Hambleside Danelaw
Rooflights

TECHNICAL MANUAL

Solar Transmission

ZENON

LOW CARBON DAYLIGHT SOLUTIONS

ISSUE 2

Solar transmission

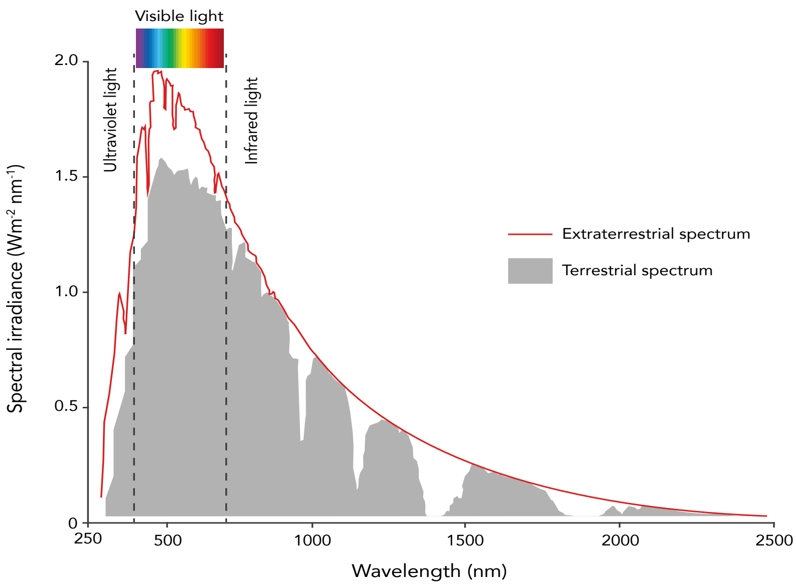
The energy from our sun is vital to life on Earth, therefore it is quite natural that we should want to harness that energy through solar thermal or photovoltaic systems. They allow us to tap in to an unlimited source of light, heat and power and they play a key role in the protection and preservation of the Earth's resources.

On an even more fundamental level, significant financial and environmental benefit can be gained from providing buildings that can maximise this freely available light and heat energy.

Solar Energy

The spectrum of solar energy at the Earth's surface is mostly spread across the visible and near-infrared ranges, with a small part in the near-ultraviolet wavelengths. Only half of the energy transmitted from the sun is in the visible light wavelengths.

With most glass and glazing systems, the heat energy that is transmitted very closely correlates with the visible light spectrum. This means that it is impossible to have rooflights and roof windows that have high levels of light transmission and low levels of solar energy transmission; the two are directly linked.



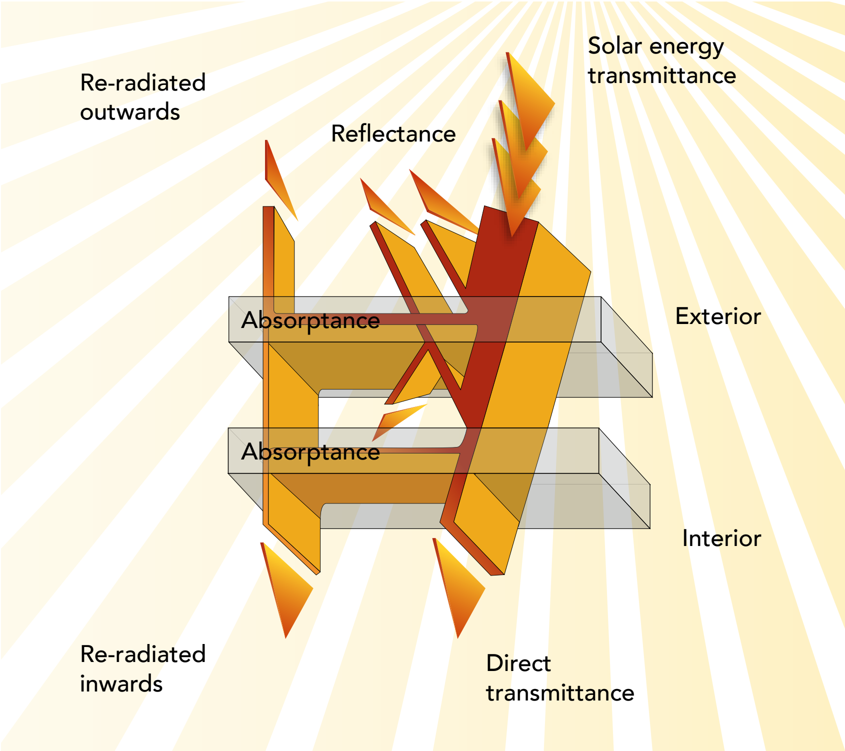
Solar spectrum

SOLAR GAIN [g-value]

Total solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

There are products available that incorporate or contain metallised films or metallic particles. The aim of such products is to prevent excessive heat gains by reducing the solar energy transmitted into a building, but it must be noted that they also reduce the light transmission proportionately.

The transmission characteristics of plastics such as polycarbonate and polyesters, as used in glass reinforced polyester (GRP) products, tend to allow more heat energy through the material in the near infrared regions. However when polyesters are combined with glass in GRP for rooflight sheets, the glass reinforcement tends to reduce this infrared element in proportion to the glass content of the material.



Solar Gain

Some light and heat energy passes directly through transparent and translucent materials, but there will always be a part of this energy that is reflected from the surface, known as reflectance, and a part that is absorbed by the material, known as 'absorptance'.

The energy that is absorbed by the material is converted to heat and re-radiated both internally and externally. The greater the mass of the rooflight assembly or material generally, the greater is the capacity for heat build-up and re-radiation. This is referred to as the 'secondary' component in solar heat gain.

The combination of the directly transmitted heat energy and the re-radiated secondary component is referred to as the total solar transmittance, or 'g-value'.

The primary reason for including rooflights into a building is to allow the entry of natural daylight and to take advantage of all of the benefits associated with it. It is also worth considering that a well-designed building with a good spread of natural daylight will also benefit from passive solar gain that can reduce the demand for space heating for many months of the year.

Internal Heat Gains

Whilst solar gain is mostly a very positive benefit, in the hottest few weeks of the year the heating effects from solar transmission can combine with the internal heat gains of a building to cause over-heating. This can lead to a requirement for cooling loads, increasing the energy demand of the building.

The internal heat gains of the building can come from a variety of sources, from occupation by people or animals, artificial lighting, computers and other electrical appliances and many other processes or operations that occur within a building. Conversely, the internal gains of a warehouse with minimal occupancy and no industrial processes will be very slight when compared to a high occupancy manufacturing building.

The intended use of the building always needs to be taken into consideration at the planning stage of the design process.

Where the processes occurring inside the building are generating high levels of heat, the additional heating effect from the sun's energy through rooflights becomes relatively insignificant. Under these circumstances, the benefits of maximising daylight can be overwhelming.

In large industrial shed buildings with minimal internal partitioning and high roofs or ceilings, there will be some degree of 'stratification' where the air temperatures at the occupied floor level may be significantly cooler that the unoccupied space overhead. Put simply, heat rises and accumulates overhead.

Lightweight metal clad buildings can have a higher tendency to overheating when compared to buildings of traditional masonry construction with a greater thermal mass, but in most cases a considered strategy for controlled ventilation can be more than sufficient to balance the internal temperature. Uncontrolled ventilation methods, such as opening doors, can be counter-productive in situations where they are left open for extended periods and too much heat is lost.

Uncontrolled ventilation can result in higher energy demands

Design Considerations

Part L of the Building Regulations defines measures to minimise or avoid excessive heat build-up in buildings, placing limits on both window and rooflight areas. Approved Document L2A recognises that the internal height of the building and the distance of the rooflights above the work or occupied areas does influence the effects of solar gain and suggests maximum rooflight areas for reference glazing systems in conjunction with frame factors and g-values for the proposed rooflights as follows:

Zone height	g-value	Frame factor	Max rooflight area	Factor equivalent
< 6m	0.68	25%	10%	0.0510
> 6m	0.46	15%	20%	0.0782

Provisional limits in accordance with ADL2A, Criterion 3, paragraph 2.53

The solar load through rooflights is calculated by: rooflight area x g-value x frame factor.

Typical Industrial Rooflight Area Calculation:
Rooflight g-value = 0.55, frame factor 12%, 7m high

0.55 x (1 -12%) x rooflight area = 0.0782

$$\text{therefore } \frac{0.0782}{0.55 \times 0.88} \times 100 = 16.2\% \text{ rooflight area}$$

These recommended rooflight areas are calculated making certain assumptions on a limited range of light, thermal and solar transmission values for rooflights, whereas the designer has the freedom to specify a wider variation of product to meet the specific needs of the building. It is therefore recommended that the designer uses the data provided from the manufacturer, obtained through responsible independent physical testing.

The design of the building and provision of rooflights has to balance several factors, in particular the perceived conflict between providing daylight and the associated energy savings together with the risk of overheating.

When using SBEM (Simplified Building Energy Model), rooflight areas of around 17-20% for buildings over 6m tall and 10-15% for lower buildings usually meet the criteria to avoid excessive solar load.

Reducing solar gain and the risk of overheating would normally only be considered where people might be occupying or working in a certain part of the building for a substantial part of the day. It is not a requirement for areas not expected to be occupied for any duration such as circulation spaces, store rooms, toilets etc.

Due to stratification in high or double-height industrial buildings, and accumulated dirt on rooflights combined with internal absorption, the impact of solar gain in occupied space is often reduced, justifying an increase in rooflight area above the limits suggested by ADL2A. The provision of adequate ventilation would allow a further increase in rooflight area.

The design, therefore, should take account of the building use and occupation, and may demand a little more attention to the provision of adequate and controllable ventilation. Reliable data on internal gains for typical warehouse buildings is difficult to obtain, but a figure of $5W/m^2$ is widely accepted. This value is entirely attributable to artificial lighting.

Occupancy is generally very low in storage warehouses and the gains from human activity can be considered negligible.

In a typical large building retail store, the internal gains resulting from occupants can be in the region of $4W/m^2$, but these retail spaces are usually very well lit, irrespective of available daylight; internal gains due to lighting can be of the order 15 to $20W/m^2$ [CIBSE, 1999].

For a well daylit building, the periods of greatest solar gain will coincide with the highest levels of daylight illuminance. By combining the use of fully automated lighting controls – dimmer systems – with natural daylight, the internal gains due to artificial lighting can be greatly reduced, if not eliminated altogether.

Where there are processes occurring in a building that result in high internal heat gains, the best approach is often considered to be localised ventilation or extraction to prevent overheating.

SBEM is a tool widely used to demonstrate compliance to Part L of the Building Regulations. It is, however, a relatively simplified tool and other, more sophisticated, forms of building modelling software can produce different and potentially more realistic results.

Buildings in use

Many users and operators of buildings with higher rooflight areas than those recommended in Part L report that overheating is never or rarely an issue. 20% rooflight to floor area is becoming more and more commonplace, yet this is generally considered too great on the grounds of solar gain in accordance with the aforementioned criteria.

Aside from adequate ventilation being provided, one possible explanation for this is lack of maintenance. Some rooflights are rarely - or never - cleaned after installation, other than by rainfall. This could be leading to a persistent reduction of light and solar transmission throughout the year.

In the winter months, partial cleansing of the rooflights by more persistent and heavier precipitation is more likely than during the warmest part of the year, where it is known that particulates suspended in the atmosphere tend to increase with rises in temperature and subsequently become deposited on the rooflights.

Frame factor

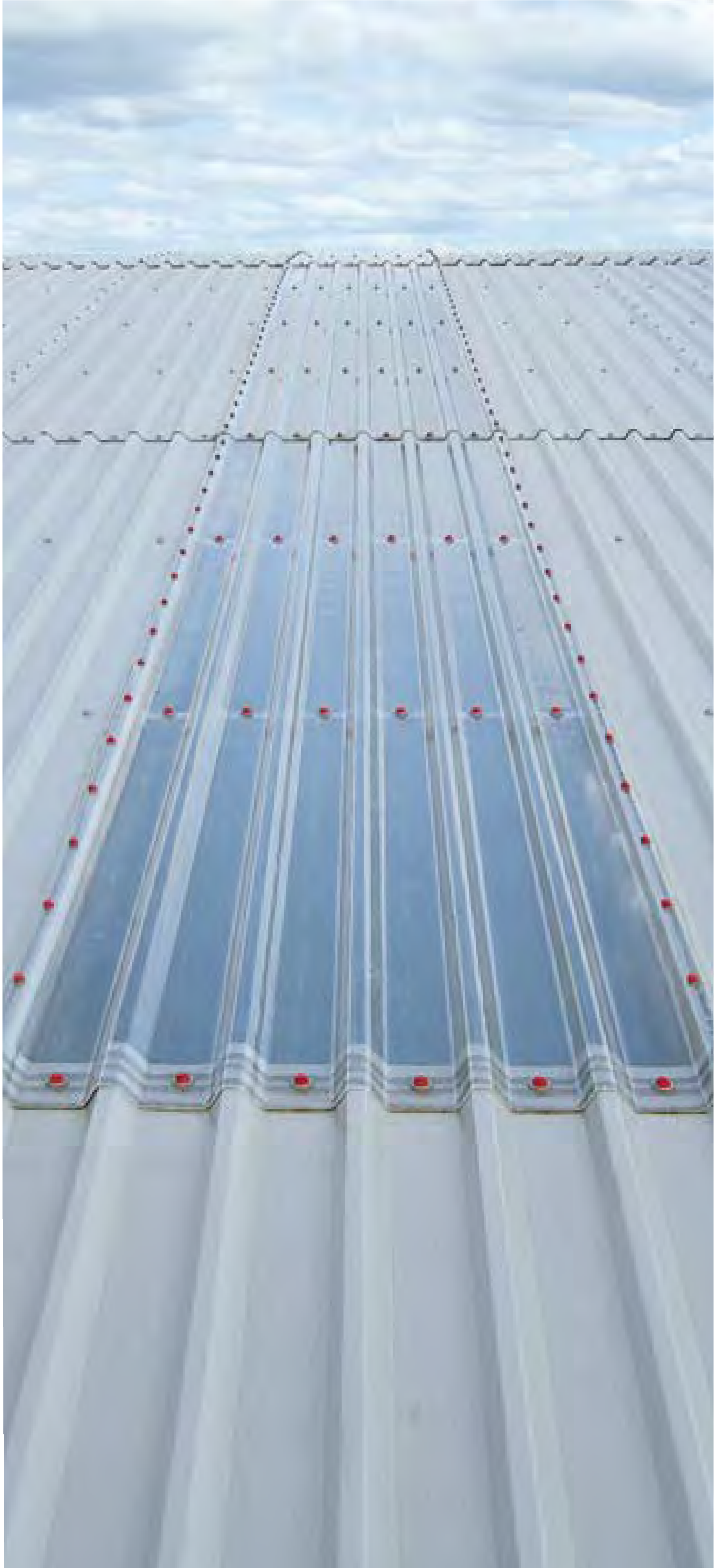
The frame factor required for rooflight design consideration is the ratio or percentage area of the rooflight that is not transmitting light due to other construction components in the assembly.

For in-plane rooflights that are effectively frameless, the reduction due to framing is created by side and end laps, with the surrounding cladding system and the supporting purlins, bracket systems and filler blocks. This will vary depending upon the roof structure and rooflight configuration.

For out-of-plane rooflights, the frame factor should be determined by any support systems or glazing bars etc., or an effective reduction in area due to splayed or sloping support kerbs.

Shading coefficient (SC)

The total shading coefficient of a window or rooflight is sometimes required by the designer. It is a simple comparison ratio of the total solar energy transmission of that window or rooflight when compared with a single layer of clear float glass, approximately 3mm in thickness, allowing a total energy transmittance of 0.87 or 87%.



Zenon Evolution

Zenon, a comprehensive range of low carbon rooflights for the metal building envelope from Hambleside Danelaw

Hambleside Danelaw Rooflights

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