



Question

What are the design considerations for low temperature space heating when using heat pumps?

Scope

This guidance note covers the outline provision of heat pump specification and design guidance for low temperature space heating systems in domestic dwellings (heat loss).

Ground loops or boreholes are not covered within this guidance and will require appropriate experts for design ensuring correct energy delivery to the heat pump.

Who should read this?

Technical and construction directors and managers, architects, designers, contractors, building services engineers and site managers.

Who is responsible?

Those who are responsible for building work (e.g., agent, designer, builder, or installer) must ensure that the work follows compliance requirements within NHBC standards 2.1 (R1 to R5).

- The durability of any external heat pump must be confirmed as appropriate for the installed location including coastal locations or installation at high level.
- The heat pump installed must be installed by an appropriately trained individual and commissioned in accordance with manufacturer's instructions. A maintenance programme designed to ensure longevity of the appliance must be offered by the manufacturer or manufacturer's agents or installer.

EU Product directives to be complied with (depending on heat pump type)

2014/35/EU Low voltage directive (LVD)

2006/42/EC machinery directive (MD)

2014/30/EU Electromagnetic compatibility directive (EMC)

2014/68/EU Pressure equipment directive (PED)

2011/65/EU Restriction of hazardous substances (RoHS) in electrical and electronic equipment

2015/863/EU Amending directive to 2011/65/EU

2017/2102 EU Amending directive to 2011/65/EU

2009/125/EC Energy related products directive (ErP)

813/2013/EU ecodesign requirements heat pumps

814/2013/EU ecodesign requirements of water heaters and water tanks

Normalised standard references (depending on heat pump type)

BS EN 60335-1 Household and similar electrical appliances safety (heat pumps)

BS EN 60335-2 Specification for safety of household and similar electric appliances (heat pumps)

BS EN 62233 Measurement methods for electromagnetic fields of household appliances

BS EN 55014-1 Electromagnetic compatibility

BS EN 55014-2 Electromagnetic compatibility
BS EN 61000-3-2 Electromagnetic compatibility limits for harmonic current emissions
BS EN 61000-3-3 Electromagnetic compatibility limitation of voltage changes
BS EN 50581 Technical documentation for the assessment of electrical/electronic products (RoHS)
BS EN 12102-1 Determination of the sound power level compressors
BS EN 12102-2 Determination of the sound power level heat pump water heaters
BS EN 12309 1-7 Gas fired absorption heat pumps not exceeding 70kW
BS EN 13203-5 DHW testing standard for hybrid boiler
BS EN 14511-1 Heat pumps terms and definitions
BS EN 14511-2 Determination of the sound power level heat pump water heaters
BS EN 14511-3 Heat pump test methods
BS EN 14511-4 Heat pumps for space heating and cooling with electrically driven compressors
BS EN 14825 Calculation of seasonal performance
BS EN 15879-1 Testing and rating of direct exchange ground source heat pumps for space heating
BS EN 16147 Testing and performance rating and marking requirements for domestic water units
BS EN 16905 1-5 Gas fired endothermic engine driven heat pumps

UK Building Regulations

England and Wales ADL & ADJ, Part F Northern Ireland or Scottish Technical Handbook

UK Certification

A manufacturer's Declaration of Conformity (DOC) detailing the appropriate standards complied with should be provided together with the certification from a registered UKAS certification body confirming compliance with the relevant standards.

UK product and installation guidance

MCS certified or other relevant and recognised body accepted by NHBC

MIS 3005-i Heat pump Installation

MIS 3005-D Heat pump Design

CIBSE Domestic heating compliance guide

Space heating design considerations for low temperature systems

- Type and suitability
- Where required "F" gas regulations must be complied with
- Back up heating requirements
- Buffer tanks to prevent short cycling
- Suitable fixings
- System and design to be included within SAP/ Part L and ensure compliance
- Running costs

Requirements for heat pump space heating design

- The heat pump selected should provide not less than 100% of the calculated design space heating power requirement at the winter design condition and include any energy required for defrost cycles. Any supplementary electric heating shall only operate when the conditions are outside of the design principle detailed in this document.

Heat loss

- All heat loss calculations should be in accordance with recognised standards and guidance, e.g., CIBSE Domestic Heating Design Guide or other approved by NHBC.
- Fabric heat loss should be based on the building design and thermal conductivity of the materials from which the element is constructed.
- The heating designs must include allowances where applicable for thermal bridging.

Additional values to be added to the U value based on construction type as set out by CIBSE domestic heating design guide (other suitable methods are used within SAP)

Type of construction	Additional thermal transmittance to be added W/m ² K
Buildings built with a high level of heat insulation (over and above national standards) and implement minimisation of thermal bridging	0.02
Buildings built to current national standards and in compliance with recognised practices regarding the minimisation of thermal bridging	0.05
Buildings with exterior wall insulation broken by solid ceilings (e.g., reinforced concrete)	0.15
All other buildings	0.1

Indoor design temperatures

Room	Temp °C
Lounge/sitting room	21
Living room	21
Breakfast room	21
Dining room	21
Kitchen	21
Family/breakfast room	21
Hall	21

Room	Temp °C
Cloakroom/WC	21
Toilet	21
Utility room	21
Study	21
Games room	21
Bedroom	21
Bedroom with ensuite	21

Room	Temp °C
Internal room or corridor	21
Bedroom/study	21
Landing	21
Bathroom	22
Shower room	22
Dressing room	21
Storeroom	21

- Where elevated temperatures are required for frail, elderly, or infirm use 23°C

External design temperatures

Typical winter external design temperatures for sites in the British Isles up to 50m above sea level. Based on CIBSE domestic heating design guide

Region	Latitude	Outdoor design temperature °C	Ground reference temperature (winter mean °C)
Scotland & Isles	56-60°N	-5	+5.5
Northern England & Northern Ireland	54-56°N	-4	+6.0
Midlands, Wales and ROI	52-54°N	-3	+6.5
London, SW England	51-52°N	-2	+7.0
Southern England	50-51°N	-1	+7.5

- To account for altitude the outside design temperature should be lowered by 0.3°C for every additional 50m above sea level or 1°C if in proximity of the coast or river or steep cliff.
- When calculating a basement or ground floor heat loss the ground reference temperatures should be used.
- When calculating heat loss to adjoining properties they should be treated as unheated, in these instances the temperature used should be the same as the UK mean of 10°C.
- Heat transfer between rooms in the same property can be disregarded if the same indoor temperature is used for all room.

Ventilation heat loss

Ventilation heat loss will depend on the rate at which the air leaves or enters the building. When calculating use the as built air change rate if known otherwise overheating or under heating may occur in given situations. If not known the below information is taken from the CIBSE domestic heating design guide.

Air changes per hour for new build housing complying with current building regulations England and Wales Part F, Northern Ireland Part K, Scottish Technical Handbook

* Where mechanical extract ventilation is to be installed in a room and the extract volume exceeds the natural infiltration, due allowance for the air extracted from any connecting room or corridor must be made.

Room	ACH
Lounge/sitting room	0.5
Living room	0.5
Breakfast room	0.5
Dining room	0.5
Kitchen	0.5
Family/breakfast room	0.5*
Hall	0.5

Room	ACH
Cloakroom/WC	1.5*
Toilet	1.5*
Utility room	0.5*
Study	0.5
Games room	0.5
Bedroom	0.5
Bedroom with ensuite	1.0

Room	ACH
Internal room or corridor	0.0
Bedroom/study	0.5
Landing	0.5
Bathroom	0.5*
Shower room	0.5*
Dressing room	0.5
Storeroom	0.5

- Where a room contains an open fire or chimney, allowances to the ventilation rate must be made as detailed in CIBSE domestic heating design guide.

Heat pump system considerations

- The heat pump selected should provide not less than 100% of the calculated design space heating power requirement at the winter design condition and include any energy required for defrost cycles. Any supplementary electric heating shall only operate when the conditions are outside of the design principle detailed in this document.
- Design mean water temperature (MWT) 42.5°C the design can utilise design mean water temperature (MWT) lower than this.
- The number and sizing of heat emitters eg. radiators or size of underfloor system must be sized to the design mean water temperature (MWT).
- The system pipework or underfloor heating must be sized to the design mean water temperature (MWT).
- The heat pump must have a minimum coefficient of performance of 3.0 for space heating.
- The heat pump must have a minimum Seasonal Coefficient of Performance of 2.7.
- The heat pump must control the pump operation.
- The heat pump must control any outdoor fan operation.
- The heat pump must control the defrost cycle for the external air side.
- Weather compensation or internal temperature control must be adopted with all heat pumps.
- Where the dwelling contains other heat sources all control should be done from a singular control unit.

- Controls need to be appropriately located and easy to access.
- Heat pumps should not be sited adjacent to sleeping areas or located on materials that transmit vibration.
- Heat pumps must be correctly sited and installed to minimise noise impact.
- Buffer tanks must be correctly designed to the system .
- A suitable electrical supply must be provided to ensure power and amperage.
- Manufacturer's installation instructions must be followed with respect to installation clearances and free space around heat pumps.
- Where required safety guards must be supplied to prevent risk of injury or damage.
- Internal systems must be hydraulically balanced to ensure correct performance.

Definitions

- **F Gas** F stands for fluorinated, and F-Gas is the term used to describe a particular family of fluorinated gases which are widely used as refrigerants in air conditioning and commercial refrigeration systems. This family of fluorinated gases is subject to stringent EU and national regulations drawn up in response to the Kyoto Protocol. The F-gases most used as refrigerants in commercial air conditioning equipment are hydrofluorocarbons [HFCs], but the F-Gas family also comprises: Perfluorocarbons [PFCs] Sulphur Hexafluoride [SF6] F-gas refrigerants are sometimes referred to by their 'R-numbers' (such as R134a, R407c, R404A and R401A, etc)
- **Short Cycling** is a term used to define when a heat pump or heating system shuts down early before completing the heating cycle. This has a detrimental effect on the system as the heat pump will not run at its most optimum as well as potential to increase wear and tear on components. Correct sizing of heat pumps, systems and buffer tanks if required is essential for an efficient overall system
- **Mean water temperature (MWT)** is a term used to denote the midpoint between the flow and return temperature, heating systems utilising a heat pump commonly use a 10°C delta. With a design flow temperature of 45°C with a return temperature of 40 °C a MWT of 42.5 °C is achieved. This should then be used in heat emitter/underfloor heating and pipe sizing calculations

Codes & reference standards

- BSRIA guide BG 4/2011 Underfloor heating and cooling
- MIS 3005 Heat pump systems
- BS EN 14511 Air conditioners, liquid chilling packages and heat pumps for space heating
- BS EN 15450 Heating systems in buildings. Design of heat pump systems
- CIBSE Domestic heating compliance guide