GREEN BUILDING INDEX – MS1525

PAM CPD SEMINAR ON MS1525:2007
Code of Practice on Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings
14th February 2009  PAM Kuala Lumpur

Ar Chan Seong Aun
M Arch (Distinction), B Arch (Hons), B Bdg Sc (VUW, NZ), APAM, AIPDM, TAM

CONTENT

1. WHY BE ENERGY EFFICIENT?
2. ENERGY EFFICIENT ARCHITECTURE
3. BASICS OF MS1525 SECTION 5 BUILDING ENVELOPE
4. COMPLYING WITH MS1525 OTTV & RTTV
5. SAMPLE BUILDING MS1525 CALCULATION
WHY BE ENERGY EFFICIENT?

- The skill and vision of those who shape our cities and homes is vital to achieving sustainable solutions to the many environmental, economic and social problems we face on a local, national and global scale

Peter Graham
Energy Efficient and Sustainable Buildings

Why?

- To reduce the pressure on our environment and our resources
- To give our children and grandchildren a (prosperous) future
- Because buildings that cannot be rated Environmentally Friendly will lose out in the property market of the future.
As Responsible Architects we have to go for a more sustainable form of Architecture

ENERGY EFFICIENT ARCHITECTURE
KEY PASSIVE DESIGN FACTORS AFFECTING ENERGY USE IN BUILDINGS FOR ARCHITECTS TO CONSIDER

- SITE PLANNING & MICRO-CLIMATE
- ORIENTATION
- SIZE & SHAPE
- PLANNING & ORGANIZATION
- THERMAL RESISTANCE
- THERMAL CAPACITY
- WINDOW SYSTEMS
- CONSTRUCTION DETAILING
SITE PLANNING & LANDSCAPING

• Landscaped surroundings can reduce the outside ambient temperatures by as much as 7 deg C.
• Peak surface temperatures of bare concrete can be as much as 25 deg C higher than surface temperatures of grassed over areas.
• The key point is to reduce the outside temperature by improving the surroundings as much as possible.
\[ T = 39 - 25 = 14^\circ C \]
SITE PLANNING & MICRO-CLIMATE

$\Delta \ T = 32 - 25 = 7^\circ C$

Urban Heat Island Effect: Case Singapore

Sketch of Urban Heat Island profile in Singapore

UHI intensity
= 4.5 degrees C
ORIENTATION

• A double storey house facing east-west can expect to get nearly 30% more solar radiation than an identical north south facing house.

• For flats and apartments, depending on the aspect ratio and height of the building, an east-west facing building can have 16% to 40% more solar gain than a north-south facing block.

Window Orientation Is Important:
North And South Windows Are Preferable
ROOF INSULATION IS ONE OF THE MOST IMPORTANT DESIGN DECISIONS FOR ENERGY EFFICIENT BUILDINGS

- The roof plane receives the most Solar Radiation and for the longest period through the day
- >75% of the Solar Gain by a typical Intermediate Single Storey Terraced House is through its ROOF
- >50% of the Solar Gain by a typical Intermediate Double Storey Terraced House is through its ROOF
- >40% of the Solar Gain by a typical 5 Storey Block of Flats is through its ROOF

THERMAL INSULATION FLAT ROOFS

Use 50-100 mm thick insulation

50mm - 100mm Insulation

<table>
<thead>
<tr>
<th>100mm Cast Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td>900mm Ceiling Air Space</td>
</tr>
</tbody>
</table>

Interior Air-Conditioned Space

12mm Ceiling Tiles
DOUBLE ROOF WITH SERVICES AT ROOF TOP

INSULATED DOUBLE ROOF

- Roof Insulation: 100mm Polystyrene Insulation
- Lift Motor Level
- Roof Beam Level
- 4th Floor Level
- 4800, 4200, 2150

THERMAL INSULATION PITCHED ROOFS

Add 100mm thick insulation & ventilate the roof

- Metal Deck Roof
- 50mm ventilation gap
- 100mm Insulation Wool
- Aluminum Sheet
- Ceiling Tiles (fiber board)

35°C
45°C

Roof Space
THERMAL INSULATION PITCHED ROOFS

Add 100mm thick insulation to the ceiling for retrofit

- Metal Deck Roof
- Existing 50mm Insulation Wool
- Aluminum Sheet
- 45°C
- 35°C
- Roof Space
- Additional 100mm Insulation on the Ceiling to prevent heat from affecting the space below.
- Ceiling Tiles (fiber board)

Source: Dr. Nigel / Lafarge
Roof Garden IBP Atrium Singapore
THERMAL INSULATION FOR WALLS

• Avoid Sandbrick
  – Very poor U-value > 3 W/m2K

• Insulated Walls
  – Aerated Lightweight Concrete (ALC)
    • U-value of 1 W/m2K for 100mm

• Use U-value < 1 W/m2K
  – 150 mm thick ALC

Typical U-value of 2.43 W/m2K
WINDOW SHADING

- External Shading Devices are more effective than Internal Blinds.
- Only need to block out Direct Sunlight.

HORIZONTAL LOUVERS FOR N-S FACING WINDOWS

VERTICAL LOUVERS FOR E-W FACING WINDOWS
AFTER AIR CONDITIONING LIGHTING ENERGY CONSUMPTION IS THE NEXT MOST IMPORTANT FOR COMMERCIAL BUILDINGS.

Energy Index

-30.0  -10.0   10.0    30.0   50.0   70.0   90.0   110.0  130.0  150.0


kWh/m²/year

WINDOWS & DAYLIGHTING IN BUILDINGS

- Daylight in Building offset electrical lighting load
- Electrical lights produces more heat than Diffused Daylight
- Zone electrical lighting system correctly
DAYLIGHTING ESSENTIALS

1. Bring the light in high, above the view plane
2. Diffuse sunlight inside the space. Don’t allow beam sunlight to strike work surfaces.
3. Use only north and south vertical windows
4. Choose the glazing carefully.

- Continuous strip of narrow windows up high
- A few view windows. These have a low visible transmittance (0.2 – 0.3), to balance the luminance of the walls with the luminance of the outdoor view. Every work place in the building should have a visual connection to the outside
- Eggshell white color in the upper part of the room to bounce the light across the room
- Mid-to-light colors in the lower part of the room
CHOOSE SPECTRALLY SELECTIVE GLAZING

ideal window transmittance

solar spectrum

visible

Wavelength, nm

0 500 1000 1500 2000 2500 3000

BASICS OF MS1525
SECTION 5: BUILDING ENVELOPE

MALAYSIAN STANDARD
• MS 1525 COMPLIANCE TO BE INCORPORATED IN UBBL REVISION BY KPKT

• ARCHITECTS & ENGINEERS REQUIRED TO COMPLY TO MS1525 FOR NON-RESIDENTIAL BUILDINGS WITH AIR CONDITIONED AREAS LARGER THAN 4000 SM AFTER UBBL AMENDMENT

• ARCHITECTS / ENGINEERS WILL HAVE TO SUBMIT OTTV & RTTV CALCULATIONS TO COMPLY WITH SECTION 5 OF MS1525

• ENGINEERS WILL HAVE TO ENSURE COMPLIANCE WITH SECTION 6, 7, 8, AND 9

Temperature and Humidity (Subang Weather Data)
Why do we need to air condition our Offices?

Temperature and Humidity (Subang Weather Data)
Why do we need to air condition our Offices?
5.8 Submission procedure

The following information shall be provided by a professional Engineer or Professional Architect:

a) a drawing showing the cross-sections of typical parts of the roof construction, giving details of the type and thickness of basic construction materials, insulation and air space;

b) the U-value of the roof assembly;

c) the OTTV calculation; and

d) the RTTV of the roof assembly, if provided with skylights.

5.2.1 The OTTV of building envelope is given by the formula below:

\[
OTTV = \frac{A_{o1} \times OTTV_1 + A_{o2} \times OTTV_2 \ldots \ldots \times A_{on} \times OTTV_n}{A_{o1} + A_{o2} \ldots \ldots + A_{on}}
\]

where,

- \(A_{oi}\) is the gross exterior wall area for orientation \(i\); and
- \(OTTV_i\) is the OTTV value for orientation \(i\) from equation (2).

5.2.2 For a fenestration at a given orientation, the formula is given as below:

\[
OTTV_i = 15 \alpha (1 - WWR) U_s + 6 (WWR) U_s + (194 \times CF \times WWR \times SC)
\]
OTTVi = 15α(1-WWR)Uw + 6(WWR)Uf + 194xCFxWWRxSC

Heat Conduction through Walls
Heat Conduction through Windows
Solar Heat Gain through Windows

OTTV < 50 W/m2

HEAT CONDUCTION THROUGH WALLS

15α(1-WWR)Uw

15 x Solar Absorb x Wall Area x U-value of wall (Heat Conduct through Wall)

α = Solar Absorption = Colour of walls

Depending on WWR this is typically 0.5% to 5% of Total OTTV for high rise buildings

<table>
<thead>
<tr>
<th>Material</th>
<th>Solar Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Paint</td>
<td>0.90-0.99</td>
</tr>
<tr>
<td>White Paint</td>
<td>0.15-0.30</td>
</tr>
<tr>
<td>Aluminium Oxide Paint</td>
<td>0.09</td>
</tr>
<tr>
<td>Red Roof Tiles</td>
<td>0.4-0.8</td>
</tr>
</tbody>
</table>
U-VALUE OF WALLS

U-value is the heat transmission value of the wall in W/m²K
U-values have to be worked out from the Thermal Resistance of the respective materials making up the wall
The Overall thermal resistance of the composite wall = Thickness x Conductivity x Resistance of each component totaled up
The Higher the Thermal Resistance, the lower the U-Value and therefore the Thermal Transmittance of heat through the walls

HEAT CONDUCTION THROUGH WINDOWS

6(WWR)Uf
6 x Window Area x U-value of Window (Heat Conduct through Window)
Depending on WWR this is between 10% to 20% of Total OTTV for high rise buildings

<table>
<thead>
<tr>
<th>WINDOW TYPE</th>
<th>TYPICAL U-VALUES w/m²K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Glazed window</td>
<td>5.7</td>
</tr>
<tr>
<td>Single Glazed Window Low-E</td>
<td>4.2</td>
</tr>
<tr>
<td>Double Glazed Window</td>
<td>2.6-2.9</td>
</tr>
<tr>
<td>Double Glazed Window Low-E</td>
<td>1.2</td>
</tr>
</tbody>
</table>
SOLAR GAIN THROUGH WINDOWS

194 \times CF \times WWR \times SC

194 \times \text{Correction Factor (Depend on Orientation-Table 4)} \times \text{Window Area} \times \text{Shading Coefficient (Table 5,6 & 7)}

Depending on WWR this is between 75\% to 85\% of Total OTTV. The large constant of 194 already hints that this is a major factor in the OTTV.

SC can be a major contributor to reducing the Overall OTTV as it can change this component by between 30\% to 80\%.

COMPLYING WITH MS1525 OTTV & RTTV VALUES
U-VALUE OF ROOFS

U-value is the heat transmission value of the Roof in W/m²K

U-values have to be worked out from the Thermal Resistance of the respective materials making up the Roof

The Overall thermal resistance of the composite Roof = Thickness x Conductivity x Resistance of each component totaled up

The Higher the Thermal Resistance, the lower the U-Value and therefore the Thermal Transmittance of heat through the Roof

Table 9. Maximum U-value for roof (W/m²K)

<table>
<thead>
<tr>
<th>Roof Weight Group</th>
<th>Maximum U-Value (W/m²K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light (Under 50 kg/m²)</td>
<td>0.4</td>
</tr>
<tr>
<td>Heavy (Above 50 kg/m²)</td>
<td>0.6</td>
</tr>
</tbody>
</table>
MS 1525 ROOF INSULATION REQUIREMENTS

a) a drawing showing the cross-sections of typical parts of the roof construction, giving details of the type and thickness of basic construction materials, insulation and air space;
b) the U-value of the roof assembly;
   • Concrete tiled roofs (Light weight) with NO INSULATION will have a U-value of 0.7 w/m2K
   • With 50mm fiberglass, the U-value will be about 0.35 w/m2K
   • 100mm Concrete roof slab (Heavy weight) will have a U-value of 3 w/m2K
   • With 50mm polystyrene foam, the U-value can be brought down to 0.56 w/m2

REDUCING SOLAR GAIN THROUGH WINDOWS

194xCFxWWRxSC

194 x Correction Factor (Depend on Orientation-Table 4) x Window Area x Shading Coefficient (Table 5,6 & 7)

Depending on WWR this is between 75% to 85% of Total OTTV. The large constant of 194 already hints that this is a major factor in the OTTV

SC can be a major contributor to reducing the Overall OTTV as it can change this component by between 30% to 80%
IMPROVING THE SHADING COEFFICIENT OF WINDOWS

Window SC = Glass SC x Shading Device SC

$$SC_{\text{window}} = 0.6 \times 0.8 = 0.48$$
a reduction of more than 50%

$$R1 = \frac{\text{Projection}}{\text{Window Height}}$$
Typical = 0.3m/1.2m = 0.25
SC = 0.8
TABLE 5

HORIZONTAL PROJECTION SHADING COEFFICIENTS

<table>
<thead>
<tr>
<th>R1 (Projection / Window Height)</th>
<th>North/South</th>
<th>East</th>
<th>West</th>
<th>NE/SW</th>
<th>NW/SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 to 0.4</td>
<td>0.77</td>
<td>0.77</td>
<td>0.79</td>
<td>0.79</td>
<td>0.79</td>
</tr>
<tr>
<td>0.5 to 0.7</td>
<td>0.71</td>
<td>0.68</td>
<td>0.71</td>
<td>0.71</td>
<td>0.72</td>
</tr>
<tr>
<td>0.8 to 1.2</td>
<td>0.67</td>
<td>0.6</td>
<td>0.65</td>
<td>0.69</td>
<td>0.66</td>
</tr>
<tr>
<td>1.3 to 2.0</td>
<td>0.65</td>
<td>0.55</td>
<td>0.61</td>
<td>0.63</td>
<td>0.53</td>
</tr>
</tbody>
</table>

R1 = Projection / Window Height
Top = 0.3m/0.3m = 1.0
SC = 0.67
TABLE 6

VERTICAL PROJECTIONS SHADING COEFFICIENTS

<table>
<thead>
<tr>
<th>R2 (Projection / Window Width)</th>
<th>North/South</th>
<th>East</th>
<th>West</th>
<th>NE/SW</th>
<th>NW/SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 to 0.4</td>
<td>0.82</td>
<td>0.87</td>
<td>0.86</td>
<td>0.83</td>
<td>0.84</td>
</tr>
<tr>
<td>0.5 to 0.7</td>
<td>0.77</td>
<td>0.82</td>
<td>0.81</td>
<td>0.77</td>
<td>0.79</td>
</tr>
<tr>
<td>0.8 to 1.2</td>
<td>0.73</td>
<td>0.78</td>
<td>0.77</td>
<td>0.72</td>
<td>0.74</td>
</tr>
<tr>
<td>1.3 to 2.0</td>
<td>0.7</td>
<td>0.75</td>
<td>0.74</td>
<td>0.69</td>
<td>0.71</td>
</tr>
</tbody>
</table>

TABLE 7

EGG CRATE SHADING COEFFICIENTS

<table>
<thead>
<tr>
<th>R1=Projection/WindowHeight</th>
<th>R2=Projection/WindowWidth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>North/South</td>
</tr>
<tr>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td>0.2</td>
<td>0.62</td>
</tr>
<tr>
<td>0.4</td>
<td>0.59</td>
</tr>
<tr>
<td>0.6</td>
<td>0.49</td>
</tr>
<tr>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>1.0</td>
<td>0.31</td>
</tr>
<tr>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>1.4</td>
<td>0.14</td>
</tr>
<tr>
<td>1.6</td>
<td>0.07</td>
</tr>
<tr>
<td>1.8</td>
<td>0.04</td>
</tr>
<tr>
<td>2.0</td>
<td>0.02</td>
</tr>
</tbody>
</table>
WINDOW SHADING

- External Shading Devices are more effective than Internal Blinds.
- Only need to block out Direct Sunlight.
HORIZONTAL LOUVERS FOR N-S FACING WINDOWS

VERTICAL LOUVERS FOR E-W FACING WINDOWS

VERTICAL LOUVERS FOR E-W FACING WINDOWS

HORIZONTAL LOUVERS FOR N-S FACING WINDOWS
WINDOW GLAZING

Spectrally Selective Glazing:
Lets in the lights, blocks out the heat

Tinted Glazing
Sp. Sel. Glazing

Typical Values, Double Glazing: Light 60% Transmission
Heat 30% Transmission

GLASS SHADING COEFFICIENTS & U-VALUES

<table>
<thead>
<tr>
<th>COLOUR</th>
<th>TINTED</th>
<th>SOLAR CONTROL</th>
<th>U-value</th>
<th>U-value (With Eclad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>0.7</td>
<td>0.54</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Grey</td>
<td>0.45</td>
<td>0.33</td>
<td>0.48</td>
<td>0.35</td>
</tr>
<tr>
<td>Bronze</td>
<td>0.5</td>
<td>0.38</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Blue-Green</td>
<td>0.5</td>
<td>0.38</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Azur Blue</td>
<td>0.4</td>
<td>0.3</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Evergreen</td>
<td>0.39</td>
<td>0.29</td>
<td>0.58</td>
<td>0.35</td>
</tr>
</tbody>
</table>

SHGC (Solar Heat Gain Coefficient)

<table>
<thead>
<tr>
<th>COLOUR</th>
<th>TINTED</th>
<th>SOLAR CONTROL</th>
<th>U-value</th>
<th>U-value (With Eclad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>0.60</td>
<td>0.62</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Grey</td>
<td>0.52</td>
<td>0.38</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Bronze</td>
<td>0.57</td>
<td>0.44</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Blue-Green</td>
<td>0.57</td>
<td>0.44</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Azur Blue</td>
<td>0.46</td>
<td>0.34</td>
<td>0.58</td>
<td>0.35</td>
</tr>
<tr>
<td>Evergreen</td>
<td>0.45</td>
<td>0.33</td>
<td>0.58</td>
<td>0.35</td>
</tr>
</tbody>
</table>

Source: Pilkington
SAMPLE BUILDING MS1525 CALCULATION
### OFFICE 1

**Building Name:** Sample Office 1  
**Building Description:** 26 storey Office Building on 3 storey Podium  
**Floor Area of AC Spaces:** 3,580 m²  
**Notes:** Brick walls & 6 mm glazing  
**BUILDING ENVELOPE DATA**

<table>
<thead>
<tr>
<th>AREA</th>
<th>SW Transmittance</th>
<th>U-value</th>
<th>R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WALL</td>
<td>0.40 WWm²K</td>
<td>0.035</td>
<td>28.56</td>
</tr>
<tr>
<td>1. North Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>2. East Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>3. West Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>TOTAL C qualify</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL C qualify**

<table>
<thead>
<tr>
<th>AREA</th>
<th>SW Transmittance</th>
<th>U-value</th>
<th>R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WALL</td>
<td>0.40 WWm²K</td>
<td>0.035</td>
<td>28.56</td>
</tr>
<tr>
<td>1. North Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>2. East Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>3. West Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>TOTAL C qualify</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### OFFICE 1A

**Building Name:** Sample Office 1  
**Building Description:** 26 Storey Office Building on 3 Storey Podium  
**Floor Area of AC Spaces:** 3,580 m²  
**Notes:** Brick walls & 6 mm glazing with Improved window shading  
**BUILDING ENVELOPE DATA**

<table>
<thead>
<tr>
<th>AREA</th>
<th>SW Transmittance</th>
<th>U-value</th>
<th>R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WALL</td>
<td>0.40 WWm²K</td>
<td>0.035</td>
<td>28.56</td>
</tr>
<tr>
<td>1. North Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>2. East Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>3. West Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>TOTAL C qualify</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL C qualify**

<table>
<thead>
<tr>
<th>AREA</th>
<th>SW Transmittance</th>
<th>U-value</th>
<th>R-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WALL</td>
<td>0.40 WWm²K</td>
<td>0.035</td>
<td>28.56</td>
</tr>
<tr>
<td>1. North Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>2. East Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>3. West Elevation</td>
<td>2.84</td>
<td>0.55</td>
<td>17.45</td>
</tr>
<tr>
<td>TOTAL C qualify</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ROOF RTV

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>Thickness</th>
<th>K-value</th>
<th>Durability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside Solar absorption</td>
<td>0.750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Surface Resistance</td>
<td>0.075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cement sand sanded</td>
<td>25</td>
<td>0.953</td>
<td>0.049</td>
</tr>
<tr>
<td>Reinforced Concrete slab</td>
<td>100</td>
<td>0.953</td>
<td>0.000</td>
</tr>
<tr>
<td>Inside Surface Resistance</td>
<td>0.148</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U-value (Win/Wk)</td>
<td>2.920</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Not to exceed 0.4 Win/m²k and 0.9 Win/m²k for double roof*