# Heat Emitter Guide
# for Domestic Heat Pumps

**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 heat pump operating SPF will be limited by the worst performing room.

The **Guidance Table** over the page 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.

## Who produced this guide?

Trade Associations representing heat pumps and heat distribution technologies have worked together to produce this useful guide which is supported by DECC and EST. Participating members are:

energy saving trust

Department of Energy & Climate Change

beama

GSHP association

HPA Heat Pump Association

HHIC Heating & Hotwater Industry Council

UHMA

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

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

New → Use the Guidance Table over the page to design a new system

Existing ↓

You need to work out the Temperature Star Rating. **Does the system have radiators?**

No → Use the Guidance Table over the page to determine the Temperature Star Rating

Yes ↓

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

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.

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

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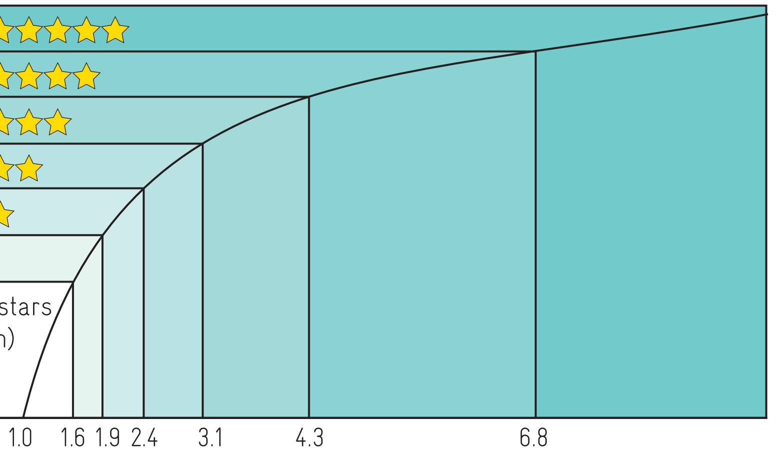
Use the chart and the calculated Oversize Factor to determine the Temperature Star Rating for that room:

| Likely space heating SPF: GSHP | ASHP | Heating circuit flow temp °C | Temperature Star Rating |
|---|---|---|---|
| 4.3 | 3.6 | 35 | ★★★★★★ |
| 4.1 | 3.4 | 40 | ★★★★★ |
| 3.7 | 3.0 | 45 | ★★★★ |
| 3.4 | 2.7 | 50 | ★★★ |
| 3.1 | 2.4 | 55 | ★★ |
| 2.8 | 2.1 | 60 | ★ |
| <2.8 | <2.1 | >60 | (No stars given) |

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**Would you like a higher Temperature Star Rating?**

No → **Proceed with installation**

Yes ↓

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?**

No → Use the existing radiator examples on this page to demonstrate the impact of reducing heat loss and increasing radiator output

Yes → Use the Guidance Table and examples over the page to investigate reducing the fabric and ventilation heat loss and switching emitter type and specification

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## EXAMPLES for EXISTING RADIATOR SYSTEMS

### 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 = -1.8°C) 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 = 60°C:** 2349W
**Existing radiator rated output at MW-AT = 50°C:** 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:** > 60°C

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 over the page to redesign the emitter system.

### 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.

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:

**Improved room heat loss:** 976W
**New oversize factor:** 1938/976 = 2.0
**New Temperature Star Rating:** 2 stars
**Radiator flow temperature:** 55°C
**Likely GSHP heating SPF:** 3.1
**Likely ASHP heating SPF:** 2.4

### 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:** 55°C
**Likely GSHP heating SPF:** 3.1
**Likely ASHP heating SPF:** 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:** 45°C
**Likely GSHP heating SPF:** 3.7
**Likely ASHP heating SPF:** 3.0

### Notes and assumptions used to create this guide

**Heat pump likely Seasonal Performance Factor (SPF) is calculated for space heating only in accordance with the following notes and assumptions:**

(a) Leeds is used for weather data. (b) Provision of domestic hot water is not included. (c) Room temperature is based on European Winter standard 21˚C operative temperature per BS EN ISO 7730. (d) The heat pump is sized to meet 100% of the space heating load and is the only heat source used in the dwelling. (e) GSHP SPF is the SCOP calculated in accordance with prEN 14825. (f) GSHP 0/35 COP = 3.5 (MCS minimum thresholds). (g) Heating flow temperature in heat emitter guide is at peak design conditions (i.e. at the lowest external design temperature). (h) The temperature difference across the heat emitters is fixed at 1/7th of the emitter circuit flow temperature. (i) Weather compensation is used. (j) 100W has been added for the electrical consumption of heating circulation pumps. (k) The heat emitter control system meets current building regulation requirements. (l) No allowance has been made for losses from: cycling, buffer vessels, or associated water pumps. (m) The GSHP ground array is designed with a minimum heat pump entry water temperature of 0˚C. (n) A ground circulation pump is included. (o) The SPF values for ASHP are 0.7 less than for GSHP, which is consistent with SAP. (p) Installation of screed UFH has floor insulation to BS EN 1264 or building regulations, – whichever is the greater – with UFH and finishing floor laid over. (q) Installation of Al-plated UFH has floor insulation to BS EN 1264 or building regulations, whichever is the greater, with UFH pipework laid on top of a proprietary aluminium plate system with no air gaps between the aluminium plates, chipboard flooring and finishing floor. (r) Performance of UFH is calculated according to BS EN 1264 and is shown using differing floor coverings with resistance values of: Carpet = $0.15 m^2K/W$ (or 1.5 TOG), Wood = $0.10 m^2K/W$, Tile = $0.00 m^2K/W$. (s) Required performance of Fan Coils, Fan Convectors and Radiators is expressed as an Oversize Factor or heat transfer multiplier to determine the required manufacturers' catalogued output per BSEN442 at a mean water to air temperature difference of 50˚C. The exponents used in the heat transfer equation to calculate the heat transfer multipliers are 1.3 for Standard Radiators, 1.1 for Fan Coils and 1.0 for Fan Convectors. The room temperature used to calculate the heat transfer multipliers is fixed at 21°C.

Divide the room heat loss by the room floor area to identify the **room specific heat loss** band on the far left of the table that should be used in the design process.

Use the colour coding (which identifies suitable options) and different emitter types, together with the Temperature Star Rating, the heating circuit flow temperatures and the likely space heating SPFs to select an emitter type and specification that achieves the desired operating conditions.

**Is the emitter an underfloor heating system?**

No: Read off the Oversize Factor and multiply it by the room heat loss to determine the required rated output (in W). Use manufacturers' data to select an emitter capable of achieving the required rated output.

Yes: Read off the **maximum pipe spacing** (PS) to be used in the design.

Proceed with installation

## Important notes:

These tables are presented as a generic aid to ensure that the correct information is being provided within the heat emitter design. Competent heating system designers will be able to provide site-specific solutions to meet your exact requirements.

These tables cover space heating only – domestic hot water is not included.

## Key for GUIDANCE TABLE

- **REDUCE FABRIC AND VENTILATION HEAT LOSS -** System cannot perform at the design parameters stated; consider reducing heat loss and/or load-sharing design with other emitter types.
- **CONSIDER MEASURES TO REDUCE FABRIC AND VENTILATION HEAT 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
- **GO AHEAD -** System can perform at the stated efficiencies with the selected emitter design.
- PS **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 50°C. Oversize Factor is the same as a Heat Transfer Multiplier

## GUIDANCE TABLE

| | Temperature Star Rating | Heating circuit flow temperature °C | Likely space heating SPF | | Oversize Factors for other emitters | | | Underfloor heating: screed | | | Underfloor heating: Aluminium panel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | GSHP | ASHP | Domestic Fan Convector/Fan-assisted Radiator | Standard Radiator | Fan Coil Unit | with TILE | with WOOD | with CARPET | with TILE | with WOOD | with CARPET |
| Room specific heat loss less than 30 W/m² | ★★★★★★ | 35 | 4.3 | 3.6 | 4.3 | 6.8 | 5.0 | PS≤300 | PS≤300 | PS≤300 | PS≤200 | PS≤200 | PS≤150 |
| | ★★★★★☆ | 40 | 4.1 | 3.4 | 3.1 | 4.3 | 3.5 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤200 |
| | ★★★★☆☆ | 45 | 3.7 | 3 | 2.4 | 3.1 | 2.6 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 |
| | ★★★☆☆☆ | 50 | 3.4 | 2.7 | 2.0 | 2.4 | 2.1 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 |
| | ★★☆☆☆☆ | 55 | 3.1 | 2.4 | 1.7 | 1.9 | 1.7 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 |
| | ★☆☆☆☆☆ | 60 | 2.8 | 2.1 | 1.4 | 1.6 | 1.5 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 |
| Room specific heat loss 30 to 50 W/m² | ★★★★★★ | 35 | 4.3 | 3.6 | 4.3 | 6.8 | 5.0 | PS≤300 | PS≤100 | | PS≤100 | Reduce heat loss | |
| | ★★★★★☆ | 40 | 4.1 | 3.4 | 3.1 | 4.3 | 3.5 | PS≤300 | PS≤200 | PS≤150 | PS≤200 | | |
| | ★★★★☆☆ | 45 | 3.7 | 3 | 2.4 | 3.1 | 2.6 | PS≤300 | PS≤300 | PS≤300 | PS≤200 | PS≤200 | PS≤150 |
| | ★★★☆☆☆ | 50 | 3.4 | 2.7 | 2.0 | 2.4 | 2.1 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤200 | PS≤200 |
| | ★★☆☆☆☆ | 55 | 3.1 | 2.4 | 1.7 | 1.9 | 1.7 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 |
| | ★☆☆☆☆☆ | 60 | 2.8 | 2.1 | 1.4 | 1.6 | 1.5 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤300 |
| Room specific heat loss 50 to 80 W/m² | ★★★★★★ | 35 | 4.3 | 3.6 | 4.3 | 6.8 | 5.0 | PS≤100 | Reduce heat loss | | | | |
| | ★★★★★☆ | 40 | 4.1 | 3.4 | 3.1 | 4.3 | 3.5 | PS≤200 | | | | Reduce heat loss | |
| | ★★★★☆☆ | 45 | 3.7 | 3 | 2.4 | 3.1 | 2.6 | PS≤300 | PS≤100 | PS≤100 | PS≤150 | | |
| | ★★★☆☆☆ | 50 | 3.4 | 2.7 | 2.0 | 2.4 | 2.1 | PS≤300 | PS≤200 | PS≤150 | PS≤200 | PS≤100 | |
| | ★★☆☆☆☆ | 55 | 3.1 | 2.4 | 1.7 | 1.9 | 1.7 | PS≤300 | PS≤300 | PS≤200 | PS≤200 | PS≤150 | PS≤100 |
| | ★☆☆☆☆☆ | 60 | 2.8 | 2.1 | 1.4 | 1.6 | 1.5 | PS≤300 | PS≤300 | PS≤300 | PS≤300 | PS≤200 | PS≤150 |
| Room specific heat loss 80 to 100 W/m² | ★★★★★★ | 35 | 4.3 | 3.6 | 4.3 | 6.8 | 5.0 | | | | | | |
| | ★★★★★☆ | 40 | 4.1 | 3.4 | 3.1 | 4.3 | 3.5 | PS≤150 | Reduce heat loss | | | Reduce heat loss | |
| | ★★★★☆☆ | 45 | 3.7 | 3 | 2.4 | 3.1 | 2.6 | PS≤200 | | | PS≤100 | | |
| | ★★★☆☆☆ | 50 | 3.4 | 2.7 | 2.0 | 2.4 | 2.1 | PS≤250 | PS≤100 | PS≤100 | PS≤150 | | |
| | ★★☆☆☆☆ | 55 | 3.1 | 2.4 | 1.7 | 1.9 | 1.7 | PS≤300 | PS≤200 | PS≤150 | PS≤200 | PS≤100 | |
| | ★☆☆☆☆☆ | 60 | 2.8 | 2.1 | 2.1 | 1.6 | 1.5 | PS≤300 | PS≤250 | PS≤250 | PS≤200 | PS≤150 | PS≤100 |
| Room specific heat loss 100 to 120 W/m² | ★★★★★★ | 35 | 4.3 | 3.6 | 4.3 | 6.8 | 5.0 | | | | | | |
| | ★★★★★☆ | 40 | 4.1 | 3.4 | 3.1 | 4.3 | 3.5 | | | | | | |
| | ★★★★☆☆ | 45 | 3.7 | 3 | 2.4 | 3.1 | 2.6 | | Reduce heat loss | | | Reduce heat loss | |
| | ★★★☆☆☆ | 50 | 3.4 | 2.7 | 2.0 | 2.4 | 2.1 | | | | | | |
| | ★★☆☆☆☆ | 55 | 3.1 | 2.4 | 1.7 | 1.9 | 1.7 | | | | | | |
| | ★☆☆☆☆☆ | 60 | 2.8 | 2.1 | 1.4 | 1.6 | 1.5 | | | | | | |
| Room specific heat loss 120 to 150 W/m² | ★★★★★★ | 35 | 4.3 | 3.6 | 4.3 | 6.8 | 5.0 | | | | | | |
| | ★★★★★☆ | 40 | 4.1 | 3.4 | 3.1 | 4.3 | 3.5 | | | | | | |
| | ★★★★☆☆ | 45 | 3.7 | 3 | 2.4 | 3.1 | 2.6 | | | | | | |
| | ★★★☆☆☆ | 50 | 3.4 | 2.7 | 2.0 | 2.4 | 2.1 | | Reduce heat loss | | | Reduce heat loss | |
| | ★★☆☆☆☆ | 55 | 3.1 | 2.4 | 1.7 | 1.9 | 1.7 | | | | | | |
| | ★☆☆☆☆☆ | 60 | 2.8 | 2.1 | 1.4 | 1.6 | 1.5 | | | | | | |

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

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.

# EXAMPLES of systems designed using the GUIDANCE TABLE

## 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 = 13.2m²
**Room specific heat loss:** 1671/13.2 = 126 W/m²
**Room specific heat loss band:** 120 to 150 W/m²

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 the first page, moves the room into a lower room specific heat loss band.

**Improved room heat loss:** 976W
**Room specific heat loss:** 976/13.2 = 74W/m²
**Room specific heat loss band:** 50 to 80 W/m²

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.

## Standard radiators

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/m² band.

**Room specific heat loss band:** 50 to 80 W/m²
**Emitter type:** Radiators
**Design Temperature Star Rating:** 4 stars ★★★★☆☆
**Design Radiator Flow Temperature:** 45°C
**Likely GSHP heating SPF:** 3.7
**Likely ASHP heating SPF:** 3.0

**Required Oversize Factor:** 3.1
**Required rated output:** 976 x 3.1 = 3024W

**Manufacturer:** Myson Select SD 70 160 (or equivalent)
**Size:** 1600mm L, 700mm H, 135mm D
**Manufacturer's Rating:** 3269W

OR

**Manufacturer:** Myson Select SX 70 100 (or equivalent)
**Size:** 2 No. 1000 mm L, 700mm H, 97mm D
**Manufacturer's Rating:** 2 x 1583 = 3166W

## 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/m²
**Emitter type:** Fan-assisted radiators
**Design Temperature Star Rating:** 5 stars ★★★★★☆
**Design Radiator Flow Temperature:** 40°C
**Likely GSHP heating SPF:** 4.1
**Likely ASHP heating SPF:** 3.4

**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

## 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/m²
**Emitter type:** Screed underfloor
**Floor covering:** Tile
**Design Temperature Star Rating:** 6 stars ★★★★★★
**Design Radiator Flow Temperature:** 35°C
**Likely GSHP heating SPF:** 4.3
**Likely ASHP heating SPF:** 3.6
**Maximum underfloor pipe spacing:** 100mm

## 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:** 45°C
**Likely GSHP heating SPF:** 3.7
**Likely ASHP heating SPF:** 3.0
**Maximum underfloor pipe spacing:** 150mm