Skylights

Skylights can make a major contribution to energy efficiency and comfort in new and retrofit low-rise buildings. Daylight is an excellent source of 'cool light' and the 'right size' of skylight admits just enough light and no more. The many available kinds of skylight can use the same energy-efficient technologies used in other window designs.

Skylights can be installed in existing and new homes. Daylight provides 'cool light', meaning that a given amount of light is accompanied by less heat gain most types of artificial light. Skylights provide some of the best ways to admit daylight and distribute it evenly, saving energy and improving visual comfort levels. Skylights increase the amenity of internal spaces that might otherwise have no windows and allow additional flexibility in architectural design. They particularly suit one- and two-storey construction.

A skylight can admit over three times as much light as a vertical window of the same size.

DESIGN PRINCIPLES

A variety of skylight shapes exist for sloping or flat roofs. Some skylight shafts exert nearly as much influence over the energy properties as the actual skylight itself. Skylighting may take the form of general glazed areas such as atria, attached conservatories or sunspaces. In this form rooflights are less likely to be factory-manufactured items and more likely to be constructed on-site.

Excellent daylighting is provided by skylights which have the potential to displace much artificial lighting, improving light quality, reducing heat generation and saving on energy costs.

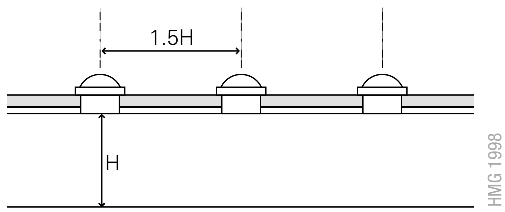
Under an unobstructed, overcast sky the amount of light, or luminance, from directly above (the zenith) is about three times as much as from the horizon.

A skylight can admit over three times as much light as a vertical window of the same size. While this performance differential may be reduced in reality (e.g. by a long shaft), in most situations a skylight has the potential to be a very effective daylighting device. Even under overcast conditions use of skylights can result in spaces that can be predominantly daylit with little supplementary artificial lighting required. Additional energy needed for space heating and cooling because of thermal movement through larger window areas will be minimised.

The 'right size' of skylight admits just enough light for the job and no more. Several methods exist for helping to decide on the size and spacing of skylights.

WERS for Skylights provides an energy rating system. The scheme takes account of key differences between the energy performance of windows and skylights and the differing responses of houses to these building elements.

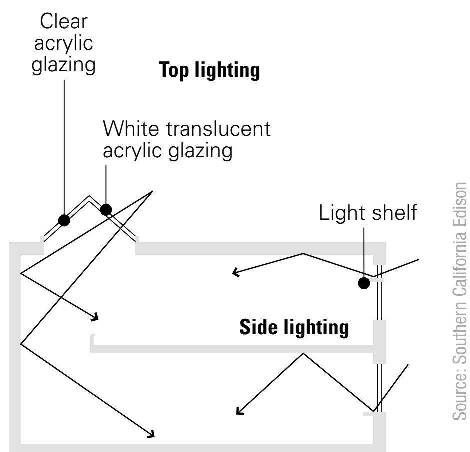
The smaller the skylight, the less its associated solar heat gain and the less its conduction gains and losses. [See: How to use WERS]



Rule of thumb for spacing skylights to help achieve uniform illuminance. (HMG 1998)

Skylight spacing is critical in large spaces. Excellent guidance is provided in several publications. The illustration above shows a rule of thumb example for skylight spacing that promotes even light distribution.

The principles of delivering daylight differ between windows and skylights.
Top lighting increases the potential for uniform light distribution.



Top versus side lighting (Energy Design Resources 1999).

SOLAR CONTROL

Provide additional shading or other solar control where necessary. Skylights are more vulnerable to direct sunlight when the sky is clear, rather than overcast.

Energy-efficient technologies used for window design may be applied to skylights. Spectrally selective glazing is discussed elsewhere in Your Home. [See: Glazing Overview]

Glazing can be designed to block or facilitate light transfer according to sun angles. For example, in summer direct sunlight from above may be rejected while light from nearer the horizon may be admitted. Skylight manufacturers may further reduce their products' solar heat gain coefficient (SHGC) and increase thermal insulation (by reducing the U-value) through the use of shafts, tubes, ceiling diffusers and supplementary blinds or integral shades. These may assist in meeting codes and standards requirements.

In temperate Australia the main limit on skylight size comes from the need to limit unwanted solar heat gain. Skylights should be selected to prevent undue heat loss or heat gain by conduction. The thermal transmittance of sloped glazing is greater (typically by 40%) than that of vertical glazing because the heat loss in winter is in the same direction (up) as the buoyancy effect that drives convection. The energy burden imposed by a skylight on a house is rarely more than a few percent of the total energy required for heating and cooling because they are usually only a few percent of the floor area, compared with 20 – 30% for typical windows.

Some inbuilt solar control is desirable in warmer climates, such as solar-control glazing or blinds.

Skylights come in many combinations of shape, size, glazing, frame and installation details. Skylights can use diffuse (opal) glazing in glass or acrylic to achieve the twin goals of even light distribution and solar control. Diffusely transmitting glazing has a back-scattering effect on incoming solar radiation. This reduces overall visible transmittance slightly but reduces the solar heat load on the space below. At the same time, diffuse transmission scatters light over a wide range of angles. This promotes soft, glare-free lighting.

SKYLIGHT TYPES

Roof windows are popular for attic rooms where there is a cathedral ceiling but no roof space. Almost all roof windows use sealed, double insulating glass (IG) units to reduce heat losses while at the same time minimising condensation. Some are openable which is highly recommended in summer conditions, especially in two-storey houses where heat would otherwise tend to concentrate on the upper level.

Double-glazing also allows the use of spectrally selective low-e coatings that reduce solar transmission. The use of a sealed IG allows the option of argon gas in the gap instead of air, which reduces the heat conducted and convected across the space.

Some double-glazed units are permanently ventilated to avoid fogging but this may contribute to draughts and heat loss, so they should be used with caution in heating climates.

Roof window frames are typically timber with external, weatherproof aluminium cladding, but may be aluminium or steel. In cool and alpine climates, uninsulated metal frames are not recommended because of the condensation they create.

Roof windows, whether operable or not, are sometimes combined with a shafts in homes that have flat ceilings. Ceiling-level diffusers are rarely used with roof windows.

Plastic dome skylights are typically single-glazed 'opal' (i.e. diffuse) moulded units. Specular top glazing may also be employed, either in clear or tinted plastic. Plastic dome skylights typically have long shafts and a diffuser panel fitted at ceiling level.

Tubular skylights reduce absolute heat loss and heat gain because of their small cross-sectional area. Sometimes called tubular daylighting devices (TDDs), their daylighting effect relies on their ability to 'capture' direct-beam sunlight and diffuse it at ceiling level around the room.

They work best in climates with a high incidence of clear, sunny days. On cloudy days the amount of daylight admitted is considerably less than for a large-area, conventional skylight.

A reflecting tube is used to direct sunlight downward. Best results are achieved by a straight tube with a silvered lining. Flexible tubes are effective provided their internal reflectance is high. Tubes should have a visible reflectance of 95% or greater (AS 4285-1995). Silver provides better colour rendition than aluminium as it is a more uniform reflector of the spectrum. Aluminium gives a slightly 'bluer' quality to the light. Diffusers should be fitted to tubular skylights to reduce glare and throw the light over a broad area.

EFFECT OF SKYLIGHT SHAFT ON LIGHT AND HEAT GAIN

Major advances have occurred in the last few years in our understanding of the effect of shafts and reflective tubes on the performance of skylights. The shape and dimensions of the shaft affect both the light transmission and actual solar heat gain obtained from the skylight.

Tests show three quantities tend to be less than predicted from a skylight's theoretical properties. These are:

> the effective Solar Heat Gain Coefficient;

> the overall solar heat gain in watts and

> the useful light that emerges from the bottom of the shaft or tube.

Some incident solar energy is absorbed by the sides of a shaft or tube. Shafts with matt white painted walls scatter some of the incoming solar radiation in all directions, a portion of which is lost to the outside. The fewer reflections experienced by incoming rays and the higher the reflectance of the sides of the shaft, the greater the transfer of light to the room below. The greatest throughput of light occurs in the case of specular tubes in TDDs.

Thermal energy is lost to the outside through the skylight glazing and frame at night. Further heat is lost through the tube or shaft walls, to the attic or roof space. During the day buoyant solar-heated air becomes trapped in the shaft (or tube) and there is almost no downward heat transfer.

The longer the shaft or tube, the less light transmitted by the skylight system. Solar heat admitted by the skylight is also less. A skylight with poorly performing top glazing may be improved thermally by using a long shaft, provided adequate overall light transmission is maintained.

MAKING THE MOST OF LOCAL SKY CONDITIONS

Effective delivery of daylight depends on many factors including:

> the sun's altitude and azimuth;

> the relative occurrence of overcast versus sunny weather;

> the season;

> levels of air pollution and haze.

In Australia it is possible to predict average sky conditions, including relative amounts of clear and overcast sky, for most populated locations as our cities are less afflicted by heavy air pollution than many overseas locations - except on isolated occasions such as during severe bushfires or dust storms.

Locations with a high incidence of cloudy skies are better served by roof windows or conventional skylights with large areas and diffuse glazing systems. In sunny locations tubular skylights deliver very high illumination levels when the sky is clear.

MAINTENANCE AND LONG-TERM PERFORMANCE

Maintenance should ensure that the external (roof) and visible internal (ceiling level) surfaces are cleaned regularly, especially if exposed to a harsh environment. In a harsh environment, skylight exteriors should be cleaned at six-monthly intervals. In benign settings, once every 24 months is adequate. Operable and ventilating skylights (e.g. openable roof windows and combined skylight/roof ventilators) may require occasional lubrication of moving hardware.

Leaf debris should not be allowed to pile up on skylight materials since rainwater leaches decomposed chemicals out of the leaf litter and causes severe staining.

Skylights are made from a variety of materials including plastics (ABS, acrylic, polycarbonate and others), glass, aluminium (plain & powder-coated), steel (in galvanised, Zincalume® and Colorbond® finishes) and stainless steel. Generally these materials have a long life.

Roof windows often use timber frames but have an exterior, powder-coated aluminium cladding to provide a weather-resistant surface. Mill-finish aluminium is very susceptible to corrosion from salt in outdoor coastal environments.

Some plastics were prone to craze, become yellow or brittle with age and cumulative UV exposure. Modern plastics are far less susceptible to such degradation.

All metals, plastic and glass can be cleaned with warm water and a mild detergent using a sponge or soft brush. Detergent residues should be washed off with clean water. Abrasive products and dry brushing should not be used.

Designers and specifiers should keep maintenance requirements in mind especially if the project is highly dependent on consistent and long-term skylight performance.

ADDITIONAL KEY REFERENCES
Skylighting Guidelines, HMG - Heschong Mahone Group 1998. Available from www.energydesignresources.com/resource/140
Lighting Guide LG10 Daylighting and window design, Chartered Institution of Building Services Engineers (U.K.) 1999. Available from www.cibse.org.

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