ENVIRONMENT DESIGN GUIDE

ADVANCED GLAZING SYSTEMS IN COMMERCIAL BUILDINGS

PC Thomas and Leena Thomas

This note PRO 19, originally published in August 1998, was reviewed by PC Thomas and Leena Thomas in June 2003. Considerable advances in the technology and application of glazing systems have been made in the past five years. The paper is now considered out of date and will be republished. In the meantime, please consider the issues below.

SUMMARY OF

ACTIONS TOWARDS SUSTAINABLE OUTCOMES

Environmental Issues/Principal Impacts

- In addition to providing a visual connection to the outdoors, and acting as a shield against weather, glazing systems impact on the heating, cooling and daylight performance of the building.
- Advanced glazing systems minimise energy use for cooling and heating in the perimeter areas of a building while maintaining the benefits of comfort and connection with the outdoors.
- In this context it is becoming well recognised that advanced glazing systems in combination with innovative daylighting and shading strategies, along with mixed-mode or natural ventilation systems are required to achieve low energy use and low greenhouse emissions. Whole building energy modelling is required to predict and optimise the integrated impact of the glazing, air conditioning and lighting systems for building design.
- Environmental rating systems that consider the energy or greenhouse gas emission performance of buildings are becoming commonplace. Programs like the Australian Building Greenhouse Rating (ABGR) schemes are increasingly referenced by government clients and private investors to monitor annual greenhouse emissions from buildings. Developers and financial institutions are increasingly interested in contracts with long-term performance clauses for new building assets.

Basic Strategies

In many design situations, boundaries and constraints limit the application of cutting EDGe actions. In these circumstances, designers should at least consider the following:

- Use the new generation, clear, high performance glazing products with very low solar heat gain coefficients. These glazing products assist designers to design buildings with low energy use while allowing high daylight levels inside.
- Consider integrating these high performance glazing systems with dimmable electric lighting systems to maximise use of available daylight, and reduce peak air conditioning loads.

Cutting EDGe Strategies

- Use an integrated approach to design the glazing, framing, shading and internal blinds as one system, evaluating how it performs to let in light, block direct sunlight, reduce glare and increase thermal and visual comfort.
- Movable shading systems offer potentially large energy and comfort benefits. However the benefits are often not realized as the control and actuating systems are not designed or installed correctly.
- Use an integrated approach for procurement of the complete window system (i.e. glazing, framing, shading and internal blinds). Consolidate budgets from base building and fit-out for the window system.
- Also consider an integrated approach to design of natural ventilation, night flush or purge cycles through control of operable glazing system elements and the environmental control system.

Synergies and References

- Use SEDA's *Commitment Agreement* process in addition to existing design methods as it forces the entire design team to make greenhouse performance of the building a central tenet.
- Hawkes, Dean and Forster, Wayne, *Architecture, Engineering and Environment*, Laurence King Publishing Ltd, 2002, ISBN 1 85669 322 8 (a number of examples of integrated design with advanced facades).
- *BDP Environment Design Guide*: DES 2, DES 6, DES 8, DES 21, PRO 3, TEC 10.

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This Note is intended for people selecting glazing systems for commercial buildings. Unlike windows for residential buildings, glazing systems for commercial buildings cannot be purchased 'off the shelf'. Thus, while the Window Energy Rating System (WERS) can be used to evaluate the energy performance of residential windows in Australia, the energy impact of windows designed for commercial buildings needs to be studied on a case-by-case basis.

This Note describes advanced glazing systems, explains critical window energy performance parameters and discusses research results for Australian climates. It also outlines the range of potential benefits offered by these products, discusses barriers to wider penetration of the technology and proposes strategies to analyse the impact of advanced glazing systems in building projects. Some of the material from Note PRO 3 The Energy Impact of Windows in Building Design *has been revisited here for the sake of completeness.*

1.0 INTRODUCTION

The choice of facade glazing influences the energy use of the building, as well as the visual comfort and psychological well being of the occupants. Limited information is available to the building industry to design, select or specify an energy efficient advanced glazing system. Although solar thermal characteristics of individual glass products are available, such information does not give a clear indication of the energy implication of a complex glazing system. Consequently, it has not been easy, until now, to make a realistic evaluation of the benefits of energy efficient, high performance glazing systems.

The benefits of an energy efficient, high performance glazing system are:

- Lowered cooling demand in the perimeter areas of the building, requiring smaller heating, ventillating and air-conditioning (HVAC) plant and reduced energy use for cooling.
- Higher levels of natural light (or daylight), enhancing visual and psychological comfort of occupants. A well lit, comfortable work environment has been linked with reduced absenteeism.
- The extra daylight can be utilised in conjunction with daylight linked electric lighting control to reduce energy use for lighting. Since electric lighting is a heat load, this has an implication in further reducing HVAC cooling needs.
- Over the life of the plant/building, the reduced energy use will lead to substantial reductions in greenhouse gas emissions.

2.0 ADVANCED GLAZING SYSTEMS

Modern glazing systems for commercial buildings can have a myriad of configurations. They may consist of two or more panes of glass, which may be laminated together to form a single pane or sealed into an insulating double glass unit at the factory. The space between the glass panes could be filled with air or a low conductivity gas, or be evacuated.

Special spacers filled with desiccant material to prevent condensation occurring within the glazing unit are used to separate the glass panes. High technology sealant materials are used for bonding the glass surfaces and spacer material. The individual glass units may be put into precisely engineered frames that may incorporate a thermal break to prevent heat loss due to conduction through the frame. In other cases, the individual glass units may be held together by structural silicone without framing members.

Each glass pane may have a body tint or surface coatings. The coatings could be spectrally selective, such as low emittance coatings, which reflect infra-red energy, but transmit visible light. Research is being carried out on angular selective glazing designed to exclude light from high sky angles. Other glazing may have variable properties e.g., electrochromic glazing that can be controlled to become dark or light coloured using a small current. Considerable research is being carried out into electrochromic glazing, with the promise of the technology becoming commercially available in the near future.

In this Note, an advanced glazing system is considered to be a complex glazing configuration incorporating one or more of the elements described above. While some of the configurations described are at the research stage, many commercially available products can be combined into high performance energy efficient, advanced glazing configurations, particularly suited for commercial buildings in Australian climates.

3.0 WINDOW ENERGY PERFORMANCE PARAMETERS

Window energy performance is well characterised by the parameters described below. Understanding these parameters will assist the designer in selecting an appropriate window for the building design.

3.1 U-value

The **thermal transmittance** or U-value of an element is the measure of heat transferred through the element when one side is hotter than the other. The U-value is measured in watts per square metre per Kelvin of temperature difference (W/m^2-K). A change of 1 Kelvin is the same as a change of 1°C. For example, if it is 20°C inside, 5°C outside, and the window has an area of 2 m^2 and the U-value is 6 W/m^2K, the heat lost continuously to the outside is (20–5) x 2 x 6 = 180 watts.

In practice, it is the effective thermal transmittance of the entire window system (the combination of the glazing configuration and the window frame), that is relevant to designers. Windows with low U-values allow smaller quantities of heat to flow across them. Such windows are more appropriate in very cold (or very hot) climates, where there are large differences between the room (inside) temperature and the ambient (outside) temperature.

It must be emphasised that the U-value says nothing about radiant energy transfer – that is, how much solar radiation penetrates the window if it is sunlit or even under overcast conditions. Radiant heat transfer is represented by the solar gain indices described below.

3.2 Solar gain indices

The **Solar Heat Gain Coefficient** (SHGC) measures what fraction of the solar radiation that strikes the outside of the window actually enters the building. For example, if the solar radiation striking the outside of the window is 800 W/m^2 and the SHGC is 0.71, the amount of solar heat entering the room both directly and indirectly from the warmed glass will be 800 x 0.71 = 568 W/m^2. Clearly, the SHGC cannot exceed 1.0.

Although an older measure, **Shading Coefficient** (SC) is listed in most product performance literature. Clear 3mm float glass which has a SHGC of 0.86, is defined to have an SC of 1.0. The SC for any other glazing can be found by dividing its SHGC by 0.86. Thus, the SC for the window in the example above, is 0.71/0.86 = 0.83. Windows with high values of SC (and SHGC) will allow more of the sun's radiant energy to enter the building and are suitable in passive solar heated residences in colder climates. However, commercial office buildings with large window areas and significant amounts of internally generated heat (from lights, computers and people) should be fitted with windows that will minimise solar radiant gain, i.e., windows with low values of SC (and SHGC).

3.3 Daylighting indices

The **visible light transmittance** (T_{vis}) of the window glazing is an indication of the amount of daylight (electro-magnetic radiation in the frequency range 0.38-0.77µm) it will let through. The **luminous efficacy**, k_e, of glazing is the ratio of T_{vis} to SC and is a measure of the light-to-heat ratio of the transmitted energy. Higher values of luminous efficacy are desirable, and indicate that the glazing is capable of transmitting more natural light (or daylight) and less heat energy.

The higher level of natural light transmitted indoors could potentially be used to reduce the energy used for electric lighting in the perimeter areas. A daylight linked lighting control system in commercial buildings will result in reduced heat generation within the space and consequently smaller air-conditioning cooling loads.

3.4 Air leakage

The **air leakage rate** measures the 'tightness' of the window in its ability to seal out draughts when closed. This depends on the quality of weather stripping materials and the dimensional tolerances between moving sashes and other parts of the frame. Air leakage is measured in litres per second per square metre of window area (L/s/m^2) at a pressure difference of 75 Pascals (75 Pa) according to the procedure set out in AS 2047 *Windows in buildings*. This standard sets an upper limit of 1 L/s/m^2 for windows to be used in air conditioned buildings and 5 L/s/m^2 for non-air-conditioned buildings.

4.0 COMMERCIALLY AVAILABLE GLAZING

Although a number of existing and new glass technologies have been listed in the introductory paragraph, only a few are available in significant quantities in the commercial market. These are clear glazing, tinted glazing, reflective glazing and low emissivity glazing. (Electrochromic glazing is a promising technology that is still quite expensive and not yet available in large quantities.) These types of glass products can be combined to construct glazing systems to suit desired energy performance criteria. Strategies for the effective combination and application of these products in commercial office buildings are discussed in this section.

4.1 Tinted glazing

Tinted glazing in single glass configuration is very popular in Australian commercial buildings, and is used to reduce solar heat gain (and sometimes to reduce glare). It is manufactured by adding a colorant, into the molten glass during manufacture. Such 'body tinted' glazing is sometimes referred to as heat absorbing glass, as it absorbs more solar radiation than clear glass. Since a greater fraction of solar radiation is absorbed by the glass, less is transmitted directly into the space. The hot glass loses heat by convection and re-radiation through both its surfaces. This heat loss is slightly biased to the surface facing the exterior since the absorbed heat will be more readily dissipated by wind. However, the reduction of solar heat gain in this manner is usually not significant when compared with clear glazing, given that the inner surface of the heated tinted glass transmits heat into the interior space over the passage of time.

The high absorption of solar radiation can result in uncomfortably high glass surface temperatures that are in the order of 60°C, on a bright summer day. The hot glass surface will re-radiate to both the outside and the inside in the infra-red wavelengths, causing discomfort to occupants seated near the window. This discomfort can be somewhat reduced by locating the tinted glass pane on the outside in a double glazed configuration. In this case, the absorbed heat is more readily dissipated away by the wind on the outside, than is convected across the air gap separating the two glass panes.

4.2 Reflective glazing

Reflective glazing has been used extensively in many older buildings in Australia. It is manufactured by coating a pane of clear glass with a mirror-like metal film that is capable of reflecting both visible light and near infra-red radiation. The coating is generally applied to the interior surface of the glass pane to protect it from weathering. Reflective glazings give good solar control due to the reflective property of the metal coating. Unfortunately, they also cut off a large portion of visible light resulting in dark interior spaces, requiring continuous dependence on the electric lighting system.

In addition to their reflective property, metal films absorb some of the incident solar radiation, causing the glass to heat up. If used in a single pane configuration, reflective glazing has the same limitations as tinted glazing (discussed above). When used in conjunction with a clear inner pane in double glazed units, this technology does offer good solar control, but at the expense of visible light transmission. Further, the reflected radiation has been known to cause discomfort and glare to people in the immediate external vicinity of the building, and many councils in urban areas place limits on the extent of reflectivity permitted for glazing. There is also an aesthetic effect which has resulted in a drop in popularity in the use of reflective glazing. In the evenings, the rear side of the reflective film reflects and scatters light from the interior electric lighting system, reducing the occupants' vision to the outside, while simultaneously allowing people on the outside to view the occupied space. This results in a loss of privacy, as well as a loss of views.

4.3 Low emissivity (low-E) glazing

A low emissivity or low-E coating is usually a very thin heat reflecting coating that is made transparent by anti-reflection coating technology (Johnson, 1991). The low-E coating is applied to a glass surface or a suspended polyester film that controls the amount of infra-red thermal radiation reflected by the window. The coating reduces thermal radiation transfer through the window and hence lowers its thermal transmittance or U-value.

There are two types of low-E coatings:

- the 'hard coat' pyrolytic coatings
- the sputtered metal based 'soft coatings'

Although hard pyrolytic coating have relatively higher emissivities (in the range of 0.15-0.35) in comparison to the more effective soft-coatings (emissivity as low as 0.04), they are more resistant to scratching and can be used in single glazed configurations. Soft coatings on the other hand must be installed in a double glazed configuration to prevent their deterioration (see PRO 3 for further information).

When the reduction of cooling energy is important, as is often the case in commercial office buildings, the coating is 'tuned' to transmit visible light, while reflecting infra-red radiation. The result is a system which has low solar transmission with good visible light transmission.

Advances in commercially available low-E glazing have made them the window systems of choice in many applications. A double glazed system which combines tinted and low-E technology is particularly suitable for commercial office buildings in Australian climates.

5.0 PREDICTED ENERGY PERFORMANCE

The findings of a recent study (Thomas and Prasad, 1998) to evaluate the potential benefits of advanced glazing technologies in commercial buildings are discussed in this section. Table 1 lists window energy parameters for six glazing systems made up by combining some of the currently available technologies. Single and double glazed tinted window systems represent commonly used choices. Three configurations covering the range of low-E products have been included. Two of these are double glazed configurations, which differ only in their solar performance. The tinted, low-E, double glazed system has significantly lower SHGC (see Table 1) compared with the clear, low-E, double glazed system. Both these double glazed systems are assumed to be argon filled. The third choice, a tinted, single laminated, low-E system, was selected to test the performance of a single sheet system with better solar performance than a single tinted sheet and reasonable thermal transmittance. Laminated glazing systems are increasing in popularity due to their inherent safety, and such a system can offer cost and weight savings compared to equivalent double glazed systems. The low-E coating on the inner face of the glazing system greatly

Table 1 Sample window energy parameters for selected glazing systems

Where: SC_c = Shading coefficient

$SHGC_c$ = Solar heat gain coefficient

T_{vis} = Visible light transmission

k_e = Luminous efficacy (ratio of light to heat transmission)

U_c = U-value or thermal transmittance

Note: The 'c' subscripts represent centre-of-glass values.

Description of glazing system	SC_c	$SHGC_c$	T_{vis}	k_e	U_c
Single tinted glazing	0.71	0.61	0.57	0.80	6.17
Double tinted glazing	0.57	0.49	0.50	0.88	2.74
Argon filled tinted double glazing with low emissivity coating	0.32	0.28	0.41	1.28	1.32
Argon filled clear double glazing with low emissivity coating	0.48	0.42	0.68	1.42	1.32
Tinted single pane laminated to a low emissivity coated pane	0.48	0.37	0.64	1.33	4.22
Single absorbing electrochromic					
– clear	0.85	0.73	0.82	0.96	6.17
– dark	0.34	0.29	0.16	0.47	6.17
Double absorbing electrochromic					
– clear	0.59	0.51	0.66	1.12	1.64
– dark	0.15	0.13	0.10	0.67	1.64

reduces the 'broiler' effect present with conventional single glazed systems, that is, radiant discomfort to occupants, caused by exposure to radiation from a hot glass surface. Although not yet cost-effective, two configurations of electrochromic window systems were also selected for analysis. Given their limitations, reflective glazings were not considered for this study.

The peak demand and energy load of a building model installed with the glazing systems listed in Table 1 was evaluated using the DOE-2.1E program by running hour-by-hour, dynamic building energy performance simulations. DOE-2 is a validated computer program used extensively by the American Society of Heating, Refrigeration and Airconditioning Engineers (ASHRAE) for research and consulting. Version 2.1E of the program, which has been used in this study, is particularly suitable for the performance analysis of advanced glazing systems, since it includes enhanced calculation routines which account in detail for the transmittance and absorbance (spectral data) of each glazing layer at different angles of incidence. The program thus calculates the angle of incidence of solar radiation at each hour, and then uses the glazing data to modify the hourly solar thermal performance accordingly. It also has extensive control routines for the performance analysis of switchable glazing such as electrochromic glazing.

Simulations were conducted for hot, temperate and cold locations around Australia, namely Darwin, Sydney and Hobart. Building energy consumption figures were generated for a 5m deep perimeter room space for each of the cardinal orientations. Such a configuration serves to isolate the effects of exterior facades in each orientation. Floors were modelled as carpeted concrete slabs, typical in commercial buildings. Lighting and office equipment was assumed to be efficient. A window-to-wall ratio of 45% was used for the study.

The performance of the building model fitted with single tinted glazing was compared against the performance of the building model fitted with the other six glazing systems listed in Table 1. Single tinted glazing was selected as a reference glazing system, following anecdotal evidence that a large proportion of 'spec built' suburban office buildings are fitted with tinted single glazed systems. The percentage improvements for the other glazing was referenced to the performance of the single tinted glazing.

The study demonstrated the benefits of advanced glazing technologies. The key findings are summarised below.

- In general, the low emissivity (low-E) coated products perform significantly better than non-low-E coated products for reducing cooling load.
- The tinted, low-E coated, argon filled, double glazed system is predicted to have the lowest cooling peak demand amongst the currently available advanced glazing systems examined. Reductions in peak cooling load varied from 43% on the north facade in Darwin, to 27% on the south facade in Sydney.
- The tinted, low-E coated, argon filled, double glazed system is predicted to have the lowest cooling annual energy demand amongst the currently available advanced glazing systems examined. Reductions in annual energy consumption varied from 32% on the north facade in Sydney, to 20% on the south facade in Sydney.
- The clear, low-E coated, argon filled, double glazed system is predicted to have the lowest heating peak demand amongst the currently available advanced glazing systems examined. Reductions in peak heating load varied from 67% on the north facade in Sydney, to 36% on the south facade in Hobart.
- The clear, low-E coated, argon filled, double glazed system is predicted to have the lowest heating *annual* energy amongst the currently available advanced glazing systems examined. Reductions in annual energy consumption for heating varied from 90% on the north facade in Sydney, to 50% on the south facade in Hobart.
- In its single glazed configuration, the electrochromic glazing system offered little benefit over other non-electrochromic systems.
- In its double glazed configuration, electrochromic glazing offered comparable or better energy and peak demand benefits to the low-E glazing systems. Unfortunately electrochromic glazings are significantly more costly than the other technologies at this time.

5.1 Energy benefits

- The reduction in peak demand due to use of advanced glazing systems will translate to a smaller HVAC system, including smaller chillers, cooling towers, air handling unit fan motors, pumps and piping. The reduction in the cost of the HVAC system will be offset either partly or wholly by an increase in the cost of the building facade. This capital cost benefit (or loss) should be estimated for every building design.
- The reduction in overall heating and cooling demand associated with use of an appropriate advanced glazing system will translate into reduced energy use and lower demand charges, resulting in an ongoing cost saving. Estimation of energy use, and thus energy cost, for alternate facade designs can only be done reliably using hourly simulation techniques.
- Since advanced glazing systems, with low-E coatings, can offer high light transmission with low solar heat gain, they can offer further demand and energy savings (not assessed here) if used in conjunction with daylight linked lighting systems in perimeter areas. Sensors check the level of daylight and, where appropriate, will reduce electrical input to the lighting system, either dimming or switching off the lights as needed (see Note PRO 3). Since such savings are high during peak times (as defined by utilities), the demand and energy cost savings could be significant.
- Reducing energy used in building operation translates into reduced greenhouse gas emissions associated with this phase of the building's life-

cycle. It is important to note that, while the reduced energy and greenhouse gas emissions within the building's operational phase resulting from use of advanced glazing systems will, most likely, result in reduced life-cycle energy use, quantifying any such reduction can only be done through application of life-cycle energy analysis techniques.

5.2 Comfort benefits

- Glazing systems which include low-E products offer increased visual comfort over conventional glazing systems having similar energy performance. In Table 1, high values of 'luminous efficacy' for the low-E combinations indicate a high light to heat transmission ratio. Thus, advanced glazing systems can offer 'cool daylight' and brighter interiors. The higher light levels allow the informed designer greater scope for better glare control. Brighter interiors have been linked to greater feeling of well being, and could lead to higher productivity and lower absenteeism.
- The inside surface temperatures of low-E coated products are lower than for conventional glazing. This will result in lower mean radiant temperatures experienced by occupants sitting in perimeter spaces.

6.0 FACILITATING WIDER ADOPTION OF ADVANCED GLAZING SYSTEMS

Clearly, advanced glazing systems that include low-E products can offer significant comfort, energy, cost and environmental benefits over conventional glazing. Considering the benefits, it is useful to try to identify some of the reasons for the slow penetration of advanced glazing systems into recent projects, given that low-E products are available in Australia from a number of importers and fabricators. Being aware of these factors will allow a project team to optimise their glazing system design solution.

6.1 Need for information on advanced glazing systems

The glazing industry itself has not made a concerted effort to educate potential users of the benefits of these products. Industry sales staff are not always aware of the substantial benefits of low-E coated glazing. Technical specifications, for example, detailed spectral data are not always available.

6.2 Need for specialised analytical capability within the design profession

Unlike residential windows, glazing systems for commercial windows are purpose designed, often combining a range of glazing products. While the solar thermal properties of single products are readily available from the manufacturer's literature, it is more difficult to determine the solar-thermal properties of a glazing system that comprises of a combination of products such as laminates, low-E coated glazing or high performance tints. This is further complicated by variations in configurations such as single or double glazed arrangements with air gaps or with noble gas (e.g. argon) infill between the glass panes.

Spectral data for the ultra-violet, visible and infra-red wavelengths is required for detailed characterisation, particularly of low-E coated glazing systems. This data, for each product, needs to be entered into a finite difference computer model (such as WINDOW 4.1 and FRAMEplus), along with weather data, frame details, gas infill and spacer materials, to calculate solar thermal performance measures for the complete glazing system. Such measures include SHGC (or SC), U-value, visible light transmittance, and inside and outside glass surface temperatures. It is imperative to correctly determine accurate values of these performance measures for any advanced glazing system used, as the solar thermal properties of glazing systems have a direct impact on HVAC system size.

Most HVAC consultants have considerable expertise in sizing and specification of HVAC systems, given accurate solar thermal properties for a glazing system. Unfortunately, few HVAC consultants have the skills to carry out dynamic building energy performance simulations, one of the most reliable ways of predicting annual energy use numbers that are required for any life-cycle analysis. In Australia, the capacity to perform building energy simulations is still largely restricted to research centres and universities. A few of the larger engineering consultancies, and some innovative small practices, are beginning to offer some of these services. Designers are encouraged to demand these services from their consultants.

6.3 Clear responsibility for an energy efficient building

There is difficulty in assigning clear *responsibility* for design of an efficient building to any single member of a design team. While facade consultants have primary responsibility for structural design, current design practice does not always raise the energy efficiency of the facade as a design issue. As stated earlier, an energy efficient facade has a considerable impact in reducing the size of the HVAC system. Further reductions in HVAC system size are possible when advanced glazing systems are combined with a daylight linked electric lighting system.

Only a total cost approach will reflect all the benefits of advanced glazing systems. The additional costs of the energy efficient facade, and the daylight linked lighting system, need to be offset against the reduced size of the HVAC system to determine the full impact on the capital cost of the building. Meaningful life-cycle cost analysis can currently best be carried out with accurate energy use data, generated using an hourly building energy performance simulation analysis.

Based on client priorities, the design team is encouraged to propose a clear method to justify use of energy efficient systems on a life-cycle cost analysis at the whole building level.

7.0 NEED FOR AN INCENTIVE BASED FEE STRUCTURE

The mechanical consultant is probably the one person in the design team who can influence choice of glazing to improve facade energy performance. An efficient facade will necessarily reduce the size of the HVAC works. Given the prevalent scenario where the consultant's fees are based on a percentage of the size of the HVAC works, there is no incentive for a designer to expend additional effort to propose or design efficient facades or HVAC systems. Clearly, there is a compelling need for the client and the design team to negotiate an explicit, incentive-based fee structure to reward good design.

8.0 NEED FOR IMPROVING GLAZING SYSTEMS THROUGH PERFORMANCE OR MATERIALS SPECIFICATION

It is possible that, as industry awareness and experience with advanced glazing systems increases, the specification of glazing systems will move towards an energy performance basis. This will set limits for solar heat gain coefficient, U-value and visible transmission parameters, in addition to structural and safety performance parameters, of glazing systems. Any such move needs to be considered carefully, however, as this could result in the shifting of design responsibility from the design consultants to the design-build subcontractor tendering on for the glazing system subcontract. For this reason, any move to implement minimum performance criteria should be done in such a manner as to ensure that those best qualified, such as the facade, or specialist glazing consultants, are responsible for design and specification of specific advanced glazing systems, tailored to meet any such performance specification.

9.0 CONCLUSION

Advanced glazing systems offer significant energy and green house reduction benefits. It is hoped that this Note enhances the awareness and understanding of the capabilities of these window systems, and enables building designers to make informed choices for their application.

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BIOGRAPHY

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