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MCS 021

HEAT EMITTER GUIDE FOR DOMESTIC HEAT PUMPS

Issue 2.1

This guide has been approved by the Steering Group of the MCS.

This guide was prepared by the MCS Working Group 12 ‘Heat Emitter Guide’.

REVISION OF MICROGENERATION GUIDANCE DOCUMENTS

Microgeneration Guidance Documents will be revised by issue of revised editions or amendments. Details will be posted on the website at www.microgenerationcertification.org

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

Users of this guide should ensure that they possess the latest issue and all amendments.

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ACKNOWLEDGEMENTS

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FOREWORD

Heat pumps can provide high-efficiency, low-carbon heat for dwellings. Their performance is optimised if low-temperature heat emitters are used for heat distribution in the house, so this guide aims to help you select an emitter type and operating temperature which will result in high efficiency and low running costs.

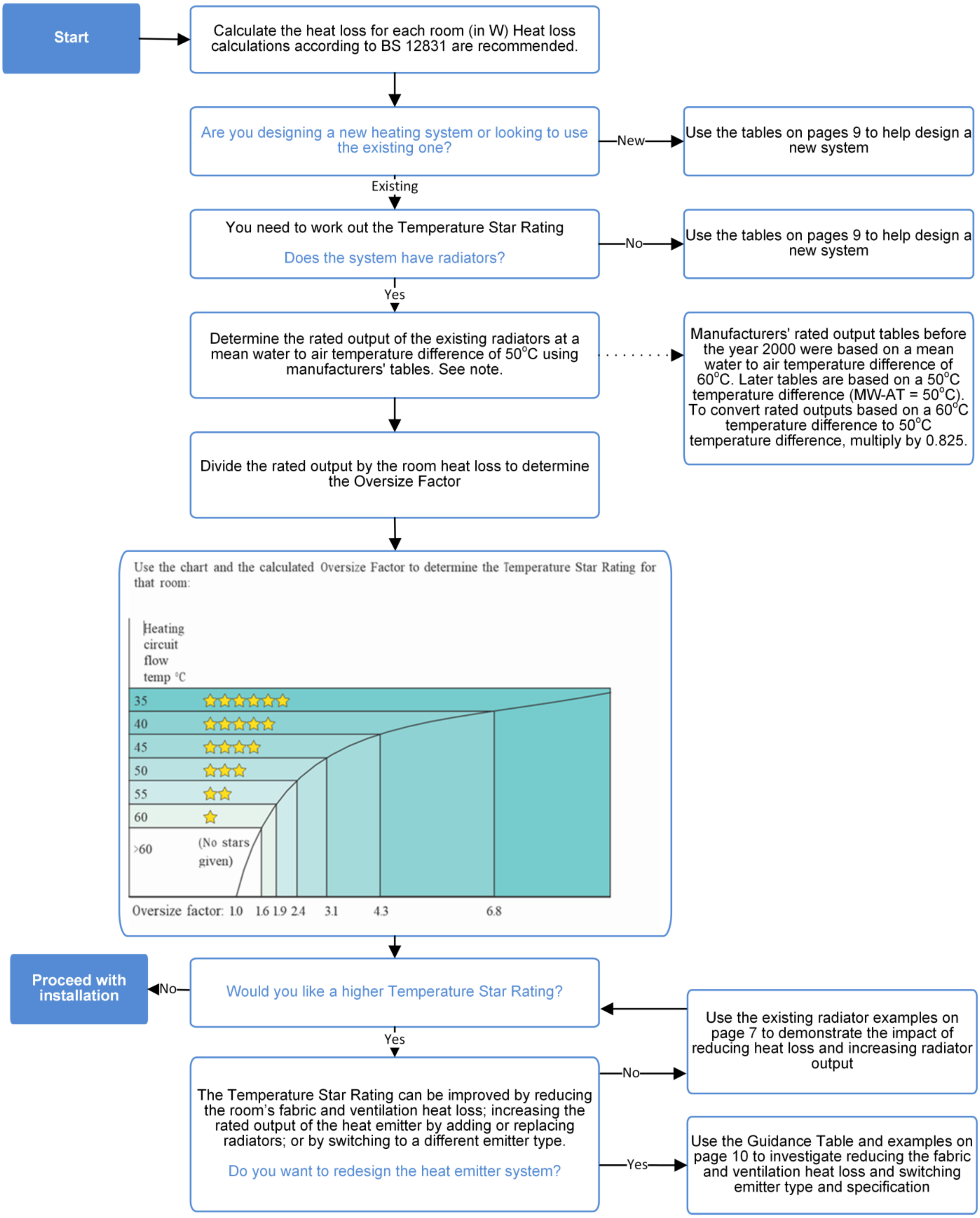
The guide uses a Temperature Star Rating to indicate how efficient the proposed system is likely to be. More efficient systems are given a higher number of stars. The maximum is 6 stars. More stars are given when lower heat emitter temperatures are used because the heat pump is able to operate more efficiently.

The guide can be used for systems with existing radiators or to design a new heat emitter system. A flow chart has been designed to help you through the process for an individual room. This process should be repeated for all of the heated rooms in the dwelling.

The Guidance Table on page 9 is annotated to help you achieve the most suitable design for the room/dwelling. Several examples are also included in the guide to illustrate the advantages of improving the energy efficiency by reducing fabric and ventilation heat loss and achieving lower emitter temperatures.

The emitter guide is not a detailed design tool, but is intended to stimulate a proper review of the dwelling-specific heat load and heat emitter design, leading to optimised performance and low running costs.

1. TEMPERATURE STAR RATING



Calculate the heat loss for each room (in W) Heat loss calculations according to BS 12831 are recommended.

Are you designing a new heating system or looking to use the existing one?

Use the tables on pages 9 to help design a new system

You need to work out the Temperature Star Rating

Does the system have radiators?

Use the tables on pages 9 to help design a new system

Determine the rated output of the existing radiators at a mean water to air temperature difference of 50°C using manufacturers' tables. See note.

Manufacturers' rated output tables before the year 2000 were based on a mean water to air temperature difference of 60°C. Later tables are based on a 50°C temperature difference (MW-AT = 50°C). To convert rated outputs based on a 60°C temperature difference to 50°C temperature difference, multiply by 0.825.

Divide the rated output by the room heat loss to determine the Oversize Factor

Use the chart and the calculated Oversize Factor to determine the Temperature Star Rating for that room:

Heating circuit flow temp °C	
35	★★★★★★
40	★★★★★
45	★★★★
50	★★★
55	★★
60	★
>60	(No stars given)

Would you like a higher Temperature Star Rating?

Use the existing radiator examples on page 7 to demonstrate the impact of reducing heat loss and increasing radiator output

The Temperature Star Rating can be improved by reducing the room's fabric and ventilation heat loss; increasing the rated output of the heat emitter by adding or replacing radiators; or by switching to a different emitter type.

Do you want to redesign the heat emitter system?

Use the Guidance Table and examples on page 10 to investigate reducing the fabric and ventilation heat loss and switching emitter type and specification

2. EXAMPLES FOR EXISTING RADIATOR SYSTEMS WITH A LOW TEMPERATURE HEAT PUMP

2.1 Calculating the Temperature Star Rating of an existing radiator system

An example of a poorly-insulated room has been adapted from CIBSE's Domestic Heating Design Guide. The room is assumed to be in London (design outside air temperature = -1.8ºC) and initially has single glazing. The heating is assumed to be used continuously.

- **Room heat loss:** 1671W
- **Size of existing radiator:** 1600mm L, 700mm H, 103mm D (double panel)
- **Existing radiator rated output at MW-AT = 60ºC**: 2349W
- **Existing radiator rated output at MW-AT = 50ºC**: 2349 x 0.825 = 1938W

Calculate the Oversize Factor and look up the Temperature Star Rating on the chart.

- **Oversize factor:** 1938/1671 = 1.2
- **Temperature Star Rating:** [no stars] ☆☆☆☆☆☆
- **Radiator flow temperature:** > 60ºC

To operate at these temperatures, a specialist heat pump would be required. You must therefore take action to ensure satisfactory operation. The examples on this page demonstrate the impact of reducing heat losses and increasing radiator output. Use the Guidance Table on page 9 to redesign the emitter system.

2.2 Reducing fabric and ventilation heat losses

Reducing the fabric and ventilation heat loss is an efficient way of increasing the Temperature Star Rating because it reduces energy consumption and improves the system efficiency – always consider reducing heat losses when making changes to a house.

- **Improved room heat loss:** 976W
- **New oversize factor:** 1938/976 = 2.0
- **New Temperature Star Rating:** 2 stars ★★☆☆☆☆

If the external walls have cavity wall insulation added, the windows are replaced with A-rated double glazing, 50mm of underfloor insulation is added, and the room is carefully draught-proofed, the example room's Temperature Star Rating is improved:

- **Radiator flow temperature:** 55ºC

2.3 Upgrading the existing radiators

Upgrading the existing radiator to one that has a higher rated output is another way of increasing the Temperature Star Rating:

- **Size of new radiator:** 1600mm L, 700mm H, 135mm D (this is a double convector with the same frontal area as the existing radiator)
- **New radiator rated output:** 3269W
- **New oversize factor:** 3269/1671 = 2.0
- **New Temperature Star Rating:** 2 stars ★★☆☆☆☆
- **Radiator flow temperature:** 55ºC

2.4 Reducing fabric and ventilation heat losses and upgrading the existing radiators

The two previous examples can be combined to produce a more efficient installation:

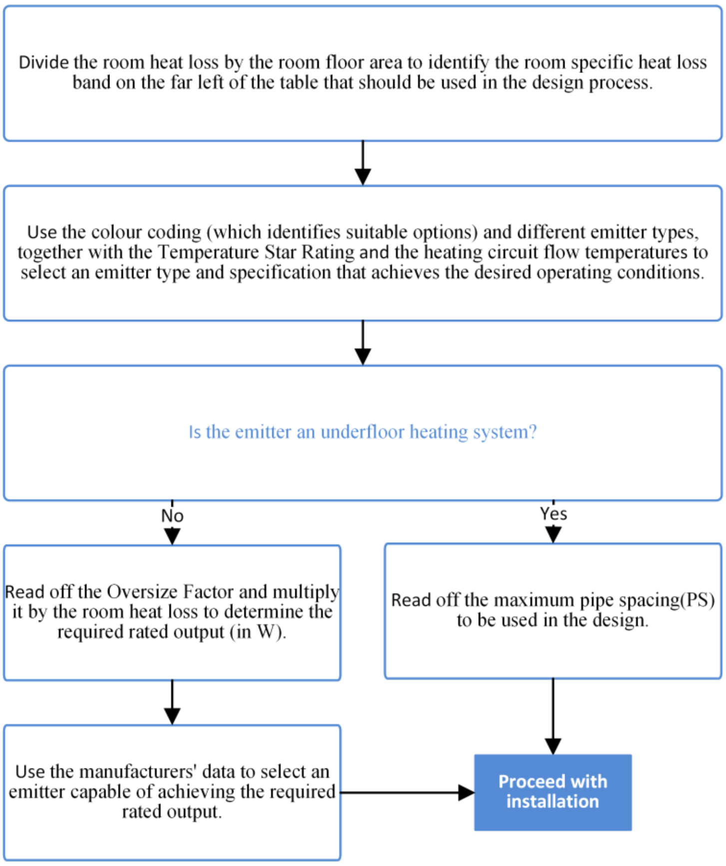
- **Improved room heat loss:** 976W
- **New radiator rated output:** 3269W
- **New oversize factor: 3269/976 =** 3.4
- **New Temperature Star Rating:** 4 stars ★★★★☆☆
- **Radiator flow temperature:** 45ºC

2.5 Change Heat Pump to a Very High Temperature Heat Pump

A Very High Temperature Heat Pump can be considered as the heat source to achieve suitable temperature star ratings from the chart on page 9 at the high radiator flow temperatures as shown in the examples 2.1, 2.2 and 2.3 above.

3. GUIDANCE TABLE

3.1 Using the Guidance Table



3.2 Key to Guidance Table

🟥	**REDUCE FABRIC AND VENTILATION HEAT LOSS** – System cannot perform at the design parameters stated; consider reducing heat loss and/or load sharing with other emitter types.
🟧	**CONSIDER MEASURES TO REDUCE FABRIC AND VENTILATION LOSS** – System can perform at these design conditions but emitter sizes are likely to be excessive.
▨	**CAUTION** – System can perform at these design conditions with extra consideration on the emitter and heat pump design sought from the specialist designer/manufacturer.
🟩	**GO AHEAD** - System can perform at the stated efficiencies with the selected emitter design.
PS≤150	**Underfloor Pipe Spacing** – PS≤150 means UFH pipes should be spaced at 150mm or less to achieve the design condition.
2.4	**Oversize Factor** – multiply the room heat loss (in W) by the Oversize Factor to determine the required emitter output with a mean water to air temperature difference of 50ºC. Oversize Factor is the same as a Heat Transfer Multiplier.

3.3 Guidance Table

Reducing fabric and/or ventilation heat loss can move a room up to the next specific heat loss band, making it easier to achieve a good SPF.

	Heating Flow temperature AFTER LEAVING BLENDING VALVE (if blending valve added, add 5degC to heat pump flow temp.) / degC	Oversize factor for other emitters			Underfloor Heating - SCREED			Underfloor Heating - ALUMINIUM PANEL		
		Domestic Fan Convector / Fan Assisted	Radiator Radiator / Skirting / Natural Convector	Fan Coil Heating Unit	with Tile	with Wood	with Carpet	with Tile	with Wood	with Carpet
Room Specific heat loss Less Than 30 W/m2	up to 35	4.3	6.8	5.0	PS≤300	PS≤300	PS≤200	PS≤200	PS≤200	PS≤150
	36 - 40	3.1	4.3	3.5	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤200
	41 - 45	2.4	3.1	2.6	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	46 - 50	2.0	2.4	2.1	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	51 - 55	1.70	1.90	1.70	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	56 - 60	1.40	1.8	1.5	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	61 - 65	1.20	1.30	1.40	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
Room Specific heat loss 30 to 50 W/m2	up to 35	4.3	6.8	5.0	PS≤300	PS≤100		PS≤100	REDUCE HEAT LOSS	
	36 - 40	3.1	4.3	3.5	PS≤300	PS≤200	PS≤150	PS≤200		
	41 - 45	2.4	3.1	2.6	PS≤300	PS≤300	PS≤300	PS≤200	PS≤200	PS≤150
	46 - 50	2.0	2.4	2.1	PS≤300	PS≤300	PS≤300	PS≤300	PS≤200	PS≤200
	51 - 55	1.70	1.90	1.70	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	56 - 60	1.40	1.6	1.5	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
	61 - 65	1.20	1.30	1.40	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300	PS≤300
Room Specific heat loss 50 to 80 W/m2	up to 35	4.3	6.8	5.0	PS≤100	REDUCE HEAT LOSS		REDUCE HEAT LOSS		
	36 - 40	3.1	4.3	3.5	PS≤200					
	41 - 45	2.4	3.1	2.6	PS≤300	PS≤100	PS≤100	PS≤150		
	46 - 50	2.0	2.4	2.1	PS≤300	PS≤200	PS≤150	PS≤200	PS≤100	
	51 - 55	1.70	1.90	1.70	PS≤300	PS≤300	PS≤200	PS≤200	PS≤150	PS≤100
	56 - 60	1.40	1.6	1.5	PS≤300	PS≤300	PS≤300	PS≤250	PS≤200	PS≤150
	61 - 65	1.20	1.30	1.40	PS≤300	PS≤300	PS≤300	PS≤250	PS≤200	PS≤150
Room Specific heat loss 80 to 100 W/m2	up to 35	4.3	6.8	5.0	REDUCE HEAT LOSS			REDUCE HEAT LOSS		
	36 - 40	3.1	4.3	3.5	PS≤150					
	41 - 45	2.4	3.1	2.6	PS≤200			PS≤100		
	46 - 50	2.0	2.4	2.1	PS≤250	PS≤100	PS≤100	PS≤150		
	51 - 55	1.70	1.90	1.70	PS≤300	PS≤200	PS≤150	PS≤200	PS≤100	
	56 - 60	1.40	1.6	1.5	PS≤300	PS≤250	PS≤250	PS≤200	PS≤150	PS≤100
	61 - 65	1.20	1.30	1.40	PS≤300	PS≤250	PS≤250	PS≤200	PS≤150	PS≤100
Room Specific heat loss 100 to 120 W/m2	up to 35	4.3	6.8	5.0	REDUCE HEAT LOSS			REDUCE HEAT LOSS		
	36 - 40	3.1	4.3	3.5						
	41 - 45	2.4	3.1	2.6						
	46 - 50	2.0	2.4	2.1						
	51 - 55	1.70	1.90	1.70						
	56 - 60	1.40	1.6	1.5						
	61 - 65	1.20	1.30	1.40						
Room Specific heat loss 120 to 150 W/m2	up to 35	4.3	6.8	5.0	REDUCE HEAT LOSS			REDUCE HEAT LOSS		
	36 - 40	3.1	4.3	3.5						
	41 - 45	2.4	3.1	2.6						
	46 - 50	2.0	2.4	2.1						
	51 - 55	1.70	1.90	1.7						
	56 - 60	1.40	1.6	1.5						
	61 - 65	1.20	1.30	1.40						

Changing the emitter specification can reduce the flow temperature and therefore increase SPF.

Changing the emitter type can enable the emitter to operate at a lower temperature

Changing the floor covering on UFH can reduce the required emitter temperature.

4. EXAMPLES OF SYSTEMS DESIGNED USING THE GUIDANCE TABLE

4.1 Benefits of reducing fabric and ventilation heat losses

The poorly-insulated example room introduced on the front page has the following heat loss and dimensions:

- **Original room heat loss:** 1671W
- **Room size:** 4.9m x 2.7m = 13.2m^2
- **Room specific heat loss:** 1671/13.2 = 126 W/m^2
- **Room specific heat loss band:** 120 to 150 W/m^2

A higher Temperature Star Rating can be achieved if the room specific heat loss (in W/m2) is reduced. This is indicated in the Design Table by the different colour coding for different specific heat loss bands. Reducing the room heat loss as in the example on page 7, moves the room into a lower room specific heat loss band.

- **Improved room heat loss:** 976W
- **Room specific heat loss:** 976/13.2 = 74W/m^2
- **Room specific heat loss band:** 50 to 80 W/m^2

These examples design standard radiator, fan-assisted radiator and underfloor heat distribution systems that achieve the maximum recommended Temperature Star Rating for this improved room.

4.2 Radiators (Standard and Skirting)

The Oversize Factor required to achieve the maximum recommended Temperature Star Rating is circled on the Guidance Table for a radiator system in a room with a specific heat loss in the 50 to 80 W/m^2 band.

- **Room specific heat loss band:** 50 to 80 W/m^2
- **Emitter type:** Radiators
- **Design Temperature Star Rating:** 4 stars
  ★★★★☆☆
- **Design Radiator Flow Temperature:** 45ºC
- **Required Oversize Factor:** 3.1
- **Required rated output:** 976 x 3.1 = 3024W
- **Manufacturer:** Myson Premier HE PM 70 DC 160 (or equivalent)
- **Size:** 1600mm L, 700mm H, 135mm D
- **Manufacturer's Rating:** 3249W

OR

- **Manufacturer:** Myson Premier HE PM 70 DC 80 (or equivalent)
- **Size:** 2 No. 800 mm L, 700mm H, 135mm D Manufacturer's Rating: 2 x 1605 = 3210W

4.3 Fan-assisted radiators

A fan-assisted radiator will have a higher heat output than a standard radiator the same size. You can therefore achieve a higher Temperature Star Rating without the heat emitter becoming too large for a room with a fixed specific heat loss. The Oversize Factor required to achieve the maximum recommended Temperature Star Rating is also circled on the Guidance Table for a fan-assisted radiator system.

- **Room specific heat loss band:** 50 to 80 W/m^2
- **Emitter type:** Fan-assisted radiators
- **Design Temperature Star Rating:** 5 stars
  ★★★★★☆
- **Design Radiator Flow Temperature:** 40ºC
- **Required Oversize Factor**: 3.1
- **Required radiator output:** 976 x 3.1 = 3024W
- **Manufacturer:** Jaga Strada DBE Type 11 (or equivalent)
- **Size:** 400mm L, 950mm H, 118mm D
- **Manufacturer's Rating:** 3114W

OR

- **Manufacturer:** Jaga Strada DBE Type 11 (or equivalent)
- **Size:** 2 No. 800 mm L, 650mm H, 118mm D Manufacturer's Rating: 2 x 1534 = 3068W

4.4 Screed underfloor heating

Depending on the floor construction and covering, an underfloor heat distribution system may be able to achieve an even lower heating circuit flow temperature - and therefore higher Temperature Star Rating - in the same room specific heat loss band.

The maximum pipe spacing required to achieve the highest recommended Temperature Star Rating is circled on the Guidance Table for a screed underfloor heat distribution system with a tile covering.

- **Room specific heat loss band:** 50 to 80 W/m^2
- **Emitter type:** Screed underfloor
- **Floor covering:** Tile
- **Design Temperature Star Rating:** 6 stars
  ★★★★★★
- **Design Radiator Flow Temperature:** 35ºC
- **Maximum underfloor pipe spacing:** 100mm

4.5 Aluminium panel underfloor heating

An aluminium panel underfloor heat distribution system with a tile covering cannot achieve such a high Temperature Star Rating. The maximum pipe spacing required to achieve the highest recommended Temperature Star Rating is circled on the Guidance Table.

- **Room specific heat loss band:** 50 to 80 W/m2
- **Emitter type:** Aluminium panel underfloor
- **Floor covering:** Tile
- **Design Temperature Star Rating:** 4 stars
  ★★★★☆☆
- **Design Radiator Flow Temperature:** 45ºC
- **Maximum underfloor pipe spacing:** 150mm

AMENDMENTS ISSUED SINCE PUBLICATION

Document Number:	Amendment Details:	Date:
1.0	First Issue as MCS 021 – Heat Emitter Guide	16/12/2013
2.0	Reformat of whole document. Updates to: Acknowledgements Layout of Notes to the assumptions Changes to the Notes to the assumptions a; g; k; m; r Revision Emitter Guidance Table Addition Low Temp SPF Table Addition Very High Temp SPF Table	21/11/2014
2.1	All references to 'likely SPF' removed.	01/05/2015