25 Year Guarantee

Subject to terms and conditions. Contact Frenger for more details.

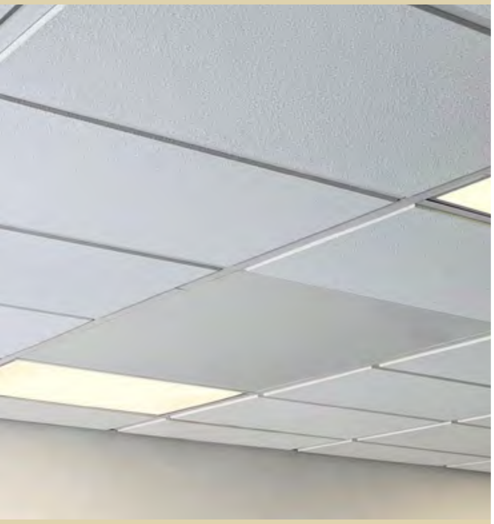
Independently tested to EN 14037:2016 at HLK Stuttgart

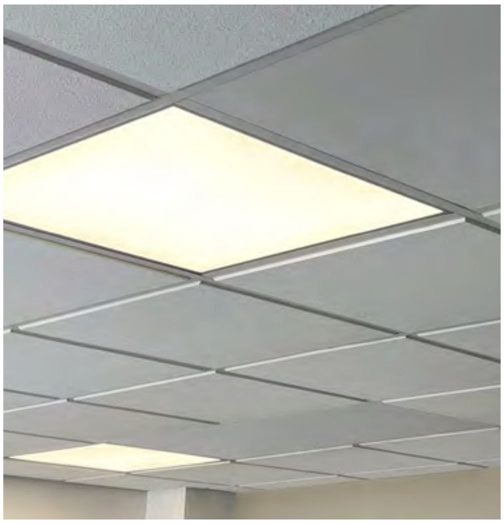
the future of space conditioning

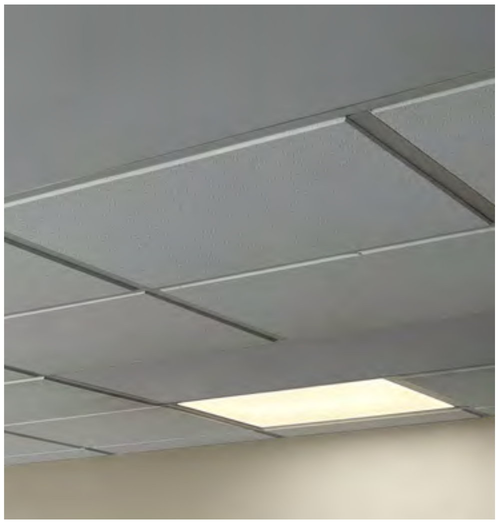
Modula

SP (Standard Performance), HP (High Performance) & SHP (Super High Performance)

LTHW radiant heating panel







Application
Commercial, hospitals, hotels, schools, shops, sports halls, offices, laboratories, food industry etc.

Installation
Ceiling integrated (recessed)
Free hanging (exposed)
Surface mounted

Capacity
Up to 588 W/m² @ 55 dtK
10mm OD and 15mm OD copper coil options

Features
Smooth finish
Anti-bacterial coating available
Technology proven over 90 years
Low construction depth
High capacity
Cost effective
Simple to install
No joints whatsoever - Full CNC formed serpentine coils
Identical appearance electric powered versions also available

www.frenger.co.uk
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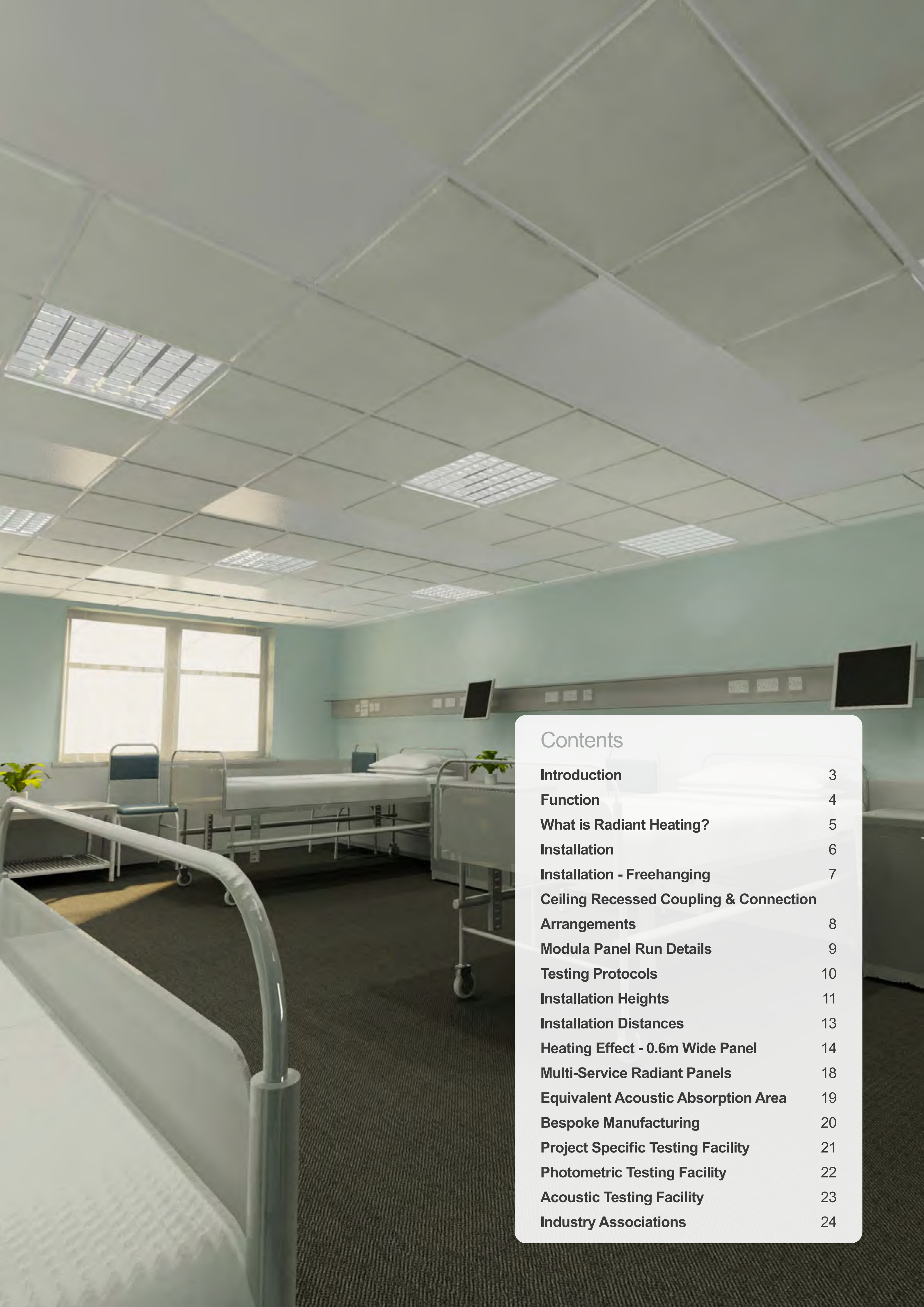
FRENGER® systems



Contents

Introduction

Description

Modula is an unobtrusive modular radiant heating panel. The panels are manufactured from 1.0mm thick smooth-faced pre coat mild steel which has a tough White paint finish equivalent to RAL 9016, which is most similar to the suspended ceiling grid, in which it is designed to be integrated. These panels are designed to be integrated within a standard exposed T-bar grid ceiling system and variants for freehanging (exposed) or surface mounted applications.

Copper pipes are expanded under pressure into extruded aluminium pipe seats to give high metal-to-metal contact and the pipe seats are bonded to the rear of the steel panels. Frenger have both 15mm OD and 10mm OD copper coil availability. All serpentine copper coils are produced in-house by Frenger on it's full CNC state-of-the-art serpentine bend machine from thousand metre drums of copper to avoid any joints in the heating coils. This arrangement delivers excellent heat transfer characteristics.

Panels are insulated with high density 25mm thick class 'O' foil encapsulated mineral wool insulation (45 kg/m³ density). The technology employed in the construction of the panel results in excellent heating capacity and with choice of smaller diameter (10mm OD) tubes available enables heat even at low water mass flow rates.

Modula has been specifically developed for use in schools and healthcare environments where a smooth faced, simple-to-install panel with the highest thermal comfortable heating capacity is the preferred solution.

Standard Features

- Modular system to fit into exposed grid ceiling systems.
- Joint free copper coils (zero risk of leaks).
- Modular lengths; 0.6m, 1.2m, 1.8m, 2.4m, 3.0m.
- Panel Widths; 0.3m, 0.6m, 0.9m.
- Panel depth 45mm.
- Smooth faced, unobtrusive design.
- Up to 588 W/m² @ 55 dtK room (mwt - room temp).
- Pre coat finished White, equivalent to RAL 9016 (20% gloss).
- Outputs Independently Certified to EN14037-1,-2,-3:2016
- SP (Standard Performance), HP (High Performance) & SHP (Super High Performance) variants available.
- Water connections: 10mm & 15mm OD Copper
- Weight: less than 21 kg / m²

Connection Possibilities

Water; vertical, same end for flow and return.
Alternative options, including horizontal, available upon request.

Maintenance

The unit has no moving parts, and therefore maintenance requirement is limited to periodic cleaning of the surface of the panel with a damp cloth with mild detergent and drying with a cotton towel.

Installation

Standard fixing arrangement from the structural soffit using either rigid threaded rod or wire cable hangers (supplied by others), suspended via pre punched keyhole slots on rear of panel.

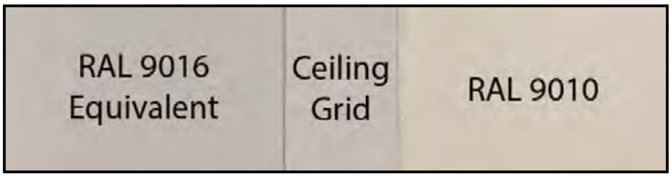
For simplicity and flexibility stainless steel braided EPDM hoses can be used to connect the Modula panel.

Model Variants

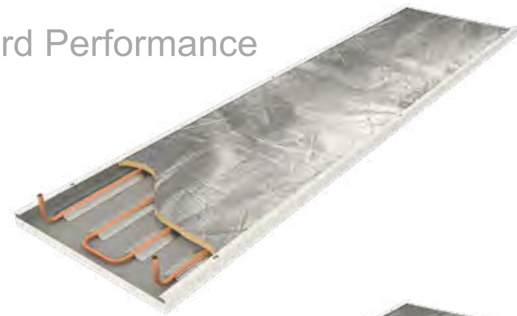
Modula radiant heating panels are available in three different model variants; Standard Performance (SP) High Performance (HP) and Super High Performance (SHP), these provide differing levels of heating output to suit a wide range of applications. (See from page 13 for heating outputs).

Modula

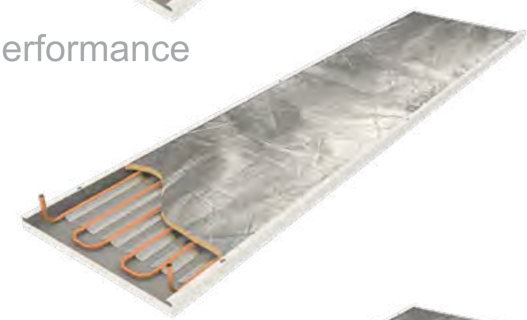
Heating Panel



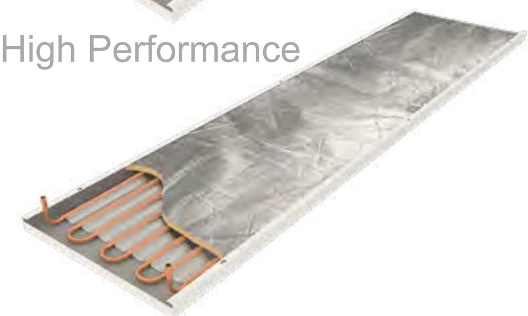
Standard Performance (SP)



High Performance (HP)



Super High Performance (SHP)



Function

With an output of up to 588 W/m² at 55 dtK. Modula is one of the most efficient smooth - faced radiant heating panels currently available.

The secret to Modula's outstanding performance rests in its unique method of expanding the water-carrying copper pipes within the heat transfer aluminium extrusions and bonding techniques. The aluminium extrusions are bonded to the rear of the zintec steel panel using a heat transfer adhesive. Due to the high metal-to-metal contact between the copper waterways and the aluminium extrusions and the fact that the aluminium pipe seats are fully bonded to the panel face, the energy transport between the water in the pipe and panel face is extremely efficient.

The manufacture of Modula is vastly automated in our purpose-built facility in Derby, UK. Panels can be produced to very high tolerances. Furthermore, the processes employed and the standardised design means that the cost of Modula remains very competitive.

Modula is so simple to install that it is quite often fitted by the suspended ceiling installer.

Design

Dimensions: Modula is available in three widths, as standard - 0.3m, 0.6m and 0.9m. These nominal dimensions are reduced by 8mm on length and width so that panels can be integrated within a traditional suspended ceiling using exposed T-bars on a 600 x 600mm grid module. The depth of the Modula panel is just 45mm.

Lengths: Modula is produced in nominal module lengths of 0.6m, 1.2m, 1.8m, 2.4m and 3.0m as standard. As mentioned above nominal lengths and widths are reduced by 8mm to enable ceiling integration. Non-standard lengths and widths are also available upon request.

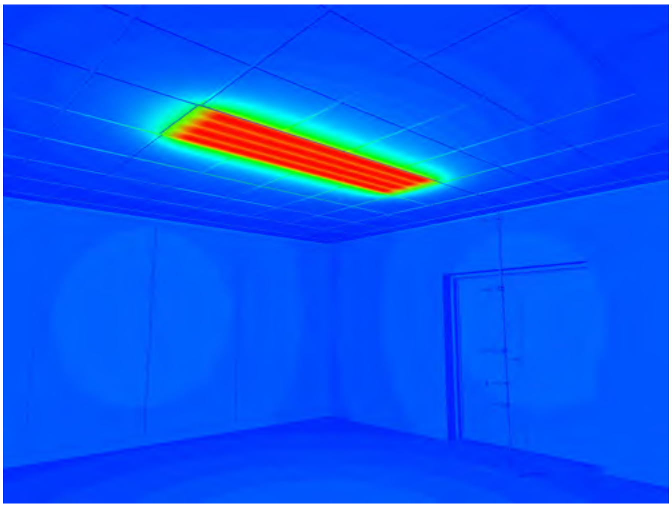
Water connection: Modula is available with various connection configurations with either 10mm or 15mm OD connections. See page 8 for further details.

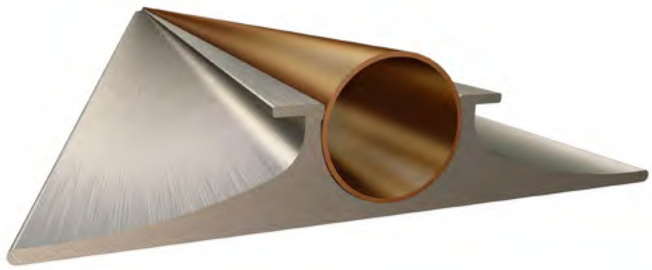
Surface finish: Modula is pre coated White as standard (equivalent to RAL 9016, 25% gloss), with an emissivity value of 0.95. Frenger also offer all RAL classic colour options to suit any architectural aesthetics (other colours available on request at additional cost). Modula can also be supplied with BioCote® antimicrobial coating technology to give increased protection against bacteria and mould at additional cost.

Insulation: Modula is supplied with integrated high density 25mm thick 45 kg/m³ class 'O' foil encapsulated mineral wool insulation within the panels returned folded flanges.

Application

Modula is particularly suited for use in hospitals, schools, shops and offices; in fact wherever there is a need for a high-output radiant heating panel which is simple to install, easy to keep clean and comes at a very competitive price. Modula is the perfect solution for integration with an exposed grid ceiling system, but is equally suited to free hanging (exposed) applications. The panel can also be adapted to suit surface mounted applications or recessed into a plasterboard ceiling (Modula trim frame kits available as optional extra).





Ceiling Recessed Modula

Flanged Modula

What is Radiant Heating?

What is Radiant Heating

Radiant Heating is a form of heat transfer. Radiant Heating Panels emit most of their heat via longwave infrared radiation as opposed to convection or conduction. The longwave radiation that is emitted from the Radiant Heating Panels travels through the air (without directly heating the air) to its surroundings of a lower temperature (such as walls, floors, desks and occupants) thus raising the temperature of these surroundings. A secondary effect of the longwave radiation being emitted from the Radiant Heating Panels is that the air that comes in contact with the warmer surfaces becomes heated and as warm air rises it is replaced with cooler air which is known as the convective heating quotient.

Most radiant heating solutions achieve approximately 70% of the total heating via radiant exchange and 30% via convection. In general with a high percentage (70%) radiant quotient, you can have an air room temperature circa 2 deg C lower than the perceived room temperature as the occupants are also heated via the long wave infrared radiation.

How does a Radiant Heating system work

A Radiant Heating Systems emits heat similarly to that of the sunshine. If you were to stand outside on a cold spring day with the sun shining onto you, then you would feel warm and comfortable as the Radiant Heat from the sunshine is travelling through the air and warming your body temperature. However, if a cloud were to prevent the sunshine from reaching you then you would immediately feel colder, even though the air temperature hasn't changed, this is because the cloud is preventing the Radiant Heat from reaching your body.

This works the same way if you think about a Radiant Heating System in an office environment. The Radiant Heat that is being emitted from the Radiant Heating System travels through the air and heats up you and the surroundings of a lower temperature, but there are no clouds in the office environment to block the radiant heat.

The surfaces of the radiant heating panel have the ability to omit radiation. The ability to omit radiation is measured as an epsilon value, whereby 1.0 is the highest possible and 0.001 the lowest. Typically, unpainted aluminium has an epsilon value of 0.2 and matt white painted metal 0.95 and matt black painted metal 0.97. The surface area and surface temperature are also critically important.

Radiant Equation:

Radiant Exchange in watts = $\varepsilon \sigma (Tp^4 - Ts^4) Ap$, where:

ε = radiant heating panel emissivity {epsilon value}.
σ = Stefan-Boltzmann Constant = 5.67×10^{-8} W/m²/K⁴.
Tp = Radiant Panel Surface Temperature in Kelvin.
Ts = Surrounding Surface Temperature in Kelvin.
Ap = Radiant panel surface area (m²).

In summary, the radiant exchange in watts is equal to the fourth power of radiant panel temperature in kelvin minus the fourth power of the surrounding temperature in kelvin, multiplied by the radiant panel emissivity (typically 0.95), multiplied by the Stephan-Boltzmann Constant (5.67×10^{-8} W/m²/K⁴) and multiplied by the radiant panel surface area in m².

Is Radiant Heat expensive to run

As illustrated in 'How does a Radiant Heating system work?' demonstrates that Radiant Heat is fairly instantaneous and as such is an ideal solution for heating large open spaces such as Sports Halls and other environments where you want to heat the occupants quickly without having the heat all the air first. Because Radiant Heating systems don't have to heat up the air first, it means that it drastically reduces energy usage and therefore can save you money as approximately 70% of the heat output is direct heat radiation.

This principle also applies to Office Developments, Hospitals, Schools, Universities, and Airports, hence why Radiant Heating is a popular solution for heating large commercial buildings.

Advantages of Radiant Heating in Buildings

1. Excellent thermal comfort which improves occupant productivity can be achieved in buildings by using ceiling mounted or suspended radiant heating panels given that radiant exchange results in reduced thermal stratification a reduced air movement within the occupied zone; the radiant transfer between the panel and floor / cold surfaces means that ankle level temperatures are higher but the air temperature at head height is still lower meaning better comfort and the reduction in convective exchange results in a reduction of airborne particles such as dust.

2. The energy consumption within buildings can be reduced using a ceiling mounted / suspended radiant heating panel system rather than other heating systems due to the lower air temperatures required; it is more efficient to heat a room's surfaces and occupants directly using radiant heat than it is to heat the air to heat surfaces and occupants as with a convective system.

3. Ceiling mounted radiant heating generally costs less to install than conventional wall mounted radiators or low surface temperature radiators (LST's) because the radiant heating panels are usually installed at ceiling level. The radiant panels can utilise the existing service pipework at high level, thus eliminating the requirement to provide additional low level pipework as necessary for wall mounted radiators and LST's.

4. Ventilation losses (air changes) have far less impact on the performance of radiant panels compared with convective systems because the room's surfaces are heated which store the heat energy, rather than the air in the room as associated with conventional radiators. This is of significant advantage for area's which often when unoccupied or before / after a lessons have doors open for access.

5. Shorter pre-heat times are associated with radiant systems due to the faster and more efficient heat transfer, resulting in lower energy consumption. Once the radiant heating panel temperature is above that of the room, a room's surfaces begin to absorb the heat.

6. Due to radiant heating panels having lower water content over traditional radiators the heating system requires less inhibitors and the systems heat up time is reduced which provides further energy savings.

7. Unlike convective heating, an increase in ceiling height above the normal 2.4 to 3.0m AFFL does not significantly increase the amount of heat energy required, therefore radiant heating provides cost savings on increased floor to ceiling heights for areas such as assembly halls and sports halls.

8. Ceiling mounted units free valuable wall and floor teaching space, so the area of a room may be fully utilised, without restriction.

9. Ceiling mounted units reduce the risk of occupants being accidental burned given the radiant heating panels are installed at high level (outside the occupied zone).

10. Acoustic absorption insulation can be incorporated into free hanging radiant panel modules to achieve specificational sound requirements such as The SRS Guide to BB93 (Building Acoustics for Education).

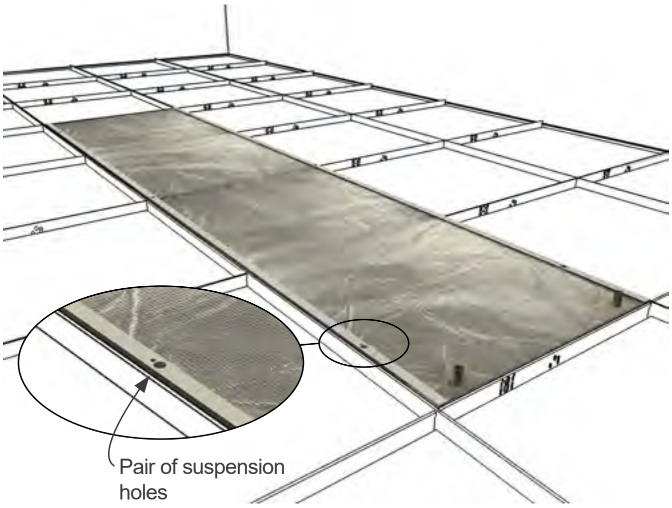
11. Radiant panels are simple to clean having only flat smooth surfaces and feature no moving parts which reduces maintenance costs and offers reduced whole life-cycle costs.

Installation

Modula panels are designed to be fixed directly back to the structural soffit. Panels are supplied with pre-punched pairs of suspension holes (one large and one small hole) which are suitable for suspension using rigid threaded rod systems (by others). Four hangers are required for each heating panel up to 1.8m long, each positioned no more than 200mm in from each end. Panels 2.4m long and longer require 6 number hangers (a pair at each end and a pair in the middle).

It should be remembered that the ceiling system "main runners" must be designed to run either side of the Modula panel and parallel to its long sides. Ceiling system "cross noggin" bayonets must be capable of being bent back so as not to clash with the Modula panel.

For simplicity and flexibility we recommend that flexible stainless steel braided EPDM hoses are used to connect the Modula panel.



Recessed into an Exposed T-Bar Grid Suspended Ceiling

Installation Examples

Surface mounted

Recessed into plasterboard ceiling

Installation - Freehanging

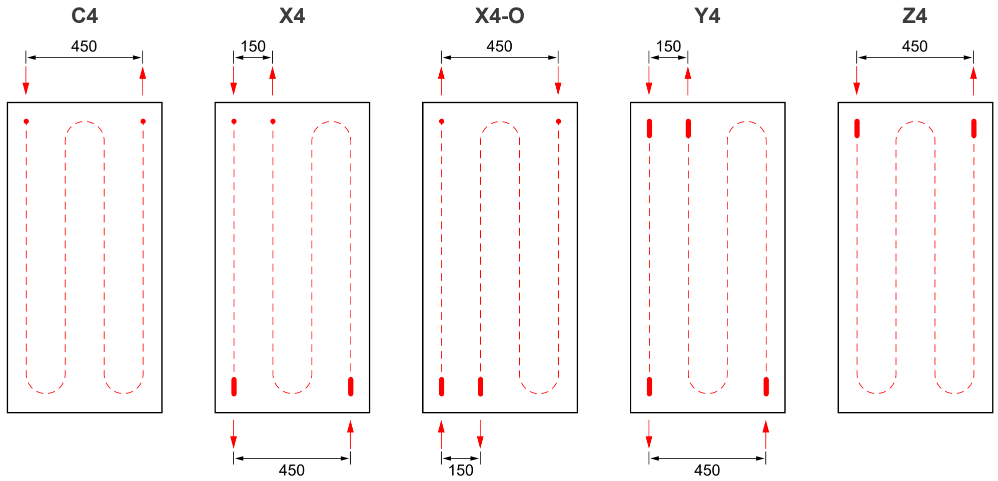
Freehanging Modula - Using rigid rods

Freehanging Modula - With and without integrated lighting

Ceiling Recessed Coupling & Connection Arrangements

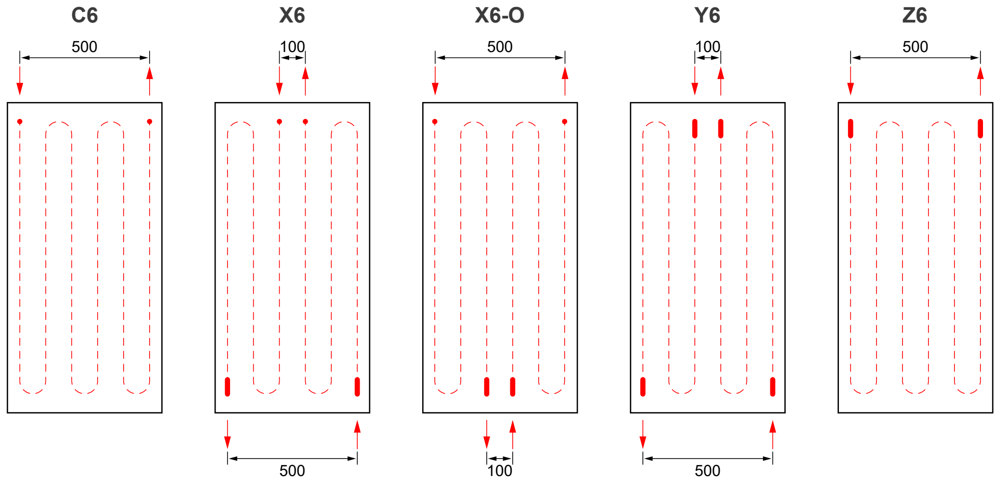
Standard Performance (SP) 600mm Coupling Details Examples

View from above (Nominal dimensions in mm)



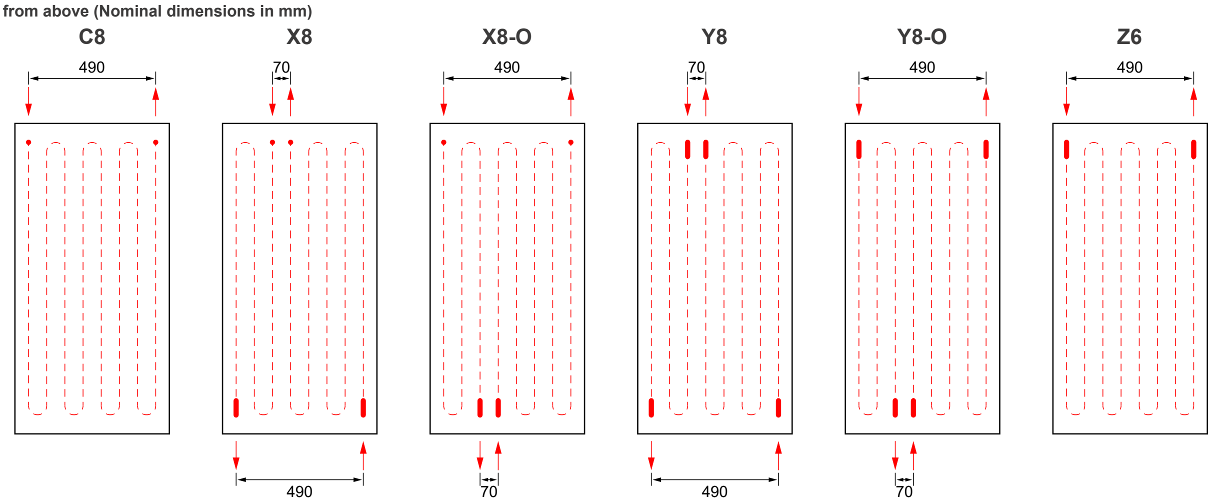
High Performance (HP) 600mm Coupling Details Examples

View from above (Nominal dimensions in mm)



Super High Performance (SHP) 600mm Coupling Details Examples

View from above (Nominal dimensions in mm)



Connection Key

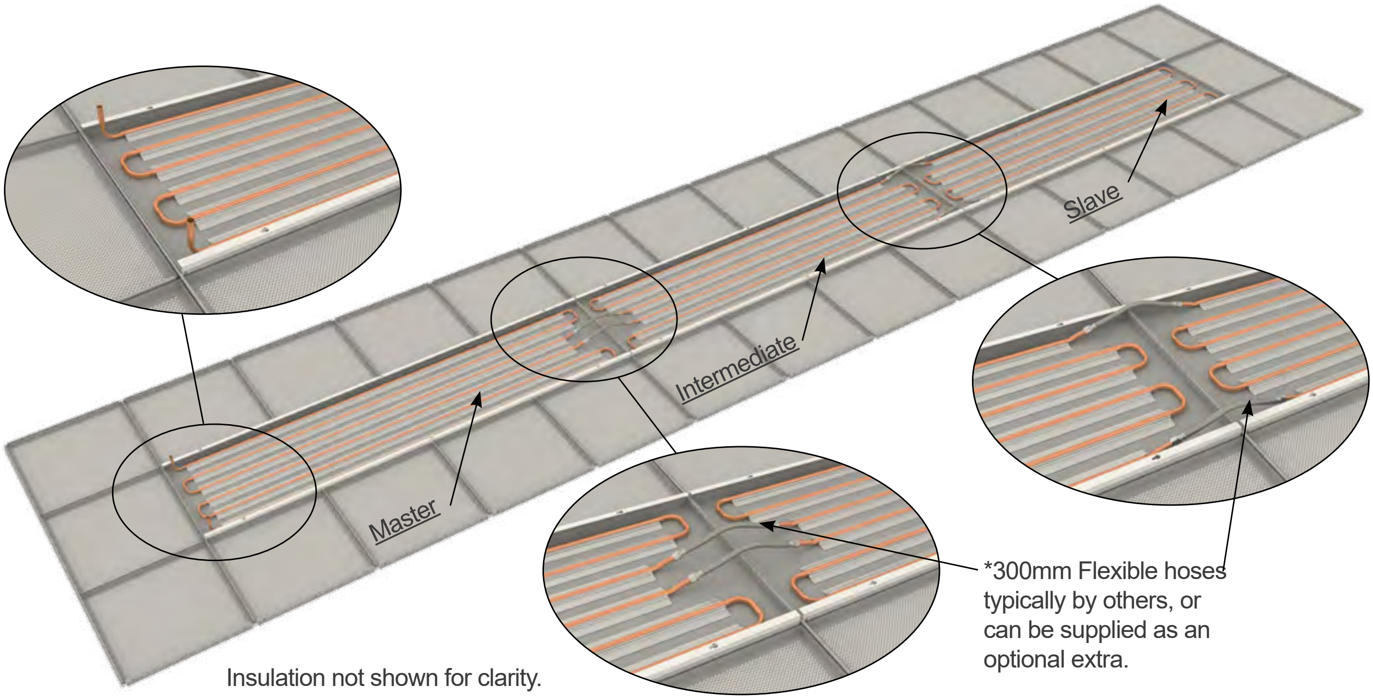
Vertical mains connection

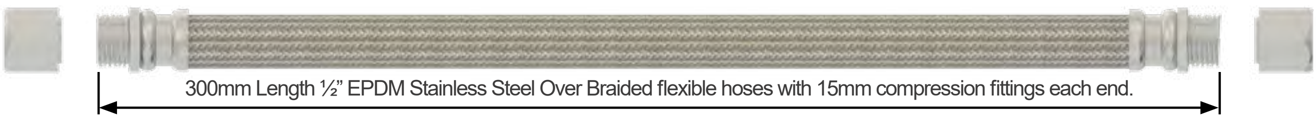
Angled interconnection

Modula Panel Specifications	
Water Content (per tube)	0.15 l/m
Panel Weight (Dry)	11.5 kg/m
Minimum Flow Rate*	Various (flow temperature dependant)
Maximum Flow Rate**	15mm = 0.105 kg/s 10mm = 0.054
Thermal Expansion***	1.6 mm/m

Note:
All flow and return connections manifolds are 10 or 15mm OD vertical.
* @ 76°C MWT
** (1.0 m/s) with ΔP = 13.7 kPa (3.0m long panel)
*** @ 55°C Above Ambient

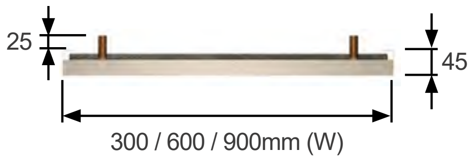
Modula Panel Run Details

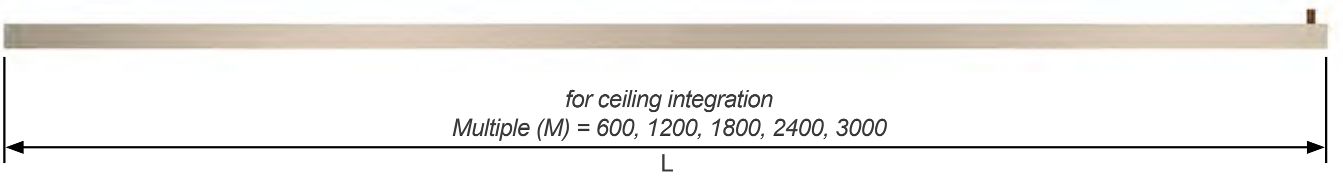




*Note: Interconnection flexible hoses measure 300mm over the outside length of thread to thread, which is the length required for correct interconnection between panel sections.

Product Dimensions (mm)





Modula is manufactured in standard module lengths (L) from 0.6m, up to 3.0m. Actual dimensions are less 8mm to fit into standard T-bars. All panels are manufactured to a dimensional tolerance of ±1mm.

Testing Protocols

Maximum working pressure	8.7 Bar (g)
Maximum test pressure	13.0 Bar (g)
Classification category	SEP
Pressure equipment directive 97 / 23 / EC	

Extrusion Specification

Section tolerances	BS 1474
Chemical properties	BS 1472
Heat treatment	BS 1490

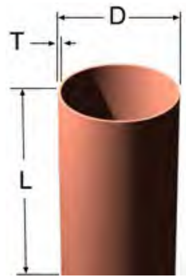
Thermal Insulation

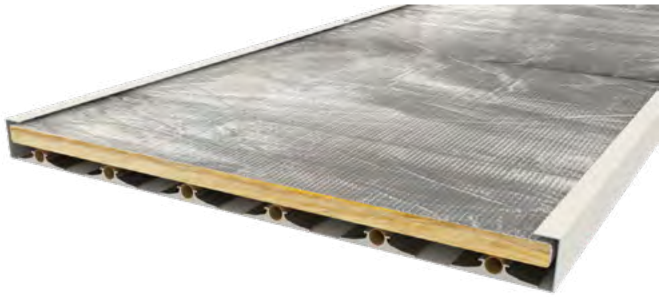
Modula panels are supplied with integrated 25mm thick high density (45 kg/m³) class 'O' foil encapsulated mineral wool insulation within the panels returned flanges.

Copper Pipe Specification

The copper pipe used in the manufacture of the Modula heating panel is compatible with the European Standard for Copper Tubes. The dimensional specification are as follows;

Outside Diameter (D): 10mm or 15mm
Wall Thickness (T): 0.38mm
Minimum Straight Length (L): 35mm

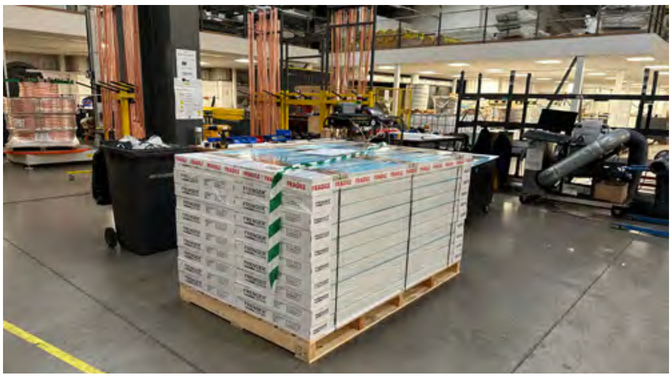




Frenger's In-house Sinusoidal Copper Bending Machine

No Joint Copper Coils for Modula Panels

Sinusoidal Copper Bending Machine Decoiler



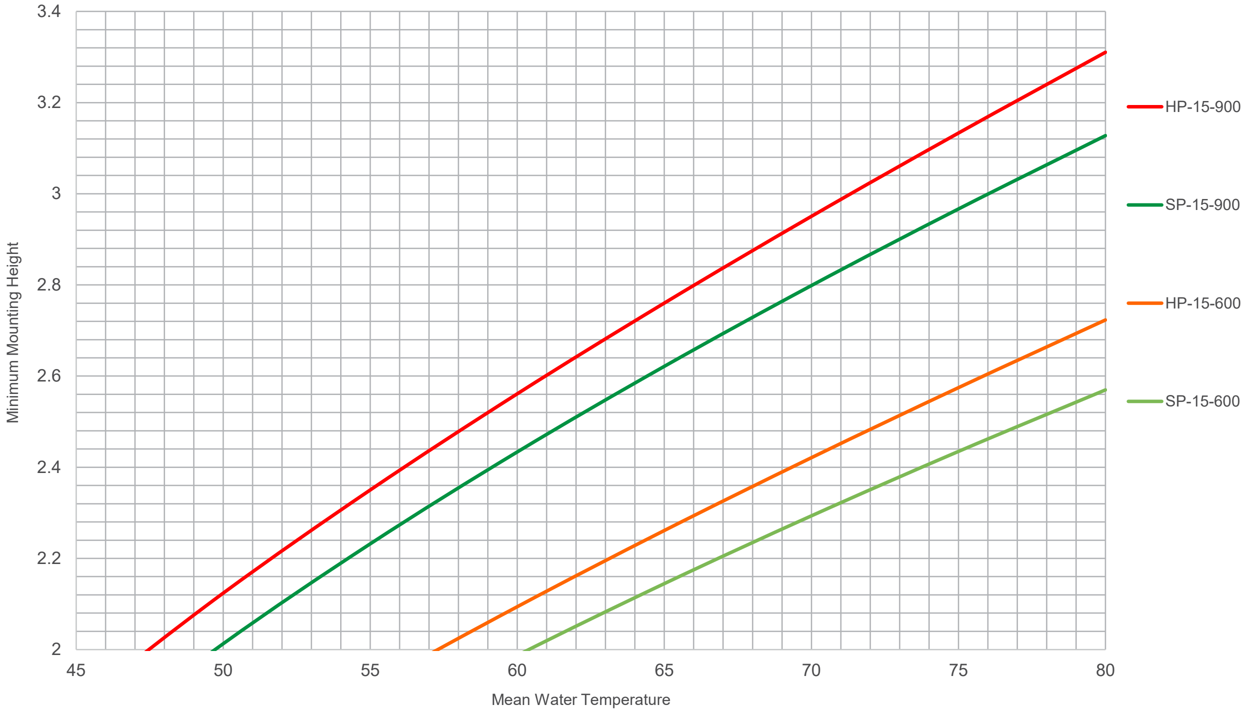
Modula Panels at Frenger's Production HQ

Installation Heights

To prevent occupant discomfort from "hot head" due to Radiant Temperature Asymmetry (RTA) which is defined in BS EN ISO 7730, the radiant panels should be mounted at certain minimum heights relative to surface temperature above finished floor level (FFL).

The maximum RTA is calculated directly under the radiant panel and depends upon several variables, namely the installation height, surface temperature of the radiant panel, size of radiant panel, the surface temperatures of the surrounding environment and is also dependent upon if the occupants are considered seated or standing. The following graphs are based upon the RTA being calculated in accordance with BS EN ISO 7726: 2001, with the occupants seated, directly below the centre of the radiant panel, and are based on the radiant plane being 0.6m AFFL in accordance with CIBSE Guide A (2015), section 1.6.6.4.

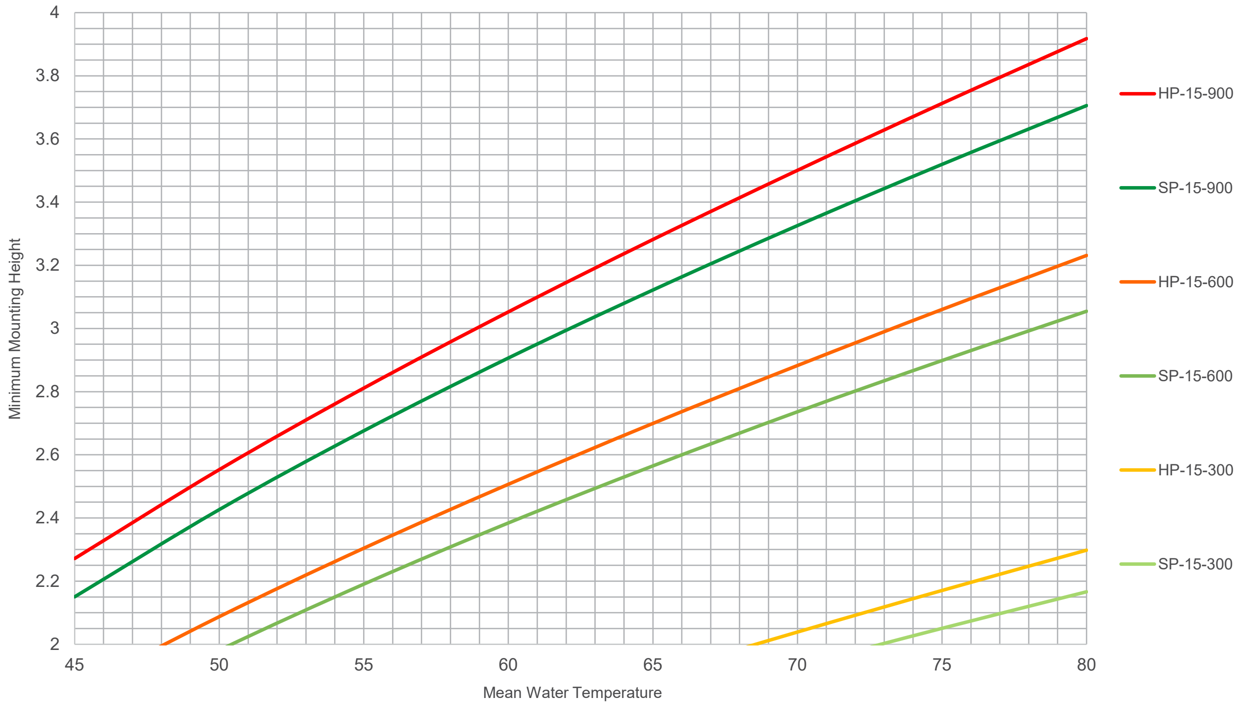
Note the following graphs meet the requirements of BB101 "Guidelines on ventilation, thermal comfort and indoor air quality in schools" where it is recommended that the RTA should not exceed 7K. Please note for installations with vulnerable pupils, e.g. those with low mobility or difficulty in thermoregulation, the RTA should be reduced to 5 K.



Modula 15mm OD Tubes - Minimum Mounting Heights for RTA < 7K

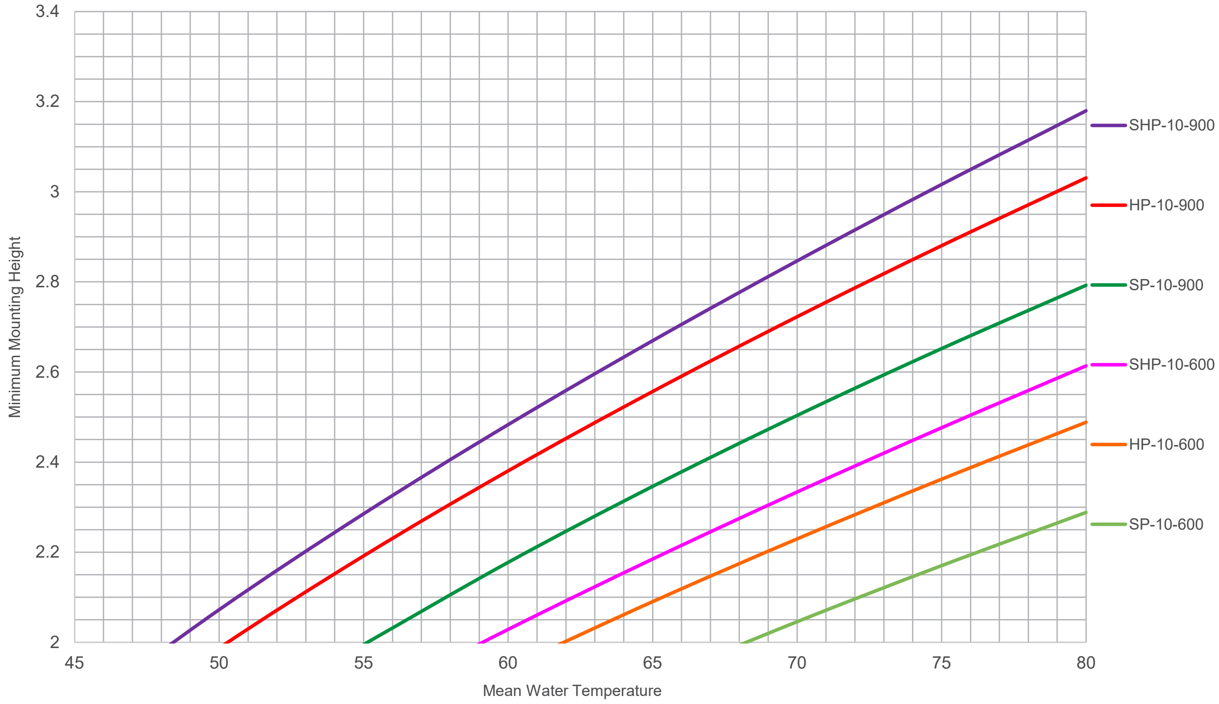
(Room = 21°C, Panel Length = 3.0m, Occupant Seated)

Note: SP 300 and HP 300 do not feature on the above graph as the minimum mounting height would be lower than 2m.



Modula 15mm OD Tubes - Minimum Mounting Heights for RTA < 5K

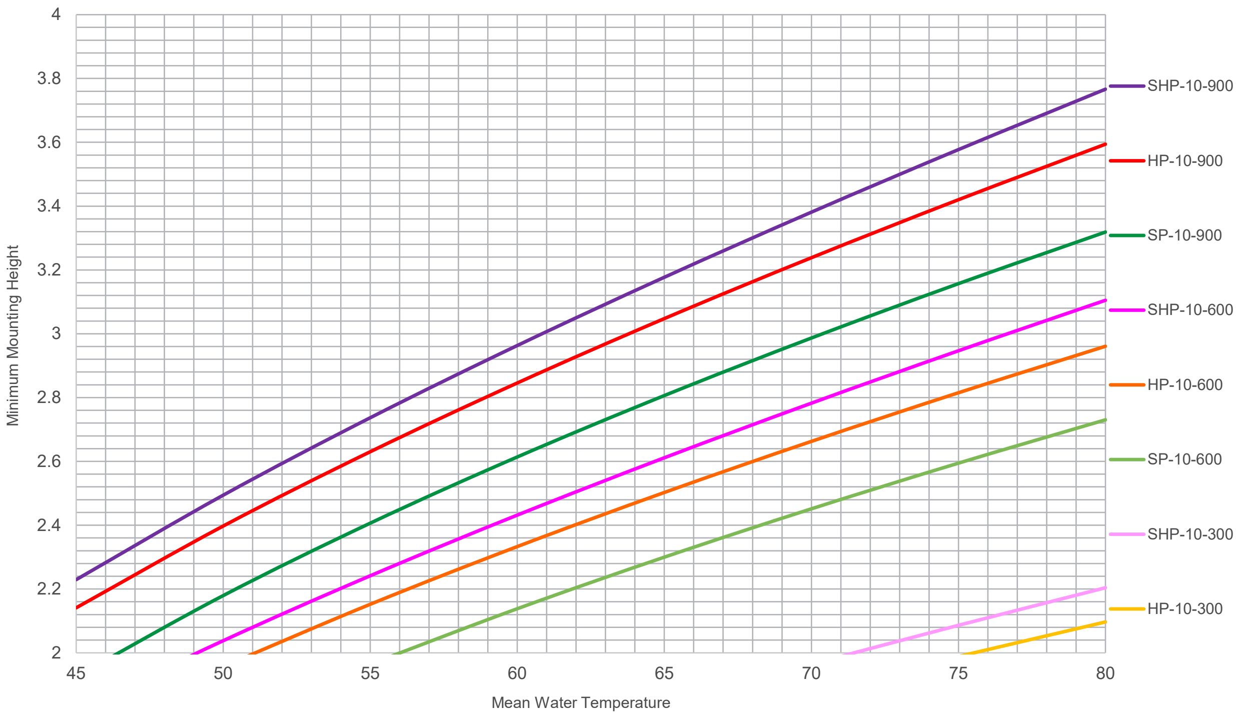
(Room = 21°C, Panel Length = 3.0m, Occupant Seated)



Modula 10mm OD Tubes - Minimum Mounting Heights for RTA < 7K

(Room = 21°C, Panel Length = 3.0m, Occupant Seated)

Note: SP 300 and HP 300 do not feature on the above graph as the minimum mounting height would be lower than 2m.



Modula 10mm OD Tubes - Minimum Mounting Heights for RTA < 5K

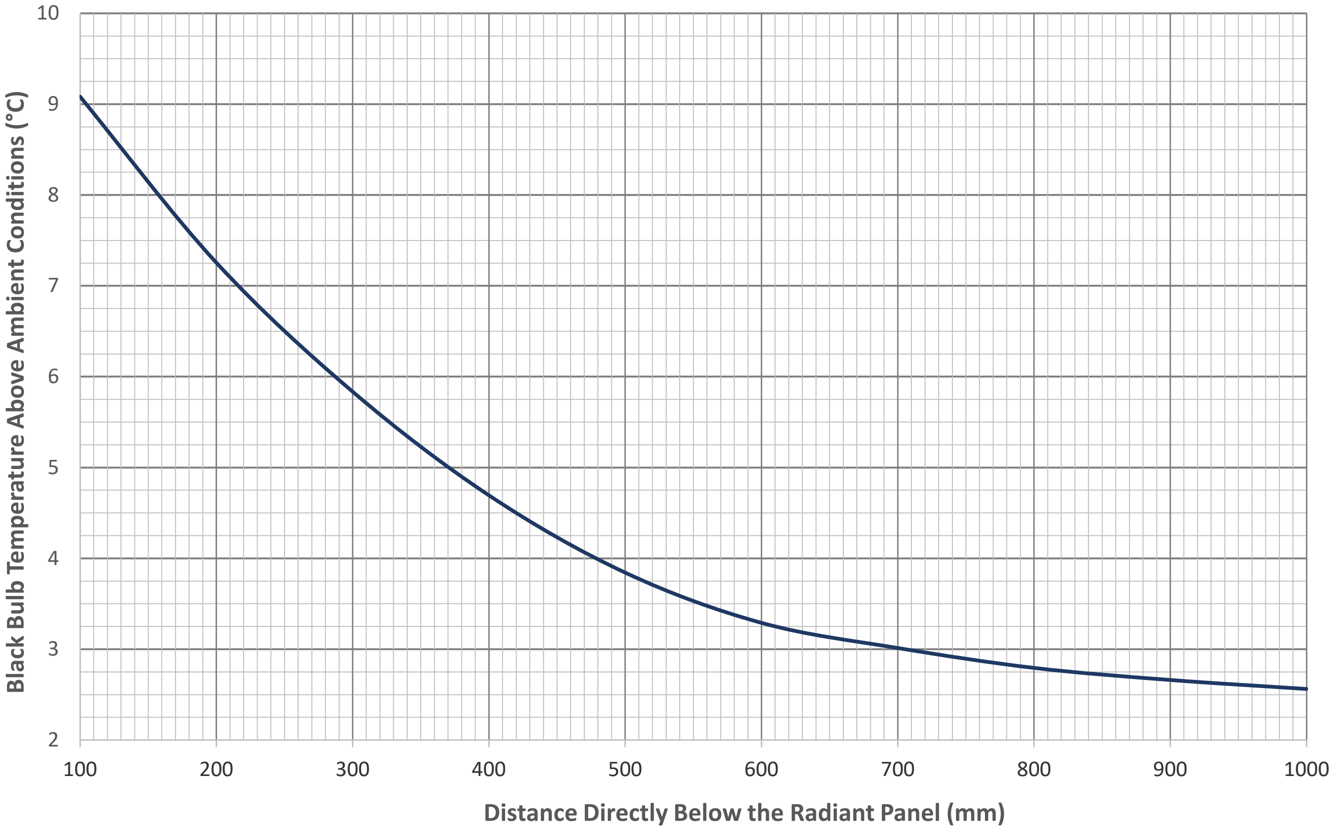
(Room = 21°C, Panel Length = 3.0m, Occupant Seated)

Note: SP 300 does not feature on the above graph as the minimum mounting height would be lower than 2m.

Note the RTA calculations take into account the difference in temperature between the mean water temperature and surface temperature, all in accordance with independent EN14037 test results (Report No. DC218 D12.4627 & DC218 D12.4628) conducted by WSP Labs in Stuttgart. Should more detailed calculations regarding the RTA be required please request our RTA calculation tool.

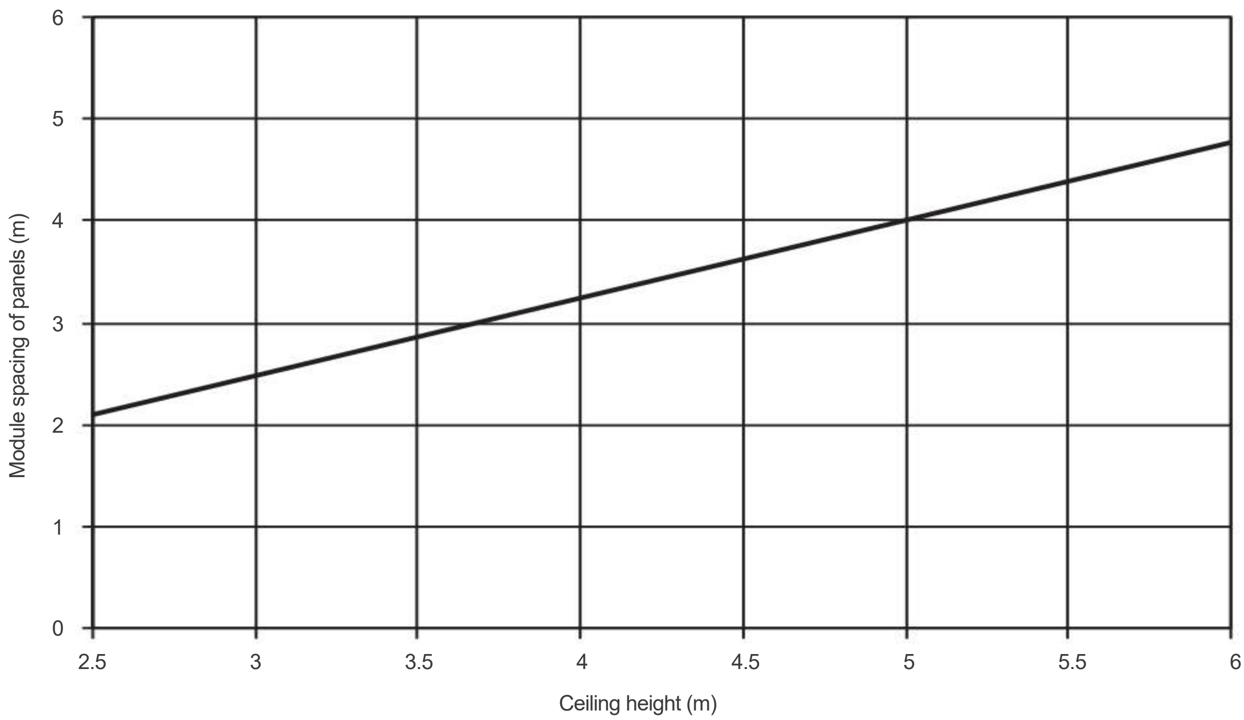
Installation Distances

It is important to note that should materials or other products be mounted directly below radiant panels they will be subjected to the direct radiant heat transfer from the hot panel surface. The following chart can be used to estimate the increase in surface temperature of materials mounted directly below the panels at various distances. Note: The following temperature increases above ambient conditions are based on Black Bulb measurements, therefore materials with lower absorptivity (α) will have a lower increase in temperature.



Black Bulb Temperature Difference Directly Below Radiant Panels
(Radiant Panel Width = 0.6m, Room Temperature = 21°C, Surface Temperature = 80°C)

Recommended spacings between heating panels (centre-to-centre)



Heating Effect - 0.6m Wide Panel

Flow & Return Temperature (°C)	Room Temperature (°C)	Model	OD Pipe Size (mm)	Heating Outputs (W) Panel Length (m) 0.6	1.2	1.8	2.4	3
85/75	16	SP	10	157	328	549	782	1005
			15	184	364	640	949	1249
		HP	10	178	388	652	910	1165
			15	205	425	748	1095	1423
		SHP	10	197	448	746	1043	1304
	18	SP	10	152	314	524	749	964
			15	178	346	607	903	1195
		HP	10	172	371	623	874	1123
			15	198	404	710	1044	1362
		SHP	10	191	428	715	991	1257
	20	SP	10	146	300	499	717	924
			15	172	328	575	857	1142
		HP	10	166	354	594	837	1082
			15	191	382	672	994	1302
		SHP	10	185	407	683	949	1210
	22	SP	10	141	286	475	684	885
			15	166	316	543	812	1087
		HP	10	160	337	565	801	1040
			15	184	362	635	943	1242
		SHP	10	178	388	650	908	1163
	24	SP	10	136	272	451	651	846
			15	160	304	513	767	1032
		HP	10	154	321	536	765	984
			15	178	342	599	892	1182
		SHP	10	172	368	618	868	1117
80/70	16	SP	10	150	293	487	700	904
			15	175	336	559	835	1114
		HP	10	170	345	579	819	1061
			15	196	373	654	968	1272
		SHP	10	189	397	667	929	1186
	18	SP	10	144	279	463	667	865
			15	170	324	528	789	1060
		HP	10	164	329	550	783	1007
			15	188	359	617	917	1212
		SHP	10	183	378	634	888	1140
	20	SP	10	139	265	439	634	826
			15	163	312	498	745	1005
		HP	10	159	313	522	747	961
			15	181	345	581	866	1152
		SHP	10	176	359	602	848	1094
	22	SP	10	134	255	416	601	787
			15	157	301	469	701	950
		HP	10	152	297	494	710	916
			15	174	332	546	816	1092
		SHP	10	169	340	570	808	1048
	24	SP	10	129	245	393	568	748
			15	150	288	440	658	894
		HP	10	146	281	466	673	871
			15	167	318	512	766	1031
		SHP	10	162	322	538	768	987

Flow & Return Temperature (°C)	Room Temperature (°C)	Model	OD Pipe Size (mm)	Heating Outputs (W) Panel Length (m) 0.6	1.2	1.8	2.4	3
75/65	16	SP	10	136	257	422	610	801
			15	157	301	474	709	963
		HP	10	153	301	501	721	933
			15	175	332	553	826	1109
		SHP	10	170	345	578	823	1058
	18	SP	10	130	247	399	577	762
			15	151	289	446	666	907
		HP	10	148	286	473	684	888
			15	167	319	519	776	1048
		SHP	10	164	327	547	782	1006
	20	SP	10	125	238	377	544	722
			15	144	277	418	624	852
		HP	10	142	271	447	646	844
			15	160	306	486	727	986
		SHP	10	158	310	515	741	956
	22	SP	10	120	228	356	513	681
			15	138	266	392	583	797
		HP	10	136	256	421	609	800
			15	154	294	455	679	924
		SHP	10	151	292	485	700	907
	24	SP	10	114	218	335	481	641
			15	132	254	366	544	743
		HP	10	130	246	395	572	755
			15	147	281	424	632	863
		SHP	10	145	275	455	658	858
70/60	16	SP	10	125	239	361	518	690
			15	143	275	397	587	802
		HP	10	142	270	426	615	813
			15	159	304	458	683	932
		SHP	10	157	298	490	709	924
	18	SP	10	120	229	340	487	649
			15	136	263	380	548	749
		HP	10	136	258	401	578	767
			15	152	290	428	637	871
		SHP	10	151	285	461	667	874
	20	SP	10	114	219	320	457	609
			15	131	251	363	510	697
		HP	10	129	247	377	542	721
			15	144	278	399	593	810
		SHP	10	145	273	432	625	824
	22	SP	10	109	209	300	428	569
			15	124	240	346	474	646
		HP	10	124	236	353	507	675
			15	138	265	381	549	751
		SHP	10	138	261	405	584	774
	24	SP	10	104	200	287	400	530
			15	118	228	330	439	597
		HP	10	118	225	330	472	629
			15	131	252	362	508	693
		SHP	10	131	248	378	544	723

All outputs tabulated above are based on a 10°C degree dt (difference in temperature) across the water Flow & Return temperatures when above the minimum mass flowrates for the heating panel size at the relevant tube OD (outside diameter).

Flow & Return Temperature (°C)	Room Temperature (°C)	Model	OD Pipe Size (mm)	Heating Outputs (W)				
				Panel Length (m)				
				0.6	1.2	1.8	2.4	3
65/55	16	SP	10	110	211	306	435	578
			15	128	249	360	480	654
		HP	10	125	238	360	515	686
			15	143	274	396	556	760
		SHP	10	139	263	412	593	788
	18	SP	10	105	201	290	407	539
			15	123	237	343	445	606
		HP	10	120	228	337	481	640
			15	136	262	377	515	703
		SHP	10	133	251	385	553	737
	20	SP	10	100	191	276	380	502
			15	116	225	327	420	559
		HP	10	113	216	315	448	595
			15	129	249	359	476	648
		SHP	10	126	239	360	515	686
	22	SP	10	95	183	262	354	466
			15	110	213	310	400	514
		HP	10	108	206	293	416	551
			15	122	236	340	437	595
		SHP	10	120	227	334	477	635
	24	SP	10	90	173	249	328	431
			15	104	202	294	379	471
		HP	10	102	195	278	385	509
			15	116	223	322	414	544
		SHP	10	113	215	310	441	586
60/50	16	SP	10	99	191	276	362	476
			15	114	222	322	416	524
		HP	10	113	216	310	425	563
			15	127	244	354	455	606
		SHP	10	125	239	342	488	649
	18	SP	10	94	181	262	336	442
			15	108	210	305	394	481
		HP	10	107	205	294	395	521
			15	120	231	335	432	556
		SHP	10	118	226	324	452	600
	20	SP	10	89	171	248	319	408
			15	102	198	288	373	452
		HP	10	101	194	279	365	480
			15	113	218	318	409	507
		SHP	10	112	214	307	417	552
	22	SP	10	83	162	234	301	376
			15	96	187	272	352	426
		HP	10	95	183	264	336	441
			15	106	206	299	385	465
		SHP	10	106	202	290	384	506
	24	SP	10	79	152	221	284	344
			15	90	176	255	331	401
		HP	10	90	172	248	318	404
			15	100	193	280	362	438
		SHP	10	100	190	273	351	462

Flow & Return Temperature (°C)	Room Temperature (°C)	Model	OD Pipe Size (mm)	Heating Outputs (W)				
				Panel Length (m)				
				0.6	1.2	1.8	2.4	3
55/45	16	SP	10	88	169	246	318	387
			15	100	194	283	367	446
		HP	10	100	192	277	356	454
			15	110	214	311	402	486
		SHP	10	111	212	305	395	521
	18	SP	10	82	159	233	300	362
			15	94	183	266	345	420
		HP	10	93	181	262	336	417
			15	104	201	293	379	458
		SHP	10	104	200	288	368	477
	20	SP	10	77	150	218	282	342
			15	87	171	250	324	395
		HP	10	88	169	246	316	381
			15	97	189	274	355	430
		SHP	10	98	188	271	346	435
	22	SP	10	72	140	205	265	320
			15	82	159	234	303	369
		HP	10	82	159	230	296	356
			15	91	176	256	332	403
		SHP	10	92	176	254	324	394
	24	SP	10	67	131	191	246	299
			15	76	149	218	282	344
		HP	10	76	148	215	276	333
			15	84	163	239	309	375
		SHP	10	85	164	236	303	363
50/40	16	SP	10	75	145	212	275	333
			15	85	167	244	318	389
		HP	10	85	165	239	308	372
			15	94	184	269	349	424
		SHP	10	95	182	263	339	407
	18	SP	10	69	136	198	257	312
			15	79	155	227	297	363
		HP	10	79	153	223	288	348
			15	87	171	250	325	396
		SHP	10	88	170	246	316	381
	20	SP	10	65	126	185	240	291
			15	74	144	211	275	337
		HP	10	74	142	207	268	325
			15	81	159	232	302	367
		SHP	10	82	158	229	294	355
	22	SP	10	59	117	170	222	269
			15	68	133	195	255	312
		HP	10	68	132	192	249	301
			15	74	146	214	278	340
		SHP	10	76	146	212	273	330
	24	SP	10	55	107	157	204	249
			15	62	122	179	234	287
		HP	10	62	122	176	229	277
			15	69	134	197	256	312
		SHP	10	69	134	195	251	304

All outputs tabulated above are based on a 10°C degree dt (difference in temperature) across the water Flow & Return temperatures when above the minimum mass flowrates for the heating panel size at the relevant tube OD (outside diameter).

Flow & Return Temperature (°C)	Room Temperature (°C)	Model	OD Pipe Size (mm)	Heating Outputs (W)				
				Panel Length (m)				
				0.6	1.2	1.8	2.4	3
45/35	16	SP	10	62	121	178	232	283
			15	71	140	206	269	330
		HP	10	71	138	201	261	316
			15	79	154	226	295	361
		SHP	10	78	153	222	287	347
	18	SP	10	58	112	164	214	262
			15	65	129	190	248	305
		HP	10	65	127	185	241	293
			15	72	142	208	272	332
		SHP	10	73	140	205	265	321
	20	SP	10	53	102	151	197	240
			15	60	118	173	227	278
		HP	10	59	116	170	221	269
			15	66	129	191	248	305
		SHP	10	67	129	188	244	295
	22	SP	10	48	93	138	180	219
			15	55	107	157	206	253
		HP	10	54	106	155	201	245
			15	59	117	173	226	277
		SHP	10	60	117	171	222	270
	24	SP	10	43	84	124	163	199
			15	49	96	142	186	229
		HP	10	49	95	140	182	222
			15	54	105	156	204	249
		SHP	10	54	106	155	200	244
40/30	16	SP	10	51	100	147	193	236
			15	57	112	166	218	269
		HP	10	58	114	166	217	265
			15	63	124	182	238	293
		SHP	10	65	125	184	239	292
	18	SP	10	46	91	134	175	215
			15	51	102	151	197	243
		HP	10	53	103	151	196	241
			15	57	112	164	216	265
		SHP	10	58	114	166	217	265
	20	SP	10	42	82	120	157	194
			15	46	91	134	177	218
		HP	10	47	92	135	177	217
			15	50	100	147	194	238
		SHP	10	52	102	150	195	238
	22	SP	10	36	72	106	140	172
			15	41	81	119	157	194
		HP	10	42	82	120	157	193
			15	45	88	130	171	211
		SHP	10	46	90	133	174	213
	24	SP	10	32	64	94	123	151
			15	36	70	104	137	169
		HP	10	36	72	105	138	170
			15	39	77	114	150	184
		SHP	10	40	79	116	153	186

All outputs tabulated above are based on a 10°C degree dt (difference in temperature) across the water Flow & Return temperatures when above the minimum mass flowrates for the heating panel size at the relevant tube OD (outside diameter).

Minimum Flowrates

Flow Temperature (°C)	Minimum Flowrates (kg/s)	
	10mm Tube	15mm Tube
85	0.006	0.010
80	0.007	0.011
75	0.007	0.011
70	0.008	0.012
65	0.008	0.013
60	0.009	0.014
55	0.010	0.015
50	0.011	0.017
45	0.012	0.019
40	0.014	0.021

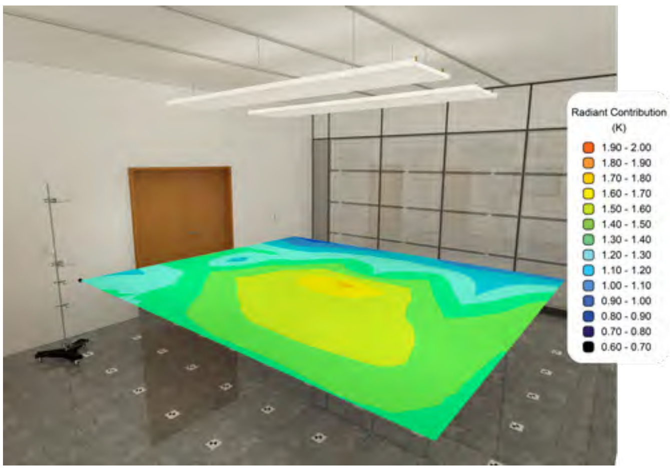
Where mass flow rates are defaulted to minimum kg/sec for heat exchange (to avoid laminar flow) the Return temperatures may vary from dt 10°C degree - see table below for minimum mass flow rates for various different Flow Temperatures and tube sizes (10mm OD and 15mm OD). 1 Litre of water = 1 Kg.

Modula Performance Testing

Frenger's Modula performance data is certified by independent testing carried out at HLK Stuttgart, to EN14037-1,-2,-3:2016.

All Frenger's product also undergo in-house testing to help optimise the products during development in Frenger's 3 number custom built, fully calibrated climatic test laboratories.

The in-house comprehensive testing utilises state of the art equipment and BSRIA calibrated instrumentation to reduce the amount of uncertainty to an accuracy of + / - 2.5%, Frenger's Modula heating panels undergo third party validation testing by HLK Stuttgart. HLK Stuttgart testing is only for performance and takes no account of the indoor environment, whereas all Frenger's testing and published catalogue data is compliant to ISO 7730, ergonomics of the indoor environment to ensure that occupancy comfort is maintained to the highest of standards.



Multi-Service Radiant Panels

Frenger's Multi-Service Radiant Panels (MSRP's) combine the radiant heating of Modula radiant heating panels (electric radiant heating is also available for Frenger MSRP units) with acoustic sound absorption and integrated LED lighting in 100% pre fabricated 'Plug n Play' free hanging units.

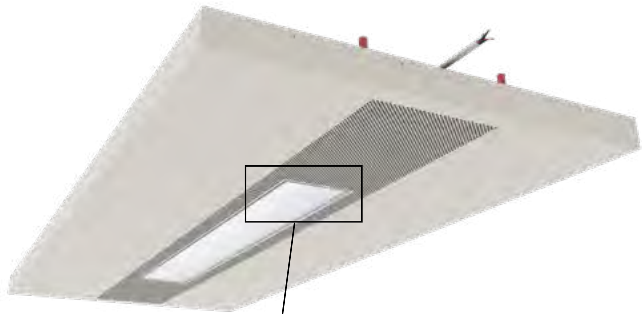
Over recent years more buildings have looked to incorporate additional services within the "free hanging" Radiant Panel System to reduce site installation time and provide a modular approach to the building design.

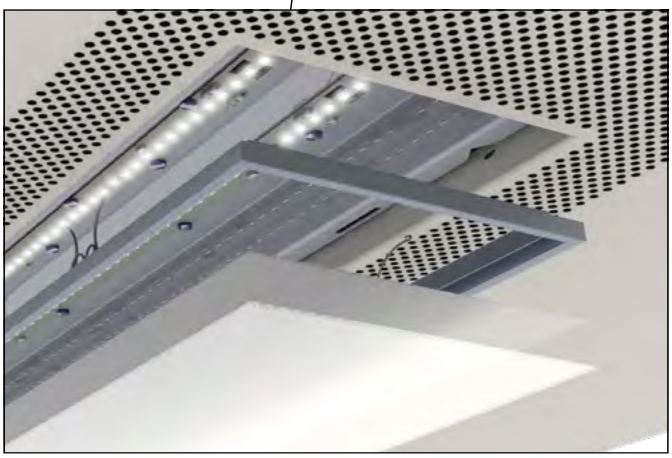
The MSRP has enabled buildings to achieve reduced room reverberation times by incorporating acoustic absorption material within the MSRP to achieve the SRS guide to BB93 (Building Acoustics for Education), optional integrated lighting to achieve LG7 compliance can also be incorporated.

You can find out more about Frenger's MSRP's units in an extensive brochure at: www.frenger.co.uk/MSRP

Angled edge slim profile MSRP with 2 number Acoustic perforated zones

Square edge MSRP with 1 number Acoustic perforated zone





Multi-layered LDPD optic consisting of a diffuser and diamond prism

Haberdashers' Boys School

Nottingham Trent University, Engineering Building

Spotlight Youth Centre

Equivalent Acoustic Absorption Area

	Model	
	Equivalent Absorption Area (m2) per linear m	
Frequency (Hz)	MSRP T1	MSRP T2
50*	0.11	0.11
63*	0.22	0.18
80*	0.13	0.08
100	0.11	0.13
125	0.42	0.54
160	0.70	0.89
200	0.77	1.02
250	1.04	1.18
315	1.12	1.04
400	1.20	1.10
500	1.26	1.25
630	1.40	1.61
800	1.26	1.31
1000	1.19	1.25
1250	1.07	1.16
1600	1.11	1.15
2000	0.98	1.07
2500	0.99	0.98
3150	0.90	0.96
4000	0.90	0.97
5000	0.99	0.96
6300*	1.05	1.10
8000*	1.00	1.17
10000*	0.87	0.89

*Denotes frequencies outside the range covered by BS EN ISO 354:2003

MSRP T1

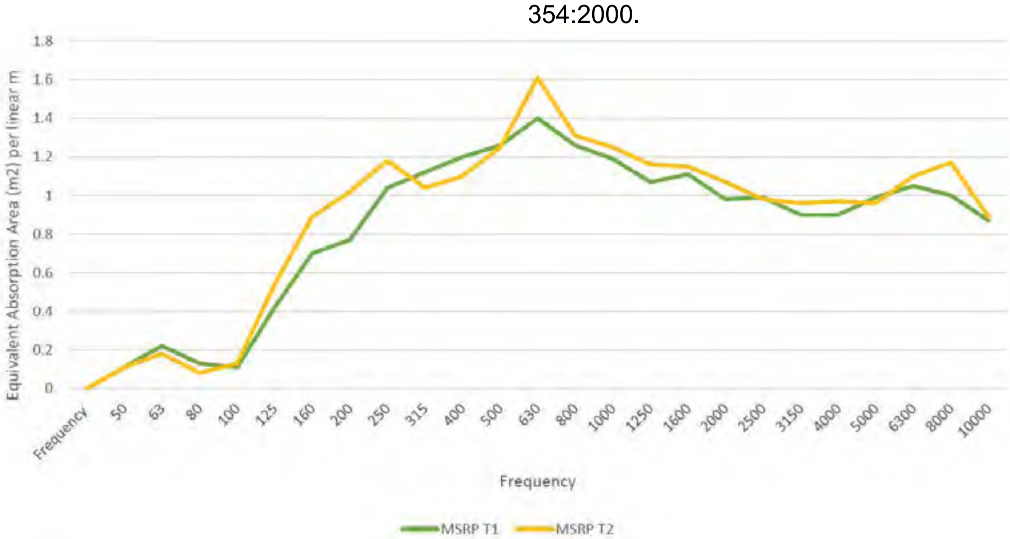
Size (W x L)	0.9m Wide x 1.0 to 3.0m Long
Acoustic Zone	4.0mm Hole / 33% Open Area
Mounting Height	350mm from the Ceiling

Note: Acoustic Absorption Area (A) figures detailed are per linear metre of MSRP, hence the absorption area's should be multiplied by the chosen panel length; all enclosed data is based on independent testing conducted by SRL (Sound Research Laboratories) Ref. C/21760/R01 to BS EN ISO 354:2000.

MSRP T2

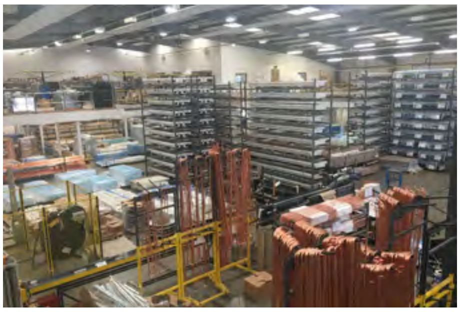
Size (W x L)	1.0m Wide x 1.0 to 3.0m Long
Acoustic Zone	4.0mm Hole / 33% Open Area
Mounting Height	350mm from the Ceiling

Note: Acoustic Absorption Area (A) figures detailed are per linear metre of MSRP, hence the absorption area's should be multiplied by the chosen panel length; all enclosed data is based on independent testing conducted by SRL (Sound Research Laboratories) Ref. C/21760/R01 to BS EN ISO 354:2000.



Bespoke Manufacturing

Frenger has the manufacturing capability required to deliver the most complex of bespoke solutions. Facilities include the latest full CNC machine centers, together with a dedicated powder-coat paint plant to paint all of the components of the products and project specific in-house testing laboratories.



Project Specific Testing Facility

The 3 number state-of-the-art Climatic Testing Laboratories at Frenger's technical facility in Derby (UK) have internal dimensions of 6.3m (L) x 5.7m (W) x 3.3m (H) high and includes a thermal wall so that both internal and perimeter zones can be simulated. Project specific testing validates product / solution performance (outputs) and resultant Room Comfort Conditions for compliance category grading in accordance with BS EN ISO 7730. All of Frenger's chilled beams have also been independently tested and certified by Eurovent in terms of product performance (output), as Eurovent can not test for thermal comfort; hence the need for Frenger's own laboratories.

Project Specific Testing

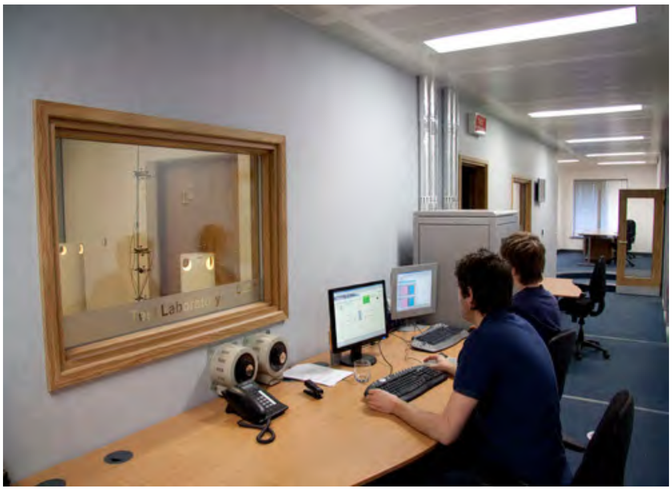
Project specific mock-up testing is a valuable tool which allows the Client to fully assess the proposed system and determine the resulting room occupancy Thermal Comfort conditions. The physical modelling is achieved by installing a full scale representation of a building zone complete with internal & external heat gains (Lighting, Small Power, Occupancy & Solar Gains).

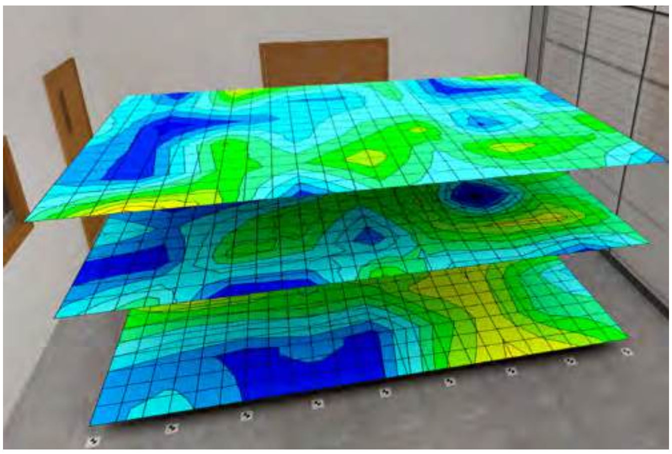
The installed mock-up enables the client to verify the following:

- Product performance under project specific conditions.
- Spatial air temperature distribution.
- Spatial air velocities.
- Experience thermal comfort.
- Project specific aesthetics.
- Experience lighting levels (where relevant).
- Investigate the specific design and allow the system to be optimised.

The project-specific installation and test is normally conducted to verify:

- Product capacity under design conditions.
- Comfort levels - air temperature distribution.
  - thermal stratification.
  - draft risk.
  - radiant temperature analysis.
- Smoke test video illustrating air movement.
- Live Thermal Imaging





Photometric Testing Facility

The in-house Photometric test laboratories at Frenger are used to evaluate the performance of luminaires. To measure the performance, it is necessary to obtain values of light intensity distribution from the luminaire. These light intensity distributions are used to mathematically model the lighting distribution envelope of a particular luminaire. This distribution along with the luminaires efficacy allows for the generation of a digital distribution that is the basis of the usual industry standard electronic file format. In order to assess the efficacy of the luminaire it is a requirement to compare the performance of the luminaire against either a calibrated light source for absolute output or against the “bare” light source for a relative performance ratio.

The industry uses both methods. Generally absolute lumen outputs are used for solid state lighting sources and relative lighting output ratios (LOR) are used for the more traditional sources. Where the LOR method is chosen then published Lamp manufacturer’s data is used to calculate actual lighting levels in a scheme and for LED light source the integration chamber is used to measure LED luminance efficacy.

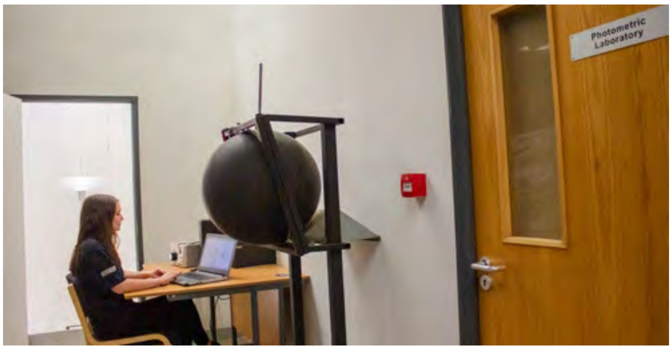
The intensity distribution is obtained by the use of a Goniophotometer to measure the intensity of light emitted from the surface of the fitting at pre-determined angles. The light intensity is measured using either a photometer with a corrective spectral response filter to match the CIE standard observer curves or our spectrometer for LED sources.

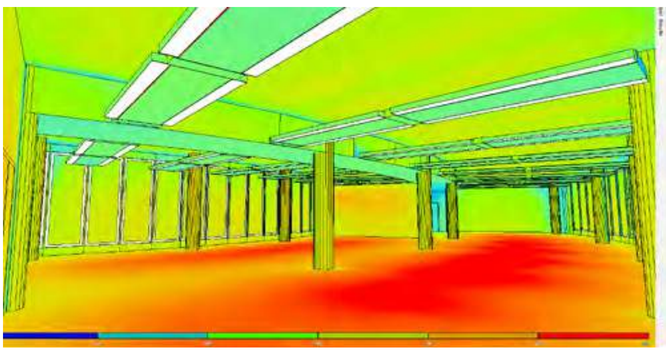
Luminaire outputs are measured using our integrating sphere for smaller luminaires or our large integrator room for large fittings and Multi Service Chilled Beams. For both methods we can use traceable calibrated radiant flux standards for absolute comparisons.

All tests use appropriate equipment to measure and control the characteristics of the luminaire and include air temperature measurements, luminaire supply voltage, luminaire current and power. Thermal characteristics of luminaire components can be recorded during the testing process as required.

A full test report is compiled and supplied in “locked” PDF format. Data is collected and correlated using applicable software and is presented electronically to suit, usually in Eulumdat, CIBSE TM14 or IESN standard file format.

Frenger conduct photometric tests in accordance with CIE 127:2007 and BS EN 13032-1 and sound engineering practice as applicable. During the course of these tests suitable temperature measurements of parts of LED’s can be recorded. These recorded and plotted temperature distributions can be used to provide feedback and help optimise the light output of solid state light source based luminaires which are often found to be sensitive to junction temperatures.





Acoustic Testing Facility

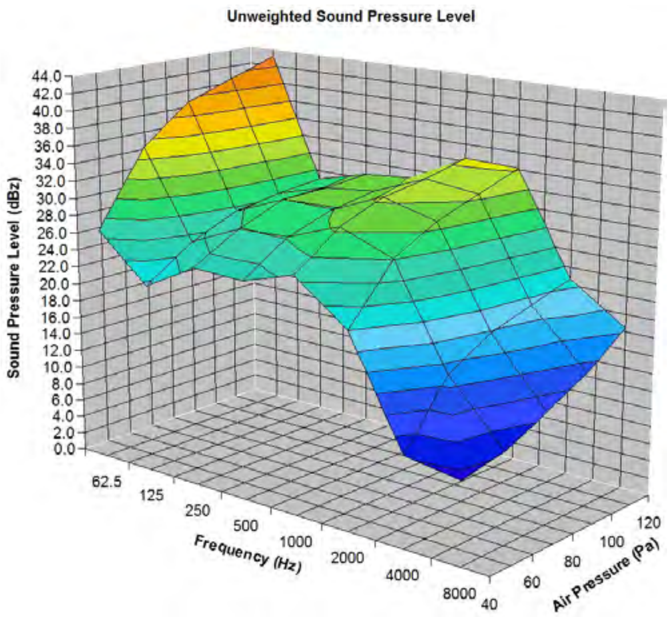
The Acoustic Test Room at Frenger is a hemi-anechoic chamber which utilises sound absorbing acoustic foam material in the shape of wedges to provide an echo free zone for acoustic measurements; the height of the acoustic foam wedge has a direct relationship with the maximum absorption frequency, hence Frenger had the acoustic wedges specifically designed to optimise the sound absorption at the peak frequency normally found with our active chilled beam products.

The use of acoustic absorbing material within the test room provides the simulation of a quiet open space without "reflections" which helps to ensure sound measurements from the sound source are accurate, in addition the acoustic material also helps reduce external noise entering the test room meaning that relatively low levels of sound can be accurately measured.

The acoustic facilities allow Frenger to provide express in-house sound evaluation so that all products, even project specific designs can be quickly and easily assessed and optimised.

To ensure accuracy, Frenger only use Class 1 measurement equipment which allows sound level measurements to be taken at 11 different ⅓ octave bands between 16 Hz to 16 kHz, with A, C and Z (un-weighted) simultaneous weightings.

In addition to the above, Frenger also send their new products to specialist third party Acoustic Testing. The results of which are very close and within measurement tolerances to that of Frenger's in-house measurement of sound.



Industry Associations

Always mindful of its place within the HEVAC industry, Frenger Systems pride themselves on broad range of trade associations and accreditations. With a clear service, product and environmental ethos across everything they do, Frenger is focused on meeting and consistently surpassing the expectations of its customers. Frenger invest heavily in achieving industry recognised accreditations and as part of ongoing commitment to their customers and continually assess the level of services they provide. Opening up their company to these independent organisations allows Frenger to continually improve their customer service and satisfaction.

As an engaged member of the HEVAC industry, Frenger are actively asked to participate in industry specific discussions and studies. With this in mind Frenger are proud to have achieved and be linked with the following associations:

BSI EN ISO 9001:2015

Frenger Systems are registered by BSI for operating a Quality Management System which complies with the requirements of BS EN 9001:2015.

Eurovent

Frenger Systems participate in the EC programme for Chilled Beams. Check ongoing validity of certificate: www.eurovent-certification.com or www.certiflash.com Certiflash.
The heat exchanger for the Recepto HRU is a Klingenburg Eurovent Certified aluminium static heat exchanger.

Chilled Beam and Ceiling Association

The Chilled Beam and Ceiling Association has been formed by leading companies within the construction industry. The objective of the Association is to promote the use of Chilled Beams and Chilled Ceilings, and encourage best practice in their development and application.

HEVAC Member

HEVAC is the heating and ventilating contractors association. As a HEVAC member Frenger Systems are subject to regular, third party inspection and assessment to ensure their technical and commercial competence.

Federation of Environment Trade Association

The Federation of Environment Trade Association (FETA), of which Frenger Systems is a member of, is the recognised UK body which represents the interests of manufacturers, suppliers, installers and contractors within the heat pump, controls, ventilating, refrigeration & air conditioning industry.

UK Trade & Investment

Frenger Systems are members of both the UK TI (the former Department of Trade and Industry) as well as the Chamber of Commerce for Export Documentation.

Certified CIBSE CPD

Frenger Systems is a CIBSE approved “Continued Professional Development” (CPD) provider. Frenger offers 1 hour lunch time CPD presentations regarding “Chilled Beam Technology”, CPD presentations are usually held at Consulting Engineers local practices with lunch provided courtesy of Frenger. Alternatively half or full day Chilled Beam Technology training is available at Frenger’s UK Technical Academy in a dedicated training theatre with fully operational BMS system with various different Chilled Beam and Ceiling solutions integrated.

Booking of a CPD Presentation can be requested on Frenger’s home page, under the drop down menu headed “Company”, then “CPD Booking”. Alternatively email sales@frenger.co.uk.

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