Electrical Heating Design

Application Guide




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The Electrical Contractors' Association (ECA) is the UK's leading trade association that represents and supports the interests of businesses involved in all aspects of electrical and electrotechnical design, installation, inspection, testing, maintenance and monitoring across England, Wales and Northern Ireland.

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1. Foreword

This guide is one of a series of application guides, prepared by the Technical Services Directorate of the Electrical Contractors Association.

The purpose of the guides is to assist practicing electrical designers and installers to execute cost effective and safe installations that are compliant with relevant standards and legislation and to provide practical and installable solutions that are backed up by sound engineering principles.

For any given application the guides will, where necessary, suggest preferred solutions – based on cost, shared experience and technical merit.

Other design and installation solutions are not precluded and feedback on new or alternative methodologies is always welcomed.

Queries on any aspect of the design application guides should be directed to the Technical Directorate of the Association or the author.

2. Introduction

The following application guide is designed to give readers additional information about electric heating systems in relation to the design and build of different projects. This guide is intended to offer practical guidance to all, although due to the nature of the subject must make reference to other guidance documents and standards.

This guide will outline the fundamentals of electric heating design; however, it should not be taken as a comprehensive design guide due to the complex nature of the subject.

3. Electrical Heating Systems

There is a great deal to be said for electric heating. There is the convenience of not relying on an additional service to be installed in the first instance; there is less ongoing maintenance and there is no need to employ multiple trades. With the potential for additional power stations in the future, the cost of electricity is likely to fall, again making the idea of electric heating more appealing.

Electric heating can be a clean, low maintenance and most efficient method of heating rooms and a combination of direct heating and storage heating give designers a multitude of choices when creating a heating plan for an installation.

Many large domestic multi-occupancy buildings consider electric heating as the first choice, but often this element is not adequately designed to enable a suitable and comfortable level of heating in the property, often relying on often outdated 'rule of thumb' designs such as simply placing more heaters until the room feels adequate.

The application guide will attempt to cover the fundamental principles that apply to sizing of heating systems, some elements to consider and some practical guidance for the designer, installer and commissioner.

Decentralized electric heating is the most common method of electric heating design, that is to say a system where electric heaters are present in each room requires heating. Centralized systems, such as electric boilers, are available but less common. This guide will cover both systems.

4. Key Terminology

In terms of dry electric heating systems there are several types of heater and heating principles that we need to be aware of:

- Storage heater
- Space heating
- Conduction
- Convection
- Radiation

These types of heaters each have their own characteristics and specific installation requirements.

Type of heating	Description
A storage heater could best be described as:	A heater that accumulates heat in the night and releases it during the day
A space heater could best be described as:	A device for heating an enclosed area
Thermal conduction can be best described as:	The transfer of heat through an object
Thermal convection can best be described as:	The transfer of heat from one place to another by movement of fluids or gasses. For our purposes it is the movement of air
Thermal radiation can best be described as:	Electromagnetic radiation generate by the motion of particles. Heat transfer from an emitter to an object that can pass through empty spaces

This guide will focus on the above heating types but will make reference to wet systems that are supplied by electricity i.e. electric boilers. This guide is not intended to cover the traditional ‘wet trades’ side of the heating system, merely the design of the heat emitters and how to undertake a basic heat loss calculation.

5. Key Documents

In terms of heating design in general, there are a multitude of Regulations and guidance documents to consider.

5.1. Building Regulations

Although no building regulation specifically relates to electrical heating design, there are two main documents that cover certain aspects of this subject.

5.1.1. Sanitation, hot water safety and efficiency: Approved Document G

Though mainly a document related to wet systems and water supplies, sections 3.43 to 3.45 relate to electric water heating. The Approved Document refers to a specific British Standard, BS EN 60335 for Household and similar electrical appliances. The Approved Document mentions the following, that fixed immersion heaters needing to comply with BS EN 60335-2-73:2003 (particular requirements for fixed immersion heaters), electric instantaneous water heaters needing to comply with BS EN 60335-2-35:2002 and electric storage water heaters needing to comply with BS EN 60335-2-21:2003 (particular requirements for storage water heaters).

Designers and contractors should ensure that suitable products are used throughout the installations that comply with the relevant standards.

5.1.2. Conservation of fuel and power: Approved Document L

Approved Document L is split into several parts, Approved Document L: Conservation of fuel and power sets the requirements to minimize the use of energy in new dwellings (L1A), existing dwellings (L1B), new buildings other than dwellings (L2A) and existing buildings other than dwellings (L2B).

The documents do not lay out specific guidelines for electric heating, but essentially inform the reader that the building should be as efficient as possible. This will mean that any design for electric heating would have to be carefully considered to ensure it meets the requirements. The requirements are too numerous to mention in this guide so reference should be made prior to the design of the heating system.

Although important, these documents do not always offer sufficient technical guidance for the practical designer or installer. Therefore, many of the Approved Documents refer to additional guides, or second tier documents. One such guide is listed in section 7.2.3

5.2. Industry guides and other standards

5.2.1. CIBSE guides

The Chartered Institute of Building Service Engineers have offered guidance on electrical heating system design for many years. Many of their documents can be purchased from their website including CIBSE guide A, Environmental Design and CIBSE Guide B, Heating Ventilating, Air-conditioning and Refrigeration.

5.2.2. PAS 2030

Publically Available Standard (PAS) 2030 is a mandatory document that is used in the design and installation of energy efficient measures under the Green Deal Scheme. Annex D holds specific information relating to the requirements for electric storage heating systems.

5.2.3. Domestic Building Services Compliance Guide

The Domestic Building Services Compliance Guide offers guidance and information on multiple aspects of domestic building services, including Section 4 devoted to electric heating. This guide has useful information on the recommended minimum use of certain controls that are required for electric heating systems relating to both dry and wet systems in dwellings.

5.2.4. Non-domestic Building Services Compliance Guide

This particular guide is in reference to non dwellings only, though follows a similar format to the previously mentioned domestic guide. Section 7 of this particular guide states the recommended minimum criteria for the controls of electric space heating in non dwellings.

6. Good Design Practice

Heating systems are a major consumer of energy in the UK. It is estimated that space heating accounts for over 40% of non transport related energy use in the UK (figures obtained from https://www.gov.uk/government/statistics/energy-consumption-in-the-uk).

Given the rising cost of fuel, the more demanding requirements for buildings and the increased awareness at energy efficiency it is understandable that a suitably designed heating system can offer many benefits to the building owner.

The fundamental components of any heating system are:

- A heat source
- A method for distributing the heat
- A means of delivering the heat into the space to be heated, i.e. the heat emitter

A good heating design needs to consider the client's needs and the type of installation. For the purpose of this guide we will assume that an electric heat source has already been specified.

This guide is not intended to cover all aspects of heating design, as the details and requirements related to this will make it impractical, but it is to give an overview of the process and remove the typical approach associated with electric heating of simply adding a standard heater to each wall.

6.1. Circuit Design

This guide is not intended to cover the topic of the fixed wiring circuit design in any details, since the ECA currently have an application guide dedicated to LV cable sizing in this series. However, electric heating will inevitably require some form of circuit design to supply the heaters.

Basic design practice should be considered as well as the requirements of BS 7671. For additional information see the ECA guide to LV cable sizing.

6.2. IP Ratings for Ingress Protection

The requirement for basic protection of any systems, product or installation will require an understanding of the International Protection codes.

Depending on the type of heater and the location, the requirements for ingress protection will differ, i.e. an external heater or one commonly for use in a room containing a bath or a shower will likely require a higher degree of protection than one in a dry room within a dwelling.

Code Letters ***IP*** ***2*** ***3*** ***D*** ***W***

International protection

First Numeral 0-6
Protection of persons and

Resistance to solid objects

Second Numeral 0-8

Resistance to ingress of water

Additional Letter (Optional)

A: up to the guard/stop face of 50 mm sphere

B: up to the guard/stop face of test finger

C: up to the guard/stop face of 2.5 mm x 100 mm probe

D: up to the guard/stop face of 1.0 mm x 100 mm probe

Supplementary Letter (Optional)

For specific applications:

- H: High voltage equipment
- M: Moving or rotation equipment - (Tested whilst in motion)
- S: Moving or rotating equipment - (Tested whilst at rest)
- W: Weather conditions

'X' Letter

The letter 'X' is used in place of the first or second numeral or both by equipment manufacturers to indicate that tests are not applicable and have therefore not been conducted.

In specifications the letter 'X' is used in place of the first or second numeral to indicate that tests are not required.

E.g.: IP4X provides protection against the 1mm probe, but has not been tested for ingress of water.

6.3. Conservation of Energy

With any design energy efficiency is crucial. Approved document L – Conservation of Fuel and Power, requires that all types of electric heating systems (storage, panel and under floor):

- Are energy efficient
- Have effective controls
- Are commissioned by testing and adjustment as necessary to ensure they use no more fuel and power than is reasonable in the circumstances

This requires the designer to make a considered approach to the heating system deployed, ensuring that they do not under or over heat the property.

7. Heat Loss and System Design

A fundamental element of heating design is considering the heat loss of the building or room. This Application Guide is not intended to offer comprehensive guidance on heat loss design, but to give an overview of the general requirements.

Regardless of the heating strategy to be used, an understanding of heat loss of a room is an essential element of heating design as without this fundamental principle being considered, everything is essentially guess work.

7.1. Heat Loss

Calculation of heat loss from a building can be a tremendously complex process, and certainly in older buildings is not 100% accurate. For the purpose of the Application Guide, rather than cover the building as a whole, we will consider a single room. In order to calculate the heat loss in a room several factors are required, these are:

- Room dimensions
- U values (WmΔt) of walls, ceilings, floors, windows etc.
- Number of air changes per hour
- temperature difference inside/outside

To expand on and understand these terms will allow the designer to appreciate the requirements of the building further.

7.2. Room Dimensions

These are typically recorded in millimetres or metres and are usually noted in length, width and height.

7.2.1. U Values

A U value is the measure of heat loss, in this case through a material. It is usually quoted in Watts per square metre per degree Kelvin (W/m2 K). The lower the value of U the better the insulation properties of the material in question, so a filled and insulated cavity wall will have a U value lower than that of an un-insulated cavity wall.

7.2.2. Air Changes per Hour

This is a measure of the air volume in a room or space, removed and replenished each hour. This is important to consider as potentially heated air needs to be removed and replaced with fresh, potentially colder air, into the room. This is often referred to as infiltration losses.

7.2.3. Temperature Difference Δt

This figure represents typical values for the temperature difference between internal and external spaces and is pronounced 'delta tee'.

Though the aforementioned values can be at times very accurate, there is often some debate about what value is to be applied specifically to individual products the same is true for air changes or exact temperatures. For example, the U values associated with windows having metal frames will actually differ between different manufacturers due to the amount of metal in the frame and the quality of the glass. The following tables are indicative of the type of values that can be expected for certain elements, temperatures and air changes. Where exact values are not known average values will normally be considered as sufficient for the purpose of sizing heat emitters.

As the structural heat loss from a room is based on the temperature difference between the room and the outside space, there is no heat loss between rooms which are normally at a similar temperature. Where a room is positioned against a cold space such as a garage, this space should be treated as if it were outside.

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The heat loss through a party wall between 2 premises is unknown as the temperature of the adjoining premises is unknown. It is common practice to estimate the heat loss value through such a wall as being half of an equivalent outside wall.

7.2.4. U Values for Walls, Windows and Roofs

Element	Composition	U value
Solid wall	Brickwork 215 mm Plaster 15 mm	2.3
Cavity wall	Brickwork 103 mm Clear cavity 50 mm Brickwork 103 mm	1.6
Cavity wall	Brickwork 103 mm Clear cavity 50 mm Lightweight concrete block 100 mm Lightweight plaster 13 mm	0.58
Cavity wall	Brickwork 103 mm Insulation in cavity 50 mm Lightweight concrete block 100 mm Lightweight plaster 13 mm	0.48
Cavity wall	Brickwork 103 mm Clear cavity 50 mm Aerated concrete block 115 mm Insulation board 55 mm	0.3
Timber frame wall	Brickwork 103 mm Clear cavity 50 mm OSB or sheathing ply 9 mm Timber frame filled with insulation 120mm Plasterboard 13 mm	0.3
Pitched roof	Tiles on battens and felt Ventilated loft airspace Mineral wool across joists 100 mm Mineral wool between joists 100 mm Plasterboard 13 mm	0.15
Window	Single glazed metal frames	5.7
Window	Single glazed, wood/PVC frames	4.8
Window	Double glazed, wood/PVC frames, low emissivity 6 mm gap	2.7
Window	Triple glazed, wood/PVC frames, low emissivity 12 mm gap	1.6
Door	Solid wooden	3.0

7.2.5. Typical Design Temperatures and Ventilation Rates

Type of building	Design temperature degrees C	Air changes per hour
Domestic		
Living room	21	1
Bedroom	18	0.5
Bathroom	22	0.5
Non domestic		
Offices, general	20	1
Classrooms, schools	18	2
Shops, large	18	0.5
Restaurants; bars	18	1
Hotel bedrooms	22	1
Factories, light work	16	NA

Figures have been quoted from:

Environmental Science in Building, 6th Edition. Randall McMullan. PALGRAVE MACMILLAN. Hampshire. 2007.

Please be aware these figures, particularly the air changes per hour, are very conservative. Numerous sources, including ventilation manufacturers suggest much higher rates, for example:

Type of building	Design temperature degrees C	Air changes per hour
Domestic		
Living room	21	3-6
Bedroom	18	2-4
Bathroom	22	6-10

http://www.vent-axia.com/files/Ventilation%20Design%20Guidelines%202.pdf

It is worth noting at this point that ventilation can be the largest contributor to heat loss in a room. Adequate ventilation may be critical to the buildings comfort and use, particularly where the building is of a modern construction. Prior to undertaking any heating installation it is essential to obtain details of the ventilation strategy for the building.

7.3. Sample Heat Loss Design

The previous information gives data on what typical values to consider acceptable when undertaking a heat loss design, however, this can sometimes be difficult translating into a real situation. The following is a sample heat loss design using the aforementioned assumed figures.

A room in a dwelling with the following criteria is to have a heat loss calculation performed on it:

4m L x 5m W x 3m H
The room has one outside wall 4m x 3m
The room has one window $4m^2$
U values WmΔt:

- Filled cavity wall 0.48
- Double glazed wood/plastic 2.7
- Floor 0.78
- 1 air changes per hour
- $21^{o}C$ Δt (temperature difference inside/outside)
- No heat loss to internal spaces including to any upstairs room
- No heat loss through ceiling so has been omitted

Note – in this instance the temperature difference has been listed as $21^{o}C$ Δt. The assumption here is that the outside temperature is 0oC and a comfortable internal temperature is $21^{o}C$.

Many factors will impact on the figures used here, such as location, building use, occupants etc.

Fabric heat losses:

Wall area L X H	Minus Window area	U value	x Δt	Total W
4 x 3	- 4	x 0.48	x 21	= 81

Window area	U value	x Δt	Total W
4	x 2.7	x 21	= 227

Floor area L x W	U value	x Δt	Total W
4 x 5 = 20	x 0.78	x 21	= 328
Ceiling area L x W	U value	x Δt	Total W
4 x 5 = 20	x N/A	x N/A	= N/A

Ventilation heat losses:

Volume	Factor	x air changes	x Δt	Total W
(4 x 5 x 3) = 60	x 0.33	x 1	x 21	= 416

Note - The factor used is a constant

Total heat loss:

Wall	Window	Floor	Roof	ventilation	Total W
81	+ 227	+ 328	N/A	+ 416	= 1052W

This suggests that a 1052W heater will be adequate for the space to maintain temperature. The designer may wish to slightly over-specify this to ensure the heat up time is limited to a reasonable period i.e. it does not take too long to get the room to adequate temperature.

Allowing approximately 10% on top of the calculated value gives a good approximation. Suitable heaters are then selected to achieve this requirement.

Please note, these figures are indicative of typical values that may be present in standard installations but should not be taken as mandatory.

Other things that may need to be allowed for are

- High rooms above 4.5m would be an additional 5%
- High rooms above 7.5m would be an additional 10%

Where you have a chimney, it will increase the ventilation rate between 2-5 air changes per hour (ACH). The guidance is that a small room with no throat restrictor would be 5 ACH, and a large room with a throat restrictor will be 2 ACH.

These calculations are based on the heating of the air only.

Please note that the previously calculated heat losses are NOT for radiant heaters. A typical radiant heater is used to heat the body of the person, not the space in which he/she inhabits.
Once a heat loss calculation has been performed then a suitable heating strategy can begin to take place.

At this point, the decision over what type of electric heating system needs to be confirmed.

8. Wet Electric Systems

Traditional heating systems in dwellings have been wet systems i.e. they rely on the heating of water which is then passed throughout the building, giving up its heat.

8.1. Electric Boilers

As an alternative to traditional gas or oil fired boilers, the use of electric boilers to supply wet systems is becoming increasingly common. Typically ranging from 4 kW to 12 kW, the heating side should be installed as any wet central heating system but rather than taking a gas or oil supply to the boiler, a suitable electric supply should be installed.

As with any electrical system, a suitable design should be undertaken before an installation takes place considering all relevant factors such as installation reference method, load, installation type etc.
Often electric boilers will require two supplies, on to heat the water in the unit and one to operate the controls. The sizing of the radiators (heat emitters) will be completed in the same manner as seen previously based on the heat loss per room.

Because of their very high electrical loading coupled with near continuous operation, it is vital that the designer properly establishes the adequacy of the existing electricity supply both within the building and external to it.

9. Dry Electric Systems

Dry electric heating in dwellings is designed to:

- Offer an alternative to traditional heating systems
- Provide a safe and comfortable means of heating
- Provide an affordable means of heating

The purpose of dry electric heating is to act as an alternate to traditional wet heating systems, often where it is impractical to install a traditional boiler and central heating.
Dry electric heating can be split into 3 main categories:

- Storage
- Instantaneous
- Radiant
- Under floor

The following sections will cover the main elements of each system and their relevant design considerations.

9.1. Storage Heaters

Storage heaters are common to most electrical contractors, often recalling with a grimace the installation or removal of them and their bricks. Storage eaters are usually charged during the off-peak hours, at night, when the cost of the electricity tariff is considerably cheaper. Traditionally the electricity suppliers offer a 7 hour window of off-peak tariff at night, though some suppliers do also offer off-peak tariffs during the day.

The concept of off peak heating was introduced in the late 1950s to try and balance out the demands on power station usage, with often tariffs developed to encourage use. The concept is still valid to this day.

Although the design of electric storage heaters is similar to that of other heating system, due to the nature of the slow release of heat the requirements are a little different.

A simple way of ascertaining the size of the heater required will be to take the room dimensions and apply a multiplier of 0.12, so:

$$w \ x \ l \ x \ h \ x \ 0.12 = kW$$

9.2. Instantaneous Heaters

Instantaneous heaters come in many shapes and sizes, though all have one thing in common – they rapidly heat a room. A common form of an instantaneous heater would be the panel heater.

These systems can offer controllable and direct heating to rooms. Depending on the level of control each room can be dedicated as its own zone, which can be independently monitored and controlled.

Panel heaters are almost 100% efficient in that the energy they convert to heat is almost all used for heating and is not lost. These heaters can be accurately designed using the guidance within this document.

9.3. Radiant Heaters

Radiant heaters are slightly different to the previously mentioned heaters as they are not intended to heat the air but the objects, usually people, beneath them.

Radiant electric heaters do not warm the surrounding area and are therefore not commonly used in rooms, but are often found in external spaces, such as gardens, to heat people beneath them. They are sometimes used in large open areas like warehouses, which have infrequent occupancy, with automatic control to sense when people are in the space.

Typically therefore you would not design a radiant heater to offer space heating; therefore the design heat loss is not important to this system.

9.4. Under Floor Systems

Under floor heating systems are increasing in their use as clients have become aware of the benefits associated with them. Although it is sometimes difficult and expensive to heat a room using solely an electric under floor heating system, they can be used to offer a comfortable and convenient background heat, especially in a tiled room.

9.5. Section 753 of BS 7671

Section 753 on BS 7671 holds specific information related to floor and ceiling heating systems, including that of electric under floor heating. This special location is something that many contractors are unfamiliar with, even those that have installed under floor heating systems for year.
The following section of the guide aims to give a synopsis of the requirements of BS 7671 though it is recommended that a review of this section be undertaken prior to any work being undertaken.

9.5.1. RCD's

Regulation 753.411.3.2 requires the use of RCD protection for disconnection devices with the characteristics specified in Regulation 415.1.1 i.e. not exceeding 30mA and operating at a time not exceeding 40ms at a residual current value of 5 $I\Delta n$. If the heating unit does not have exposed-conductive-parts, a suitable conductive covering needs to be applied to the heater, for example a metallic grid. This is usually now achieved by having earthed screened heating tapes / cables.
Additionally Regulation 753.415.1 requires similar RCDs for heating equipment of Class II construction or equivalent insulation.

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9.5.2. Temperatures

Particularly in a floor heating system, there is a likelihood of contact with skin. Where skin, or even footwear, is likely to come into contact with a surface heated by a floor heating system, the temperature of the floor shall be limited, for example to 35 ^{O}C.
Regulation 753.424.3.1 requires protection against overheating to be considered, there are 3 methods of completing this:

i. Appropriate design of the heating system
ii. Appropriate installation of the heating system in accordance with the manufacturer's instructions
iii. Use of protective devices

The same regulation requires that the heating unit be connected to the electrical installation by cold tails. The cold tails should be permanently connected to the heating unit i.e. by use of a crimped connection

9.5.3. Identification

Regulation 753.514 requires a number of identifications and notices to be applied to an under floor heating system. There are 16 requirements in 753.514 that must be noted in a plan and fixed to or adjacent the distribution board of the heating system:

i. Manufacturer and type of heating units
ii. Number of heating units installed
iii. Length/area of heating units
iv. Rated power
v. Surface power density
vi. Layout of the heating units in the form of a sketch, drawing or picture
vii. Position/depth of heating units
viii. Position of junction boxes
ix. Conductors, shields and the like
x. Heated area
xi. Rated voltage
xii. Rated resistance (cold) of heating units
xiii. Rated current of overcurrent protective device
xiv. Rated residual operating current of RCD
xv. The insulation resistance of the heating installation and the test voltage used
xvi. The leakage capacitance

Item vi is the part that usually gets ignored or not properly implemented. Its aim is to give a detailed and dimensioned plan of the under floor element(s), to avoid the risk of damage if the floor were ever to have holes drilled in it.

10. Heat Emitters and their Locations

Within this guide we have covered many different types of heat emitters, although in practice the specific type of heat emitter doesn't matter. A heat emitter is simply a product that emits heat; the fuel that creates this heat is irrelevant.

Earlier in the guide we calculated the heat output required per room. Once the size of the heater required has been determined the next consideration is the location of the heater.

There are some myths associated with the locations of heat emitters and their effectiveness, the following section is intended to explain the reasoning behind the locations of the heat emitters.

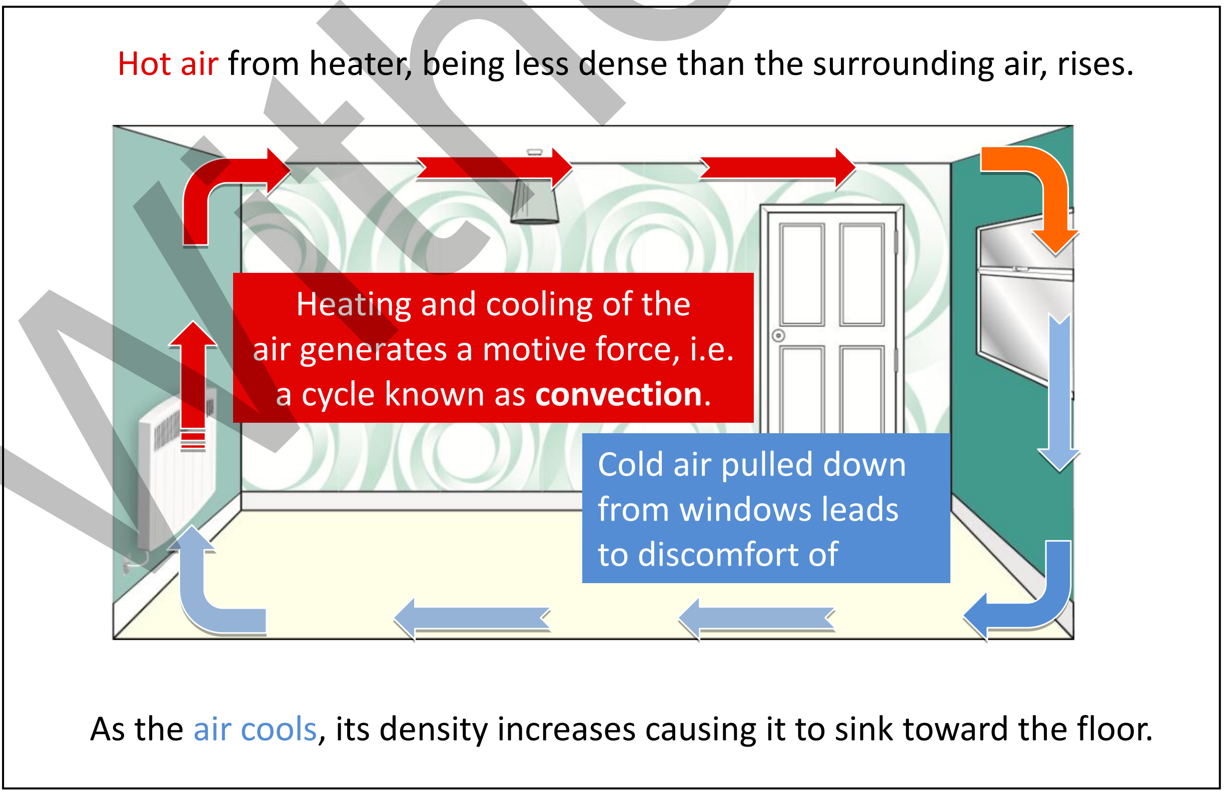
10.1. Location of Heat Emitters

The design of the installation is not restricted to just the size and type of the heater, where the heat source is placed will have an impact on how effective the heater is.
As a general rule radiators have been traditionally fitted under a window, quite often installers have no idea why this is. In reality there are several reasons why this has been the case, aesthetics being one of them. However, the technical reason for this is the ability of the heat emitter to heat the room to a comfortable level.

10.2. Heat Emitter Opposite a Window

Placing a heat emitter such as an instantaneous panel heater opposite a window has an effect of creating hot air above the heater. This hot air rises up to the ceiling, circulates through the room at high level, still very warm, then starts to cool once it comes into contact with a window. The air then gives up additional heat to the window, which is inevitably colder than the wall. The cooler air falls to the floor and moves through the room back towards the heat emitter, where it is warmed and the cycle begins again.

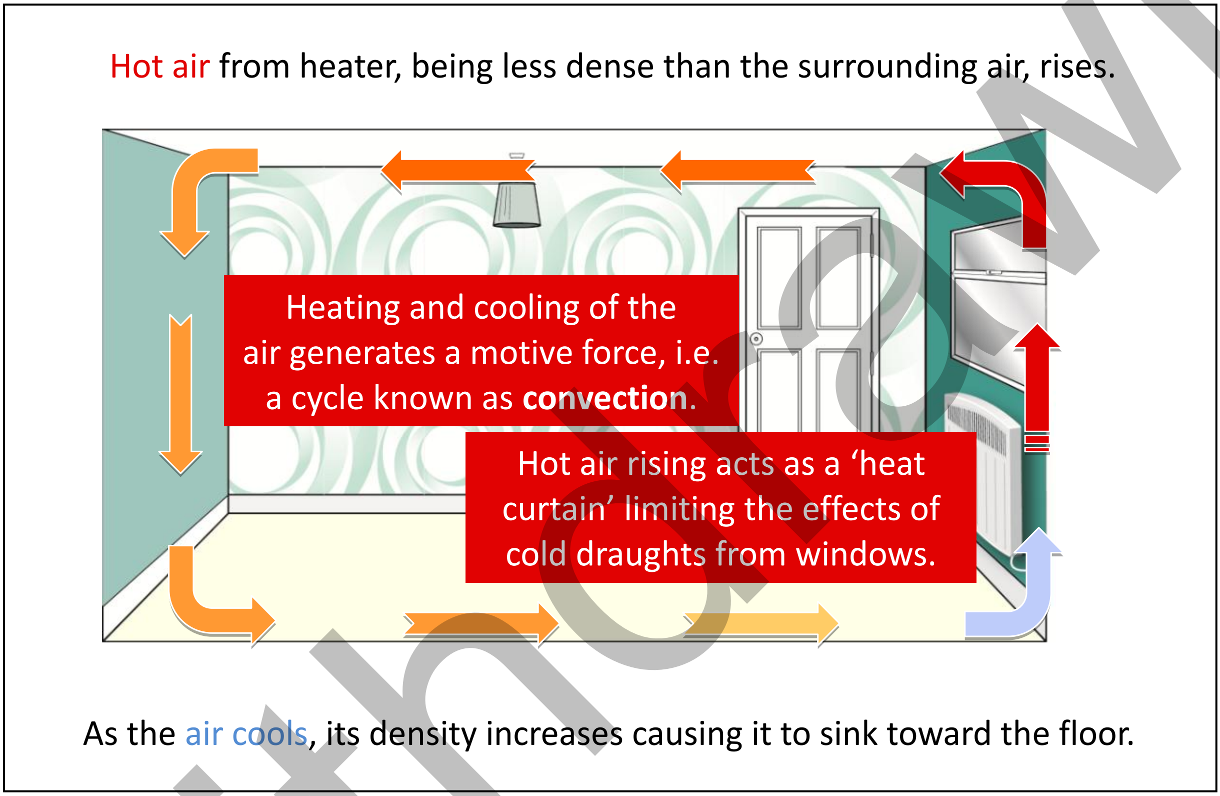
This sounds pleasant enough but what it creates is a temperature differential between the ceiling (warm) and the floor (cool). Occupiers of the room notice this difference and it creates an uncomfortable experience for anyone in the room, as cold feet but a warm head is not particularly enjoyable.



10.3. Heat Emitter Under a Window

With a heat emitter under a window, the process of hot air rising, cool air falling and circulating is the same, however in this scenario the hot air hits the window immediately, giving up some heat immediately to the cold window. The warm air then moves throughout the room, cooling slighting when it comes into contact with the opposite wall, not too much but just enough to continue the convection effect.

In this scenario the room has a moderate level of heat spread evenly throughout, offering a much more pleasant environment for the occupants.



Images courtesy of Certsure

10.4. Domestic Electric Heating Controls

Table 20 in the Domestic Building Services Compliance Guide states the type and nature of controls that are associated with the different heating systems, for example panel heaters should have both time and individual temperature controls. Table 20 also states that for storage heaters automatic control of input charge should be provided.

Table 20 Recommended minimum controls for primary and secondary electric heating systems (other than with electric boilers)

System	Control type	Minimum standard	Supplementary information
Warm air	**1.0 Time and temperature control, integral to the heater or external**	a. Systems should be provided with: i. a time switch/programmer and room thermostat, or ii. a programmable room thermostat.	
	2.0 Zone control	a. Dwellings with a total floor area ≤ 150 m² should have at least two space heating zones with independent temperature control, one of which is assigned to the living area. b. Dwellings with a total floor area > 150 m² should have at least two space heating zones with independent temperature *and* time control. Time control may be provided using: i. multiple heating zone programmers, or ii. a single multi-channel programmer, or iii. programmable room thermostats, or iv. separate timers to each circuit, or v. a combination of (iii) and (iv) above. c. In single-storey, open-plan dwellings in which the living area is greater than 70% of the total floor area, sub-zoning of temperature control is not appropriate.	
Panel heaters	**3.0 Local time and temperature control**	a. Time control should be by a programmable time switch integrated into the appliance or by a separate time switch. b. Individual temperature control should be by integral thermostats or by separate room thermostats or programmable room thermostats.	Panel heaters provide instantaneous heat.
Storage heaters	**4.0 Charge control**	a. Automatic control of input charge should be provided.	Charge control is the ability to detect the internal temperature and adjust the charging of the heater accordingly.
	5.0 Temperature control	a. Temperature control should be by adjusting the rate of heat release from the appliance, using an adjustable damper or other thermostatically-controlled method.	

Figure 1 Table 20 from the Domestic Building Services Compliance Guide relating to controls

10.5. Non-domestic Electric Heating Controls

The non-domestic building services compliance guide holds information related to installations other than dwellings, section 7 references direct electric space heating.

Though the application may well be larger, the basic principles within this guide to sizing heating systems still apply.

Table 23 Recommended minimum controls for electric boiler systems

Type of control	Standard	Comments
Boiler temperature control	a. Boiler fitted with a flow temperature control and capable of modulating the power input to the primary water depending on space heating conditions.	
Zoning	b. For buildings with a total usable floor area greater than 150 m^2, at least two space heating zones with independent time and temperature controls using either: i. multiple heating zone programmers, or ii. a single multi-channel programmer.	
Temperature control of space heating	c. Separate temperature control of zones within the building using either: i. room thermostats or programmable room thermostats in all zones, or ii. a room thermostat or programmable room thermostat in the main zone and individual radiator controls such as thermostatic radiator valves (TRVs) on all radiators in the other zones, or iii. a combination of (i) and (ii) above.	
Time control of space and water heating	d. Provide using: i. a full programmer with separate time control for each circuit, or ii. separate timers for each circuit, or iii. programmable room thermostats for the heating circuits, with separate time control for all the circuits.	

Note: An acceptable alternative to the above controls is any boiler management control system that meets the specified zoning, timing and temperature requirements.

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Table 24 Recommended minimum controls for primary and secondary electric heating systems other than electric boilers

Type of electric heating system	Type of control	Standard	Comments
Warm air	Time and temperature control, either integral to the heater or external	a. A time switch/programmer and room thermostat, or b. a programmable room thermostat.	
	Zone control	c. For buildings with a total usable floor area greater than 150 m², at least two space heating circuits with independent timing and temperature controls using either: i. multiple heating zone programmers, or ii. a single multi-channel programmer.	
Radiant heaters	Zone or occupancy control	a. Connection to a passive infra-red detector.	Electric radiant heaters can provide zone heating or be used for a full heating scheme. Common electric radiant heaters include the quartz and ceramic types.
Panel/skirting heaters	Local time and temperature control	a. Time control provided by: i. a programmable time switch integrated into the appliance, or ii. a separate time switch. b. Individual temperature control provided by: i. integral thermostats, or ii. separate room thermostats.	Panel heater systems provide instantaneous heat.
Storage heaters	Charge control	a. Automatic control of input charge (based on an ability to detect the internal temperature and adjust the charging of the heater accordingly).	
	Temperature control	b. Manual controls for adjusting the rate of heat release from the appliance, such as adjustable damper or some other thermostatically-controlled means.	
Fan/fan convector heaters	Local fan control	a. A switch integrated into the appliance, or b. a separate remote switch.	
	Individual temperature control	c. Integral switches, or d. separate remote switching.	

11. PAS 2030

PAS 2030 is a mandatory document to be used in the installation of energy efficiency measures under the Green Deal. PAS 2030 reference many topics and subject matters, including that of electric storage heaters. Table D1 in PAS 2030 states the requirements for the documentation that is to be handed over to the client upon completion of a domestic dry electric heating system, these are:

1. Building regulations compliance certificate
2. Relevant electrical installation certificate (EIC or MEIWC)
3. Product manufacturers installations and servicing instructions
4. Any manufacturer or product data or information sheets
5. Product warranty information and guarantees
6. Commissioning certificate that meets the requirements of the building regulations

Any additional information should be given that is required by the manufacturer.

Prior to commencement of work, PAS 2030 requires a pre-installation survey should be undertaken and states the following:

As a minimum, the pre-installation survey shall investigate and determine if the:

- *Condition of the existing electrical installation is satisfactory in relation to the proposed work;*
- *Condition of the building fabric is satisfactory in relation to the proposed work;*
- *Installation work will result in non-compliance with the Building Regulations in relation to workmanship, materials, structural stability, fire safety, conservation of fuel and power and electrical safety;*
- *Storage heater installation work will result in non-compliance with the IET Wiring Regulations;*
- *Proposed installation will be compliant with any requirements set by the storage heater product manufacturer;*
- *Relevant checks have been undertaken to determine if asbestos containing materials are present.*

Other documents such as Approved Document L – Conservation of Fuel and Power, and the Domestic Building Services Compliance Guide also offer other guidance on this subject.

12. Lot 20

Lot 20 is a manufacturer based requirement that states that all space heaters manufacturer in the EU after 1st January 2018 must comply with a minimum efficiency standard. This will generally require manufacturers to have timers and temperature controls on all space heaters.

As this is a manufacturer requirement there is no need for designers or installers to change their requirements though it may be useful to be aware of these changes when specifying space heaters. It is worth noting that any space heaters installed after 1st January 2018 should be Lot 20 compliant.

13. Certification

As these systems will require an electrical supply, BS 7671 requires suitable certification to be completed. Additional requirements, such as those in section 753 of BS 7671 for under floor heating or the pre-installation survey in PAS 2030, may require additional certification to be completed.

14. Notification

Many of these systems installed in dwellings will require notification to the Local Authority Building Control (LABC), installation work should not start until it has been confirmed that the LABC has been informed or the installer is registered with a suitable Competent Person Scheme.

The document is for informational purposes only and no further maintenance will be carried out.

15. Appendices

15.1. Appendix A – Other standards referenced in this guide

Approved Document L1A	Conservation of fuel and power in new dwellings
Approved Document L1B	Conservation of fuel and power in existing dwellings
Approved Document L2A	Conservation of fuel and power in new buildings other than dwellings
Approved Document L2B	Conservation of fuel and power in existing buildings other than dwellings
Approved Document G	
BS 7671:2008+A3:2015	Requirements for Electrical Installations. IET Wiring Regulations
BS EN 60335	Household and similar electrical appliances
CIBSE Guide A	Environmental Design
CIBSE Guide B	Heating Ventilating, Air-conditioning and Refrigeration
PAS 2030	
Domestic Building Services Compliance Guide	
Non-domestic Building Services Compliance Guide	
Environmental Science in Building, 6th Edition. Randall McMullan. PALGRAVE MACMILLAN. Hampshire. 2007	

15.2. Appendix B – Basic Heat loss calculation

The following is a sample of a basic heat loss calculator. Complete the yellow fields.

Edit the yellow cells to complete a basic heat loss calculation			
Building length	15		
Building width	35		
Building height	3		
External wall length	4		
External wall height	3		
Window m2	4	U value for window	0.48
Temperature differential	21	U value for wall	2.7
Air changes per hour	1	U value for floor	0.78
Ventilation factor	0.33	U value for ceiling	0

Fabric heat loss	Watts
Wall	81
Window	227
Floor	8600
Ceiling	0
Ventilation heat loss	10915
Total loss (W)	19822

ECA
ECA Court
24-26 South Park
Sevenoaks
Kent
TN13 1DU

Tel: 020 7313 4800
www.eca.co.uk

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