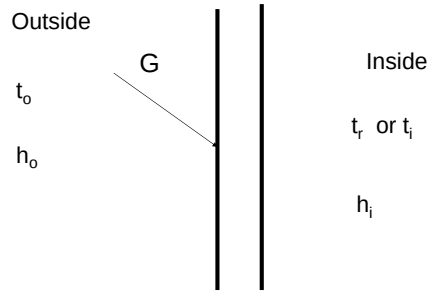
## Heat Gain though Fenestration

# Solar Heat Gain Coefficient

**SHGC**

1

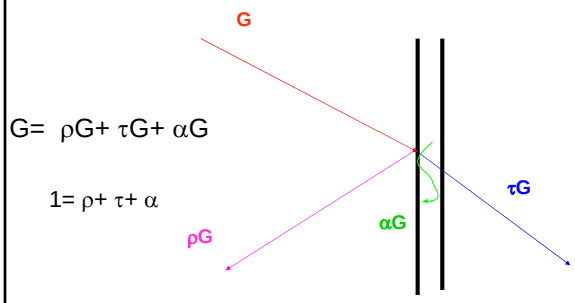
## Radiation through a fenestration




**Window**

2

## Radiation through a fenestration




3

## Solar Heat Gain Coefficient SHGC

$$SHG = \tau G_i + N_i \alpha G_i = G_i(\tau + \alpha N_i) = G_i * SHGC$$

**Transmitted**

**Fraction absorbed and admitted to space**

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## Definition of Solar heat Gain Coefficient (SHGC)

The Solar heat gain flux through a window is given by

$$q'' = G_i * SHGC$$

$G_i$ is the incident solar radiation

q" is the solar heat gain flux (SHG)

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## Instantaneous heat gain due to a fenestration (Window)

$$q'' = Solar\ heat\ gain + Conduction\ heat\ gain$$

$$q'' = \left[G_i * SHGC + U(t_o - t_r)\right]$$

**Direct Rad.** **Diffuse Rad.**

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## Instantaneous heat gain due to a fenestration (Window)

**Neglecting the frame effect**

$$\dot{Q}_{SHG} = SHGC_{g,D} A_{sl,g} G_D + SHGC_{gd} A_g G_d$$

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## Solar Heat Gain due to a window - Simplified Procedure

**Including the frame effect**

$$\dot{Q}_{SHG} = \left[SHGC_{g,D} A_{sl,g} + SHGC_f A_{sl,f}\right] G_D + \left[SHGC_{gd} A_g + SHGC_f A_f\right] G_d$$

$$SHGC_f = \alpha^s{}_f \left[\frac{U_f A_f}{h_o A_{surf}}\right]$$

**Table 11.3**

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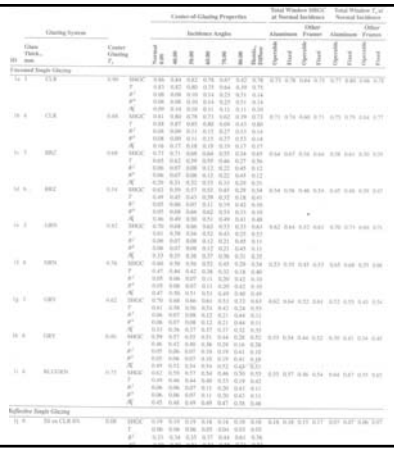
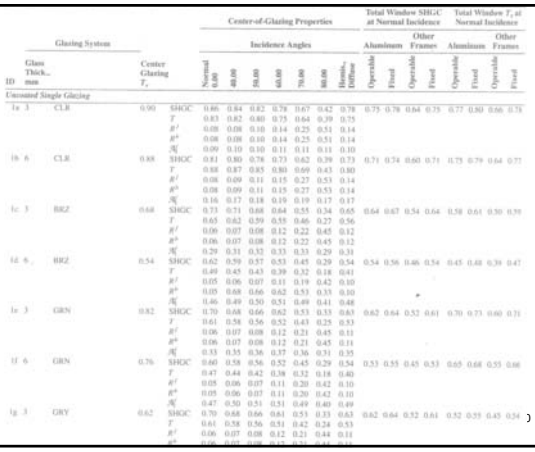
**Table 11.3**





## Solar Heat Gain Coefficient for the frame

$$SHGC_f = \alpha^s{}_f \left[\frac{U_f A_f}{h_o A_{surf}}\right]$$

$\alpha^s_f$ frame absorptivty, Table 11.4

$h_o$ Exterior heat transfer coefficient, Ch. 10

$A_f$ projected area of the frame

$A_{surf}$ actual surface area. If the window is setback from glass, $A_{surf} > A_f$

$U_f$ Frame overal heat transfer coeff. Ch. 10

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**Table 11.4 solar absorptance of some surfaces**

| Surface | Absorptance |
|---|---|
| Brick, red (Purdue)[a] | 0.63 |
| Paint, cardinal red[b] | 0.63 |
| Paint, matte black[b] | 0.94 |
| Paint, sandstone[b] | 0.50 |
| Paint, white acrylic[a] | 0.26 |
| Sheet metal, galvanized, new[a] | 0.65 |
| Sheet metal, galvanized, weathered[a] | 0.80 |
| Shingles, aspen gray[b] | 0.82 |
| Shingles, autumn brown[b] | 0.91 |
| Shingles, onyx black[b] | 0.97 |
| Shingles, generic white[b] | 0.75 |
| Concrete[a,c] | 0.60–0.83 |
| Asphalt[c] | 0.90–0.95 |
| Grassland[d] | 0.80–0.84 |
| Deciduous forest[d] | 0.80–0.85 |
| Coniferous forest[d] | 0.85–0.95 |
| Snow, fresh fallen[c] | 0.10–0.25 |
| Snow, old[c] | 0.30–0.55 |
| Water, incidence angle 30° | 0.98 |
| Water, incidence angle 60° | 0.94 |
| Water, incidence angle 70° | 0.87 |
| Water, incidence angle 85° | 0.42 |

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## Solar Heat Gain for internally shaded window Simplified Procedure

$$\dot{Q}_{SHG} = \left[SHGC_f A_{sl,f} G_D + SHGC_f A_f G_d\right] + \left[SHGC_{gD} A_{sl,g} G_D + SHGC_{gd} A_g G_d\right] IAC$$

**IAC=Interior Attenuation Coefficient**

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**Table 11.5 IAC for an internally shaded window with Venetian blinds or roller shade**

| Glazing System[a] | Nominal Thickness[b] Each Pane, in. | Glazing Solar Transmittance: Outer Pane | Glazing Solar Transmittance: Single or Inner Pane | Glazing SHGC[c] | IAC: Venetian Blinds: Medium | IAC: Venetian Blinds: Light | IAC: Roller Shades: Opaque Dark | IAC: Roller Shades: Opaque White | IAC: Roller Shades: Translucent Light |
|---|---|---|---|---|---|---|---|---|---|
| **Single Glazing Systems** | | | | | | | | | |
| Clear, residential | $\frac{1}{8}$ | | 0.87 to 0.80 | 0.86 | 0.75[d] | 0.68[d] | 0.82 | 0.40 | 0.45 |
| Clear, commercial | $\frac{1}{4}$ to $\frac{1}{2}$ | | 0.80 to 0.71 | 0.82 | | | | | |
| Clear, pattern | $\frac{1}{8}$ to $\frac{1}{4}$ | | 0.87 to 0.79 | | | | | | |
| Tinted | $\frac{1}{8}$ to $\frac{1}{4}$ | | 0.74, 0.71 | | | | | | |
| Above glazings, automated blinds[e] | | | | 0.86 | 0.64 | 0.59 | | | |
| Above glazings, tightly closed vertical blinds | | | | 0.85 | 0.30 | 0.26 | | | |
| Heat absorbing[f] | $\frac{1}{8}$ | | 0.46 | 0.59 | 0.84 | 0.78 | 0.66 | 0.44 | 0.47 |
| Reflective coated glass | | | | 0.26 to 0.52 | 0.83 | 0.75 | | | |
| **Double Glazing Systems[g]** | | | | | | | | | |
| Clear double, residential | $\frac{1}{8}$ to $\frac{1}{4}$ | 0.87 | 0.87 | 0.76 | 0.71[d] | 0.66[d] | 0.81 | 0.40 | 0.46 |
| Clear double, commercial | $\frac{1}{8}$ to $\frac{1}{4}$ | 0.80 | 0.80 | 0.70 | | | | | |
| Heat absorbing double[f] | $\frac{1}{8}$ to $\frac{1}{4}$ | 0.46 | 0.80 | 0.47 | 0.72 | 0.66 | 0.74 | 0.41 | 0.55 |
| Reflective double | | | | 0.17 to 0.35 | 0.90 | 0.86 | | | |
| **Other Glazings (Approximate)** | | | | | 0.83 | 0.77 | 0.74 | 0.45 | 0.52 |
| **Range of Variation[h]** | | | | | 0.15 | 0.17 | 0.16 | 0.21 | 0.21 |

[a]Systems listed in the same table block have the same IAC.
[b]Values or ranges given for identification or appropriate IAC value; where paired, solar transmittances and thicknesses correspond. SHGC is for unshaded glazing at normal incidence.
[c]Typical thickness for residential glass.
[d]From measurements by Van Dyke and Konen (1980) for 45 deg open Venetian blinds, 35 deg solar incidence, and 35 deg profile angle.
[e]Use these values only when operation is automated for exclusion of beam solar (as opposed to daylight maximization). Also applies to tightly closed horizontal binds.
[f]Refers to gray-, bronze-, and green-tinted heat-absorbing glass (on exterior pane in double glazing).
[g]Applies either to factory-fabricated insulating glazing units or to prime windows plus storm windows.
[h]The listed approximate IAC value may be higher or lower by this amount, due to glazing/shading interactions and variations in the shading properties (e.g., manufacturing tolerances).

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## IAC for drapery fabrics

**Fabric Index**

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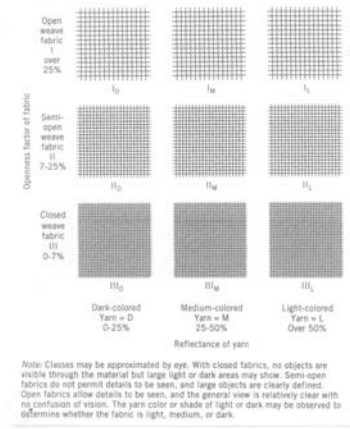


*Note:* Classes may be approximated by eye. With closed fabrics, no objects are visible through the material but large light or dark areas may show. Semi-open fabrics do not permit details to be seen, and large objects are clearly defined. Open fabrics allow details to be seen, and the general view is relatively clear with no confusion of vision. The yarn color or shade of light or dark may be observed to determine whether the fabric is light, medium, or dark.

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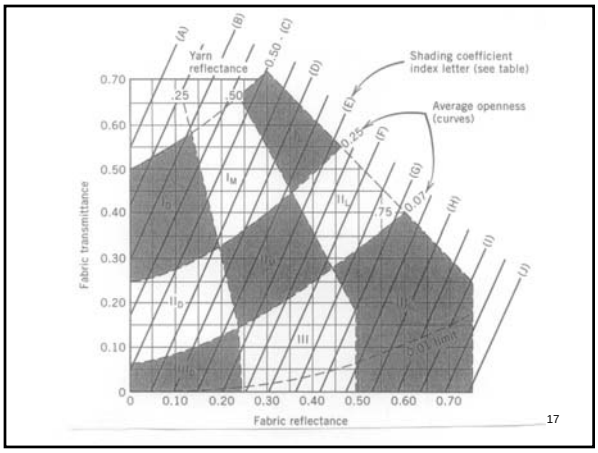


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**Table 11.6 IAC for fabric draperies**

| Glazing | Glass Transmission | Glazing SHGC (No Drapes) | IAC A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Single glass | | | | | | | | | | | | |
| $\frac{1}{8}$ in. clear | 0.86 | 0.87 | 0.87 | 0.82 | 0.74 | 0.69 | 0.64 | 0.59 | 0.53 | 0.48 | 0.42 | 0.37 |
| $\frac{1}{4}$ in. clear | 0.80 | 0.83 | 0.84 | 0.79 | 0.74 | 0.68 | 0.63 | 0.58 | 0.53 | 0.47 | 0.42 | 0.37 |
| Reflective coated | | 0.52 | 0.95 | 0.90 | 0.85 | 0.82 | 0.77 | 0.72 | 0.68 | 0.63 | 0.60 | 0.55 |
| | | 0.35 | 0.90 | 0.88 | 0.85 | 0.83 | 0.80 | 0.75 | 0.73 | 0.70 | 0.68 | 0.65 |
| Insulating glass, $\frac{1}{4}$ in. air space ($\frac{1}{8}$ in. out and $\frac{1}{8}$ in. in) | 0.76 | 0.77 | 0.84 | 0.80 | 0.73 | 0.71 | 0.64 | 0.60 | 0.54 | 0.51 | 0.43 | 0.40 |
| Insulating glass, $\frac{1}{2}$ in. air space | | | | | | | | | | | | |
| Clear out and clear in | 0.64 | 0.72 | 0.80 | 0.75 | 0.70 | 0.67 | 0.63 | 0.58 | 0.54 | 0.51 | 0.45 | 0.42 |
| Heat-absorbing out and clear in | 0.37 | 0.48 | 0.89 | 0.85 | 0.82 | 0.78 | 0.75 | 0.71 | 0.67 | 0.64 | 0.60 | 0.58 |
| Reflective coated | | 0.35 | 0.95 | 0.93 | 0.93 | 0.90 | 0.85 | 0.80 | 0.78 | 0.73 | 0.70 | 0.70 |
| | | 0.26 | 0.97 | 0.93 | 0.90 | 0.90 | 0.87 | 0.87 | 0.83 | 0.83 | 0.80 | 0.80 |
| | | 0.17 | 0.95 | 0.95 | 0.90 | 0.90 | 0.85 | 0.85 | 0.80 | 0.80 | 0.75 | 0.75 |

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