TYPE 687: NATIONAL FENESTRATION RATING COUNCIL (NFRC) WINDOW

General Description

The Type687 model calculates the amount of solar energy and illumination transmitted through a window given only the basic information available on the National Fenestration Rating Council label of any window commercially available in the United States. It takes, as input data the window's solar heat gain coefficient, overall u value and visible light transmittance.

Nomenclature

$\dot{Q}_{thermal}$	[W]	The rate of thermal energy transfer across the window
U	[W/m^2.K]	The window thermal loss coefficient
A	[m^2]	The window area
$T_{ambient}$	[º C]	Outdoor environmental temperature
T_{zone}	[º C]	Indoor zone temperature
$\dot{Q}_{solar}$	[W]	The rate of energy transfer due to solar radiation
SHGC	[-]	The solar heat gain coefficient of the window
$I_{diffuse}$	[W/m^2]	The amount of diffuse solar radiation incident on the window
I_{beam}	[W/m^2]	The amount of beam solar radiation incident on the window
θ	[degrees]	The angle of incidence of solar radiation on the window
$\dot{I}ll$	[lm]	The luminous flux (rate of illumination transfer) through the window
$\tau_{visible}$	[0..1]	The window's visible light transmittance.

Detailed Description

Input Data

According to their website "The National Fenestration Rating Council (NFRC) is a non-profit, public/private organization created by the window, door and skylight industry. It is comprised of manufacturers, suppliers, builders, architects and designers, specifiers, code officials, utilities and government agencies. The NFRC attempts to provide a consistent rating system for window, door and skylight products." These products are labeled with a set of standardized values; namely: the window's U value, transmittance to visible light, and solar heat gain coefficient.

The following definitions are given by the NFRC on their website [1].

"The U-factor measures how well a product prevents heat from escaping. The rate of heat loss is indicated in terms of the U-factor (U-value) of a window assembly. U-Factor ratings generally fall between 0.20 and 1.20. The insulating value is indicated by the R-value which is the inverse of the U-value. The lower the U-value, the greater a window's resistance to heat flow and the better its insulating value."

The "Solar Heat Gain Coefficient (SHGC) measures how well a product blocks heat caused by sunlight. The SHGC is the fraction of incident solar radiation admitted through a window, both admitted through a window, both directly transmitted, and absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits."

The "Visible Transmittance (VT) measures how much light comes through a product. The visible transmittance is an optical property that indicates the amount of visible light transmitted. VT is expressed as a number between 0 and 1. The higher the VT, the more light is transmitted."

Type 687 performs the following calculations. Its prediction of the energy gain through the window is based on Equation 687.1.

$$\dot{Q}_{thermal} = UA\left(T_{ambient} - T_{zone}\right) \qquad \text{(Eq. 687.1)}$$

Thus energy transferred from ambient to the zone (a gain or an additional cooling load) is considered to be positive.

Energy gains from solar radiation are calculated using Equation 687.2.

$$\dot{Q}_{solar} = \dot{Q}_{solar,beam} + \dot{Q}_{solar,diffuse} = SHGC * A\left(0.84 I_{diffuse} + I_{beam}\sqrt{\cos\theta}\right) \qquad \text{(Eq. 687.2)}$$

The 0.84 multiplier on the diffuse radiation term is an estimate of the decrease in SHGC based on the method of assigning an effective incidence angle to diffuse radiation and the sqrt(cos(theta)) term is an estimate of the window's transmittance absorbtance product as a function of incidence angle.

Type687 also computes transmitted illumination for daylight calculations. The luminous flux is defined as "the radiant flux evaluated in terms of a standardized visual response." [2] In other words, it is the amount of radiation in the visible portion of the spectrum passing through a given area. Luminous flux is measured in lumens and is calculated using Equation 687.3.

$$\dot{I}ll = \frac{\tau_{visible}\left(I_{beam} - I_{diffuse}\right)}{SHGC} \qquad \text{(Eq. 687.3)}$$

The luminous efficacy of the window gives an idea of how much luminous flux is obtained per unit of radiation entering the zone. A high value of luminous efficacy Luminous efficacy is computed using Equation 687.4.

$$Efficacy = \frac{\dot{I}ll}{\dot{Q}_{solar}} \qquad \text{(Eq. 687.4)}$$

Type687 also calculates the ratio of illumination from beam radiation to total illumination. The value is equal to the ratio of beam radiation to total radiation.

References

[1] National Fenestration Ratings Council Web Site:
[2] Kurt Zimmerman, Indiana University: http://www.cs.utah.edu/~kuzimmer/IES/IES.html