NEEC
NORTHWEST ENERGY EFFICIENCY COUNCIL

Solar Gain Management Fact Sheet

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WHAT IS THE PURPOSE OF THIS REQUIREMENT?

Solar energy is a free energy resource that when properly managed can be used to provide needed daylighting and heat energy in a building. Unmanaged solar heat gain introduces heat energy into a building when and where it is not needed. Solar heat gain through building fenestration is a significant contributor to the cooling load that subsequently must be managed by the building cooling systems. This in turn increases the amount of electric energy required to maintain comfort conditions in the building.

Example of Solar Shading.

There are two parts to solar heat gain:

> *Direct solar radiation from the sun (such as a beam of sunlight), and*

> *Absorbed solar radiation such as the heat transferred through the glazing and framing materials to interior spaces by conduction, convection, and radiation.*

There are two primary methods of controlling solar gain through fenestration:

> *Tinting or coating of the actual glass that blocks or re-radiates solar energy away from the building*

> *External and internal shading devices*

The National Fenestration Rating Council (NFRC) has established a method of rating the level of effectiveness of a fenestration product at reducing solar gain. This means of measurement is the Solar Heat Gain Coefficient (SHGC), which is described in their standard *NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficients at Normal Incidents.* "A simple way to explain SHGC is in terms of a ratio; where 1 is the maximum amount of solar heat gain that can come through a window at normal incidence and 0 is the least amount. A SHGC of 0.40 then means that 40% of the available solar heat is coming through the window." – *NFRC 200*

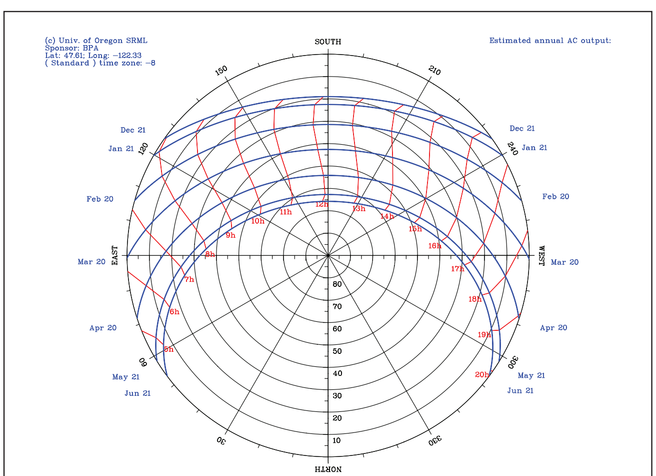
Shading devices can be a very effective way to mitigate solar gain. Exterior shading is more effective at reducing solar gains than interior shades (such as blinds) because the solar heat absorbed or deflected by the shading device is not transferred into the building. According to ASHRAE, fenestration products fully shaded from the outside reduce solar heat gain by as much as 80%[1]. Exterior shading includes roof overhangs, awnings, architectural projections, trees, vegetated trellis, etc. Shading devices attached to the building should incorporate a thermal break through the shade supports where they penetrate the building's thermal envelope.

In an integrated design, solar shading reduces solar heat gain, provides glare control for occupant visual comfort and is often a critical component to a successful daylighting system.

Example of Solar Shading.

Otherwise, the shading devices will act as a radiator and accelerate heat loss in winter.

The design of fixed solar shading should be based on site specific solar information and the orientation of glazing because the sun's position in the sky changes throughout the day and from season to season. The design should include shading size, type, location, and the most effective angle and orientation. The design should also include interactions with lighting and HVAC systems. Properly designed solar shading will minimize overheating in summer, optimize beneficial heat gains in winter to offset building heating, and minimize discomfort caused by glare. A combination of vertical and horizontal shading is more effective than just horizontal shading on the east and west facades of buildings because the sun is low in the sky early in the morning and late afternoon. One method of determining solar impact on a building site is through the use of a sun path chart. These charts plot the path of the sun as viewed from the ground (imagine lying on the ground on your back looking straight up). A sun path chart is used to determine the position (angle) of the sun in the sky relative to a point on a building. The angle of the sun is then used to calculate how much shade a particular shading device provides over fenestration.



Sample Sun Path Chart

WHAT DOES THE WSEC REQUIRE?

The Energy Code defines maximum allowable SHGC ratings for fenestration in WSEC Tables 13-1 and 13-2 Building Envelope Requirements (Climate Zones 1 and 2). If a building project is demonstrating compliance through the prescriptive path, the area-weighted average SHGC of all glazing elements shall not exceed the values in these tables. Area weighting refers to calculating the average SHGC based on the total glazing area.

Glazing elements included in these tables:

> *Vertical fenestration - Non-metal and metal framing, fixed and operable*

> *Overhead fenestration or skylights - With and without curb*

> *Entrance doors with glazing components, including roll-up doors*

SHGC ratings of fenestration elements shall be determined, certified and labeled per the NFRC 200 standard. These ratings must be provided by a certified, independent testing agency licensed by NFRC.

There are three ways to comply prescriptively:

> ***Maximum allowable SHGC equal on all four orientations***

Glazing components on all orientations shall have a rated SHGC that is equal to or lower than the specified maximum SHGC. Area weighting between glazing components is allowed with no restrictions.

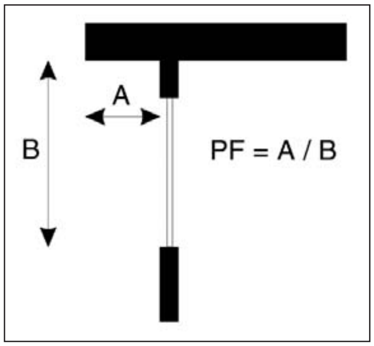
> ***Exception 2 - North orientation allowed higher SHGC than west, south and east***

North-facing glazing includes all vertical fenestration that is oriented within 45-degrees of north (N, NE, NW). This glazing is allowed to have a rated SHGC that is 0.05 greater than the specified maximum SHGC. If this exception is taken, all north facing glazing must be calculated separately from glazing on the other three orientations. Area weighting of north-facing glazing components is allowed, but north-facing glazing cannot be area-weighted with glazing on other orientations.

> ***Exception 3 - Glazing components allowed higher SHGC if provided with permanent shading devices***

Permanent shading devices are defined as permanent horizontal projections that will last as long as the building itself. If shading devices are being provided, these shaded glazing components may be allowed to have a rated SHGC that is higher than the specified maximum SHGC in WSEC Tables 13-1 and 13-2 depending on the geometry of the shading devices. This geometry is referred to as the projection factor.

Projection factor (PF) is the ratio of the horizontal depth (distance between outside edge of shading to the outside surface of the glass) of the external shading projection (Item A) divided by the sum of the height of the fenestration plus the distance from the top of the fenestration to the bottom of the farthest point of the external shading projection (Item B), in consistent units. Refer to **WSEC Figure 13B** below.



WSEC Figure 13B

To take this exception, the projection factor for the shading device is calculated and this number is then matched with the corresponding multiplier. Refer to **SHGC Multiplier Table** below. This multiplier is then applied to the rated SHGC of the glazing component that is being installed with a permanent shading device. If this resulting value is equal to or lower than the specified maximum SHGC, then this value may be used to demonstrate prescriptive compliance. Glazing components with permanent shading devices may be area-weighted with other glazing components. Area-weighting limitations for north-facing glazing still apply.

Projection Factor	SHGC Multiplier (All Orientations Except North-Oriented)	SHGC Multiplier (North-Oriented)
0 0.10	1.00	1.00
<0.10 0.20	0.91	0.95
<0.20 0.30	0.82	0.91
<0.30 0.40	0.74	0.87
<0.40 0.50	0.67	0.84
<0.50 0.60	0.61	0.81
<0.60 0.70	0.56	0.78
<0.70 0.80	0.51	0.76
<0.80 0.90	0.47	0.75
<0.90 1.00	0.44	0.73

SHGC Multiplier Table

[1] ASHRAE Handbook of Fundamentals, 2009, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, Georgia. p.15.29.

Example Projection Factor Calculation

A 6-foot tall window will be shaded by a two-foot deep horizontal shade mounted so that its bottom surface is one-foot above the top of the window. The window faces south, has an NFRC SHGC of 0.54, and the glass is recessed 0.25 feet from outside of the frame, which is flush with the building. What is the Projection Factor? Does this combination of window and shading device meet the requirements in WSEC 1323.3?

Projection Factor = (2.0 + 0.25) ÷ (6 + 1) = 0.39

Projection Factor 0.39 corresponds to a SHGC multiplier of 0.74

Therefore, the effective SHGC is 0.74 x 0.54 = 0.40, which meets the code requirement.

There is an additional exception for glazing separating conditioned space from semi-heated space or unconditioned space. Since this glazing does not communicate with the exterior there is no solar gain impact.

Interior shading devices do provide some level of solar gain management, although they are not as effective as exterior shading. Interior shades are not addressed in the WSEC.

Existing Building Glazing Alteration and Repairs

In the case of a building upgrade where glazing components are being replaced, this glazing shall comply with the U-factor and SHGC requirements of WSEC Tables 13-1 and 13-2. An exception may be taken if the SHGC rating of the replacement glazing ie equal to or lower than that of the other existing glazing (WSEC 1132.1, Exception 3).

Additional Resources

National Fenestration Rating Council (NFRC) - Solar Heat Gain and Windows Factsheet –
http://www.nfrc.org/documents/solarheatgain.pdf

Lawrence Berkeley Labs - Tips for Daylighting with Windows, Section 5, Shading Strategy –
http://windows.lbl.gov/daylighting/designguide/section5.pdf

National Institute of Building Sciences, Whole Building Design Guide - Sun Control and Shading Devices –
http://www.wbdg.org/resources/suncontrol.php

University of Oregon Solar Radiation Monitoring Laboratory – Sun Path Chart Basics –
http://solardat.uoregon.edu/AboutSunCharts.html

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Northwest Energy Efficiency Council

Resources

Several technical resources are available in support of the 2009 Washington State Non-Residential Energy Code (NREC).

Refer to the NEEC website under the Energy Codes tab – http://www.NEEC.net/energycodes
All of these resources are available for download from our website.

COMPLIANCE FORMS

NREC compliance forms have been designed as tools to help designers comply with the Energy Code, and to assist building officials, plans reviewers and inspectors with enforcement of the Energy Code. The following forms are available:

> *Building Envelope Compliance Forms*

> *Lighting Compliance Forms*

> *Energy Metering Compliance Forms*

> *Mechanical Systems Compliance Forms*

WEBINARS

Recorded webinars are available for the following topics:

> *NREC Chapter 13 – Building Envelope*

> *NREC Chapter 14 – Mechanical System*

> *NREC Chapters 12 & 15 – Lighting and Energy Metering*

> *NREC Compliance Forms Instructions*

> *Continuous Insulation*

RESIDENTIAL ENERGY CODE TECHNICAL SUPPORT

NEEC provides technical support for the Non-Residential sections of the Energy Code, which includes Multi-Family Residential buildings. For Energy Code technical support for Single-Family Residential buildings contact the Washington State University Energy Extension Office – http://www.energy.wsu.edu/BuildingEfficiency/EnergyCode.aspx

FACT SHEETS

Detailed fact sheets are available for several key topics in the NREC that provide context to Code requirements and perspective from industry experts.

> *Air Barrier Management*

> *Continuous Insulation*

> *Daylighting Controls*

> *Economizer*

> *Energy Recovery*

> *Solar Gain Management*

ADDITIONAL RESOURCES

> ***2009 NREC Technical Reference Manual –*** *This manual provides useful guidance and information for the Energy Code by various industry experts.*

> ***Classroom Training Presentation –*** *NEEC presented classroom trainings around the state that provided a summary of updates and additions to the NREC from the 2006 to the 2009 Energy Code edition. Presentation material is available.*

> ***Air Leakage Test Protocol for Measuring Air Leakage in Buildings –*** *The 2009 NREC has requirements for air pressurization/depressurization testing for some buildings. The U.S. Army Corps of Engineers has published an air leakage test protocol that may be helpful to those needing more information on this procedure.*