Colorcoat® technical paper
The role of the building envelope in Part L 2013 compliance
The 2013 revision of Approved Document L requires an aggregate 9% reduction in the CO₂ emissions from buildings other than dwellings.

We have worked closely with a number of cladding system manufacturers including our own Tata Steel, with technical input from Oxford Brookes University School of Architecture, to assess the impact of enhancing different aspects of the building envelope and provide guidance on which aspects of the building envelope and services will provide the greatest reduction in overall CO₂ emissions.

About Tata Steel

Tata Steel, is one of Europe’s largest steel producers. We serve many different and demanding markets worldwide, including aerospace, automotive, construction, energy and power, and packaging. Our primary steelmaking operations in the UK and the Netherlands are supported by a global sales and distribution network.

Innovation and continuous improvement are at the heart of our performance culture. We aim to create value by offering a sustainable and value-added steel product range supported by unrivalled customer service.

By working in partnership with you, we find the best solutions to meet your needs and help your business to perform.

Our European operations are a subsidiary of Tata Steel Group, one of the world’s top ten steel producers. With a combined presence in nearly 50 countries, the Tata Steel Group including the Europe operations, Tata Steel Thailand and NatSteel Asia, has approximately 80,000 employees across five continents and a crude steel production capacity of over 28 million tonnes.

Working together to deliver Part L 2013 compliance

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We have worked closely with a number of cladding system manufacturers including our own Tata Steel, with technical input from Oxford Brookes University School of Architecture, to assess the impact of enhancing different aspects of the building envelope and provide guidance on which aspects of the building envelope and services will provide the greatest reduction in overall CO₂ emissions.
Overview

The UK government has a stated trajectory towards zero carbon buildings by 2019. In England and Wales, the conservation of fuel and power is covered by Approved Document L of the Building Regulations.

Approved Document L is subdivided into four sections, covering dwellings’ and buildings other than dwellings’ for new build and existing buildings. This technical paper focuses on Approved Document L2A for new buildings other than dwellings.

The 2013 revision of this document has been issued and further revisions with associated reductions in CO₂ emissions are expected in 2016 and 2019.

The thermal performance of the building envelope has a key role in retaining heat within the building, allowing sufficient natural light and useful solar gains into the building, while ensuring that the building does not overheat.

This Colorcoat® Technical Paper, quantifies the effect of changing different aspects of the building envelope on the building heat losses and the CO₂ emissions on a range of different size industrial buildings. The CO₂ emission reductions generated by improving the building lighting efficiency and control systems are compared with the reductions that can be achieved through building envelope enhancements.

These have been assessed by the Colorcoat® Centre for the Building Envelope, based at Oxford Brookes University, using the current version of SBEM (simplified building energy model) and other dynamic simulation modelling tools.

Low and zero carbon renewable energy systems can also be integrated with pre-finished steel cladding, and can contribute towards a CO₂ reduction strategy.
Main changes to Part L for 2013

History of changes to Part L

<table>
<thead>
<tr>
<th>Year</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>U-value for wall, roof and floor 0.7. Rooflights 5.7.</td>
</tr>
<tr>
<td>1990</td>
<td>U-values for wall, roof and floor tightened to 0.45.</td>
</tr>
<tr>
<td>1995</td>
<td>Rooflight U-value tightened to 3.3.</td>
</tr>
<tr>
<td>2002</td>
<td>Air-tightness testing requirement first introduced. All buildings over 1000 m² to achieve minimum of 10 m³/m²/h.</td>
</tr>
<tr>
<td>2006</td>
<td>Introduction of whole building CO₂ emissions with a target based on approximately 25% improvement over a 2002 notional building. Development of National Calculation Methodology and SBEM for calculation of CO₂ emissions. All buildings over 500 m² to achieve minimum of 10 m³/m²/h.</td>
</tr>
<tr>
<td>2010</td>
<td>Overall 25% reduction in whole building CO₂ emissions over 2006. Based on the ‘aggregate approach’.</td>
</tr>
<tr>
<td>2013</td>
<td>Overall 9% reduction in whole building CO₂ emissions over 2010. Separate regulations for Wales.</td>
</tr>
<tr>
<td>2015</td>
<td>2016 zero carbon homes target is dropped, as is the 2019 target for non-domestic zero carbon buildings. Proposed ‘allowable solutions’ CO₂ offsetting scheme scrapped.</td>
</tr>
<tr>
<td>2020</td>
<td>Nearly zero energy buildings.</td>
</tr>
</tbody>
</table>

Main changes to ADL2A with effect from April 2014

1. An overall 9% reduction in CO₂ emissions across the projected UK new building stock.
2. The target emission rate for the building will be generated by a 2013 notional building specification.
3. CO₂ emissions compliance will be calculated using an updated version of SBEM or other approved modelling package.
4. Separate regulations for Wales.

Specification for the 2013 notional building (envelope parameters)

The specification for the 2013 notional building envelope parameters and building service details are embedded within the SBEM calculation and compliance methodology. The building envelope specifications for the 2010 notional building and the backstop or worst allowable performance for the individual elements are summarised below.

Table 1. Specification for the 2013 notional building

<table>
<thead>
<tr>
<th>2013 notional building</th>
<th>Backstop value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wall U-value</td>
<td>0.26</td>
</tr>
<tr>
<td>Roof U-value</td>
<td>0.18</td>
</tr>
<tr>
<td>Rooflights U-value</td>
<td>1.8</td>
</tr>
<tr>
<td>Rooflight area</td>
<td>12%</td>
</tr>
<tr>
<td>Windows U-value</td>
<td>NA</td>
</tr>
<tr>
<td>Air permeability</td>
<td>3-7</td>
</tr>
<tr>
<td>dependant on building</td>
<td>3-5</td>
</tr>
</tbody>
</table>

Table 2. 2013 Notional building air-tightness for different size and type of buildings

<table>
<thead>
<tr>
<th>Gross internal floor area</th>
<th>Air tightness m³/m²/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Heat Only</td>
</tr>
<tr>
<td>&lt; 250 m²</td>
<td>5</td>
</tr>
<tr>
<td>250 m² – 3,500 m²</td>
<td>3</td>
</tr>
<tr>
<td>3,500 m² – 10,000 m²</td>
<td>3</td>
</tr>
<tr>
<td>&gt; 10,000 m²</td>
<td>3</td>
</tr>
</tbody>
</table>
Background to CO₂ emissions calculations

The EU Energy Performance of Buildings Directive (EPBD) was introduced in the UK from January 2006 with a three year implementation period ending January 2009. Its objective was to improve energy efficiency and reduce CO₂ emissions as part of the government’s strategy to achieve a sustainable environment and meet climate change targets agreed under the Kyoto Protocol.

The EPBD introduced higher standards of energy conservation for new and refurbished buildings and requires energy performance certification for all buildings when sold or leased.

The EPBD required member states to develop a methodology for the calculation of whole building energy performance/CO₂ emissions.

There are two types of energy certification required for new and existing commercial buildings;
1. Energy Performance Certificates (EPC) that are required on construction, sale or lease of all buildings from October 2008.
2. Display Energy Certificates (DEC) required for public buildings over 1000 m² from April 2008.

National Calculation Methodology

The National Calculation Method (NCM), is defined by the department for Communities and Local Government (CLG). The procedure for demonstrating compliance with the Building Regulations for buildings other than dwellings is by calculating the annual CO₂ emissions for a proposed building and comparing it with the CO₂ emissions of a comparable ‘notional building’. Both calculations make use of standard sets of data for different activity areas and call on common databases of construction and service elements.

The CO₂ emissions target and actual building emissions are calculated using approved dynamic simulation modelling software. The BRE have developed SBEM, the simplified building energy model for CLG as a simplified compliance modelling tool.

The NCM defines the operating conditions under which each building must be assessed. The conditions may be different from those under which the building operate, however this approach allows comparison against a standard building, under standardised conditions. This also allows comparison between buildings when calculating EPC ratings.

The aggregate approach

The aggregate approach to CO₂ reductions was first introduced in 2010 and has been retained for the 2013 revision.

DECC (department of energy and climate change) are committed to reducing the UK building stock CO₂ emissions in the most cost effective manner. The aggregate approach supports this by recognising that CO₂ reductions in some buildings is vastly more cost effective than in others.

The aggregate approach means that there is no direct improvement factor to apply to a building constructed to a previous revision of Part L. Instead a specification for the notional building, which is used for target setting, has been developed which when applied across the predicted new building will deliver an overall 9% reduction in CO₂ emissions.

Some buildings will deliver more than 9% some will deliver less. The actual % improvement for an individual building cannot be calculated simply, however for compliance purposes the only criteria for the building is that the emission rate for the actual building is ≤ target emission rate set by the notional building.

The designer does not have to use the values for the notional building as in most cases this will not be the most cost effective approach.

Dynamic Simulation Modelling

SBEM and other Part L approved dynamic simulation modelling packages produce a virtual model of the building. A detailed description of the building geometry, construction, building services and end use are required. Standard operating conditions for each building type are defined in the NCM and are applied to the building being assessed.

From this data, the building energy requirements and CO₂ emissions are calculated. This data is also broken down and attributed to heating, lighting, hot water and auxiliary power. The energy use and CO₂ emissions are also calculated for a 2013 notional building which generates a target emission rate (TER).

SBEM is a simplified modelling package and was originally based on the Dutch methodology NEN 2916:1998 (Energy Performance of Non-Residential Buildings). It has since been modified to comply with the recent CEN Standards. It makes use of standard data contained in associated databases.

SBEM produces consistent and reliable evaluations of energy used in non-domestic buildings for Building Regulations Compliance and for Building Energy Performance Certification purposes.

For design modelling, more sophisticated modelling packages should be used.
This technical paper focuses on the role of the building envelope, however this cannot be assessed on its own. SBEM (ie Modelling using SBEM) along with other dynamic simulation modelling has been undertaken to assess the effect of changing building envelope and building service parameters. The effect of different energy sources and the role of renewables that can easily be integrated into the building envelope has also been considered.

Factors to consider for Part L 2013 compliance

When looking to achieve CO₂ emissions compliance for Part L 2013, the building designer has to consider all aspects of the building design and specification. These are summarised in the diagram below.

Figure 1. Factors affecting building CO₂ emissions
Heat losses through building details

Building details such as vertical corners, the ridge, eaves, verge and junctions around windows and doors, have additional heat losses associated with them. The additional heat loss for each metre of a detail is known as the psi ($\psi$) value. This additional heat loss is dependant upon the type of detail, the thermal conductivity of the cladding materials and the quality of the detail design and installation.

Approved Document Part L2A places specific emphasis on the performance of building details and the additional heat losses through linear thermal bridging.

In order to demonstrate that the designer has taken reasonable provision to allow for these additional losses, One of the following approaches should be taken:

1. A quality assured approach by a person with suitable expertise using the methods set out in BR497.
2. Unaccredited details with no linear transmittance calculations carried out. For these, the generic values given in the BRE Information Paper IP1/06 should be increased by 0.04 W/mK or 50%, whichever is greater, before being used in the BER calculation.

It can be seen that there is an increasing penalty for the use of details with a lesser degree of accurate assessment of performance.

A modelling exercise has been carried out on a 2400 m² warehouse to assess the effect of using different levels of building details upon the overall heat loss and estimated effect on the building CO₂ emissions.

<table>
<thead>
<tr>
<th>Modelled details</th>
<th>Generic details IP1/06 values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal bridging heat loss 21 $\psi$ from details</td>
<td>162 W/K</td>
</tr>
<tr>
<td>Total envelope loss (W/K)</td>
<td>2891 W/K</td>
</tr>
<tr>
<td>% Heat loss by thermal bridging</td>
<td>5.62%</td>
</tr>
<tr>
<td>Approximate increase in CO₂ emissions *</td>
<td>Base case</td>
</tr>
</tbody>
</table>

* The results have been calculated assuming that lighting and heating account for 60% and 40% respectively of the building’s CO₂ emissions which is typical for this type of building.

- When ‘generic details’ are used the heat loss is increased by approximately a factor of 3. This is due to two reasons firstly, the fact that the generic details perform much worse than well designed modelled details and secondly the additional applied 50% penalty.
- The overall effect on the building CO₂ emissions is an increase of approximately 10% however this will vary from building to building.

As pre-finished steel has a very high thermal conductivity, this places additional emphasis on good quality design and installation. Subsequent modification of a building detail (on site) could invalidate the calculations, resulting in the same penalty as a generic building detail.

Using generic details will very significantly increase the calculated CO₂ emissions, making compliance much more difficult.
Increasing the building fabric insulation has often been the first approach taken when looking to reduce the thermal losses from a building. The designer needs to consider the implications of specifying a more highly insulated construction, against the relatively small overall reductions in CO₂ emissions which will be delivered.

The thermal transmittance of a construction is given by the U-value. This is the heat in Watts (W) passing through a square metre of construction per degree temperature difference from inside to outside. Maximum allowable U-values are given in ADL2. Increasing insulation thickness, to lower U-values, will reduce fabric losses from the building, but the benefits become proportionately less as thickness is increased. U-values are already low, so the advantage of adding more insulation is limited.

The relationship between U-value and insulation thickness is not linear. To half the U-value of an insulation product requires the thickness to be doubled. This relationship is shown in the graph below for two typical insulation materials. Actual cladding systems will vary due to factors such as repeating thermal bridging and insulation material properties.

It is always important to consult the cladding system manufacturer for actual U-values of a particular system.

Reducing U-values will have a greater impact on the total heat loss and CO₂ emissions, of smaller buildings than for larger ones. This is due to the ratio of building volume to surface area. So, for typical industrial, warehouse or retail buildings, with relatively high volume, increasing insulation has much less effect than in small buildings.
Effect of changing building envelope parameters

Assessment approach
In order to assess the effect of changing building envelope parameters on the overall building CO₂ emission rate, a series of generic buildings have been modelled using SBEM. These buildings are summarised in the table below.

Table 4. Generic warehouse dimensions

<table>
<thead>
<tr>
<th>Building size</th>
<th>Area</th>
<th>Height to eaves</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>1000 m²</td>
<td>4 m</td>
<td>40 X 25 m (1 bay)</td>
</tr>
<tr>
<td>Medium</td>
<td>4000 m²</td>
<td>6 m</td>
<td>80 X 50 m (2 bays)</td>
</tr>
<tr>
<td>Large</td>
<td>10,000 m²</td>
<td>6 m</td>
<td>125 X 80 m (4 bays)</td>
</tr>
</tbody>
</table>

To enable a meaningful comparison of the data, and to ensure that all buildings started from the same point, the base case building was taken as one which met the 2013 backstop criteria for the building envelope and had building services equivalent to the a 2013 notional building.

A series of enhancements to each element of the building envelope were then modelled to assess the effect on reducing the CO₂ emissions.

The enhanced envelope performance figures were categorised as ‘good’, ‘better’, ‘best’.

This classification followed the same principles as those used by AECOM during the initial modelling work for CLG (Department for Communities and Local Government) and are tabulated below. The criteria for ‘best’ are based on what was deemed currently technically feasible. In many cases, this may not be practical or financially viable.

Table 5. Generic warehouse building envelope parameters

<table>
<thead>
<tr>
<th>Element</th>
<th>2013 Notional</th>
<th>Backstop</th>
<th>Good</th>
<th>Better</th>
<th>Best</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air-tightness</td>
<td>3.70</td>
<td>10.00</td>
<td>7.50</td>
<td>5.00</td>
<td>2.50</td>
</tr>
<tr>
<td>Roof U-value</td>
<td>0.18</td>
<td>0.25</td>
<td>0.20</td>
<td>0.15</td>
<td>0.10</td>
</tr>
<tr>
<td>Rooflight U-value (12% area)</td>
<td>1.80</td>
<td>2.20</td>
<td>1.50</td>
<td>1.20</td>
<td>0.90</td>
</tr>
<tr>
<td>Wall U-value</td>
<td>0.26</td>
<td>0.35</td>
<td>0.30</td>
<td>0.25</td>
<td>0.20</td>
</tr>
</tbody>
</table>

In addition to SBEM assessment, the total heat losses through the building fabric have been calculated for the different size buildings with a 2013 notional building envelope specification. An alternative, more cost effective approach to achieving the same level of building envelope heat loss performance has been proposed.

While this approach is not adequate for the whole building CO₂ assessment, it does enable the effect of changing the building envelope parameters to be easily calculated, without the need to completely specify the building services and carry out the complete SBEM calculations.

To demonstrate the improvements over 2006, the heat losses for a 2006 compliant building have also been calculated. This shows the overall reduction in heat losses, but more importantly demonstrates the main areas where the improvements have been made.
Small buildings

Whole building modelling using SBEM

Small buildings have proportionately greater building envelope surface area for the enclosed building volume and floor area. They also have proportionately more wall surface area. The 2013 target emission rate (kgCO₂/m²/yr) generated from the 2013 notional building will be higher for small buildings.

For this particular size of building, the wall area is fairly similar to the roof (excluding rooflight) area. Consequently enhancing the U-value of wall or roof elements show very similar reductions in the CO₂ emissions, due to the relatively high surface area.

When all the building envelope parameters are set at the backstop values, the amount of heat lost through the rooflights is similar to the amount of heat lost through the rest of the insulated roof construction.

Modern rooflights are able to perform much better than the backstop values and reducing the U-value can show greater reductions in CO₂ emissions than changing other elements in the design. This will be dependant upon the area of rooflights specified.

Increasing the air-tightness of the building envelope yields the greatest reduction in CO₂ emissions.

Any non linearity in the graphs is due to actual values chosen for each parameter when classifying them as ‘good’, ‘better’ or ‘best’.

As SBEM version 5 will be the main compliance assessment tool, the designer will have to confirm his specification and building emission rate, by a building specific calculation.
Small buildings

Building envelope heat losses

An SBEM assessment of a building requires the complete building envelope and services to be specified, along with the building type, location etc.

An alternative approach, to assess the impact of each element of the building envelope on thermal performance, is to calculate the building heat losses through each element.

The pie charts show the actual heat loss through from specific elements and the relative quantity of heat escaping through them for each degree centigrade temperature differential between the internal and external conditions.

The typical heat losses from a 2006 notional warehouse building, show how much heat is being lost through air leakage and rooflights. Moving from the 2006 to the 2013 notional building, it can be seen that to create the very large overall reduction in heat loss, the air-tightness aspect has been enhanced the most.

Is the 2013 notional specification the best way to comply?

An alternative, more cost effective solution is very difficult, as most aspects of the building envelope have been ‘pushed’ to their limits.

It is not practical to reduce air-tightness any lower than 7 m³/m²/h on this size of building and dependant upon the complexity of design/number of interfaces etc, it may be challenging to achieve 7 m³/m²/h.

There is only minimal scope to relax the roof and wall U-values.

To achieve the 2010 floor slab U-value will almost certainly require under slab insulation. It is more likely that the backstop value without insulation would be used. (Note for buildings much smaller than 1000 m², an insulated floor slab or ring beam will be required to meet the backstop value.)

In summary, designing and ensuring that the building envelope as installed performs at a similar level to the 2013 notional building, will be challenging. The designer needs to consider the relative cost effectiveness of enhancing the building envelope performance, compared with enhancements to the building services.

Figure 4. Small warehouse (40 m x 25 m x 6 m) 2006 notional building envelope specification

Figure 5. Small warehouse (40 m x 25 m x 6 m) 2013 notional building envelope specification

Figure 6. Small warehouse (40 m x 25 m x 6 m) Alternative 2013 building envelope specification

In summary, designing and ensuring that the building envelope as installed performs at a similar level to the 2013 notional building, will be challenging. The designer needs to consider the relative cost effectiveness of enhancing the building envelope performance, compared with enhancements to the building services.
Medium buildings
Whole building modelling using SBEM

Buildings between 3000 and 5000 m² floor area account for a significant portion of the UK’s new building stock. In these buildings the roof cladding to wall cladding area ratio is much higher and is much closer to the large building, than the small building.

The modelled results are given in the graph and shown that enhancing the wall U-value only shows a very small reduction in CO₂ emissions, due to the lower relative area.

Enhancing the roof U-value shows a significant reduction in CO₂ emissions, although not as great as was seen on the small building.

Due to the lower surface area: building volume ratio, enhancing the U-values show a relatively smaller effect than on the small building and will incur greater costs.

Enhancing the rooflight U-value again shows a very significant reduction in the CO₂ emissions and is relatively straightforward.

Increasing the air-tightness of the building envelope yields the greatest reduction in CO₂ emissions.

Any non linearity in the graphs is due to actual values chosen for each parameter when classifying them as ‘good’, ‘better’ or ‘best’.

As SBEM version 5, will be the main compliance assessment tool, the designer will have to confirm his specification and building emission rate, by a building specific calculation.
Medium buildings

Building envelope heat losses

The pie charts show the actual heat loss through specific elements and the relative quantity of heat escaping through them for each degree centigrade temperature differential between the internal and external conditions.

Figure 8. Medium warehouse (80 m x 50 m x 6 m)
2006 notional building envelope specification

Figure 9. Medium warehouse (80 m x 50 m x 6 m)
2013 notional building envelope specification

Figure 10. Medium warehouse (80 m x 50 m x 6 m)
Alternative 2013 building envelope specification

The typical heat losses from a 2006 notional warehouse building, show how much heat is being lost through air leakage and rooflights.

Moving from the 2006 to the 2013 notional building, it can be seen that to create the very large overall reduction in heat loss, the air-tightness aspect has been enhanced the most.

Is the 2013 notional specification the best way to comply?

Significant reduction in heat loss can be made by specifying a higher performing rooflight, so that it is possible to relax the roof and wall U-values, and so reduce overall building envelope cost. There is little benefit in specifying ultra low U-value roof lights as these require an additional fourth layer and this results in a reduction in light transmission. There is also a large cost penalty when moving from a U-value of ~1.3 to 0.9 W/m²/K.

Air-tightness of 5 m³/m²/h should be relatively straightforward on a building of this size, provided attention is paid to detail during construction.

In this case the floor slab notional U-value can be achieved without insulation. (Note the notional floor slab U-value decreases with increasing floor slab size.)

In summary, there are a number of options which are now available which can significantly reduce the cost of the building envelope.
Large buildings

Whole building modelling using SBEM

Larger buildings generally have a low surface area: volume ratio, which reduces the area for heat loss; additionally they require a lower light output to achieve the same level of internal luminance. For these reasons, the target emissions rates (kgCO₂/m²/yr) are lower than for smaller buildings.

Enhancing the wall U-value only shows a minimal reduction in CO₂ emissions, due to the relatively low wall surface area. Enhancing the roof U-value shows a reasonable reduction in CO₂ emissions, however given the relatively large area of roof, this is unlikely to be a cost effective solution.

Enhancing the rooflight U-value again shows a significant reduction in the CO₂ emissions. Increasing the air-tightness of the building envelope yields the greatest reduction in CO₂ emissions. This is relatively straightforward for buildings of this size and it is quite reasonable to consider a target air-tightness of 2.5 m³/m²/h.

Any non-linearity in the graphs is due to actual values chosen for each parameter when classifying them as ‘good’, ‘better’ or ‘best’.

As SBEM version 5, will be the main compliance assessment tool, the designer will have to confirm his specification and building emission rate, by a building specific calculation.
Large buildings

Building envelope heat losses

The pie charts show the actual heat loss through specific elements and the relative quantity of heat escaping through them for each degree centigrade temperature differential between the internal and external conditions.

Figure 12. Large warehouse (125 m x 80 m x 6 m) 2006 notional building envelope specification

<table>
<thead>
<tr>
<th>Key</th>
<th>Specification</th>
<th>Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>U-value 0.35</td>
<td>855 W/°C</td>
</tr>
<tr>
<td>Roof</td>
<td>U-value 0.25</td>
<td>2212 W/°C</td>
</tr>
<tr>
<td>Rooflights</td>
<td>U-value 2.20</td>
<td>2655 W/°C</td>
</tr>
<tr>
<td>Air-tightness</td>
<td>10</td>
<td>6331 W/°C</td>
</tr>
<tr>
<td>Floor slab</td>
<td>U-value 0.25</td>
<td>2500 W/°C</td>
</tr>
</tbody>
</table>

14553 W/°C

Figure 13. Large warehouse (125 m x 80 m x 6 m) 2013 notional building envelope specification

<table>
<thead>
<tr>
<th>Key</th>
<th>Specification</th>
<th>Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>U-value 0.26</td>
<td>635 W/°C</td>
</tr>
<tr>
<td>Roof</td>
<td>U-value 0.18</td>
<td>1593 W/°C</td>
</tr>
<tr>
<td>Rooflights</td>
<td>U-value 1.80</td>
<td>2172 W/°C</td>
</tr>
<tr>
<td>Air-tightness</td>
<td>3</td>
<td>1583 W/°C</td>
</tr>
<tr>
<td>Floor slab</td>
<td>U-value 0.12</td>
<td>1200 W/°C</td>
</tr>
</tbody>
</table>

7183 W/°C

Figure 14. Large warehouse (125 m x 80 m x 6 m) Alternative 2013 building envelope specification

<table>
<thead>
<tr>
<th>Key</th>
<th>Specification</th>
<th>Heat Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>U-value 0.35</td>
<td>855 W/°C</td>
</tr>
<tr>
<td>Roof</td>
<td>U-value 0.20</td>
<td>1770 W/°C</td>
</tr>
<tr>
<td>Rooflights</td>
<td>U-value 1.30</td>
<td>1569 W/°C</td>
</tr>
<tr>
<td>Air-tightness</td>
<td>3</td>
<td>1583 W/°C</td>
</tr>
<tr>
<td>Floor slab</td>
<td>U-value 0.12</td>
<td>1200 W/°C</td>
</tr>
</tbody>
</table>

6977 W/°C

The typical heat losses from a 2006 notional warehouse building, show how much heat is being lost through air leakage and rooflights.

Moving from the 2006 to the 2013 notional building, it can be seen that to create the very large overall reduction in heat loss, the air-tightness aspect has been enhanced the most.

Is the 2013 notional specification the best way to comply?

Air-tightness performance on a building of this size is relatively straightforward and provided attention to detail during construction it should be relatively straightforward to achieve 3.0 m³/m²/h.

It should be noted that the floor slab is part of the envelope for air-tightness calculation purposes and this will be a larger portion of the envelope for a larger building. The relative number of interfaces and more difficult to seal junctions and penetrations will also be lower, which will again contribute to an improved performance.

In this case the floor slab notional U-value can be achieved without insulation. (Note the Notional floor slab U-value decreases with increasing floor slab size.)

In summary, air-tightness and rooflight U-value can be enhanced significantly and will make a very large contribution to reducing the CO₂ emissions. This will allow the designer more flexibility with other elements of the building envelope which can significantly reduce the cost.
Building services

Figure 15. Effect of building envelope and services on CO₂ emissions (small warehouse)

As well as modelling the effect of changes to the building envelope, the effect of varying the building lighting system and control has also been modelled.

In the notional building, lighting contributes approximately 50% of the building’s CO₂ emissions.

Using efficient lighting and automated dimming control will significantly reduce the CO₂ emissions. It can be seen that a building with the envelope set at backstop values can almost meet the TER by specifying a more efficient lighting system with automated dimming control. This may be more cost effective than building envelope enhancements.

Installation of an automatic light dimming control system, will generate significant CO₂ reductions and is essential to maximise the benefits from installation of rooflights/windows and daylighting.

Note that when dimming control is introduced, the heating load increases slightly as the lighting is not heating the building as much, this is greatly outweighed by the reduction in lighting. Heating by light is very inefficient.

Pushing envelope technology and lighting to the limit of current technical feasibility (excluding LED/OLED type lighting) indicates that a further reduction in overall CO₂ emissions, of up to ~50% beyond the 2010 standard may be feasible, however this may not be the most cost effective approach towards further CO₂ reductions.
Fuel CO₂ emission factors

The operational CO₂ emissions are all created by the building services; enhancing the specification of building envelope will reduce the requirement.

Table 25 in the 2013 edition of the NCM guide specifies the CO₂ emission factors per kilowatt hour for each different energy source. The most relevant fuels are detailed below.

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>CO₂ emission factor kgCO₂/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>0.216</td>
</tr>
<tr>
<td>Grid supplied electricity</td>
<td>0.519</td>
</tr>
<tr>
<td>Grid displaced electricity</td>
<td>0.519*</td>
</tr>
</tbody>
</table>

* This is effectively the credit which will be generated when electricity producing low or zero carbon (LZC) technologies have been included in the design and SBEM calculation.

It can be seen that electrical services will produce approximately 2 ½ times as much CO₂ emissions as gas services for the same power. For this reason, gas fired heating systems are usually specified.

This explains why in buildings such as warehouses with relatively low heating requirements, lighting is the largest cause of CO₂ emissions.

The actual emission factors have changed since pre-2009.

- CO₂ emissions from electricity have increased by approximately 25%. This is due to changes in the national grid generating power station mix and also the transmission losses have been recalculated and revised upwards.

- There has been minimal change in the gas factors.

When installing electricity generating renewables, the slightly higher ‘grid displaced electricity’ factor can be claimed. This gives a slight further incentive to install electricity generating renewables as part of an overall CO₂ compliance strategy.
Low and zero carbon energy

There are many low and zero carbon (LZC) technologies now available for incorporation into the building including photovoltaics, hot water from solar thermal panels, heating from transpired solar collectors, heating and cooling via heat pumps and various fuels derived from biomass. As CO₂ emission targets are reduced through further revision to Part L, it will become increasingly difficult to meet these targets without incorporating some form of renewable energy.

Two of these technologies which are most suitable for integration with the building envelope and recognised within SBEM are photovoltaic systems and active solar air heating.

Active solar air heating

Active solar air heating systems such as the transpired solar collector (TSC) is a globally proven system that uses the sun’s energy to pre heat air prior to it being drawn into the building.

The TSC is installed as an additional skin on a southerly elevation of the building.

How it works

- Solar radiation is absorbed by the collector, which in turn warms its surface.
- The heat from the conductor is transferred to the boundary layer of air.
- The heated boundary layer of air is then drawn through the perforated collector by a fan unit, into the specifically engineered cavity in the wall construction.
- From the air cavity, the heated fresh air can then be delivered directly into the building or as preheated air to the building’s main heating plant.

The additional skin has thousands of tiny perforations, uniformly spaced across the full face of the collector.

Colorcoat Prisma® by Tata Steel is the material of choice for the outer skin.
The SBEM interface has a section under building services where the exact details of the transpired solar collector can be specified. It should also be noted that the distribution ducting will also provide a means of destratification in the building and can reduce heat losses through the roof and rooflight elements.

The energy produced is heat and so usually will offset gas heating, which has a relatively low CO₂ emission factor.

Independent studies of a typical transpired solar collector have shown that these reductions in gas usage for heating and associated CO₂ can be up to 50%.

The installed systems would be expected to pay back the additional costs within three to eight years dependant upon the installation and are virtually maintenance free. The TSC can easily be integrated with other heating systems.

Transpired solar collectors are relatively low cost and provide a simple heating source, which as well as providing CO₂ reduction for Part L compliance, can also meet the Merton rule requirements.

Modelled annual building heat demand and renewable energy delivered by Colorcoat Renew SC® for a large distribution shed.

Colorcoat Renew SC® is the solar air heating offering from Tata Steel. The system is up to 75% efficient in converting solar energy to usable heat energy, with 1 m² of collector area delivering approx 250 kWh/year.

The system can typically supply 30-40% of daytime heating demand during the heating season, and provides up to 50% saving on annual heating bills.
Photovoltaic panels

Photovoltaic panels (PVs) convert energy from the sun directly into electricity. This can then be credited as 'grid displaced electricity'. The SBEM interface has a specific section under building services, where the exact details of the photovoltaic system can be specified.

Photovoltaic modules come in a number of different forms. Lightweight laminates and modules are most suitable for pre-finished steel buildings as these will impose the lowest additional loads on the building structure. In all cases these additional loads must be calculated to ensure that no additional reinforcement is required.

Crystalline PVs are generally heavier. They have a much higher output per unit area than lightweight laminate systems, however provided overall roof area is not the restricting factor, the lightweight laminates allow the additional weight to be spread over a larger area.

Photovoltaic systems are generally very capital intensive and would not have been viable purely as a means of carbon emission reductions. Following the introduction in April 2010 of the Feed in Tariffs (FIT); PV systems can be a long term cost effective solution.

It should be noted that while the FITs have been heavily reduced, the cost of installed PV has also reduced by a similar factor. This means that a PV array can typically pay back in less than 10 years.

Products which are listed in the Micro-generation Certification Scheme (MCS) must be used to be eligible for the feed in tariff unless the installation is over a threshold size.

There is generally a good public perception of the benefits of PVs, so their installation can also boost the environmental image of the building owner or occupier. They can also contribute to improved BREEAM rating and lower EPC rating, with improved neutral values.

Photovoltaic systems which are MCS approved, may provide a cost effective solution to reducing CO2 emissions, once the feed in tariffs have been taken into account.

For Colorcoat HPS200 Ultra® with the Confidex® Guarantee, Tata Steel allows the material under ‘clip and fix’ PV modules to be included within the Confidex® Guarantee for the current duration matrix of up to 40 years.

This is the market-leading guarantee for use of pre-finished steel with PV and is available due to the extensive testing undertaken with Colorcoat HPS200 Ultra®.

For more information visit www.colorcoat-online.com/confidex or call our Colorcoat Connection® helpline on +44 (0) 1244 892434.
Conclusions

Cladding systems general

1. The 2013 revision of Part L2A requires an average 9% reduction in CO2 emissions from 2006. This is referred to as the ‘Aggregate’ approach.

2. The target emission rate is set by a new 2013 notional building specification. There is no reference back to the previous revision’s building performance.

3. The 2013 notional building specification provides a good starting point for the actual building specification, however it will not necessarily be the most cost effective solution.

4. For all buildings, improving the air-tightness, is the most cost effective approach to reducing building heat losses. Heat losses on industrial/commercial buildings can be reduced by approximately 10% by improving air-tightness. All Tata Steel supply chain partners provide guidance and systems to maximise this saving.

5. Increasing roof and wall fabric insulation beyond the Part L backstop values shows only limited reduction in building CO2 emissions, and can significantly increase the envelope and building cost. Increased fabric insulation may be required for smaller buildings.

6. Small buildings have only limited scope for modification of the building envelope specification, to achieve the same performance as a 2013 notional building specification at the lowest cost. Specifying higher performance rooflights will allow some relaxation of the roof or wall U-values.

7. For medium buildings, specifying higher performance rooflights will allow some relaxation of the roof or wall U-values. Dependent upon the building, it may also be possible to achieve an air-tightness lower than 5 m3/m2/h.

8. For large buildings the most cost effective way to meet regulations is to allow the relaxation of U-values. Enhancing rooflights and air-tightness can provide most of the building envelope thermal improvements required to achieve 2010 compliance.

9. Installation of efficient lighting and an automated dimming control system will produce very significant reductions in CO2 emissions and will be more cost effective than building envelope enhancements.

10. A rooflight area of approximately 10–12% is the optimum for Part L2A compliance through SBEM. This provides a balance between installed cost, natural lighting gains, useful solar heat gains and heat losses. It also minimises the risk of excessive solar gains and overheating.

11. The use of well designed and accurately modelled building details will significantly reduce building envelope heat losses and CO2 emissions.

12. Use of generic building details and the associated 50% penalty can increase the building CO2 emissions by as much as 10%, which will make Part L compliance much more difficult.

13. Any deviation in the design and installation of a building detail would invalidate the modelled thermal performance, meaning that only the generic detail performance and associated 50% penalty can be claimed. The use of recommended system installers will contribute to ensuring that the building details are installed as they were designed and assessed.

14. Low or zero carbon (LZC) technologies can be easily integrated building envelopes with using Colorcoat® pre-finished steel. These systems are included in the SBEM calculation database. It is likely that the use of renewable energy technology will increase with future revisions of Part L.

Colorcoat® Supply Chain Partners

1. All Tata Steel supply chain partners supply roof and wall cladding systems, which meet the Part L2A ‘2013 notional building’ specification for new build.

2. All Tata Steel supply chain partners can provide guidance on the design and specification of the building envelope, to provide a more cost effective solution than the 2013 notional building specification for Part L compliance.

3. All Tata Steel supply chain partners provide building details designed and modelled to reduce the associated heat losses from the building. The use of these details will provide a performance, significantly better than the industry standard. A building designed and built using these high performance details will have a CO2 emission rate within % of one using fully accredited details.

For more information on our supply chain partners visit www.colorcoat-online.com

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Our expertise and knowledge on Part L extends to the following CPD Seminar:

**Part L 2013: The role of the building envelope in compliance for buildings other than dwellings**

To request this or any of our CPDs from one of our dedicated specification team please call our Colorcoat Connection® helpline on +44 (0) 1244 892434 or visit www.colorcoat-online.com/cpd
The Colorcoat® brand

The Colorcoat® brand provides the recognised mark of quality and metal envelope expertise exclusively from Tata Steel. For 50 years Tata Steel has developed a range of technically leading Colorcoat® pre-finished steel products which have been comprehensively tested and are manufactured to the highest quality standards. These are supported by a range of services such as comprehensive guarantees, colour consistency and technical support and guidance.

Colorcoat® products are manufactured in the UK and are certified to independently verified international management system, ISO 14001 and are fully recyclable, unlike most other construction products.

Colorcoat® products and services

Colorcoat® products offer the ultimate in durability and guaranteed performance reducing building life cycle costs and environmental impact.

We have detailed Life Cycle Costing and Life Cycle Assessment information that demonstrates the positive performance of Colorcoat® products when compared with other alternatives. This is available from www.colorcoat-online.com

**Colorcoat® BES 6001 approved**

Colorcoat® pre-finished steel products manufactured in the UK are certified to BES 6001 Responsible Sourcing standard, the first steel envelope products in the world to achieve this.

**Colorcoat HPS200 Ultra®**

Colorcoat HPS200 Ultra® pre-finished steel combines outstanding performance with exceptional durability and comes with the Confidex® Guarantee for up to 40 years for the weatherside of industrial and commercial buildings with no inspection or maintenance to maintain its validity.

**Colorcoat Prisma®**

Designed to withstand the rigours of the external environment, versatile, lightweight and strong, Colorcoat Prisma® pre-finished steel is the ideal choice for your building envelope for contemporary, long lasting colour.

Whatever your type of building from warehouses to offices, or schools to houses, Colorcoat Prisma® offers you a range of attributes that enables you to create beautiful, modern and durable roofs and walls, Confidex® guaranteed for up to 30 years.

**Confidex® Guarantee**

Offers the most comprehensive guarantee for pre-finished steel products in Europe and provides peace of mind for up to 40 years. Upon registration. Unlike other guarantees, Confidex® covers cut edges for the entirety of the guarantee period with no inspection or maintenance to maintain its validity. Available only with Colorcoat HPS200 Ultra® and Colorcoat Prisma®.

The Confidex® Guarantee includes cover for Colorcoat HPS200 Ultra® under photovoltaic (PV) modules for the full guarantee period. PV modules can be installed at any time during the Confidex® Guaranteed Period and the pre-finished steel will be covered for the remainder of the guarantee period.

For further information on Colorcoat® products and services please contact the Colorcoat Connection® helpline on +44 (0)1244 892434 or email colorcoat.connection@tatasteel.com Alternatively visit www.colorcoat-online.com

![Certifications and Awards](image-url)
Colorcoat® Technical Support Team

Colorcoat® products are supported by a comprehensive range of services, technical advice and guidance. Our knowledge and expertise of the complete range of building envelope systems available with Colorcoat® products, means that the advice and support that we can offer you is truly objective.

We can help you to achieve the best technical solution for your building with the optimum in performance and environmental credentials. If you are building to specific sustainability credentials or performance criteria, we can work with you at the design phase of your project to help you integrate these requirements and deliver technically superior buildings that match your vision.

Whether you require information on the latest building regulations, calculations for a specific project or advice on integrating renewable technologies you can contact the Colorcoat Connection® helpline on +44 (0) 1244 892434 to request a visit from your regional representative for impartial advice and support on a broad range of topics including:

- Specification support.
- CDM Regulations.
- Building Regulations.
- Energy Efficiency, savings and paybacks.
- Building integrated renewable technologies.
- Responsible sourcing to BES 6001.
- System suitability, durability and guarantees for project specific applications.
- Environmental Product Declarations.
- Structural implications.
- Health and Safety.
- Fire performance.
- Acoustics.
- Sustainability assessment tools such as BREEAM.

Colorcoat Connection® helpline

This dedicated helpline offers immediate and easily accessible advice and guidance on a wide range of construction industry issues. Contact us on +44 (0) 1244 892434 or email colorcoat.connection@tatasteel.com