NCC Section J and Commercial Building Facade Design - 2016 Update

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ABSTRACT

To address the growing contribution to Australia’s greenhouse gas emissions by the commercial building sector, Section J of the National Construction Code (NCC) Volume One codifies minimum glazing thermal performance measures for both facade vision glazing and roof lights. In 2016, the NCC moved to a three year cycle, with the next revision due in May 2019.

The difficulty with Section J is that it fails to explain succinctly to a designer what is meant by a compliant design or what one might look like. This paper attempts to address this failure by presenting a range of strategies and design charts for different climate zones to enable commercial building designers to quickly design innovative, high-performance, NCC-compliant facade concepts.

This note updates EDG 82 BCA Section J and Commercial Building Facade Design to reference the NCC 2016.
Introduction

A key part of commercial building energy efficiency is facade design. This involves the placement of glazing and associated external shading devices on a building. By manipulating the orientation of a conceptual building plan, and locating shading and glazing in relation to local sun paths, an architect can make a considerable difference to occupant comfort and the building’s operating energy consumption. This in turn has a large impact on the building’s whole-of-life greenhouse gas emissions footprint.

In many cases, however, current facade design practices for commercial buildings contribute significantly to the heating and cooling energy consumption of these buildings. In particular, large expanses of unprotected, low-performance glazing and framing can increase unwanted solar heat gains entering commercial buildings, which typically already have high internal loads from occupants, lighting and equipment. Often there are no ventilation openings that would allow that internal heat to dissipate naturally during mild external conditions.

To address this problem of excessive solar heat gain, Section J codifies minimum glazing thermal performance measures for both facade vision glazing and roof lights. A good understanding of Section J and passive design principles can lead to a thermally efficient building with sufficient opportunities for external views and daylight entry.

While Section J attempts to codify good passive design of glazing, in the way it is currently written, it fails to provide designers the information in a user-friendly format. Nor does it encourage designers to improve upon the minimum requirements when using the prescriptive ‘Deemed-to-Satisfy’ (DTS) compliance route or the performance-based compliance route using energy modelling known in the NCC as the ‘JV3 Verification Method’. This paper sets out to assist designers to better understand the impacts of window thermal performance, orientation and shading on the maximum proportion of vision glazing permitted on facades for building code compliance.
Background

Though energy efficient design for commercial buildings was first codified in the Building Code of Australia (BCA) in 2006, the regulations were made more stringent in 2010. In particular, external glazing allowances became much more stringent, with significant implications for the design of commercial building facades. Glazing thermal requirements for aged care facilities (building class 9c) were relaxed slightly in 2014. No further changes to Section J were incorporated in NCC 2016, which will remain current until May 2019.

The rules for maximum permitted external facade glazing area have evolved over time. There are now four stringency levels for the different building classes. In the NCC 2016 these stringency levels are set by the ‘Energy Index’ values in Table J2.4a, or set in the dropdown box of the glazing calculator compliance spreadsheet:

1. Class 3 residential buildings such as hotels and accommodation for people with disabilities
2. Class 9c aged care buildings
3. Display glazing for Class 6 shops or Class 7 showrooms
4. All other facade glazing for building Classes 5 through to 9b, such as office buildings, glazing other than shopfront display glazing in retail premises and showrooms, warehouses, laboratories, manufacturing facilities, healthcare buildings, public assembly buildings and schools.

Key Concepts

In order to design innovative, high-performance, NCC-compliant facade concepts, it is essential that designers grasp five key concepts:

1. Passive design
2. Facade area
3. Glazing thermal performance
4. P/H sun-break shading ratio
5. Prescriptive compliance through adopting ‘Deemed-to-Satisfy’ measures versus more flexible ‘Performance Solution’ compliance, which is generally proven by annual building energy use calculations, commonly referred to as energy modelling.

PASSIVE DESIGN

Passive design is an integrated building design approach which considers a building’s orientation, layout, form and materials with respect to climatic conditions to assist in maintaining thermal comfort and reduce operational energy requirements (adapted from ‘Glossary of environmentally sustainable design’, EDG 70 Glossary, Day et al. 2011).

Passive design for non-residential buildings differs in important respects from residential passive design. The most apparent difference is the presence of larger internal heat loads that must be removed in order to achieve occupant thermal comfort for much of the year. These heat loads come from higher densities of occupants, electric lighting and heat-generating equipment and appliances. Non-residential buildings typically have higher lighting requirements for work-related visual tasks than residential buildings. The need to avoid solar gain in most non-residential buildings is generally far greater than the need to capture it for passive winter heating in Australian climates. These higher internal loads also mean that non-residential buildings like offices typically use more energy in cooling annually for a given floor area than residential buildings.

As with residential design for some Australian climates, east and west facing glazing should be reduced or used sparingly, as treating these orientations for sun control in warm weather is difficult. As far as possible, the building should be also be oriented to face true or solar north, to allow optimised control of sun ingress through external horizontal shading devices. (For residential passive design strategies refer to EDG 66 GC ‘Residential Passive Design for Temperate Climates’).
form a part of the thermal envelope separating the conditioned interior from external conditions.

**Glazing thermal performance**
The area of each glazing element in the building thermal envelope must be entered into the glazing calculator. The area of each glazing element includes the area of the window frame or frame of a glazed door. The Solar Heat Gain Coefficient (SHGC) and U-values (the ease with which heat conducts through a building element) entered into the glazing calculation are the ‘Total System’ values for each glazing element. This means that the values must include the thermal performance of not just the glazing but also any associated frame. Glazing-only SHGC and U-values obtained from glazing manufacturers must therefore be adjusted to account for the thermal effect of the window frame on the total window assembly.

**P/H (sun-break shading ratio)**
The sun-break ratio, represented by P/H, relates to overhangs that shade glazing. P is the horizontal depth of the solid shading device from the shadow casting edge to the glazing line and H is the vertical distance from the shadow-casting edge of the shading device to the window sill.

To gain credit, the shading device must be solid for the full depth P and completely opaque to the direct sun. As such, slats or tinted glass overhangs that allow some direct solar gain onto the glazing underneath are not credited in the glazing calculator.

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**FACADE AREA**
The minimum allowable glazing thermal performance is set out in the current building code clause J2.4 as glazing equations that limit the ‘aggregate air-conditioning energy’ per annum to a maximum value. Effectively these equations are limits - expressed per square metre of facade area - on the total predicted heating and cooling energy allowed to be used in the perimeter zones. The equations differ for each climate zone (refer figure 1 for zones), orientation and building classification. Compliance is checked separately for every level on each orientation with glazed areas.


In order to use the glazing calculator correctly, however, the designer must understand the definition of facade area.

Facade area (figure 2) for each orientation is defined as the area of the external building envelope that encloses internal conditioned spaces. This includes service spaces within a building, such as an underfloor supply air plenum, a ceiling void or a return air plenum, that are in contact with an external wall and where the air temperature is likely to be conditioned. External walls that extend up above the roofline as parapet walls are not included in facade area because they do not form a part of the thermal envelope separating the conditioned interior from external conditions.

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Figure 2: ‘Facade Area’ illustrated in terms of the NCC’s Glazing Calculator.
The shading device must extend a minimum horizontal distance \( P \) on both sides of the window to be compliant with Section J clause J2.5. In some climate zones and orientations, increases to the depth \( P \) of the shade may not provide an improvement to the glazing area allowance. In all of the Tables 3–10 and Figures 4–19, the shading device has a shadow-casting edge at the same level as the window head height; so in terms of Figure 3, distance \( G \) in the tables and figures would equal zero. Horizontal shading devices with casting edges above or below the window head height will yield different glazed area allowances.

**LIST OF ACRONYMS AND TERMINOLOGY**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>DTS</td>
<td>Deemed-to-Satisfy</td>
</tr>
<tr>
<td>WWR</td>
<td>Window-to-wall (area) ratio, where ‘window’ includes glazed doors</td>
</tr>
<tr>
<td>SHGC</td>
<td>Solar heat gain coefficient</td>
</tr>
<tr>
<td>U-Value</td>
<td>A measurement that quantifies the ease with which heat conducts through a building element</td>
</tr>
<tr>
<td>NCC</td>
<td>National Construction Code</td>
</tr>
<tr>
<td>Energy Index</td>
<td>Parameter in Section J (Table J2.4a) that sets the maximum glazing area allowed on a facade</td>
</tr>
<tr>
<td>Compliance Indicator</td>
<td>A facade design’s level of compliance as compared with the Section J minimum energy requirements for glazing. A value of less than or equal to 100% is compliant. A value of higher than 100% is not.</td>
</tr>
</tbody>
</table>

Table 1. Acronyms and terms from the NCC. Also see the Glossary of Terms at the end of the paper.
Modelling (building) energy use

Designers who choose not to take the prescriptive ‘Deemed-to-Satisfy’ (DTS) route in their design must offer a ‘Performance Solution’. The most commonly used ‘Performance Solution’ compliance route is the ‘Verification Method’ called ‘JV3 Verification using a reference building’. This is often referred to as building energy modelling or building energy simulation. In this method, predicted annual building energy use is modelled via specialised computer software. This approach offers greater design flexibility than the prescriptive DTS approach by allowing designers to demonstrate that their preferred design is more energy efficient than the DTS ‘Reference Building’ design baseline. This gives the designer greater freedom (for instance, to employ more glazing) than the DTS approach allows.

A building envelope’s thermal performance is considered by the ABCB regulators to be an important component of building energy use. This is due to the envelope’s anticipated longevity and long-term influence on building energy use (relative to other components like HVAC or lighting, which are expected to have shorter lifecycles). As such, minimum requirements for the building envelope in Section J have had a bigger impact on existing design practices than those requirements for energy efficient building services.

To reflect this relative importance given by regulators to envelope thermal performance the ‘JV3’ method is structured in such a way that dictates that all buildings are to achieve minimum standards of building envelope thermal performance at least as energy efficient as that of the DTS ‘Reference Building’.

The modelled ‘Performance Solution’ building envelope design must perform as well as or better than a ‘Deemed-to-Satisfy’ design with the same geometry, roof light areas and facade glazing areas. Investment in high efficiency building services cannot be traded off against a building envelope that performs more poorly than a DTS ‘Reference Building’.

The important thing for designers to remember at the early concept stage is that if the DTS provisions are exceeded in some glazing orientations at some levels of the building, other major orientations may be well within compliance. Through the energy modelling calculations in a JV3 solution, ‘unused’ glazing area allowances (or thermally compliant portions of facades) are effectively traded across the building to compensate for parts of the design that exceed the DTS glazing requirements. Improved insulation levels can also form a part of a ‘JV3 Performance Solution’.

The JV3 ‘Performance Solution’ approach should be almost standard practice when designing residential accommodation buildings (Class 3 and 9c aged care buildings). This will allow designers to pursue better daylighting design than what would be permitted by the ‘Deemed-to-Satisfy’ glazing provisions. The glazing calculator encourages darker glazing and external shading, and often ignores the energy benefits of improving the glazing U-value for residential buildings which are predominantly occupied overnight when heating may be required for thermal comfort.

### Impact of Strategy

<table>
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<tr>
<th>Impact of Strategy</th>
<th>Symbol</th>
<th>Recommendation</th>
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</thead>
<tbody>
<tr>
<td>nominal &gt;30% increase in allowable WWR %</td>
<td>++</td>
<td>Adopt if possible</td>
</tr>
<tr>
<td>nominal &lt;30% increase in allowable WWR %</td>
<td>+</td>
<td>Consider adoption</td>
</tr>
<tr>
<td>No impact on WWR %</td>
<td>0</td>
<td>none</td>
</tr>
<tr>
<td>nominal &lt;30% decrease in WWR %</td>
<td>–</td>
<td>Consider avoiding</td>
</tr>
<tr>
<td>nominal &gt;30% decrease in WWR %</td>
<td>– –</td>
<td>Avoid if possible</td>
</tr>
</tbody>
</table>

Table 2: Key to strategy recommendation symbols in Tables 3–10.
Increasing window-to-wall ratio under the current code

Section J attempts to codify good passive design through optimising building orientation for each climate zone. The equations were based upon research on the impact of external glazing on energy use in perimeter zone heating and cooling for commercial buildings in different climate zones (Donnelly 2004). Understanding the effectiveness of shading and the impact of glazing selection for each orientation will help designers to orient their buildings on the site and to locate external glazing where it will be easiest to achieve a higher window-to-wall ratio (WWR). For most climate zones, effectively shaded north glazing and south glazing offer the highest WWR, while east and west orientations offer the lowest.

In this paper, the glazing regulations have been analysed to determine the benefit of different glazing strategies selected for their appropriateness in each of the eight climate zones. The glazing strategies tested include different values for shallow and deep external overhang depths (expressed as the sun-break ratio, P/H), high and low glazing system U-values and high and low SHGCs. The output of the tests is expressed in terms of the maximum allowable values for WWRs.

Each glazing strategy is assessed in terms of how it assists or hinders the designer in increasing glazed areas on that orientation. The analysis underpinning Tables 3-10 was conducted specifically for offices, non-shopfront retail or showroom glazing, warehouses, laboratories, healthcare and assembly buildings – or building classes 5 through 9b. That said, the tables also provide guidance for increasing glazing allowances for the other commercial building classes addressed in the graphs:

- shopfront and display (classes 6 and 7)
- accommodation (class 3)
- aged care facilities (class 9c)

Table 2 is the key to the symbols used in Tables 3–10. It is important to note that the percentages in Table 2 are relative. For example, where a given WWR for a particular type of glazing is 30%, a strategy deemed ‘++’ would increase the glazing area allowance by at least 30% of the initial 30%, to a final WWR in excess of 39% of the facade area.

Graphs of allowable WWRs as percentages are presented in Figures 4 to 19 to assist designers in determining compliant glazing proportions for their facade designs for the four stringency levels and associated building classification. In each graph, the vertical axis describes the allowable WWR, with the left and right vertical axes scaled to different building classes. The horizontal axis lists the eight solar orientations.

In Figure 4a, the right vertical axis indicates the allowable WWR for shopfronts (or display glazing), while the left vertical axis shows the allowable WWR for all other non-residential commercial building classes except shopfront glazing, noting that the NCC categorises aged care and hotels to be commercial. In Figure 4b, the left vertical axis shows the allowable WWR for Class 3 accommodation buildings, while the right vertical axis shows the allowable WWR for Class 9c aged care buildings.

A WWR of more than 100% (such as for Figure 6a) indicates that a fully glazed wall does not exceed the DTS allowance for this orientation. This means there is a potential opportunity to trade off the ‘unused’ allowance with another facade orientation through JV3 modelling (see ‘Modelling building energy use’ above).

Chart colours have been chosen to enable quick interpretation of the graphs. The warmer colours represent the high SHGC glazing option, which allows for the most solar heat gain, while the cooler colours represent the low SHGC glazing option, which allows for the least solar heat gain:

- yellow: unshaded
- red: P/H=0.4 sun-break ratio of shading
- brown: P/H=0.8 sun-break ratio of shading (only for warmest climates)
- light blue: unshaded
- dark blue: P/H=0.4 sun-break ratio of shading
- purple: P/H=0.8 sun-break ratio of shading (only for warmest climates)
STRATEGIES FOR ZONE 1

Locations: Darwin, Townsville, Cairns

<table>
<thead>
<tr>
<th>Glass orientation</th>
<th>Decrease U-value from 6.5 to 2.7</th>
<th>Decrease SHGC from 0.7 to 0.3</th>
<th>Introduce shading overhang of P/H=0.4</th>
<th>Increase shading overhang P/H from 0.4 to 0.8</th>
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<tr>
<td>E, NE, N, NW &amp; W</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>SE, S, SW</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

Table 3: Glazing strategies for climate zone 1.
STRATEGIES FOR CLIMATE ZONE 2

Locations: Mackay, Rockhampton, Brisbane, Coffs Harbour

Glass orientation | Decrease U-value from 6.5 to 2.7 | Decrease SHGC from 0.7 to 0.5 | Introduce shading overhang of P/H=0.4 | Increase shading overhang P/H from 0.4 to 0.8
---|---|---|---|---
E, NE, N, NW & W | - | ++ | + | ++
SE, S, SW | 0 | ++ | + | ++

Table 4: Glazing strategies for climate zone 2.
STRATEGIES FOR CLIMATE ZONE 3

Location: Alice Springs

<table>
<thead>
<tr>
<th>Glass orientation</th>
<th>Decrease U-value from 6.5 to 2.7</th>
<th>Decrease SHGC from 0.7 to 0.5</th>
<th>Introduce shading overhang of P/H=0.4</th>
<th>Increase shading overhang from P/H=0.4 to 0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>SE, E, NE, N, NW, W &amp; SW</td>
<td>+</td>
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</tr>
<tr>
<td>S</td>
<td>+</td>
<td>+</td>
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</table>

Table 5: Glazing strategies for climate zone 3.

Figure 8a. Zone 3: other classes and shopfronts, U=6.5.

Figure 8b. Zone 3: class 3 and 9c buildings, U=6.5.

Figure 9a. Zone 3: other classes and shopfronts, U=2.7.

Figure 9b. Zone 3: class 3 and 9c buildings, U=2.7.
STRATEGIES FOR CLIMATE ZONE 4

Locations: Mildura, Albury-Wodonga, Dubbo, Kalgoorlie-Boulder

<table>
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<th>Glass orientation</th>
<th>Decrease U-value from 6.5 to 2.7</th>
<th>Decrease SHGC from 0.7 to 0.3</th>
<th>Introduce shading overhang of P/H=0.4</th>
<th>Increase shading overhang from P/H=0.4 to 0.8</th>
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<tbody>
<tr>
<td>NE &amp; N</td>
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<td>++</td>
<td>++</td>
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<tr>
<td>S</td>
<td>++</td>
<td>-</td>
<td>0</td>
<td>0</td>
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</table>

Table 6: Glazing strategies for climate zone 4.
STRATEGIES FOR CLIMATE ZONE 5

Locations: Sydney coastal, Newcastle, Adelaide coastal, Perth

<table>
<thead>
<tr>
<th>Glass orientation</th>
<th>Decrease U-value from 6.5 to 3.7</th>
<th>Decrease SHGC from 0.7 to 0.3</th>
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<tr>
<td>S</td>
<td>++</td>
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Table 7: Glazing strategies for climate zone 5.

Figure 12a. Zone 5: other classes and shopfronts, U=6.5.

Figure 12b. Zone 5: class 3 and 9c buildings, U=6.5.

Figure 13a. Zone 5: other classes and shopfronts, U=3.7.

Figure 13b. Zone 5: class 3 and 9c buildings, U=3.7.
STRATEGIES FOR CLIMATE ZONE 6

Locations: Melbourne, Sydney west, Adelaide Hills

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<th>Glass orientation</th>
<th>Decrease U-value from 6.5 to 3.7</th>
<th>Decrease SHGC from 0.7 to 0.3</th>
<th>Introduce shading overhang of P/H=0.4</th>
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<tr>
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<tr>
<td>S</td>
<td>++</td>
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Table 8: Glazing strategies for climate zone 6.

Figure 14a. Zone 6: other classes and shopfronts, U=6.5.

Figure 14b. Zone 6: class 3 and 9c buildings, U=6.5.

Figure 15a. Zone 6: other classes and shopfronts, U=3.7.

Figure 15b. Zone 6: class 3 and 9c buildings, U=3.7.
STRATEGIES FOR CLIMATE ZONE 7

Locations: Hobart, Canberra

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<th>Glass orientation</th>
<th>Decrease U-value from 6.5 to 2.7</th>
<th>Decrease SHGC from 0.7 to 0.3</th>
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<td>SW &amp; S</td>
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Table 9: Glazing strategies for climate zone 7.

Figure 16a. Zone 7: other classes and shopfronts, U=6.5.

Figure 16b. Zone 7: class 3 and 9c buildings, U=6.5.

Figure 17a. Zone 7: other classes and shopfronts, U=2.7.

Figure 17b. Zone 7: class 3 and 9c buildings, U=2.7.
STRATEGIES FOR CLIMATE ZONE 8

Locations: alpine regions (above elevation 1200m on mainland Australia or above 900m in Tasmania)

Glass orientation | Decrease U-value from 2.7 to 2.0 | Decrease SHGC from 0.6 to 0.4 | Introduce shading overhang of P/H=0.4
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<tr>
<td>SW &amp; S</td>
<td>++</td>
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Table 10: Glazing strategies for climate zone 8.
Exceeding Minimum Practice

It is generally desirable for designers to demonstrate to clients that their building envelope designs perform better than the minimum performance required by the current NCC so as to minimise the energy costs of running a building. Where energy modelling is not undertaken, one way of demonstrating this for a ‘Deemed-to-Satisfy’ facade design is to add up a facade area-weighted set of the glazing compliance indicators from each glazed orientation. [These indicators can be found expressed as percentages on the far right hand side of the glazing calculator spreadsheet. See Figure 20 below.] This total is then divided by the total facade areas for all of the orientations, on all of the levels of the building.

For the Glazing Calculator example in Figure 20, the overall glazing compliance ratio is calculated by dividing 107.5 by 200 which equals 0.537. The steps in this calculation are set out in Table 11. In this way a designer can report a percentage of facade thermal performance improvement over the minimum glazing measures required by the NCC. In this example a designer can report to the client that the glazing design is 46.3% better than the maximum DTS allowance across every facade orientation. (This maximum DTS allowance would equate to a compliance indicator of 100%.)

Table 11: Example overall glazing ‘Compliance Indicator’ calculations.
Summary and Further Recommendations

The editions of the National Construction Code from BCA 2010 onwards have glazing regulations that are considerably more stringent than those in BCA 2009, particularly in temperate and cool climates. Designers need easy-to-use glazing design information to inform their development of early facade concepts. Charts of a limited range of glazing and shading options have been presented to enable early decision making on building orientation, glazing size and performance, the location of facade glazing and the design of external shading devices. Particular attention should be paid to the development of facade designs for both hotels/hostels and aged care facilities, where allowable glazed areas are quite small.

Where possible, designers should strive to design for better facade energy performance than that resulting from adoption of the 'Deemed-to-Satisfy' minimum requirements for glazing. To achieve this, the services of an experienced energy modeller should be procured as early as possible in the design stage. Where an energy modeller is not used, the compliance indicators in the glazing calculator can be used to demonstrate to a client that the design exceeds the minimum glazing requirements of NCC Section J by a minimum percentage improvement target, which can be set by the client at the start of the project.

The three year lead time to the next iteration of the NCC gives the ABCB sufficient time to develop, with informed input from industry working groups, more stringent and better targeted minimum energy performance requirements. Specific areas for improvement include:

1. Revising the equations dictating the glazing/shading requirements in the glazing calculator to provide energy efficient glazing solutions appropriate for class 3 and 9c buildings that have a residential use profile that is markedly different to non-residential buildings;
2. Building envelope minimum airtightness standards in climate zones where they are appropriate;
3. Significantly lower lighting power density targets.

Glossary of Terms

Air-conditioning: a system or unit installed in a building to control the temperature of the air by heating or cooling. These systems range from a simple package unit installed in the wall through to a complex integrated system made up of a number of distinct sub-systems and components, as found in plant rooms or on roofs.

Conditioned Space: a space within a building, including a ceiling or under-floor supply air plenum or return air plenum, where the environment is, by the intended use of the space, likely to have its temperature controlled by air-conditioning or heating.

'Deemed-to-Satisfy' Provisions: the prescriptive provisions contained in the NCC which must all be met in order to comply with the 'Performance Requirements' of the code when not pursuing a 'Performance Solution'. These can restrict design freedom.

Envelope: the parts of a building’s fabric that separate a conditioned space or habitable room from the exterior of the building or a non-conditioned space (such as a plant room, car park or warehouse space).

Fabric: the basic building structural elements and components of a building including the roof, ceilings, walls and floors.

'Performance Solution': formerly known as an ‘Alternative Solution’, a ‘Performance Solution’ is a building design that complies with the ‘Performance Requirements’ of the NCC by means other than complying with the ’Deemed-to-Satisfy’ provisions.

'Reference Building': a hypothetical building that is used to calculate the maximum allowable annual energy consumption for a proposed building design. In other contexts, this is sometimes referred to as a baseline building or design baseline.

Solar heat gain coefficient (SHGC): SHGC measures how well glazing (including glass and frame) transfers heat caused by sunlight. The SHGC is the fraction of incident solar radiation admitted through a window, directly transmitted as well as absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window’s SHGC, the less solar heat it transmits (YourHome, 2014).

'Total System U-value' refers to the ability of a composite glazing element to conduct heat. This value also accounts for the effect of any air spaces and associated surface resistances and the effect of conduction (thermal-bridging) through frame elements supporting the facade glazing or roof light.

U-value: a coefficient of heat transfer that describes the ability of a material or construction assembly to conduct heat. It is the inverse of the R-Value, which measures the ability of a material or a material assembly to resist heat flow by conduction.
About the Author

Educated in both engineering and architecture, Michael Shaw is the ESD Manager at Connor Pincus Group services engineering consultants. He has worked in government and in private consulting and has extensive experience in the application of environmental rating systems. He has delivered many training seminars for architects, engineers and building surveyors in the application of NCC Section J.

References


