



STEEL INDUSTRY  
GUIDANCE NOTES

## Thermal Performance

The burning of fossil fuels to produce energy and the subsequent release of carbon dioxide (CO<sub>2</sub>) have made a significant contribution to global warming. The UK Government has set a target of reducing CO<sub>2</sub> emissions by 60% by 2050, with half of these savings coming from reduced energy demand. Energy consumption in buildings accounts for nearly half of all energy used in the UK. Reducing energy consumption of buildings will not only reduce CO<sub>2</sub> emissions and depletion of non-renewable fossil fuels, but will also lower operational costs.

The embodied energy of most buildings (the energy required to manufacture the component parts of the building) is far outweighed by the operational energy (the energy required to operate the building) over its lifetime. For an air-conditioned office building, the operational energy is between 5 and 10 times greater than the embodied energy over a 60 year design life. Building designers can make the greatest impact on energy consumption by minimising the operational energy required by buildings.

One of the most effective ways of reducing operational energy consumption is by improved thermal performance of the building envelope. The issue of thermal performance is applicable to all buildings that are heated i.e. commercial buildings, industrial buildings and residential buildings.

### Legislation

The EU Energy Performance of Buildings Directive (EPBD) aims to promote improved energy performance of buildings. This EU Directive was implemented in England and Wales by the revised Part L of the UK Building Regulations Conservation of fuel and power which came into effect in April 2006.

In the past, compliance with Part L of the Building Regulations has been defined in the corresponding Approved Documents in terms of the thermal transmittance (U-value) and air leakage of individual building elements. Limiting values for both parameters were given in the Approved Documents. Traditionally, U-values were seen as the primary means of improving thermal performance, resulting in a gradual increase in insulation thickness over several years to meet the ever stricter requirements. Limits on air leakage were also included in the Approved Documents, but were not strictly enforced in practice.

The 2006 revision of Approved Document L differs from the previous approach in that building designers are required to demonstrate an improvement in energy performance compared to the requirements of the 2002 Regulations, but they are given the freedom to choose how to achieve this improvement. The energy performance is quantified in terms of the CO<sub>2</sub> emissions associated with the operational energy requirements of the building.



New Approved Documents for Part L were published in March 2010 and will replace the current editions on

1 October 2010. These new documents continue the trend of reducing the operational energy used in buildings. Many of the changes in the new documents are aimed at improving compliance and more clearly distinguishing between requirements and guidance.

The energy requirements are a function of many aspects of the building design, such as the detailed design of the cladding, the availability of natural light and the type and efficiency of building services installed.

Since 2006 Part L has considered the performance of the whole building, rather than the thermal properties of the individual elements of the building envelope. It is, therefore, no longer sufficient to specify cladding components or even whole systems based solely on manufacturers' published data. Instead, compliance with the Regulations must be demonstrated using a whole building calculation model, such as the Simplified Building Energy Model (SBEM) for non-dwelling buildings or Standard Assessment Procedure (SAP) for dwellings.

Minimum performance criteria in terms of U-values and air leakage are still included in the Regulations, but compliance with these limits is no longer sufficient in itself.

Future regulatory changes will inevitably continue the trend towards improved thermal efficiency.

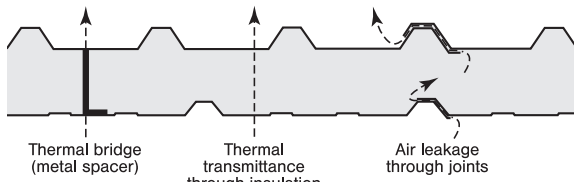
### Theory

The thermal efficiency of a building envelope is a function of three characteristics:

1. U-Values - the thermal performance of the planar elements (e.g. wall, roofs, windows).

2. Thermal bridges - the local heat losses that can occur around the planar elements and where the planar elements are penetrated by building components.
3. Airtightness - the ease at which air can pass through the envelope.

These three factors are shown in the figure below in a metal cladding system but are applicable for all types of building envelope.



**Figure 1. Figures affecting thermal performance**

### U-values

The U-value of an element or system is a measure of the ease with which it permits the passage of heat; the smaller the U-value, the less heat is transmitted. U-values are usually quoted in  $W/m^2K$  and may be obtained by advanced thermal modelling techniques or from laboratory testing using a calibrated hot box.

For an individual component such as a cladding panel, the elemental U-value depends on the conductivity and thickness of the insulation, the profile shape and the presence of thermal bridges, e.g. metal spacers.

Changes to the Building Regulations over recent years have significantly reduced the maximum permissible elemental U-values resulting in a considerable increase in insulation thickness. The thermal conductivity of common construction materials are shown in the table below.

Material	Thermal conductivity, $\lambda$ (W/mK)
Steel	45 to 50
Stainless steel	15 to 17
In-situ normal weight concrete	1.7 to 2.2
Brickwork	0.6 to 0.8
Gypsum-based board	0.16 to 0.22
Plywood	0.12 to 0.15
Mineral wool insulation	0.03 to 0.04
Closed cell insulation	0.02 to 0.03

### Thermal bridges

Thermal bridges are areas or components within the envelope whose thermal insulation properties are lower than those of the surrounding material, thereby permitting local high heat flows. In general, all metal components that pass through the envelope will act as thermal bridges, because of their high thermal conductivity, unless specific measures are taken to interrupt the heat flow by introducing a layer of thermal insulation. Thermal bridging increases the heat loss from a building, thereby increasing the operational energy requirement. It can also lead to a reduction in the internal surface temperature of the cladding, causing condensation to form under certain conditions.

### Airtightness

The airtightness of a building is central to the requirements of Approved Document L and is likely to become even more important as architects strive to improve the thermal performance of the building envelope without significant increases in insulation thickness. The airtightness of a building is quantified in terms of its air permeability, which is defined as the volume flow rate of air per square metre of building envelope and floor area at a given pressure.

There are many potential sources of air leakage in a building, for example poorly-fitting window frames or badly-detailed service penetrations, but this does not in any way diminish the importance of correctly specifying and installing the roof and wall cladding. Laboratory tests have demonstrated the ability of profiled metal cladding to provide a high degree of airtightness when properly detailed and installed.

## Key Points

- The most effective way of cutting energy consumption in buildings is by reducing operational energy requirements.
- Thermally efficient buildings can be constructed in steel with low operational energy demands.
- The issue of thermal performance is applicable to all buildings that are heated i.e. commercial buildings, industrial buildings and residential buildings.
- Thermal performance is a function of U-values, thermal bridges and air-tightness.
- Part L of the Building Regulations for England and Wales deals with Energy Efficiency.
- Part L of the Building Regulations requires a whole building model to be used to determine operational energy usage.
- New Approved Documents for Part L were published in March 2010 and will replace the current editions on 1 October 2010.

## Further Sources of Information

1. SCI-P352 Sheet 1 – Energy Efficiency
2. SCI-P380 Avoidance of Thermal Bridging in Steel Construction
3. SCI-P346: Best practice for the specification and installation of metal cladding and secondary steelwork
4. SCI-P386 Code for Sustainable Homes: How to satisfy the code using steel technologies
5. P367: Energy Efficient Housing using Light Steel Framing
6. Approved Documents L1 and L2
7. SIGNS Jun 2006 - Achieving airtightness with metal cladding systems
8. SCI-EP36 Best Practice in Steel Construction - Residential Buildings
9. Guidance for the design of metal roofing and cladding to comply with Approved Document L2 published jointly by MCRMA and EPIC.