GUIDE TO DAYLIGHTING AND EN 17037

VELUX®
Commercial

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EXECUTIVE SUMMARY

A new European Standard for daylighting in buildings is helping change the focus of building design, and the role of glazing in those designs, to improve occupant comfort and overall energy efficiency. The need to provide glazed openings and well distributed daylight to interior spaces, while reducing artificial lighting use, must be considered with the balance between heat loss and solar gains.

EN 17037 covers four areas of daylighting: daylight provision, assessment of the view out of windows, access to sunlight, and the prevention of glare. Although written for new buildings, its provisions can also be applied to works to existing buildings.

Used in combination with facade (vertical) glazing, roof glazing offers greater access to unobstructed sky and sunlight, and brings daylight deeper into a building. Modular skylights provide a flexible design solution to achieve good daylighting while also contributing to the building's energy balance and ventilation strategy.

INTRODUCTION

'Daylighting' is the name given to the controlled use of natural light in and around buildings. It is the deliberate positioning of glazed elements, including windows, roof glazing and skylights, within the building design to provide the best quality of daylight, as well as quantity.

We all understand the importance of light in terms of being able to see, and being able to use buildings and spaces for what they are intended. We also understand that artificial light - however well designed it is - is less able to meet these needs than natural daylight. When we allow natural light to enter our buildings, we are also maintaining a view out and a connection with our wider environment - something that artificial light cannot do.

Light impacts our mood as well; a concept that is not easy to measure through mathematics and physics. The proliferation of technology, and the amount of time we spend staring at screens, is beginning to raise awareness of the types of light we expose ourselves to and the effect it has on sleep and the body's natural rhythms.

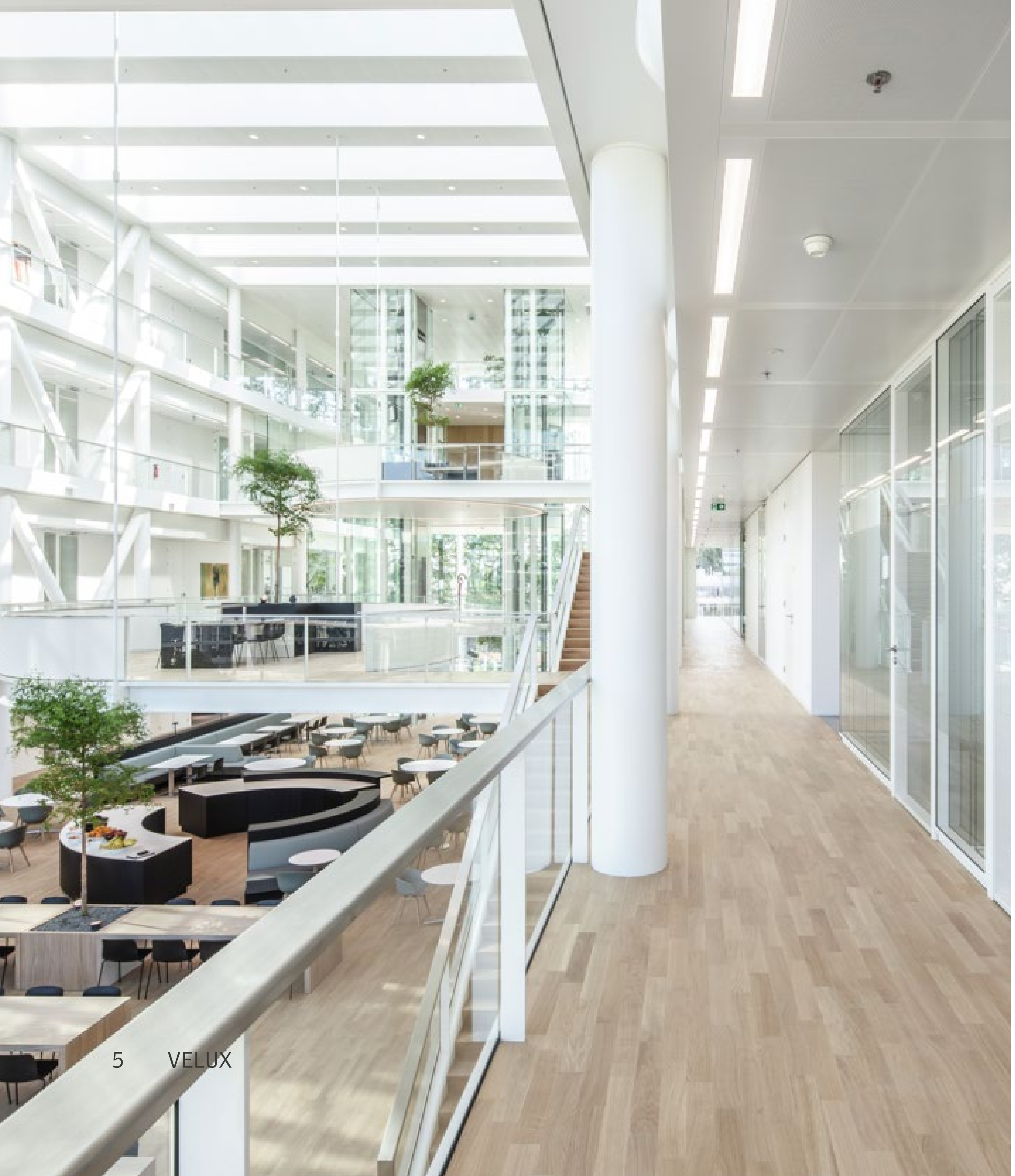
We need that same increased awareness when it comes to buildings. We need to control the light entering windows - through appropriate shading and orientation - so we don't create spaces that are too bright.

We know we crave a connection with the outside; we know we want well-lit spaces. If, at face value, we have those things then we rarely pay attention to exactly how they've been achieved. If we find ourselves in a room with south-facing glazing, and the room is overheating or we are exposed to glare from windows, do we question whether the building could have been designed to avoid it?

The good news is, something can be done about it - and there is now an agreed approach for measuring our efforts. The end of 2018 saw the publication of the first coordinated European Standard, EN 17037, to help building designers achieve appropriate levels of daylight in any type of building.

This white paper introduces EN 17037, gives an overview of its content and the four different aspects of daylighting design it covers, and looks at how VELUX Modular Skylights can be used to help achieve its recommendations.

Beyond the provision of daylight for people to be comfortable and able to undertake tasks, there is also the balance between energy use and daylight provision to think about. Also explored in this document is how increased heat loss and energy use through glazed elements can be offset by solar gains, and less reliance on artificial lighting when daylight is well distributed throughout the space



EN 17037 - WHAT IS IT AND WHY DOES IT MATTER?

It is an oft-quoted statistic that the average person spends around 90% of their time indoors - around 22 hours of the 24 hour day. Even leaving aside questions of indoor air quality (IAQ) and whether our buildings are sufficiently ventilated, most of us would benefit from spending more time outdoors generally.

We can all pinpoint reasons why decreasing that average is easier said than done, of course. Work and family pressures, the weather, and the level of access we enjoy to high quality outdoor spaces - any or all of these can mean we unintentionally spend more time inside buildings than outside them.

Designing buildings to provide healthy, comfortable living and working spaces is more critical than ever. The provision of daylight is one such area where design can be improved. Offering building users improved comfort through the benefits of daylight, and a connection to outside, required a dedicated code of practice.

What is EN 17037?

Published at the end of 2018, after a decade or so of discussion and writing, EN 17037 is the first Europe-wide standard to deal exclusively with the design for, and provision of, daylight in buildings.

It replaces a patchwork of standards across different European countries, or provides one where no standard previously existed.

The UK had BS 8206-2:2008, the code of practice for daylighting, giving recommendations for daylight design in buildings - including electric lighting design when used in conjunction with daylight. By contrast, EN 17037 deals exclusively with daylight. It includes methods of calculation for design parameters that do not feature in BS 8206-2.

Some existing European Standards include daylight as a factor - for example, EN 12464-1 and EN 15193. However, both of these also look at it in the context of electric lighting provision, and so EN 17037 is truly unique in focusing on the quantity and quality of daylight for building users.

The exact date of adoption for EN 17037 depends on when it is incorporated into national standard frameworks. Standards bodies in each country must produce a national annex (NA), detailing local information that helps with applying the recommendations of the standard in the specific country.

In the UK, the full BS EN 17037 is expected to become effective by the end of 2019, and any conflicting national standard has to be withdrawn by mid-2019 - this is expected to include those parts of BS 8206-2 that conflict with EN 17037.

What aspects of daylight design does the standard cover?

To achieve its multiple aims in respect of daylighting and occupant comfort, EN 17037 covers four different areas. Some designers may have familiarity with designing to provide daylight, but the other three aspects of design significantly extend the scope of the standard compared to existing best practise:

■ Daylight provision.

Daylight provision, or illuminance levels, allow users to carry out tasks and play a part in determining the likelihood of artificial lighting being switched on. Assessment can be via either climate-based modelling or daylight factor calculations.

■ Assessment of the view out of windows.

Building users should have a large, clear view of the outside. EN 17037 considers the width and outside distance of the view, as well as landscape 'layers' (sky, landscape and ground). The view should be perceived to be clear, undistorted and neutrally coloured. Width of view can be established via a detailed or simplified approach. Outside distance and number of layers are each measured by a single approach.

■ Access to sunlight.

Calculating access - or exposure - to sunlight is a comfort and health factor for users of dwellings, nurseries and hospital wards. Daily sunlight exposure can be established through detailed calculation or table values.

■ Prevention of glare.

As its name suggests, prevention of glare is concerned with removing the probability of glare for building users, especially those who do not choose where they sit. It uses a detailed calculation of daylight glare probability (DGP), or a standard table of values for sun-screening materials.

What performance levels does the standard set?

To provide flexibility at the same time as making the standard useable and understandable, EN 17037 sets a minimum level of performance that must be achieved for each of these four areas. On top of that, there are two further performance levels: medium and high.

Users of the standard are free to select the performance level that best relates to the building design and proposed building use. A simplified and detailed method is available with which to assess each design area.

For example, the minimum illuminance of 300 lux is based on a number of studies. It is considered as suitable illumination for prolonged office work, and the level at which the probability of switching on electric lighting is low. Typical design levels for artificial lighting also use a 300 lux threshold.

How are local conditions accounted for?

As a standard covering all of Europe, the potential differences between one site and another are considerable. Daylight hours and angle of the sun vary for two sites within the same country, never mind at extreme points of the continent, so calculation results for any of the four aspects of daylighting will be unique on every project.

The standard provides common methods of calculation for evaluating daylight. Those calculations, however, take into account national and local conditions through climate-based modelling so solutions are appropriate and specific to each project.

What building types does EN 17037 apply to?

The standard has been written so that it can be applied to any building. The areas of design covered, and the flexibility for designers to choose what performance level is achieved, means internal spaces can be designed to suit intended activities.

This means the standard is not confined to new buildings. Proposals for renovating and/or converting an existing building can benefit from the intentions of EN 17037. Its tools provide a good means to assess existing openings in terms of the four aspects of daylighting, and inform changes to the building fabric to make it better suited to the proposed use.

Section 5.3 of EN 17037 describes assessment of exposure to sunlight, and is the only part of the standard to offer some building-specific guidance. It says that at least one habitable space in dwellings, hospital patient rooms and nursery playrooms, should be provided with the minimum performance level for sunlight exposure.

While access to sunlight is generally desirable, over-exposure can be detrimental to health and wellbeing. This unique example of building-specific guidance within EN 17037 is an acknowledgement that, in certain situations, building users need a 'calmer' space that does not achieve the levels of sunlight set as medium or high performance.

THE IMPACT OF DAYLIGHT ON BUILDING PERFORMANCE AND OCCUPANT COMFORT

Daylighting can be a daunting concept to think about when designing a building, but it doesn't need to be. While it is undoubtedly a complex subject - especially when accounting for four different areas of daylight design, as covered in EN 17037 - seeking advice at an early stage and getting the benefit of daylight modelling calculations will smooth the process considerably.

As is always the case with a construction project, getting something like daylighting right at the start improves certainty. Glazing products - among the rest of the building fabric and services specification - can be specified to the right dimensions and performance level, and priced accordingly. It makes it more likely that the finished building will deliver what is promised at design stage, in terms of both building performance and occupant comfort.

The alternative is to avoid the cost of calculations and modelling exercises, because it seems like a saving. But if late changes have to be made to a design because something was not given proper consideration at the outset, the knock-on effects can prove even more expensive.

If the glazing provision is made incorrectly, the potential impacts include delays on site or the redoing of already-completed construction work. Changes to the product specification, such as finding that blinds should have been specified and pre-mounted in the factory, can incur further delays or mean the contractor being called back at a later date to carry out retrofitting.

Daylight design for building performance

Good building design requires a holistic approach, otherwise it is impossible to fulfil all of the functional criteria of a building. Compromises must be made so as to ensure all functions - comfort, structural stability, weather protection, energy efficiency, security and safety, privacy etc. - can be met together and to a reasonable standard.

It's a question of balance. In terms of glazing and energy efficiency, that balance means complementing thermally efficient, airtight building fabric with the right area of glazed openings. The result is reduced electric lighting use, thanks to the availability of natural light, and avoiding excessive solar gains - as well as giving occupants a connection to the outside.

This holistic approach is supported by whole-building assessment methods like the Standard Assessment Procedure (SAP), the Simplified Building Energy Model (SBEM), and the Passivhaus Planning Package (PHPP). All take into account glazing area and orientation as part of predicting the energy use of buildings.

The first two, SAP and SBEM, form the basis for calculations in national building regulations. They are intended to be a reasonable approximation of building performance; a means of establishing compliance and comparing predicted energy efficiency and running costs of buildings.

PHPP is the foundation for the Passivhaus standard (which, contrary to the sound of the name, can be used to assess all types of buildings; a number of schools have been built to the Passivhaus standard with good results). Thanks to its increased accuracy compared to SAP and SBEM, PHPP also underpins a number of other voluntary building performance standards.

Since maximising solar gains in winter, while avoiding summer overheating, is a key tenet of Passivhaus methodology, it should come as no surprise that the thermal performance of glazed openings, their size and orientation, and any shading, are key metrics in PHPP assessments.

Using daylight to its full potential can reduce, or even eliminate, the electricity demand for artificial lighting during the day. To reach this conclusion, VELUX investigated the effect of daylight on energy use in a building.

A scenario was modelled where a house had no windows and light levels had to be achieved with electric lighting only. Using electric lighting influences heating and cooling demand, so the energy use for lighting, cooling and heating was evaluated together.

The results showed that relying on electric lighting to provide lux levels equivalent to daylight resulted in an energy demand some five times greater than an equivalent house with well-designed glazing and no electric lighting.

Studies of office buildings have demonstrated similarly positive results. While they are more complex in terms of having unique occupancies, internal layouts and lighting controls (manual and automatic), and therefore less suited to a 'definitive' assessment, energy savings of 20 to 60% have been evidenced.

When it comes to well-designed glazing, roof windows and skylights deliver more daylight than facade (vertical) windows - at least twice as much, in fact, for windows of the same size. In real terms, that means roof windows can help achieve required illuminance levels with a smaller total area of glazing - and with a better distribution of light in the room as well.

Using daylight modelling to help refine the client's brief means the balance of facade windows and roof windows can be part of initial design concepts, addressing any overheating concerns and keeping electric lighting demand to a minimum. When whole-building performance is eventually addressed, these benefits will contribute to a positive outcome.

Daylight design for occupant health and comfort

Many aspects of human health, including the length and quality of our sleep, are linked to the light signals we receive during the day. We perceive spaces with a high level of daylight to be 'better'; they enhance our mood and morale, and reduce fatigue.

Morning light dictates our alertness levels, and a high level of daylight through to early evening maintains that alertness and gives the body the signals it needs to regulate circadian rhythms. Into the evening, decreasing the level of light to which we're exposed readies the body for night-time darkness and sleep.

Work environments with good daylighting have been shown to improve job satisfaction, and it promotes more effective learning in classrooms and education environments. In hospitals, daylight exposure and a view of green space have been linked to improved postoperative results.

There is no measurable, universal target for what is the 'right' or 'necessary' light dose - but what is clear is that people need a greater level of interior light than is prescribed in standards for electric lighting. Daylight is dynamic; it varies in intensity, colour and direction, and is therefore more stimulating than artificial lighting.

In terms of a view to the outside - one of the four measures covered by EN 17037 - a number of generalisations can be made: a natural view can impact positively on a building user's wellbeing, and is preferred to a view of a man-made environment; a wide, distant view is superior to a narrow, near view; and a diverse, dynamic view is more interesting than a monotonous view.

The positive impact of daylight on building occupants and their wellbeing is recognised by assessment methodologies like the WELL Standard and BREEAM. In BREEAM, for example, the health and wellbeing category HEA01 includes a credit for visual comfort, and requires that 80% of the occupied space meets a minimum daylight factor of 2% - or, for excellent level, 3%.

Light transmittance is a key measure for glazing, but how that light is distributed is a key measure of comfort. A space is better illuminated by diffused light, whereas occupants are more likely to experience discomfort from direct light, which causes glare.

Thermal performance of roof glazing

A building's carbon dioxide emissions and energy use are heavily influenced by the balance of heat loss against solar gains. It is helpful to understand some of the ways in which glazing can be treated to achieve different levels of performance, and how that performance is measured, in order to understand the impact on daylighting.

The relationship between light transmittance, or how much light is allowed into the building, and reflectivity is the perfect illustration.

Specifying a particular level of reflectivity influences the level of light transmittance achieved. For example, where privacy is a concern or a requirement, a high level of reflectivity might be specified for an almost mirror finish. There is a corresponding reduction in light transmittance, but also an increase in solar control thanks to less solar radiation entering the building.

Low reflectivity, by contrast, is designed to make the glazing almost invisible to the naked eye. While privacy is greatly reduced, the interior space benefits from a greater level of daylight.

The measure of solar energy entering a building through the glazing is the total solar energy transmittance, or g value. It is the ratio between the solar gain transmitted through the glazing and the incident solar gain on the glazing, expressed as a value from 0 to 1. Accessories, such as automatic or user-controlled shading, can work in combination with the glazing to give a dynamic g value, which can therefore be changed in response to internal or external conditions.

Several smaller roof glazing units not only allow a better distribution of light throughout the day, but they also don't need the application of solar control that larger expanses of glazing require.

As well as controlling the amount of short wave radiation allowed into the building, glazing can be treated to reduce the loss of long wave radiation back out of the building. Glazing with a low emissivity (low-e) coating reflects long wave radiation, keeping it - and its heat - inside the building.

Like the building fabric in which it is installed, the measure of heat loss from warm to cold through glazing is the thermal transmittance, or U-value.

For both g values and U-values, performance can be quoted for the whole glazing unit, or just the centre pane. As the names suggest, whole-unit values take into account both the glazing and the frame, while centre pane values refer to the glass only.

Centre pane values appear lower, because the effect of the frame is not accounted for. It's important to make sure that like-for-like comparisons are made between different products - and that representative values are used in whole-building assessments.

Ventilation

Glazing units, including roof glazing, make an important contribution to ventilation in buildings. Even when the majority of the fresh air requirement is supplied by controlled, mechanical systems, having the option to open windows is important for building occupants to have some say in their own sense of comfort.

Ventilation is closely linked to thermal comfort, and the provision of fresh air is closely linked to feeling a connection to the outside. Taking into consideration everything we have covered in this document so far, the connection of ventilation to the daylighting and energy efficiency roles performed by roof glazing and skylight solutions cannot be underestimated.

Like much of what we have discussed to this point, ventilation is a compromise, balancing energy consumption, health and costs. Excessive ventilation increases energy use, as heated warm air is lost and replaced by cold air that has to be heated again.

Insufficient ventilation, while retaining heat within airtight building fabric, causes poor indoor air quality and potential health problems. Living and working in damp, humid environments is the most likely trigger for illnesses such as coughs, allergies and asthma.

Ventilation removes stale indoor air - odour, pollutants and moisture - from the building and provides fresh air for the occupants to breathe. Fresh air is linked to increased alertness and wellbeing, evidenced by studies in both schools and office buildings.

It's critical to make sure that a ventilation strategy appropriate to the building fabric airtightness is implemented - or the correct rate of ventilation for the building use simply won't be attained. It is this need to design for airtightness and ventilation with equal care that has led to the phrase, 'Build it tight, ventilate it right'.

Ventilation requirements in national building regulations are widely regarded as not having kept pace with the thermal performance and energy efficiency requirements. Undertaking more detailed assessment and modelling is therefore critical to achieving successful real-world building performance, especially in complex buildings for the commercial, education and healthcare sectors.

Mechanical ventilation, with filters to keep external pollutants out of the building, is increasingly seen as the preferred solution. It provides a predictable, consistent and controlled supply of fresh air. Natural ventilation is driven by external air pressure and air movement, and therefore cannot be entirely depended upon on the occasions it is most needed.

Natural ventilation does have advocates, but is arguably best employed as a supplement to a mechanical system, to take advantage of the days when it is most effective.

USING VELUX MODULAR SKYLIGHT SOLUTIONS TO HELP MEET THE STANDARD

What are the solutions we can implement to help achieve the standards of daylighting, thermal comfort and ventilation discussed up to this point?

We have described the benefits that roof glazing offers in comparison to vertical facade glazing, but larger commercial projects require more than a series of well-placed individual rooflights. That is where modular skylights come in.

Benefits of modular skylights

VELUX Modular Skylights are fully prefabricated offsite, complete with customised flashings and integrated insulation. Being factory-made, to tight tolerances, they offer consistent, repeatable and dependable performance.

Skylight modules are designed to work as a single system from the moment they are made, and can be linked together in combinations to suit the building shape and roof design. Where required, any optional accessories - such as blinds, ventilating modules and actuators - are installed in the factory too, so the units are delivered to site ready to be fitted with a minimum of fuss.

It isn't just the quality and performance that are consistent either - the appearance of the skylight modules is too. Ventilating skylights look the same as fixed skylights, achieving a consistent aesthetic regardless of the mix of units needed to achieve the ventilation specification.

There is no limit to the number of skylights that can be installed next to each other in a row or run - the only constraint is the building structure itself, and the effect of any movement or expansion joints. Modules of different widths are easily accommodated, though the length must be consistent in a run. Meanwhile, trapezoidal modules offer options at the roof edges depending on the shape of the building.

Getting the best from modular skylights means, ideally, factoring them into the design at an early stage. Setting out the support structure to fit with known module sizes makes life a lot easier further down the line, compared to fitting a combination of modules into a random size.

Thermal and ventilation performance

VELUX modular skylights are available as double or triple glazed units. The thermal performance of double glazed units is a good fit for most building designs, but triple glazed modules are available for projects where the specification requires them.

Modular skylights also contribute to the chosen ventilation strategy - be it a fully natural solution, or a hybrid solution featuring mechanical and natural ventilation. They provide background ventilation, such as via the VELUX ventilation flap, providing a permanent-but-limited flow of air to contribute to the overall air change rate.

They can also be opened to provide purge ventilation, when the internal climate has become too warm or 'stuffy' and a rapid, usually user-driven, airing is required.

As well as manual controls, modular skylights with programmable and sensor-driven controls, for both background and purge ventilation, remove the need for continuous manual adjustment, which can easily get forgotten.

Operating modular skylights

Modular skylights can be supplied in one of two control styles: open, or 'plug and play'. Open operation allows the skylights to be incorporated into a Building Management System, from which they can be operated based on temperature, humidity or carbon dioxide levels. Where automatic smoke ventilation is provided as part of the building's fire safety strategy, that can only be provided via a Building Management System.

'Plug and play' modules, like the VELUX INTEGRA®, feature sensors as part of the module, but the control units can have additional sensors connected in.

Whole-building assessment methodologies

There are some twelve different areas in which VELUX Modular Skylights can help obtain credits as part of a BREEAM assessment. And as the role of buildings in wellbeing is increasingly recognised, accepted and designed for, assessments under the WELL standard are also likely to increase - with a corresponding increase in focus on daylighting, thermal comfort and ventilation.

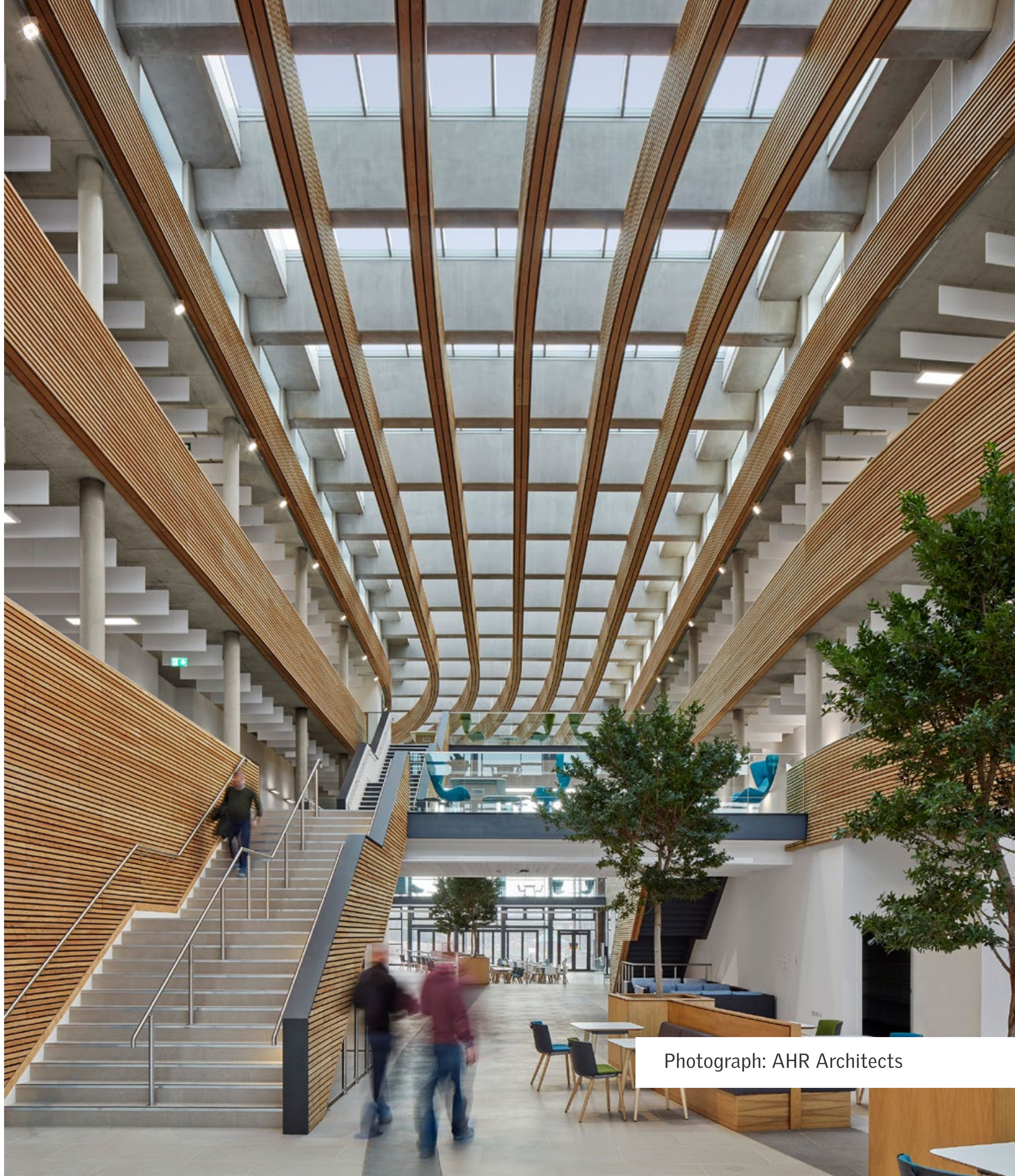
UK Hydrographic Office (UKHO)

VELUX Modular Skylights were used to provide daylight and ventilation to the atrium of the new UK Hydrographic Office building, which is part of the Ministry of Defence.

With office spaces either side of the atrium, the roof design featured multiple rows of modular monopitch skylights, with trapezoidal units stepping out to suit the curve of the building where appropriate. The skylights were supported on pre-cambered concrete beams, which meant factoring in not just initial settlement but future deflection too.

That long-term view was evidenced in the ventilation provision too. More opening rooflights than needed were installed, ensuring the building has extra ventilation capability in the future should the changing climate make it necessary.

Architects AHR designed baffles below the skylights to help disperse light, eliminate glare and create a 'wave ripple' visual effect. The baffles were an integral architectural feature of the building as well as assisting in the distribution of good quality daylight through the atrium.



Photograph: AHR Architects

CONCLUSION

Like any code of practice, the contents of EN 17037 constitute recommendations only. The more those recommendations are adopted, however, the greater the weight and authority that the standard will come to carry in design offices and on construction sites - and the more it will come to feature in client briefs.

Architects and design professionals must rise to the challenge of delivering buildings that respond to the current climate and achieve genuine occupant comfort. Indeed, future versions of building regulations may give them no choice. As a result, awareness of glazing performance and, in particular, its contribution to daylighting is only going to increase.

In the short term, EN 17037 is likely to feature mainly in projects aiming for standards like BREEAM and WELL, where meeting its requirements will assist in claiming extra credits. In time, though, its reach will extend beyond that and feature in more specifications.

Perhaps unsurprisingly, initial modelling suggests it's the upper storeys of taller buildings where the performance levels of EN 17037, especially the high and medium performance thresholds, are most likely to be met.

For new-build developments on open sites, meeting required performance levels might be relatively straightforward; the development of tighter sites could need significant changes if good daylighting is to be properly embraced.

Roof glazing, and modular skylights particularly, offer greater access to unobstructed sky and sunlight, and are the perfect complement to vertical windows in external walls that might be faced with significant constraints from adjacent buildings or other obstructions.

VELUX Commercials expertise in providing modular skylights for education, healthcare and office buildings - like UKHO - means we can assist designers and specifiers from an early stage on how roof glazing can help achieve the right performance levels across the four areas of daylighting covered by EN 17037.

For project and technical support, or price estimates for commercial roof glazing solutions, ***contact us*** to discuss your requirements. ***Brochures and guides*** are available from our website, as are ***CAD and BIM object downloads***.

We also offer a ***comprehensive, RIBA CPD-accredited learning programme,*** highlighting the importance of daylight in commercial buildings, and the benefits of modular products in creating better environments for learning, working and recovering.

Sources and further reading

For a more in-depth exploration of the topics covered in this white paper - including a wider discussion of the studies referenced in the section on 'The impact of daylight on building performance and occupant comfort' - VELUX's Daylight, Energy and Indoor Climate book is a comprehensive and readable guide, intended for architects, engineers, students and researchers alike.

The VELUX DEIC book is available online at:
www.velux.com/deic

GLOSSARY OF TERMS

Access to sunlight

Daily sunlight exposure, established through detailed calculation or table values.

BREEAM

The Building Research Establishment's Environmental Assessment Method.

BS 8206-2

'Lighting of buildings. Code of practice for daylighting' - British Standard dealing with daylight design prior to the publication of EN 17037.

Centre pane values

A g value or U-value given for glazing only, not accounting for any frame material.

Climate-based modelling

A technique developed to assess daylight provision based on building-specific location and orientation, and 365-day climate data. Allows glare to be calculated.

Daylight factors

The traditional method of assessing daylight provision, developed some 60 years ago. Assesses the ratio of external light to internal light, but based on permanently overcast conditions, which lacks accuracy and can't predict glare.

Daylight modelling calculations

The process of undertaking climate-based modelling to assess daylighting in respect of a particular building design.

Daylight provision

Illuminance levels, allowing users to carry out tasks. Also determines the likelihood of artificial lighting being switched on.

Daylighting

The controlled use of natural light in and around buildings.

Diffused light

A softer light that does not have the glare or intensity of direct light.

EN 12464-1

'Light and lighting. Lighting of work places. Indoor work places'

EN 15193

'Energy performance of buildings. Energy requirements for lighting. Specifications'

EN 17037

'Daylight in Buildings' - The first harmonised European standard dealing with the design for, and provision of, daylight in buildings, published in 2018.

g value

Solar energy transmittance, or the measure of solar energy entering a building through glazing.

Glare

Excessive and uncontrolled brightness, especially from direct light.

Indoor air quality (IAQ)

A measure of how the air inside a building impacts on the health and comfort of building users.

Light (artificial)

Light emitted from lamps or LEDs, usually through the application of a current, to provide illumination when daylight is not sufficient or unavailable.

Light (natural)

The part of the electromagnetic spectrum possessing wavelengths recognised by the human eye.

Light transmittance

The ratio of light that passes through a medium to that absorbed by the medium.

Lux

The unit of illuminance.

Modular skylights

Factory-assembled rooflights designed to be linked together to cover large roof areas, delivered to site with all accessories ready-installed. Usually double glazed, but can be triple glazed for a lower (better) U-value.

National annex (NA)

Section of a European Standard detailing local information that helps with applying the recommendations of the standard in the specific country.

Solar gains

'Free' heat energy from the sun which, when planned for in a building design and accompanied by efficient building fabric, can reduce space heating in winter without risking overheating in summer.

Thermal comfort

The subjective view of building occupants as to whether they feel too hot or too cold.

U-value

Measure of thermal transmittance in W/m2K, the amount of heat energy that passes through one square metre of building fabric, for every degree of temperature difference between the warm and cold sides.

VELUX INTEGRA®

An innovative system that uses VELUX supplied operation devices to operate venting modules and roller blinds to any desired position.

Ventilation

The removal of stale air from a building, which causes poor indoor air quality, replacing it with fresh air. Removes moisture, odour and pollutants. Ventilation strategies can be natural, mechanical or hybrid (a combination of the two).

View, **assessment** of

Consideration of the width and outside distance of the view, as well as landscape 'layers' (sky, landscape and ground). Should be perceived to be clear, undistorted and neutrally coloured.

WELL Building Standard

Evidence-based system for measuring, certifying and monitor-ing building features that impact on health and wellbeing.

Whole-unit values

A g value or U-value given for a whole glazing unit, including the frame.

Find out more at
commercial.velux.co.uk