Heat Emitter Supplement

To the Domestic Heating Design Guide

Tables of Heat Emitter outputs

The heat emitters contained in the tables are considered typical of those found in existing buildings, and are intended to be used to ascertain if the existing heat emitters in a system can be used when the heat generator is replaced by a new boiler, heat pump or any unit that will operate at a lower mean water temperature than the heat generator being replaced.

It may be found that, subject to the heat emitter's size and condition, it can be used with the new heat generator. However, in many cases it is suspected that new heat emitters of the correct sizes will be needed.

Historically, systems installed in the UK before metrication in 1972 would have been based on water and air temperatures related to Btu/hour. Traditionally 180°F (Flow), 160°F (Return) and 70°F (Air) were used to determine the mean water to air (MW-AT) differential. Whilst equation and exponent remained unchanged, MW-AT became expressed as 55.6 deg Celsius.

After metrication the IHVE Guide (1977) published an equation, aligned with European practise where the MW-AT became 60 degC (more correctly expressed as degrees Kelvin)

Latterly, after year 2000, further refinement of Radiator emissions, in line with modern engineering practices, using an updated test standard BS EN 442, caused the MW-AT to fall further to either 50K for "high" temperature systems or 30K for "low" temperature systems

Currently the method for the correct sizing of heat emitters is detailed in Section 10 of the Domestic Heating Design Guide, and is used in the example calculations in this supplement.

Prepared by the Institute of Domestic Heating & Environmental Engineers
for use with the Design Guides from the Domestic Building Services Panel at CIBSE
and the Heat Emitter Guide for Domestic Heatpumps from the Heat Pump Association Group.

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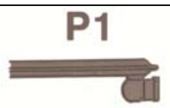
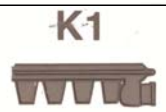
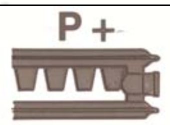
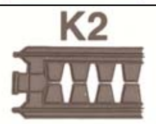
Supplementary tables of heat emitter outputs.

The outputs are listed by height and by each 100mm of length, and are for a mean water to air temperature difference [mw-air Δt] of 50 degC (50K). Conversion factors for other mw-air differences are given in Table 10.1 of the Domestic Heating Design Guide.
Tables 10.2, 10.3 and 10.4 may also need to be used.

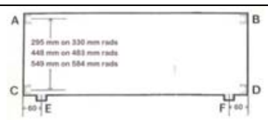
Similar to Stelrad Super or Hullrad or Belkon – 40mm wide sections – Period 1960/70/80

	Watts output per each 100mm of length at a mean water to air Δt of 50degC. (Rounded to the nearest Watt)				
	HEIGHT (mm)	300	440	590	740
	Single Panel	38	52	68	82
	Double Panel	60	83	107	131
	Triple Panel	83	114	147	179

Similar to Stelrad Accord -- 40mm wide sections – Period 1980/90

	HEIGHT (mm)	300	450	600	750
	Single Panel	37	53	69	83
	Single Panel with extended surface	51	74	96	117
	Double Panel with one extended surface	78	113	145	176
	Double Panel with Two extended surfaces	94	136	176	214

Convector radiators

	HEIGHT (mm)	330	483	584	
	Thermalrad	87	130	174	
	HEIGHT (mm)	366	516	616	716
	Thermalpanel 85mm projection	81	112	132	153
	Thermalpanel 115mm projection	90	126	150	175

The outputs above and in all tables in this document are quoted at 50 Δt degC (50K).
Use the Tables 10.x in the Domestic Heating Design Guide to adjust the outputs for other mean water to air temperature differences and factors.

Example: How much heat will a P1 style radiator, 600 high by 1760 long, on a plain flat wall emit if the room temperature is 21°C and the mean water temperature is 51°C, the flow/return temperatures being 55/47

m.w. to air temperature difference...... 30°C (51 – 21)
Factor *f1* from Table 10.1 .... 0.515
Factor *f2* from Table 10.2 .... 0.96
Factors *f3* and *f4*................................. 1.00
Conversion factor............................. 0.494 (*f1* x *f2* x *f3* x *f4*)

No. of 100mm increments (1760 / 100) x Output per section = Output from radiator
17.6 x (69 x 0.494) = 600 Watts

But, the calculated heat load for the room is 1200 Watts. How many Catalogue Watts are needed from a replacement Stelrad Compact radiator of a similar length, not longer than the existing?

Closest length to existing..................1600 (in this example a longer radiator will not fit)
Select from current catalogue ....**2429** Watts (1200 / 0.494)
Radiator selected...............................Stelrad Compact K2 600 high x 1600 long (2771 W)

Radiator Output @ 30 Δt degC .....1369 Watts (2771 x 0.494)

However, with current Building Regulations requiring both time and temperature control of heating zones, the facility exists to switch off the heating or to reduce the temperature overnight or even during the day.

In such cases the internal temperature will fall. In the following example calculation it is assumed that the internal temperature when the heating switches on will have fallen to 15°C. Therefore the selected radiator's output after switching back on and reaching design flow temperature will be:-

m.w. to air temperature difference...... 36 (51 – 15)
Factor *f1* from Table 10.1 .... 0.652
Factor *f2* from Table 10.2 .... 0.96
Factors *f3* and *f4*................................. 1.00
Conversion factor............................. 0.626 (*f1* x *f2* x *f3* x *f4*)

Radiator Output @ 32 Δt degC ....1735 Watts (2771 x 0.626)

This equates to 27% more output than when the room temperature is at 21°C.
Thus an average of 15% over the warm-up period results in the recommended Intermittent Heating Allowance addition to heat generator sizing.

Beeston Cast Iron Radiators

New Royal 2-Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 3.5" deep	406	89	57	0.093	**47**	0.37
24" High, 3.5" deep	559	89	57	0.124	**62**	0.53
30" High, 3.5" deep	711	89	57	0.155	**80**	0.66

New Royal 3-Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 5.5" deep	406	140	57	0.139	**69**	0.54
24" High, 5.5" deep	559	140	57	0.186	**91**	0.78
30" High, 5.5" deep	711	140	57	0.232	**112**	0.98
36" High, 5.5" deep	864	140	57	0.279	**136**	1.17

New Royal 4-Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 7.5" deep	406	191	57	0.176	**83**	0.69
24" High, 7.5" deep	559	191	57	0.242	**113**	1.01
30" High, 7.5" deep	711	191	57	0.297	**138**	1.25
36" High, 7.5" deep	864	191	57	0.362	**165**	1.52

New Royal 5-Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
13" High, 9.5" deep	298	241	57	0.163	**80**	0.64
18" High, 9.5" deep	419	241	57	0.223	**102**	0.88
24" High, 9.5" deep	562	241	57	0.297	**133**	1.26
30" High, 9.5" deep	714	241	57	0.381	**165**	1.62
36" High, 9.5" deep	867	241	57	0.464	**198**	1.98

New Royal 7-Column Window Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
13.5" High, 13.25" deep	343	337	57	0.232	**105**	0.99

Hospital Easy Clean 3.5" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 3.5" deep	406	89	51	0.093	**47**	0.52
24" High, 3.5" deep	559	89	51	0.116	**59**	0.70
30" High, 3.5" deep	711	89	51	0.149	**75**	0.90

Hospital Easy Clean 5" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 5" deep	394	127	57	0.130	**55**	0.73
24" High, 5" deep	546	127	57	0.163	**70**	0.98
30" High, 5" deep	699	127	57	0.204	**88**	1.23
36" High, 5" deep	851	127	57	0.242	**104**	1.46

Hospital Easy Clean 7" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 7" deep	394	178	64	0.163	**68**	1.02
24" High, 7" deep	546	178	64	0.209	**87**	1.42
30" High, 7" deep	699	178	64	0.279	**115**	1.89
36" High, 7" deep	851	178	64	0.334	**136**	2.27

Beeston Royal School 5.5" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 5.5" deep	397	140	57	0.121	**56**	0.60
24" High, 5.5" deep	549	140	57	0.167	**77**	0.90
30" High, 5.5" deep	702	140	57	0.214	**96**	1.14
36" High, 5.5" deep	778	140	57	0.260	**110**	1.39

Beeston Royal School 5.5" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 7.5" deep	397	191	57	0.163	**76**	0.81
24" High, 7.5" deep	549	191	57	0.223	**103**	1.19
30" High, 7.5" deep	702	191	57	0.288	**129**	1.54
36" High, 7.5" deep	778	191	57	0.348	**148**	1.87

Beeston New Royal Wall Panel Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 16" Panel	457	54	406	0.477	**232**	1.56
24" High, 16" Panel	610	54	406	0.650	**315**	2.29
30" High, 16" Panel	762	54	406	0.780	**406**	2.75

Beeston Wall Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
14.5" High, 22.75" Section	368	64	578	0.743	**345**	3.48
22.5" High, 14.13" Section	572	64	359	0.697	**337**	3.51

CRANE Cast Iron Radiators

Pall Mall 2-Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 3.5" thick	387	67	57	0.070	**35**	0.28
24" High, 3.5" thick	540	67	57	0.093	**47**	0.40
30" High, 3.5" thick	702	67	57	0.124	**63**	0.53

Pall Mall 4-Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 5.625" thick	387	143	57	0.139	**65**	0.48
24" High, 5.625" thick	540	143	57	0.204	**96**	0.75
30" High, 5.625" thick	692	143	57	0.251	**117**	0.92
36" High, 5.625" thick	778	143	57	0.307	**143**	1.13

Pall Mall 6-Column Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 8.625" thick	387	219	57	0.214	**94**	0.73
24" High, 8.625" thick	540	219	57	0.297	**131**	1.09
30" High, 8.625" thick	692	219	57	0.381	**168**	1.40
36" High, 8.625" thick	778	219	57	0.464	**204**	1.71

Pall Mall 9-Column Window Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
13" High, 13.25" thick	330	333	57	0.242	**105**	1.01

Hospital Easy Clean 3" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 3" thick	384	76	51	0.070	**35**	0.41
24" High, 3" thick	537	76	51	0.093	**47**	0.59
30" High, 3" thick	689	76	51	0.121	**61**	0.76

Hospital Easy Clean 5.75" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 5.75" thick	384	146	67	0.139	**61**	1.02
24" High, 5.75" thick	537	146	67	0.186	**81**	1.46
30" High, 5.75" thick	689	146	67	0.232	**101**	1.83
36" High, 5.75" thick	841	146	67	0.279	**121**	2.20

Hospital Easy Clean 7.125" Sectional Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 7.125" thick	384	181	67	0.167	**69**	1.31
24" High, 7.125" thick	537	181	67	0.223	**93**	1.87
30" High, 7.125" thick	689	181	67	0.288	**120**	2.42
36" High, 7.125" thick	841	181	67	0.344	**143**	2.89

CRANE Cast Iron Wall Panel Radiator	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
18" High, 16" Panel	457	51	406	0.464	**218**	1.59
24" High, 16" Panel	610	51	406	0.619	**291**	2.28
30" High, 16" Panel	762	51	406	0.764	**359**	2.81

CRANE Cast Iron Skirting Heating	Radiator Height (mm)	Radiator Depth (mm)	Section Length (mm)	Area per Section (sq.m)	Heat Output per Section (Watts @ 50K)	Water Content (L/section)
6" high, (Radiant) Type R,	173	45	305	0.066	**47**	0.75
9" high, (Radiant) Type R,	251	48	305	0.090	**69**	1.15
9" high, (Radiant/Convector) RC	251	48	305	0.087	**120**	1.05

Example calculation.

An existing dwelling has a heating system with a floor standing cast iron gas boiler serving column radiators, which from consulting the dimensions in the above tables appear to be of the Crane Pall Mall 4 column type.

The radiator in the Lounge is approximately 690mm high and 140mm deep, being 24 sections in length.

The calculated heat loss now from the Lounge at 21°C room temperature is 2120 Watts.

The boiler is to be replaced by a heat pump providing a flow temperature of 45°C and return of 39°C. (A mean water temperature of 42°C). At these temperatures the output from the radiator will be:-

Output for 50K m.w.- air Δt	117 x 24 sections	=	2808 Watts
Output at 21K (42 – 21)	2808 x 0.324	=	909 Watts

To achieve 2120 Watts from the radiator the mean water temperature will need to be 61°C.

Proof: Output at 39K (60 – 21)	2808 x 0.724	=	2033 Watts

Therefore a 65°C flow temperature from the heat pump would be required if the radiator size is not to be increased.

In addition to the calculation of radiator sizes, it is important to check if existing pipework is large enough to carry the required heat energy at the smaller system temperature differentials necessitated by heat pump design when connected directly to the emitter circuit.

Example:

For a pre-condensing boiler system the flow rate needed to carry 2120 Watts when the flow/return temperatures were 82/70°C was 0.042 kg/s[1]

For a system designed for a condensing boiler system the flow rate needed to carry 2120 Watts when the flow/return temperatures were 70/50°C was 0.025 kg/s[2]

The flow rate needed to carry 2120 Watts when the flow/return temperatures are 65/55°C will be 0.051 kg/s

In any given size of pipe this will increase the resistance to flow to be overcome by the circulating pump by approximately 13% [1] or 47% [2], so care must be taken to ensure that existing pipework is adequately sized for the proposed heat pump installation using standard circulators.

Copperad WALLSTRIP or similar - Skirting Heating

Description: Profiled sheet metal casing, nominally 8" (200mm) high, originally supplied in modular lengths from 36"(914mm) to 96"(2438mm). Heat Exchangers were mostly 3/4" Copper Tube (BS 659) with mechanically bonded Aluminium fins (steel tube was provided to special order). Some more recent types used 15mm copper tube, although this limited the output per metre run.

The actual output from any installed metre run of finned tube element will depend on a number of factors.
(a) The mean water temperature, (b) the flow rate, (c) whether connected as individual room heat emitters or as a series loop serving a complete zone.

To establish the output of an existing length of skirting heating the following may be used. Outputs are for the portion of Finned Element length only, which is 2.5" (63mm) shorter than casing length, and based on a Water flow rate of 226kg/hour (0.063 kg/s)

Basis Emission Q = 368 Watts per metre of Finned Element at 20°C Room Temperature with a MW-Air ΔtdegC of 50K. (i.e. 70°C MWT and 20°C design room temperature.) Outputs are usually given for a flow rate through the element of 0.05 kg/s.

Other Factors to be considered:
a) Dampers = Q x 0.92
b) Return pipe above fins = Q x 1.04,
c) Casing with plain tube only (no fins) = Q x 0.12
(d)Water Flow rate factor, for 3 times normal flow rate (3 x kg/s) add 7% to emission output.

Emission Factor Basis = mean water to air differential of 50K and exponent n =1.30

Equations:

Emission Factor $= (\text{Actual MW-Air } \Delta t / 50)^{n}$

kg/s to carry required heat = Watts / (circuit Δt x 4187)

It should be noted that some installations may be found with skirting heating in individual rooms connected like a radiator, i.e. separate flow and return to each room. Other installations may have a complete floor where all skirting heating is connected as a single series loop. This increases the flow rate through the skirting heating and thus will increase the emission per metre run throughout the loop.

For systems where the heat generator is a heat pump, the flow/return temperature differential will be significantly less than, for example, a condensing boiler. Typically, the differentials of the two types of system can be 8degC or 20degC respectively.

Where a system that had a traditional boiler is being considered for conversion to a heat pump system, the differences in mean water temperature and flow rates become significant.

For any given Watts requirement the increased flow rate because of the smaller flow/return differential will increase slightly the output per metre run, but the much lower mean water temperature will reduce the available Watts per metre run.

So care should be taken when upgrading a system having existing skirting heating.

Copperad Fan-Coil (3-Row) Heating Units (post 1965)

Description: Vertical cased FCU models with modular front inlet & outlet grilles from 1965 to approx 1990 share common dimensions, all 9" (225mm deep) and 24" (610mm) high.

Standard lengths are 24" (610mm), 36" (914mm), 48" (1219mm) and 60" (1524mm). Original Btu/h values have been converted to Watts with ΔT=50 Kelvin and Exponent n=1.10

All heat exchangers listed are 3-Row finned copper tube with screwed 1"BSP connections. Air and Low Water temperature cut-off thermostats were included on the fan-deck.

Note: Mk10 Models manufactured after 1990 have new lengths: 600/900/1200mm also depth is reduced to 203mm, Heat exchangers and Fan decks were modified. Additionally, Motor efficiencies improved by 40-50% on average.

Copperad Fan-Coil (3-Row) Heating Units (post 1965)

Model Reference	Fan Speed	Fan Motor (Watts)	Air Volume (L/sec)	**Output (Watts @ 50K)**
SF324	Super	85	90	**3684**
	Normal	80	68	**3083**
	Low	70	47	**2482**
SF336	Super	170	182	**7369**
	Normal	165	135	**6088**
	Low	140	94	**4939**
SF348	Super	250	274	**10818**
	Normal	245	201	**8989**
	Low	210	142	**7290**
SF360	Super	345	364	**14685**
	Normal	330	269	**12150**
	Low	280	189	**9929**

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Issue: 11/13 Version: online