Low-E Glasses: Energy Savings, Comfort, Productivity and more

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Today’s Discussion

• Highlights on studies conducted by WGBG and Carnegie Mellon University

• Compare 18 types of glass products
  – ETTV
  – VLT
  – CRI

• Noise and Acoustics
Health, Wellbeing and Productivity in Offices

WGBC - The next chapter for green building

• 2013 serious effort to quantify health & wellbeing
• Studied the Human Benefits of Green
  – HEALTH – physical and mental
  – WELLBEING – feeling satisfied
• Put a $$ value on Green in addition to energy and upfront capital equipment costs
• Published in March 2014
Report Findings:
Typical Business Operating Costs

- 1% Energy Costs
- 9% Rental Costs
- 90% Staff Costs
Report Findings:
Key Areas that Contribute to Staff Well Being

• **Indoor air quality & ventilation**
• **Thermal comfort**
• **Lighting & Daylighting**
• **Biophilia & views of nature**
• **Noise & acoustics**
• **Interior layout**
• **Active design and exercise**
Natural light has been shown to be psychologically beneficial, the more light, the better.

Recent studies link natural light with improved work environments and increased productivity.
Lighting & Daylighting

• Quantity $T_{vis}$
  – Clear glass
  – Tinted glasses
  – Reflective coated glasses
  – Low-e glasses

• Glare
  – Tinted glasses – absorb light
  – Reflective glasses – reflect light
  – Fritted glasses – reflect light

• Internal reflection
  – Requires balance
  – Result of controlling other factors
Basis of Comparison for Energy
ETTV: Envelope Thermal Transfer Value

\[ ETTV_{Sg} = 12(1-WWR)U_w + 3.39(WWR)U_f + 211(WWR)(SC) \]

WWR = 70%,
U wall = 2 W/m²K
U window = varies
SC window = varies
## Basis of Comparison for Energy Products

<table>
<thead>
<tr>
<th>Material</th>
<th>U summer</th>
<th>SC</th>
<th>ETTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>5.27</td>
<td>0.94</td>
<td>158.41</td>
</tr>
<tr>
<td>CL-CL IG</td>
<td>2.85</td>
<td>0.81</td>
<td>133.48</td>
</tr>
<tr>
<td>Gray Tint</td>
<td>5.27</td>
<td>0.67</td>
<td>118.39</td>
</tr>
<tr>
<td>Blue Tint</td>
<td>5.27</td>
<td>0.57</td>
<td>103.75</td>
</tr>
<tr>
<td>Light Reflective Blue</td>
<td>4.91</td>
<td>0.53</td>
<td>97.03</td>
</tr>
<tr>
<td>2x Ag laminate</td>
<td>4.91</td>
<td>0.52</td>
<td>95.55</td>
</tr>
<tr>
<td>Dark Reflective Blue</td>
<td>5.2</td>
<td>0.44</td>
<td>84.59</td>
</tr>
<tr>
<td>Dark Gray Tint</td>
<td>5.27</td>
<td>0.41</td>
<td>80.16</td>
</tr>
<tr>
<td>3x Ag lami Neutral</td>
<td>4.91</td>
<td>0.36</td>
<td>71.93</td>
</tr>
</tbody>
</table>

6mm monoliths, 66.4lami, 6-12-6 IGU
## Basis of Comparison for Energy Products

<table>
<thead>
<tr>
<th></th>
<th>U summer</th>
<th>SC</th>
<th>ETTV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x Ag IGU Neutral</td>
<td>1.6</td>
<td>0.45</td>
<td>77.36</td>
</tr>
<tr>
<td>2x Ag IGU Blue</td>
<td>1.6</td>
<td>0.32</td>
<td>58.17</td>
</tr>
<tr>
<td>3x Ag IGU Neutral</td>
<td>1.5</td>
<td>0.32</td>
<td>57.99</td>
</tr>
<tr>
<td>2x Ag IGU Gray</td>
<td>1.6</td>
<td>0.29</td>
<td>53.74</td>
</tr>
<tr>
<td>3x Ag IGU Blue</td>
<td>1.5</td>
<td>0.29</td>
<td>53.5</td>
</tr>
<tr>
<td>4x Ag IGU Neutral</td>
<td>1.5</td>
<td>0.27</td>
<td>50.55</td>
</tr>
<tr>
<td>4x Ag IGU Blue</td>
<td>1.5</td>
<td>0.24</td>
<td>46.12</td>
</tr>
<tr>
<td>3x Ag IGU Gray</td>
<td>1.5</td>
<td>0.23</td>
<td>44.64</td>
</tr>
<tr>
<td>4x Ag IGU Gray</td>
<td>1.5</td>
<td>0.19</td>
<td>38.73</td>
</tr>
</tbody>
</table>

6mm monoliths, 66.4lam, 6-12-6 IGU
ETTV and Tvis

- ETTV
- VLT

Clear
CL CL IG
Gray Tint
Blue Tint
2x Ag laminate
Dark Reflective Blue
2x Ag IGU Neutral
3x Ag IGU Neutral
2x Ag IGU Blue
3x Ag IGU Blue
4x Ag IGU Neutral
4x Ag IGU Blue
3x Ag IGU Gray
4x Ag IGU Gray

Graph showing variations in ETTV and VLT across different materials.
Biophilia and views of nature

Color Rendering Index (CRI) of Glasses

- Scale 1 – 100
- Accuracy of actual color when viewing through the window

<table>
<thead>
<tr>
<th>6mm Monolithic</th>
<th>CRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra Clear</td>
<td>99-100</td>
</tr>
<tr>
<td>Clear</td>
<td>97-98</td>
</tr>
<tr>
<td>Gray</td>
<td>95-96</td>
</tr>
<tr>
<td>Bronze</td>
<td>94-95</td>
</tr>
<tr>
<td>Green</td>
<td>90-91</td>
</tr>
<tr>
<td>Blue</td>
<td>85-86</td>
</tr>
<tr>
<td>Blue Green</td>
<td>78-79</td>
</tr>
</tbody>
</table>
Color Rendering Index, ETTV and VLT

ETTV, VLT, and CRI values for different materials and conditions.
CRI – Clear, Gray and Blue Glasses
Museo Amparo, Mexico
Shanghai Cultural Center, Shanghai, China
Queen Alia Airport, Jordan
Cotroceni Mall, Bucharest, Romania
CRI 90

Times Square Mall, Seoul, S.Korea
Noise and Acoustics

• **Sound Transmission Class Rating (STC)** – applicable to interior building partitions and viewing windows where the sound source is human speech and/or office equipment.

• **Outdoor-Indoor Transmission Class (OITC)** – applicable to exterior walls (including doors and windows) where the sound source is due to transportation vehicles (cars, trucks, trains).
### GENERIC STC and OITC RATINGS
Not to be used for design or specification purposes

<table>
<thead>
<tr>
<th>Glass Product Type and Thickness</th>
<th>STC Rating</th>
<th>OITC Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>6mm monolithic</td>
<td>31</td>
<td>29</td>
</tr>
<tr>
<td>12mm monolithic</td>
<td>36</td>
<td>33</td>
</tr>
<tr>
<td>6mm – 12 air – 6mm</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>6mm + PVB + 6mm</td>
<td>38</td>
<td>34</td>
</tr>
<tr>
<td>3 mm + PVB + 3mm + 12mm air + 6mm</td>
<td>39</td>
<td>31</td>
</tr>
<tr>
<td>3mm + PVB + 6mm + 12mm air + 6mm</td>
<td>40</td>
<td>31</td>
</tr>
<tr>
<td>12mm Gypsum board, screwed to metal studs</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
Noise and Acoustics

- **For Monolithic Glass**
  - Increase glass thickness

- **For Laminated Glass**
  - Increase glass thickness
  - Use different glass thickness for individual glass lites

- **For Insulating Glass Units**
  - Increase glass thickness
  - Increase air space dimension
  - Evaluate different gas fills
  - Evaluate different spacer and sealant materials
  - Use different glass thickness for individual glass lites
  - Use a laminated component for one or both of the plies.
Summary

- Studies show glass in a commercial building can affect occupants health, wellbeing and productivity
- Occupants want to be one with nature:
  - View of outdoors
  - Large WWR, requires low SC
  - Undistorted view, requires high CRI
  - High performing low-e coatings on clear provides high VLT, low SC, high CRI
- Occupants do not want disturbed by city noise or office noise
  - Requires higher performing glasses, i.e. low-e coated glasses, in a lami, lami-IG
Future of Architectural Glasses

- Higher Performance Low-e (4xAg)
- Neutral Reflected Color
- Complex Configurations
QUESTIONS?

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