0,88	0,87	0,86

Tab. 10

For a higher installation height, please seek the advice of our technical department.
To obtain an homogeneous distribution of radiation, the maximum distance between two hot water panels has to be lower than the installation height: I max<=H.
Do not consider any correction factor to calculate both the thermal power of the boiler and the flow rate of the installation

I max (maximum center-to-center distance)

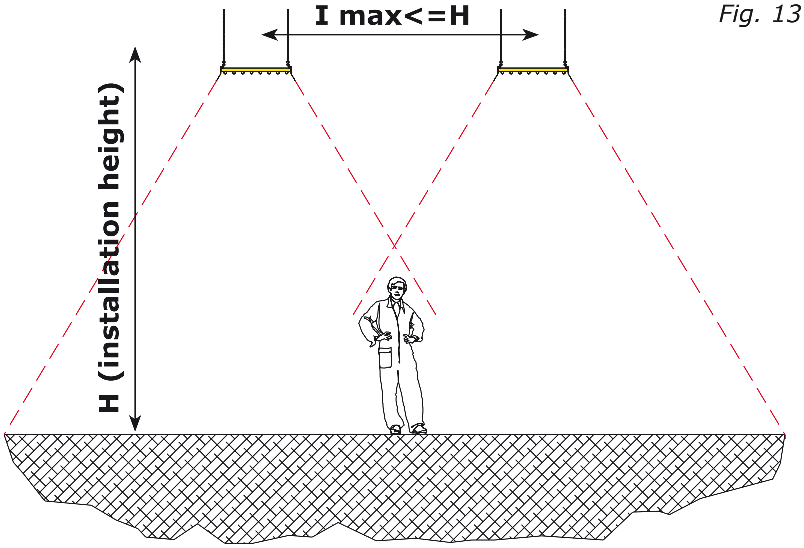


Fig. 13

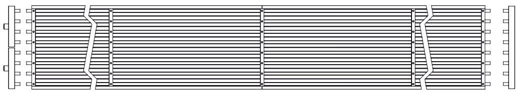
Minimum recommended installation height:

Water mean temperature [°C]	Minimum installation height				
	WP2-060 WP2-090	WP3-040 WP3-030	WP3-060 WP3-090	WP2-120	WP3-120
60	3,10	3,10	3,20	3,20	3,30
70	3,20	3,20	3,30	3,30	3,40
80	3,30	3,30	3,50	3,40	3,60
90	3,50	3,40	3,70	3,70	3,90
100	3,70	3,50	4,00	3,90	4,20
110	4,00	3,60	4,20	4,30	4,40

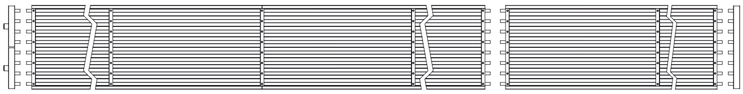
Tab. 11

2.4 EXAMPLES OF WATERSTRIP COMPOSITION

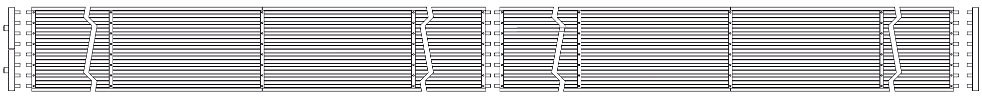
Here below are shown some examples of composition with WATERSTRIP panels.



6 m panel



6 m panel + 4 m panel = 10 m line



6 m panel + 6 m panel = 12 m line

Fig. 14

Length of lines

By means of standard 4 and 6 meter modules, it is possible to obtain every line having length with multiple of 2. The minimum length is 4 meters. In the following table find the possible lengths:

	Total length [m]																							
[m]	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**42**	**44**	**46**	**48**	**50**
4 m panels	1		2	1		2	1		2	1		2	1		2	1		2	1		2	1		2
6 m panels		1		1	2	1	2	3	2	3	4	3	4	5	4	5	6	5	6	7	6	7	8	7

Tab. 12

2.5 EXEMPLES OF INSTALLATION

Circuit type D

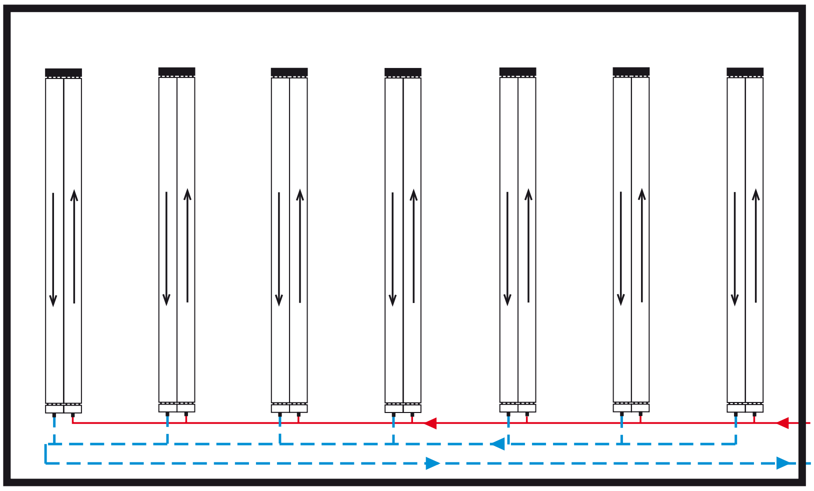


Fig. 15

Circuit type B

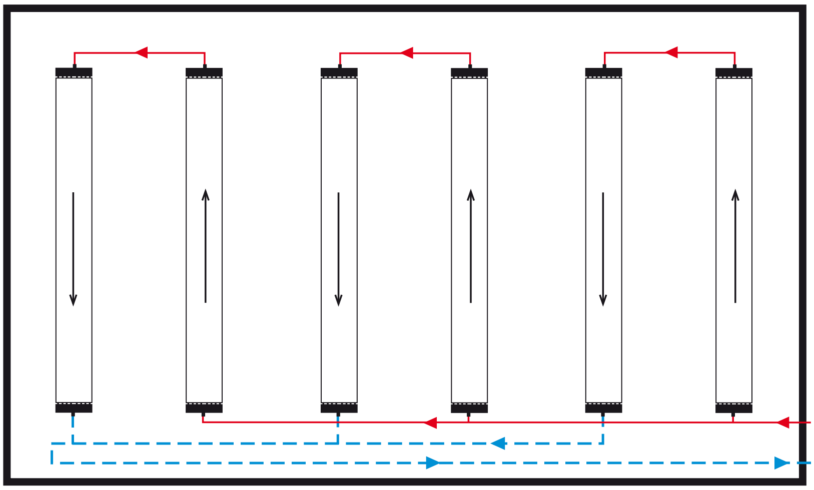


Fig. 16

Circuit type D

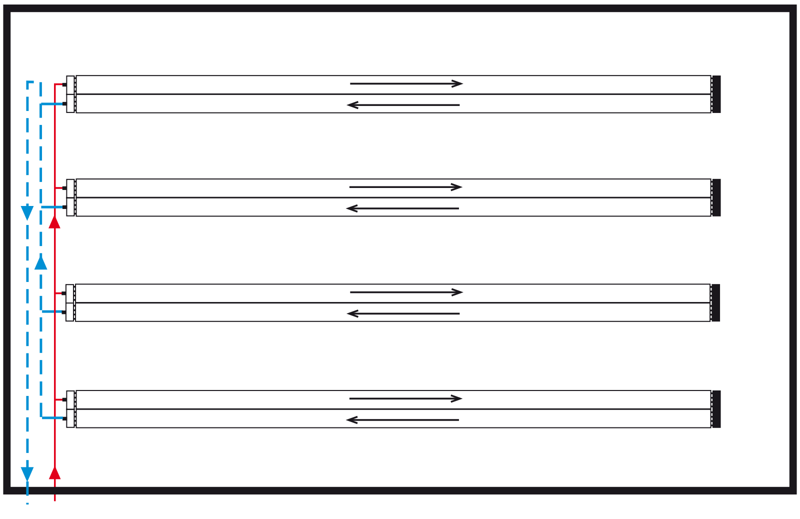


Fig. 17

Thermoregulation and balancing of the plant

To optimize the heating plant and its efficiency, the water flow of different lines should be adjusted to the same value. Three-way modulating valve at every line inlet can be applied to that purpose.

If the lines have the same length, the hydraulic plant could be balanced by adopting a simple three-tube configuration on the return pipe. If the plant has more different lines, it is advisable to install the automatic water flow stabilizer on the return pipe of each line.

In order to obtain the best control of the temperature, one or more temperature globe-probes should be used. Some examples of balanced circuits are in the following pictures.

Heating plant with external temperature probe and input water temperature regulation

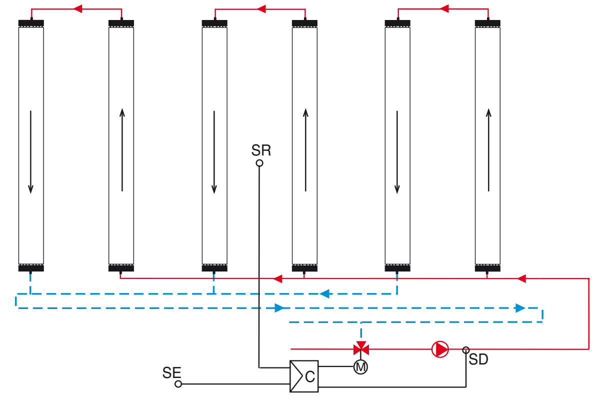


Fig. 18

Key:

CP: Main controller
CZ: Zone controller
M: Motorized three-way valve
SD: Water input temperature probe
SE: External temperature probe
SR: Ambient temperature probe
A: In
R: Out

Spot heating

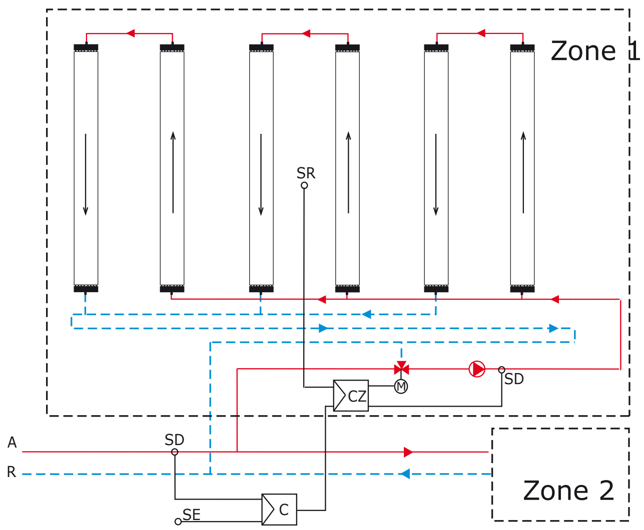


Fig. 19

Circuit with water flow stabilizer

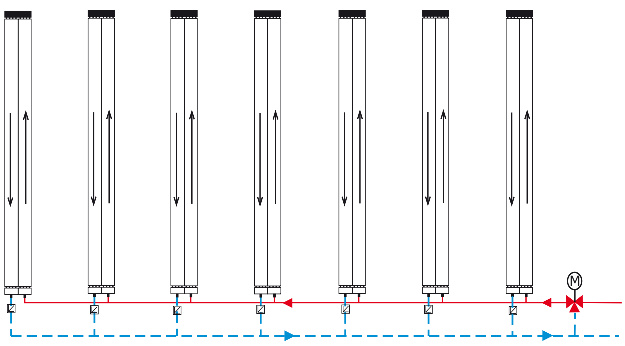


Fig. 20

Temperature globe probe and digital on/off thermostat

Fig. 21

2.6 EXAMPLES OF CALCULATION

Example A - building dimension: 50x20 m; height: 7 m.
By considering the internal temperature Ta=17°C, we assume that the required power is 130 kW.
We assume the input water temperature Ti=80°C and the output temperature Tu=70°C; the mean temperature is: Tm=(Ti+Tu)/2=75°C; then: ΔTm=Tm-Ta=58°C
In this case, the first choice is considering 48 m lines applying the panel model WP3-120.
In the table of thermal powers, by considering ΔTm =58°C, the correspondent power is 692 W/m for the panel WP3-120 and 445 W for the relative couple of collectors.
To get the length of each line it's sufficient to divide the total power by the linear specific power of the panel: 130000/692=187.9 meters
By considering 4 lines: 48 x 4 = 192 meters
Thermal power of each line: (48 m) x (692 W/m) = 33216 W
Thermal power of a couple of collectors: 445 W
Total thermal power of one line: 33216 + 445 =33661 W
Total thermal power of the plant: 33661 W x 4 lines = 134644 W
The installation height is higher than 6 m, so the power of the plant should be increased compliantly. In the table, by considering 7 m as installation height, 0.97 is the correction factor.
Thermal power of plant is: 134644 x 0.97 = 130605 W, so this solution is correct.

Water flow resistance
The thermal power of each line is 33,216 kW, that is: 33,216 x 860 =28566 kcal/h
The same power is carried by water according to this formula: Q = G x c_p x ΔT,; Q is the thermal power (28566 kcal/h), c_p is the specific heat (1 kcal/°C), ΔT is the temperature difference between the input temperature Ti=80°C and the output temperature Tu=70°C (ΔT=10°C), G is the water flow. By applying the reverse formula: G = Q/(c_p x ΔT)=28566/(1 x 10) = 2856,6 litres/h
In the table, the value of flow resistance corresponding to that water flow is 5,89 mm c. w. (column of water) per each meter (circuit type B); if we consider the type D circuit, the value of flow resistance is double: 39,92 mm c. w.
The total flow resistance in each 48 m line is then:
circuit type B : (48 x 5,89) x 1,1 = 311 mm c. w. (1,1 to consider collector influence);
circuit type D: (48 x 39,92) x 1,1 = 2108 mm c. w.

Example B – building dimension: 50x20 m; height: 5 m; good isolation.
By considering Ta=15°C, we assume that the required power is 105 kW. We assume the same water temperatures of the previous example, so ΔTm = 60°C.
We choose to apply the panel WP3-090: in the table of thermal powers, by considering ΔTm =60°C, the correspondent power is 561 W/m for the panel and 349 W for the relative couple of collectors.
By considering four lines: 48 x 4 = 192 meters
Thermal power of each line: (48 m) x (561 W/m) = 26928 W
Thermal power of one couple of collectors: 349 W
Total thermal power of one line: 26928 + 349 = 27277 W
Thermal power of plant is: 27277 W x 4 lines = 109108 W, so this solution is correct.

Water flow resistance
The thermal power is 26,928 kW, that is 23158 kcal/h; G = Q/(c_p x ΔT)=23158/(1 x 10) = 2315,8 litres/h
In the table, the value of flow resistance corresponding to that water flow is 7,45 mm c. w. (column of water) per each meter (circuit type B); if we consider the type D circuit, the value is 52,03 mm c. w.
The total flow resistance in each 48 m line is then:
circuit type B: (48 x 7,45) x 1,1 = 357,6 mm c. w.
circuit type D: (48 x 52,03) x 1,1 = 2747 mm c. w.

3.0 COOLING

In summertime, the heating plant with WATERSTRIP panels could be used as a cooling system in order to improve the thermal comfort.
The application of the same plant for both heating and cooling purposes leads to fast recovery of the investment.
If we compare the radiant panel system to the traditional cold air systems, we can find out some important advantages:

- By considering the same comfort condition, the air temperature is higher;
- Noiselessness;
- No air movement;
- Better condition for the human health;
- Low installation and running costs;
- Low electrical consumption.

Like the application for heating purposes in winter time, in summer this system allows to save energy because it cools the surfaces without cooling the volume of air in between. The thermal comfort depends on the operative temperature:
Top = (Ta+Tw)/2 (Ta= air temperature; Tw= temperature of walls and floor)
If we assume Top=25 °C, this temperature can be obtained with a traditional system when Ta=23 °C and Tw=27 °C.
The same result can be obtained with the WATERSTRIP radiant system when Ta =27°C and Tw = 23°C.
The higher air temperature allows to reduce the nominal power of the heating system and to reduce the energy consumption. If we consider that a cooling plant with the radiant panel WATERSTRIP has a low electrical energy consumption and it needs little maintenance, the overall running costs of this plant is much lower than those of a standard one.
In order to avoid the condensation of atmospheric humidity, the temperature of the panel surface should be higher than the dew-point temperature. To this purpose, the best result could be obtained by adding a dehumidifying system to the radiant cooling plant.
For any further information about the application of radiant cooling systems please contact our commercial department.

Traditional air cooling system

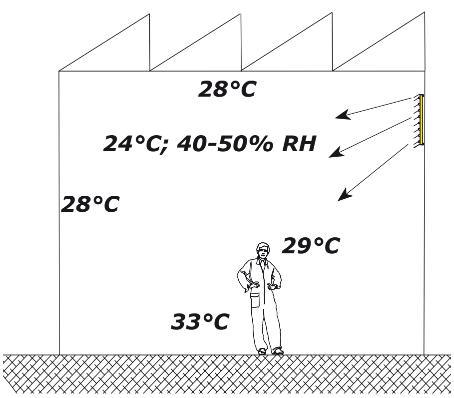


Fig. 22

Comfort diseases because of temperature differences and air flow

Radiant cooling system

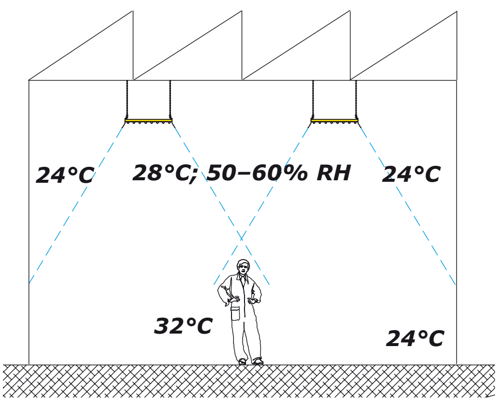


Fig. 23

Comfort condition (homogeneous distribution of temperatures)

4.0 UNI EN ISO 9001:2008 CERTIFICATION

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Refer to quality manual for details of applications to ISO 9001:2008 requirements

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